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Immobilization of Adult Bull Bison With Etorphine¹

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Between 1967 and 1972, 66 bison (*Bison bison*) (Linnaeus) bulls, 1 cow and 1 calf were dosed with the narcotic etorphine (M-99) on open range at Fort Niobrara National Wildlife Refuge, Valentine, Nebraska and at Wind Cave National Park, Hot Springs, South Dakota. Etorphine administered at levels of 5 to 6.3 mcg/lb of body weight brought the animals to sternal recumbency. Underdosing was associated with long, difficult pursuit and considerable chance

Studies of lone bull bison movements and incidence of brucellosis in bison have required that these animals be restrained so that radio-equipped collars could be attached or blood samples could be drawn. Bison cows and younger bulls were driven to corrals for these purposes, but old bulls, which averaged 907 kg (1 ton) in weight, resisted movement to corrals. These circumstances provided opportunity to test the drug etorphine (M-99) and its antagonists for immobilizing bison on open range. Etorphine has been used successfully on a variety of African species (Harthoorn 1965) and on free-ranging moose (*Alces alces shirasi*) (Houston 1970).

The authors wish to express their appreciation to the American Cyanamid Co., Princeton, N.J., for making available experimental quantities of the drugs. W. Linkenheimer and W. Johnson of that company provided much useful help. The cooperation of personnel at Fort Niobrara National Wildlife Refuge and at Wind Cave National Park is appreciated. Former Wind Cave Park Superintendent W. Hotchkiss approved the initiation of the study at that park, and current Park Superintendent L. McClanahan and his staff provided continued cooperation.

MATERIALS AND METHODS

The animals were immobilized with the narcotic drug etorphine, a thebane derivative chemically related to morphine (Bentley and Hardy 1963). The immobilizing action of etorphine was reversed with antagonists cyprenorphine (M-285) and diprenorphine (M50-50), also thebane derivatives and narcotin in nature (Amer. Cyanamid Co. N.D. a and b).

The etorphine, cyprenorphine, and diprenorphine were received

of not apprehending the drugged animal. Adding of methotrimeprazine (Levoprome) up to 74.88 mcg/lb of body weight to the etorphine dosages for some old bulls seemed to have no noticeable effect. The efficiency of antagonists for etorphine is indicated by the fact that dosages of diprenorphine brought 71 percent of 28 bison to their feet in less than 10 minutes and all the animals in less than 20 minutes. Cyprenorphine brought 52 percent of 25 bison to their feet in less than 10 minutes, 84 percent in less than 20, and all within a period of 27 minutes.

INDEX DESCRIPTOR: Bison, bison immobilization



Fig. 1. Immobilizing equipment: a— vacuum bottle for keeping drugs cool and handy in the field; b— crossbow; c— cap-chur dart with fletched wood shaft; d— practice arrow weighted to match loaded dart; e— syringe for administering antagonist; f— rubber hose safety cover (cork in one end) for carrying darts.

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from American Cyanamid Co. To date, these drugs have been available in the United States only on an experimental basis and under a narcotic license. Drugs were kept refrigerated at all times except when loaded dart syringes were taken into the field for use that day. They were then carried in a widemouthed vacuum bottle.

After a few preliminary experiences with a CO₂-powered "Cap-Chur" gun in which change in pressure resulted in change in trajectory for loaded dart syringes, a crossbow (custom-made by Stevens Crossbows, Huntsville, Ark.) was tried with good results. The crossbow (Figure 1) had steel limbs, sights, a 140-lb. pull strength, and cast (propulsion power) approximately equal to a 70-lb longbow. Even

BISON IMMOBILIZATION

heavy 10-ml syringes attached to the crossbow arrow were delivered consistently and successfully. In immobilizing the bison on open range, the dart syringes were shot from distances of 2 to about 35 yards, from both vehicles and on foot. The dart syringes were aimed to hit in the hip but on a few occasions were aimed at the shoulder. Cap-chur syringes with impact detonators were used to effect the etorphine injections.

Antagonist doses of cyprenorphine or diprenorphine were administered to "downed" bulls with hypodermic syringes. In two instances where an animal failed to go down, a dose of cyprenorphine was delivered by a crossbow-fired dart syringe. In the early part of the study, the antagonists were injected intramuscularly; in later experiments, half the dose was injected intramuscularly and half subcutaneously.

