

Paper 21

Use of M99 Etorphine and Antagonists to Immobilize and Handle Black Bears

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INTRODUCTION

A research study of the black bear (*Ursus americanus*) in the Catskill Region of New York was initiated in 1970 by the State Department of Environmental Conservation in response to declining bear harvests and increasing human use of previously wild areas. The continuing study was designed to determine the present status of the Catskill bear population with respect to population size and dynamics, extent of occupied range, reproductive potential, and basic relationships of bears' and man's influence on bear habitat.

As part of the study, bears were live trapped and handled to obtain data on age, sex, reproductive success, physical measurements, and to mark for later identification. This paper reports the results of using the narcotic drug M99 Etorphine with its antagonists, M50-50 Diprenorphine and M285 Cryprenorphine, for immobilizing black bears during June, 1970 to May, 1974.

Earlier immobilizing techniques for black bears utilized ether, sodium pentobarbital, and succinylcholine chloride (Erickson 1957; Black 1958; Black *et al.* 1959). More recent black bear studies have used the drug phencyclidine hydrochloride (Pearson *et al.* 1968) or a combination of phencyclidine hydrochloride and promazine hydrochloride (Seal *et al.* 1970).

Because of the narcotic properties of M99, its use as an immobilizing agent has been restricted, although it has been used for polar bears (Flyger *et al.* 1967; Larsen 1971) and for other big game. Other wildlife agencies in the United States are presently employing M99 for black bear investigations (R. Ernst, M. R. Pelton, J. Raybourne, J. Rieffenberger; personal communications).

MATERIALS AND METHODS

Both culvert (or barrel) traps and Aldrich foot snares were used to capture black bears. Culverts were set at garbage landfills, homes, campgrounds or apiaries where bears had been previously observed. The procedure of culvert trapping has been described by Black (1958). During 1970, ether was used to immobilize bears captured in culvert traps (Black *et al.* 1959). Bears trapped in culverts after 1970 and all bears trapped in foot snares during the present study were processed with M99, delivered by means of carbon dioxide propelled syringe darts, fired by handgun projector (Palmer Chemical and Equipment Company, Douglasville, Georgia).

Because of a relatively low density of bears in the Catskills, trapping with foot snares has proven to be an appropriate technique (Miller *et al.* 1973). Most bears were trapped using the snare in isolated areas. Trapping success using foot snares was approximately 200 trap-nights per capture.

TABLE 1. BLACK BEARS IMMOBILIZED SUCCESSFULLY USING A SINGLE INJECTION OF M99 ETORPHINE.

Number	Share(s) or culvert(c)	Sex	Age class	Weight (kg)	Dosage (mg/kg)	Immobiliza- tion (min.)	Recovery ^{2/} (min.)	Remarks
70-14	s	M	1	39.5	.0152	11	15	
70-17	s	M	1	35.5	.0141	10	2	
71-10	s	F	6	67.0	.0180	10	2	
71-11	s	M	1	34.0	.0147	6	9	Captured in company of year- ling male Very wet; actual weight probably less
71-12	s	M	6	157.0	.0112	9	2	
73-1	c	M	2	81.0	.0154	13	3	Recapture from previous year
73-3	s	F	9	74.0	.0134	6	4	
73-1 r ^{3/}	s	M	2	(81.0)	(.0154)			
73-6	s	F	1	est.	est.	7	3	Not weighed
73-7	s	F	5	31.0	.0194	6	14	
73-8 r1	s	M	8	56.0	.0178	6	3	
73-9	s	F	7	158.0	.0110	10	4	Recapture from previous year
73-11	s	M	1	71.0	.0141	7	4	
73-18	s	M	2	29.5	.0119	6	2	
73-20	c	M	2	98.5	.0143	8	2	
				95.0	.0220	11	14	

73-21	s	M	3	103.5	.0097	9	2	Recapture, same year
73-22	c	F	7	105.0	.0134	10	2	
73-20 r1	s	M	2	94.5	.0158	10	2	
73-28	s	M	1	60.0	.0167	6	2	
73-18 r	c	M	2	(98.5) est.	(.0143)	11	1	Recapture, same year; not weighed
73-20 r2	c	M	2	92.5	.0152	8	19	Recapture, same year
73-8 r2	c	M	8	211.0	.0132	11	7	Recapture, same year
73-34	s	M	1	48.5	.0143	4	17	
73-23 r	s	M	3	153.5	.0163	20	5	Recapture, same year
73-31 r	c	M	1	64.0	.0218	12	2	Recapture, same year
73-32 r	s	M	2	104.0	.0167	14	1	Recapture, same year
74-1	c	M	11	152.0	.0125	17	4	
74-2 r1	s	M	2	66.0	.0158	9	11	Recapture from previous year
74-3	s	F	4	54.0	.0185	5	7	Recapture, same year
74-2 r2	s	M	2	73.0	.0136	7	15	
74-4	s	M	1	23.0	.0238	6	1	
74-5 r	s	M	4	105.0	.0200	11	3	Recapture from previous year
74-6	s	M	1	30.0	.0167	11	2	Wet and caked with mud
74-7	s	M	2	77.0	.0183	15	1	

1/ Bears are listed chronologically, in order of capture. First number indicates year of capture (e.g., 70 for 1970).