The study was conducted on free-ranging bison, mainly old "lone" bulls, during 1967 through 1972, at Fort Niobrara National Wildlife Refuge, Nebraska and Wind Cave National Park, South Dakota. The dosages of etorphine were administered with projectile syringes (Palmer Chemical and Equipment Co., Inc.). Weights of the large bulls had to be estimated, according to previously secured weights of similar corralled bulls. Ages were based on records, horn growth and wear (McHugh 1958), and general appearance of the head as shown by the length of hair and the "bell".

All the bulls were mature animals ranging in age from 5 to over 14 years; most were 8 to 12 years old. One cow and one calf were immobilized as a means of estimating essential dosage of etorphine for handling smaller animals.

Effort was made to keep the darted animals in sight but not to follow them too closely. Almost all animals were kept in sternal recumbency, at times through force by two or three people.

RESULTS

IMMOBILIZATION. Of eight bulls dosed with etorphine at the dosage

level of 3.75 mcg/lb or less of live weight, only two went down (Figure 2). A third bull dropped to sternal recumbency; however, because of its lively condition, we decided to restrain it in this position by roping one hind foot and forcibly stretching it back, thereby preventing the bull from regaining its feet.

With dosages of etorphine from 4.25 mcg to 4.8 mcg/lb of body weight, four of six bulls were dropped for successful handling. Dosages of 5.0 to 5.9 mcg/lb successfully immobilized 19 of 20 animals, and dosages of 6.0 to 6.3 mcg/lb immobilized all of 22 animals most satisfactorily (Figure 3).

The addition of limited quantities of methotrimeprazine to 22 of the dosages of etorphine seemingly had little effect (Figure 2). Since the dart syringes available had a maximum capacity of 10 ml and the etorphine at first was available in concentrations of 1 mg/ml, and later at 2 mg/ml, only small amounts of methotrimeprazine could be added (available at 20 mg/ml). In one case, 74.9 mcg of methotrimeprazine/lb of body weight were administered along with 2.41 mcg etorphine/lb; however, the animal did not go down. In all other instances, 25 or fewer mcg of methotrimeprazine/lb were used.

Dosages of 4.2-6.3 mcg etorphine/lb of body weight immobilized 58 percent of 48 animals in 10 minutes or less; 13 animals (27 percent) went down in 10.1 to 20 minutes; 4.4 percent after 20 minutes; and 6 percent failed to go down.

Variation in time lapse for bison to collapse may be due to the location of injection by the syringe. While the main target was the hip muscle, a hit slightly forward would be injected into the flank, a high hit might place the drug diagonally just under the skin on the rump or in the root of the tail, consequently, each location might make a difference in the absorption rate of the drug. Distances also differed, and with 10 ml dart syringes, trajectory had to be considered. The use of a crossbow to deliver the dart syringes permitted an 8¼-inch arrow shaft with fletching so that the dart syringes always flew directly, needlepoint ahead, toward the animal instead of flying to the target sideways, thereby

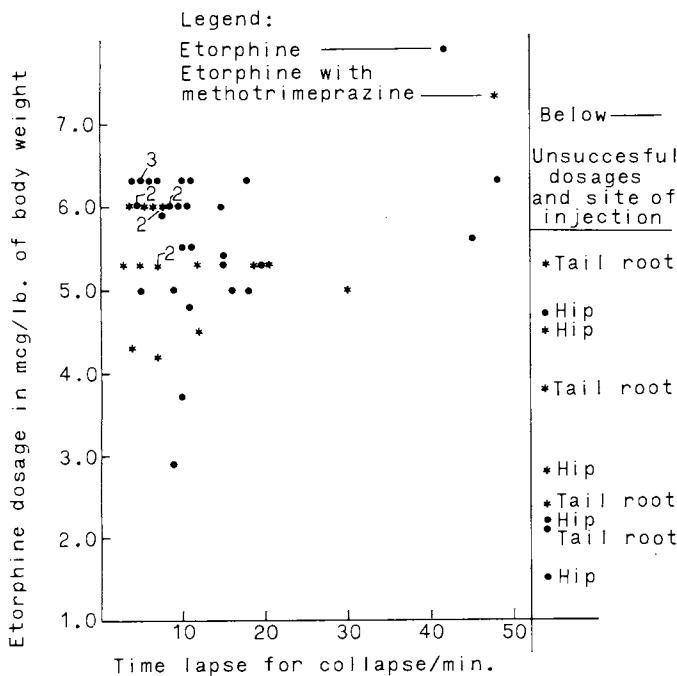


Fig. 2. Relationship of etorphine immobilization drug to time lapse for bison to collapse to reclining position.

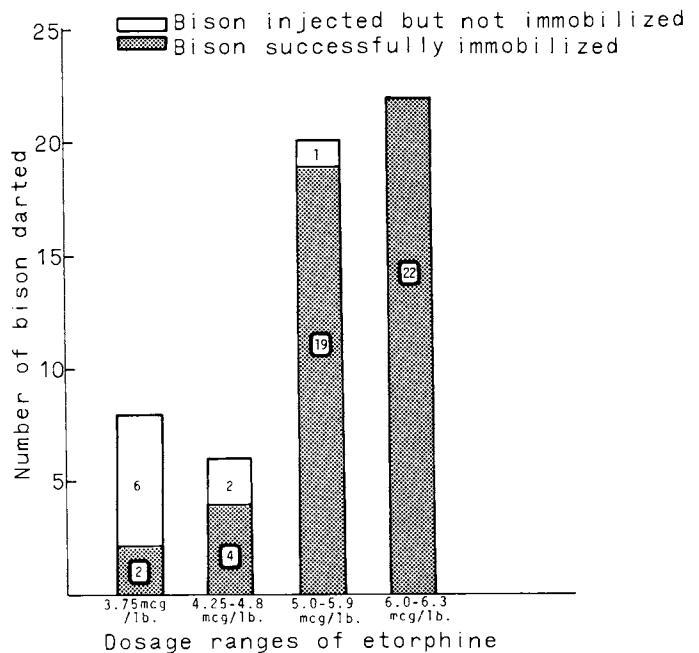


Fig. 3. Immobilization success on bison bulls at four dosage ranges of etorphine.

resulting in the dart tumbling out and away if the hit was on a sloping surface. One or two tufted dart syringes shot from a CO₂-powered projectile gun were seen to tumble off in such a way and some of the drug was sprayed into the air.

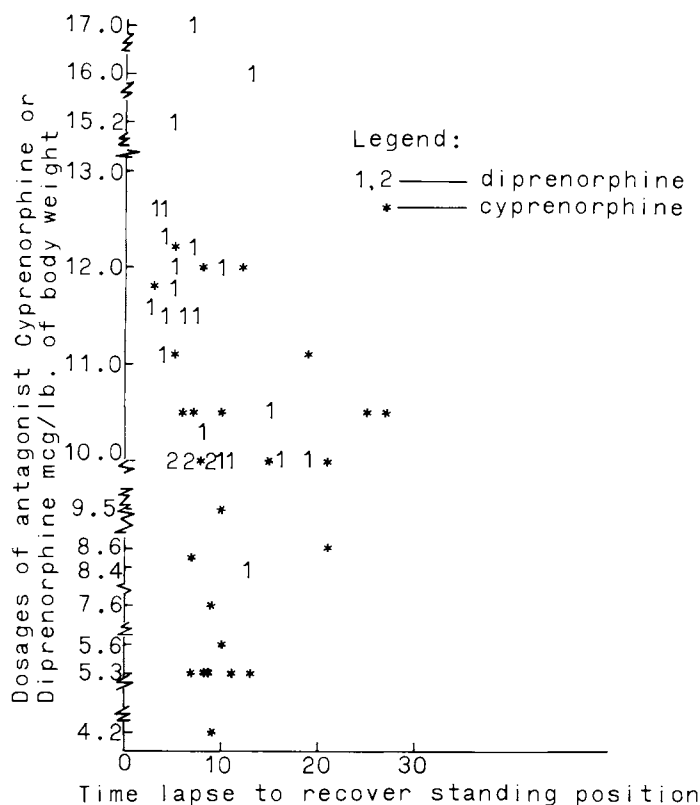


Fig. 4. Comparative relationship of antagonists cyprenorphine and diprenorphine to time lapse for bison to regain standing position after immobilization with etorphine.