2/ Time, from injection of antagonist drug M285 or M50-50, to complete recovery and departure of bear from trap site.

3/ Recapture of a bear previously handled and ear-tagged.

TABLE 2. BLACK BEARS REQUIRING MORE THAN ONE INJECTION OF M99 ETORPHINE.

Number	Snare(s) or Culvert(c)	Sex	Age Class	Weight (kg)	Dosage (mg/kg)		Immobiliza- tion (min.) ^{2/}	Recovery (min.) ^{3/}	Remarks
					Initial	Total			
70-11	s	M	15	127.0	.0079	—	24	15	Ether used to complete handling
70-12	s	M	6	189.0	.0079	.0158(2) ^{4/}	41	27	Initial dose had no effect
70-13	s	F	4	52.0	.0077	—	42	20	Ropes and ether used to complete handling
70-15	s	M	3	91.0	.0110	—	24	13	Ether used to complete handling
70-16	s	M	3	88.0	.0099	—	30	3	Ether used to complete handling
70-31	s	M	12	149.0	.0051	.0152(2)	21	20	Ether used to complete handling
71-2	s	M	6	172.5	.0101	.0200(3)	113	2	Weight under-estimated
72-2 r ^{5/}	s	M	7	177.0	.0119	.0152(2)	57	22	Recapture from previous year. Weight under-estimated
73-2	c	M	12	233.5	.0055	.0268(5)	300	2	Dart pistol misfired, only partial dose received.
73-19	s	M	6	188.5	.0075	.0202(3)	62	3	Dart pistol misfired, only partial dose received.

73-23	c	M	3	158.0	.0132	.0200(3)	67	1	Initial dose made bear drowsy but not manageable, dogs barking near
73-31	c	M	1	67.0	.0209	.0262(2)	33	2	At 24 min. bear was nearly immobilized Additional .35 mg given with hand syringe. Weight initially underestimated; additional doses needed to immobilize.
73-32	c	M	2	113.5	.0123	.0242(3)	66	1	Weight initially underestimated. Bear never fully immobilized; pulled away and escaped; not weighed.
73-33	s	M	1	51.5	.0097	.0165(2)	51	5	
73-35	c	M	—	(113.5) est.	(.0154) est.	.0220(3) est.	—	—	

1/ Bears are listed chronologically in order of capture. First number indicates year of capture.

2/ Time, from injection of initial dosage of M99 to complete immobilization.

3/ Time, from injection of antagonist drug M285 or M50-50, to complete recovery and departure of bear from trap site.

4/ Parentheses denote number of doses of M99 required for immobilization in those instances when additional doses were given.

5/ Recapture of a bear previously handled and ear-tagged.

As a narcotic, the drug M99 Etorphine (American Cyanamid Company, Princeton, New Jersey) is subject to regulations of the Bureau of Narcotics and Dangerous Drugs of the United States Department of Justice. It was supplied in concentrations of 1 mg/cc distilled water. Drugs used to antagonize the effects of M99 included Cyprenorphine (M285) and Diprenorphine (M50-50) and were supplied in concentrations of 2 mg/cc. Following processing of a bear, the antagonists (M285 in 1970, M50-50 thereafter) was injected by hand syringe into the femoral vein at twice the concentration of dart-delivered M99.

Trapping was carried out from June to October in 1970, and thereafter during April, May, June, part of July and during September and October. In 1972, no major trapping effort was undertaken because of budgetary restrictions.

A bear caught in a foot snare was distracted by one crew member, while another fired the syringe dart into the upper hind leg muscles. In the case of culvert-trapped bears, the door was raised and a flashlight used to observe the bear's size. Again, one crew member attempted to draw the bear's attention towards the far side of the trap, while a second crew member fired the syringe dart through the partially raised door.

Dosages of M99 were based on an estimate of body weight. Originally, an intended dosage of .008 mg/kg body weight (.35 mg/100 lbs) was used at the manufacturer's suggestion. Subsequent field experience with the drug led to an increase in this dosage.

RESULTS

Thirty-six individual bears were immobilized and handled on 49 different occasions with M99 and its antagonists, M285 or M50-50. No cubs were trapped during this study. Foot snares accounted for the capture of 38 bears, while 11 were taken in culvert traps.

Handlings were divided into (1) those that were 'successful' in the sense that the bear became immobilized with a single dart containing M99, and (2) those that required additional doses of M99 or, in five instances, where ether was used to finally subdue the animal.

Bears 'successfully' handled with M99 are listed in Table 1. Average dosage of M99 required to successfully immobilize 34 bears with a single dart was .016 mg/kg body weight (.72 mg/100 lbs). Times for immobilization ranged from 4-20 minutes after injection and averaged 9.5 minutes. Time needed to recover from the effects of M99 after administering the antagonist ranged from less than one to 19 minutes, and averaged 5.5 minutes. Weights of bears successfully immobilized with M99 given in a single dose averaged 82.6 kg (range, 23.0-211.0 kg).

On fifteen other occasions, more than a single dose of M99 was required to complete immobilization (Table 2). One of these bears (73-35) never did become completely manageable even after receiving three separate doses of M99 within an hour. This was the only instance of failure of the drug to take effect among the 49 handlings experienced. Even in this case, the crew did manage to insert ear tags before the bear escaped into a swamp without receiving the antagonist drug.

For handlings requiring additional doses of M99, immobilization times averaged 66.5 minutes (range, 21-300 minutes). The longest handling involved the

TABLE 3. DOSAGES AND EFFECTS OF M99 ETORPHINE ON 46 WEIGHED* BLACK BEARS CAPTURED IN FOOT SNARES OR CULVERT TRAPS, BY SEX.

Type of trap	Immobilized with initial injection				Not immobilized with initial injection				Totals	
	No.	Mean wt. ±SD (kg)	Mean dosage ±SD (mg/kg)	No.	Mean wt. ±SD (kg)	Mean dosage ±SD (mg/kg)	No.	Mean wt. ±SD (kg)	Mean dosage ±SD (mg/kg)	No.
Snare										
Males	19	78.4 ± 44.3	.0153 ± .0033	9	137.1 ± 50.4	.0090 ± .0021	28	97.3 ± 53.3	.0133 ± .0042	
Females	8	58.8 ± 15.8	.0169 ± .0025	1	52.0 ± 0	.0077 ± 0	7	57.9 ± 14.7	.0156 ± .0041	
Total	25	73.7 ± 40.0	.0157 ± .0032	10	128.6 ± 54.6	.0089 ± .0020	35	89.4 ± 50.5	.0137 ± .0042	
Culvert										
Males	6	115.9 ± 55.2	.0167 ± .0042	4	143.0 ± 70.9	.0130 ± .0063	10	126.8 ± 59.7	.0152 ± .0052	
Females	1	105.0 ± 0	.0134 ± 0	0	—	—	1	105.0 ± 0	.0134 ± 0	
Total	7	114.4 ± 50.6	.0162 ± .0040	4	143.0 ± 70.9	.0130 ± .0063	11	124.8 ± 57.0	.0150 ± .0049	
Combined										
Males	25	87.4 ± 48.7	.0156 ± .0035	13	138.9 ± 54.3	.0102 ± .0041	38	105.0 ± 55.8	.0138 ± .0045	
Females	7	65.4 ± 22.6	.0164 ± .0026	1	52.0 ± 0	.0077 ± 0	8	64.1 ± 20.9	.0153 ± .0039	
Total	32	82.6 ± 45.0	.0158 ± .0033	14	132.7 ± 57.1	.0100 ± .0040	46	97.8 ± 53.7	.0140 ± .0044	

* Although 49 bears were handled with M99, weights were not obtained for three bears excluded from this table.

∇ Based on initial dosage given; multiple dosages have not been included.

largest bear captured during the study (233.5 kg). For fourteen bears for which weights were obtained, initially ineffective dosages averaged .010 mg/kg (.50 mg/100 lbs). Total dosages received, in from two to five doses, averaged .020 mg/kg (1.0 mg/100 lbs). Weights were significantly higher ($P < .01$) than for those bears successfully immobilized with single darts, averaging 132.7 kg (range, 51.5-233.5 kg). Recovery times averaged 9.7 minutes (range, 1-27 minutes), significantly ($P < .05$) greater than that for bears immobilized with single doses of M99.

For all bears handled, no statistical differences (for the 95 percent confidence level) were observed in mean dosages of M99 required by males versus females, or by bears caught in foot snares versus those taken in culvert traps. A summary of dosages and effect of M99 on bears captured, for which weights were obtained, is provided in Table 3.

The 'typical' response of bears to M99 varied somewhat depending on the dosage received. When a bear was immobilized with one dart, within five minutes after injection the animal became lethargic, its head would drop and, over the next four or five minutes, it would fall to one side losing consciousness. Some bears, particularly when underdosed (below .016 mg/kg), exhibited a brief (less than a minute) excitation period, during which the bear would paw the ground, perhaps climb a tree (if snared), and show considerable agitation. Bears that required multiple doses would become drowsy and inactive, but when approached or otherwise disturbed by noise or movement, became alert, often showing agonistic behavior.