REVERSAL OF NARCOSIS. Reversal of etorphine narcosis with cyprenorphine and diprenorphine occurred, as a rule, in 10 minutes or less (Fig. 4, Table 1). Diprenorphine brought 71 percent of 27 bison to their feet in less than 10 minutes, and all the animals, in less than 20 minutes. Cyprenorphine brought 52 percent of 25 bison back to their feet in less than 10 minutes, 84 percent in less than 20 minutes, and all within 27 minutes. Reversal was considered accomplished as soon as the undisturbed animal regained its standing position. As a general rule, the manufacturer's recommendation was to administer twice as many mcg of antagonist/lb of body weight as the mcg of etorphine used to immobilize the animal. For some of the animals handled in the early part of the study when cyprenorphine was used, the dosage of antagonist was administered at about the same level in mcg as the dosage of etorphine. During the breeding season, three bulls were handled in this manner. They got up as usual and trotted out of sight. Later, however, they were found dead or dying, presumably because of relapse caused by inadequate dosage (half the recommended amount) of antagonist. Thereafter, the dosage of cyprenorphine or diprenorphine was administered at approximately a 2:1 ratio with etorphine. One half was administered deep into hip muscles, and the second half

Table 1. Time lapse for bison to recover standing position following injection of antagonist to reverse etorphine narcosis.

Antagonist and dosage (mcg/lb)	Number animals	Average time (minutes)	Range of time
Cyprenorphine			
4.21-5.55	7	9.5	7-13
7.57-9.52	4	11.8	7-21
10.00-10.50	8	14.8	5½-27
11.11-11.76	3	9.0	3-19
12.00-12.02	3	8.3	5-12
	25	11.35	5.5-18.4
Diprenorphine			
10.0-10.53	12	10.0	5-18¼
11.11-11.77	6	4.8	2½-7
12-12.63	6	5.5	3-10
15.38-17.0	3	8.2	5-13
	27	7.65	4.9-12.1

was placed just under the skin by inserting the needle diagonally under the skin of the rump region. No mortality occurred in bison whose narcosis reversal was accomplished with this method of administering the antagonist.

TEMPERATURE RESPONSE TO M-99. Of the six bison dosed with etorphine which collapsed in less than 5 minutes, little or no change in rectal temperature occurred since an average of 101.7°F was found (Table 2). Normal mean temperature for bison is 102°F (Spector 1961). Eighteen bulls downed within 5 to 15 minutes showed an average temperature of 102.4°F. Animals that remained on their feet for longer periods of time, however, allowing more excitement and trotting activity, showed increased temperatures with an elevation of about 2°F in the 15-20 min. activity bracket, a 4°F rise for the 20-30 min. bracket, and 3.5°F for animals that stayed excited and active for 30 minutes and longer. Extreme elevations of 5.0, 5.1, and 6.8 were experienced by three old bulls, each of which remained active and trotting for more than 18 minutes. The animals with higher elevations, however, survived handling operations with no known deleterious effects.

Data available indicated that the way to avoid temperature elevations is to drug the animals with doses heavy enough to immobilize them quickly and thereby avoid extended periods of excitement and running. It was assumed that rapid immobilization, coupled with short periods of handling, will cause less physiological stress than those immobilizations which require extended time.

Table 2. Association of rectal temperature of bison with length of time between dosing with etorphine and collapse.

Time lapse for collapse (minutes)	Number animals	Average temperature ¹	Temperature range
3-5	6	101.7	100.0-102.8
5-10	13	102.4	101.0-104.8
10-15	5	102.4	99.0-106.0
15-20	5	103.9	103.0-107.0
20-30	2	106.0	103.2-108.8
30-up	5	105.5	104.3-107.1

¹Normal temperature 102°F (39°C) (Spector 1961).

DISCUSSION

Immobilization of bull bison with etorphine proved successful. Several behavioral responses to the drug were noted. A drugged animal could usually be identified by its actions even though the dart may have fallen out and the bull was not yet immobilized.

The first sign of drug response was usually a slight ataxia of the hindquarters. As the drugged condition increased, ataxia became more severe. The animals became excited and trotted away with a Hackney-type gait (described here as prancing with short, mincing steps and high lifted feet, giving the appearance of floating over the ground). The prancing trot became progressively more pronounced and was usually very slow and exaggerated just before the bull went down. Stumbling was frequent late in this period. Galloping was sometimes observed midway through the sequence.

Bulls drugged in herds or bull groups generally left the other animals when the drug began to take effect. Bulls frequently ran past tree trunks cracking off low branches with their humps as they passed beneath. The sound of breaking of branches often helped operators relocate drugged animals that had escaped from sight.

Thus, the depressant phase of drug response was usually preceded by an excitement phase. When dosed too lightly, the excitement phase was longer and some bulls were fatigued before they went down. Animals not greatly disturbed by the observers and/or the injection often just walked and grazed as the drug took effect. These bulls did not travel far before they became fully immobilized.

Another sign of drug response appeared in the tail about the same time as the prancing trot was exhibited. As the drug began to take effect, bulls had a tendency to hold their tails nearly horizontal. The tail was usually switching at this time. As the drugged condition increased, the tail seemed to become progressively more rigid and switching often ceased. It was still held horizontal or slightly above horizontal.

Bulls displayed a tendency to seek higher ground when coming under the influence of the drug (M-99). This was most evident in bulls that were dosed at lower levels and which stayed on their feet longer.

Some bulls, which received lighter doses and remained active longer, sweated and salivated. Furthermore, their respirations were likely to be rapid and deep (when excited) or shallow (when excited and fatigued) when finally immobilized. Wallowing and attempted wallowing by bulls with lighter doses were observed prior to and after immobilization on a few occasions.

Most immobilized bulls remained in sternal recumbency. This position is similar to the typical resting posture, with all legs to one side of the body. Many still remained alert and watched handlers even when approached slowly from behind. Two bison were able to roll onto their sides and accurately aim kicks at handlers standing near the animal's rump.

Some bulls which received heavier doses maintained a squatting-type posture when immobilized, with both front legs under the body and each hind leg stretched forward along its respective body side. These bulls remained relatively quiet throughout the handling and did not roll or fall to the side. Some which were heavily drugged exhibited depressed respiration and occasionally could not hold their heads off the ground. Unlike most other bulls, these animals sometimes exhibited

a poor eye response to hand movement or a touch near the eye.

Immobilized bulls that rolled onto their side and were unable to right themselves were, with great effort by two or three people, again rolled onto their brisket to prevent bloating. This operation involved some risk. Under no circumstances was it safe to work on the animals from the side of their feet. All operations were performed from the back side, except when it was necessary to get on both sides of the bull's head to complete the radio attachment procedures. When collars were attached, the operators worked at full arms' length to avoid strikes from the head which the immobilized animal could swing about 2 feet to either side. As a safety precaution, while near the head of the downed bison, we kept one hand on the animal's horn whenever possible. This precaution allowed the handler to be thrown clear whenever the animal swung its head to the side.

Other behavioral responses were also noted. Lacrimation by immobilized bulls frequently occurred. Eye response was usually good. In some instances, bulls' eyes appeared to be "bugged out," particularly when they were straining forward in attempts to rise. In these cases, the rectum was sometimes everted an estimated 2 inches. Belching was occasionally recorded just prior to and during actual immobilization. Tremors were observed in a number of downed bulls, appearing in any of several body areas: in the tail, base of the tail, hindquarters, shoulders, neck and head. In more severe cases, tremors continued for a few minutes after the bulls regained their feet.

After the antagonist had been injected, several bulls made several unsuccessful attempts before regaining a standing position. At first these animals characteristically appeared unsteady and usually displayed a prancing trot. This unsteadiness disappeared within a few minutes. The testes of some bulls appeared elevated in the scrotum when the animal rose, but they gradually descended. Browsing, particularly on ponderosa pine needles, was common immediately following recovery from immobilization.

Bulls were considered potentially dangerous after regaining their feet and before fully recovered from the effects of the drug.

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