During immobilization, breathing was very pronounced, with respiratory rates of from two to five deep breaths per minute. One bear respired at 27 breaths per minute, yet remained immobilized.

Recovery time for all bears handled was very rapid when the antagonist was injected into the femoral vein. Recovery took place in less than three minutes for 54 percent of the sample, with the bear's respiration increasing dramatically less than a minute before complete alertness returned. Occasionally, recovery was delayed, possibly because the antagonist was not injected fully into the vein.

One bear (71-12) appeared to be in respiratory difficulty when only three very deep breaths were observed over a two-minute period. A partial dose of M50-50 was administered; breathing increased and processing continued without further incident.

DISCUSSION

M99 is a thebaine derivative chemically related to morphine but perhaps 6,000 times as potent (Burkhart 1968) as an immobilizer and analgesic. The mode of action of M99 is believed to involve the quantity of acetylcholine released from postganglionic elements (Dieterich 1968). High dosages of the drug may cause a decrease in respiratory and heart rates of polar bears as well as a depression of deep body temperature due to peripheral vasodilation (Øritsland 1967). Larsen (1971) points out that these complications may prove fatal in an arctic environment and recommends administration of the antagonist immediately after handling. For these reasons, more recent studies requiring capture of polar bears have relied on phencyclidine hydrochloride.

During initial use, M99 was given in the dosage recommended by the manufacturer—a dosage of .008 mg/kg body weight (.35 mg/100 lbs). Following poor

results at this dosage and at .011 mg/kg (.50 mg/100 lbs), satisfactory results were achieved at the presently employed .016 mg/kg (.72 mg/100 lbs) base rate.

Our experiences with M99 would seem to suggest, however, that it is more efficient to give 'overdoses' initially rather than attempt to give minimum effective doses. Underdosing may cause excitation as well as a delay in the entire handling procedure. Mean effective dosage was .016 mg/kg for 34 bears handled with a single injection. Because of difficulty in estimating body weights greater than 90 kg (see Miller *et al.* 1973), it is suggested that higher dosages, from .018 to .020 mg/kg (.8-.9 mg/100 lbs), be given when bears are judged to be of large size. Four of five bears receiving as much or more than .020 mg/kg unintentionally during this study were immobilized without difficulty within ten minutes. The fifth bear actually required a second dose before he could be processed.

A major advantage of M99 over other immobilizing drugs presently in use include the ability to antagonize its effects almost immediately after processing a bear, so that the animal can be observed until safely away from the trap site. New York's experience with M99 has indicated a very wide safety margin between effective and lethal dosages. During this study, minimum effective dosage for bears immobilized with a single injection was .010 mg/kg, while a yearling male received the maximum single dosage of .024 mg/mg without any discernible harmful effects. Other biologists working with M99 report non-lethal dosages up to 2.5 times the maximum dosage used in New York (M. R. Pelton, unpublished).

Other than an observed marked decrease in breathing rate which appears typical of M99's action, no ill effects of the drug have been noted. Of 49 handlings of bears with M99, all left the trap site immediately after regaining consciousness. We had no further indications of drug relapses occurring. Sixteen were subsequently recaptured at periods of five days to fourteen months later, and another fifteen were killed by hunters from one month to 38 months after their release. Therefore, 63.3 per cent (31 of 49) of the bears handled were known to be alive at a later date. One bear (73-35) did escape before being given the antagonist drug and no record of its fate is available. An additional seventeen handlings have not yet resulted in recovery records (as of December, 1974). There appears to be no reason to relate this lack of recovery data with other than normal bear activity and a relatively low success in both the trapping and hunting of Catskill bears.

When M99 was administered at or above a dosage of .016 kg/mg in a single injection, immobilization time was rapid and the induced state of unconsciousness deep and persisting. With the injection of the antagonist, full recovery was extremely rapid. Although we have not had experience with phencyclidine hydrochloride, this drug does not appear to provide any advantages as an immobilizer for black bears over M99 and, in fact, one wildlife researcher reports mortalities due to its use (J. D. Henry, pers. comm.). M99, with its antagonists, appears to be an improvement over previous handling techniques used on black bears in New York.

ACKNOWLEDGEMENTS

Many people contributed to this investigation and their assistance is greatly appreciated. The authors are especially thankful to those Fish and Wildlife Technicians who worked on trapping crews, and to Stuart L. Free, Eugene R.

McCaffrey, William T. Hesselton and Stephen H. Clarke, who served as Project Leaders during the Catskill Bear Study. This research was partially funded by Federal Aid granted under the Pittman-Robertson Act to Big Game Project W-89-R.

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