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DIAZEPAM AND ALPHA-CHLORALOSE MIXTURES TO CAPTURE WATERFOWL[1,2]

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ABSTRACT

Various mixtures of diazepam and alpha-chloralose were tested on waterfowl in Florida and Maryland by oral administration on baits. A total of 3,233 waterfowl of a variety of species was anesthetized sufficiently to be captured. All mixtures which were tested reacted faster, and we believe more safely than did either of the two compounds separately. Several species were captured simultaneously at the same bait stations. Reactions to winter-spring capture versus fall capture revealed seasonal differences in physiological effects of the drugs. Local conditions may require special adaptation of the techniques in some cases.

INTRODUCTION

Animal capture techniques with oral drugs applied to bait has aroused interest among wildlife workers. The application of oral anesthetics to capture wildlife other than waterfowl has been reviewed by several writers——some of the more practical discussions are by Williams (1966) and Williams, Austin and Peoples (1966) on turkeys *(Meleagris gallopavo),* Austin and peoples (1967) on hogs *(Sus scrofa),* Martin (1967) on mourning doves *(Zenaidura macroura)* and Stafford and Williams (1968, in press) on bears *(Ursus americanus).* Alphachloralose anesthesia to capture Canada geese *(Branta canadensis)* and other water fowl species was described by Crider and McDaniel (1966), and Crider and McDaniel (1967). Capture with this compound was reported to be more effective and economical than conventional traps in situations where it was tried. However, the relatively lengthy induction period (approximately 30 minutes) has been considered a major limitation in the use of this compound.

The objectives of this study were to learn (1) if induction time could be reduced by combining a fast-acting tranquilizer with alpha-chloralose, and (2) to discover faster-acting substitutes for the latter drug. Only the work in the first phase is presented here. Progress on the second objective is discussed elsewhere in these proceedings (Crider and McDaniel, in press).

Murray and Dennett (1963) found diazepam (trade name Tranimal) to be a fast-acting tranquilizer in domestic turkeys and a variety of mammals. This prompted our initial pen tests with diazepam on mallards *(Anas platyrhynchos).*

Diazepam is a tranquilizer of the benzodiazepine class which was provided by Hoffman-LaRoche, Inc. A detailed discussion of its chemical make-up and pharmacological properties is given by Knight and Burgess (1968).

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MATERIALS AND METHODS

Source of Materials. Alpha-chloralose was obtained for about $20 a pound from the Fisher Scientific Company and the Nutritional Biochemicals Corporation. It can also be obtained from British Drug Houses Canada Ltd., Barclay Avenue, Toronto 18, Ontario. Diazepam was provided under research permit by Hoffman-LaRoche, Inc., Nutley, New Jersey.

The corn for bait, triple beam balances on which the drugs were weighted, and containers in which to mix and hold the various combinations of bait were acquired locally. An industrial vacuum cleaner and its power source, a 1,000 watt – AC, gasoline alternator, were also purchased locally as were burlap bags, dip nets, holding cages and pens and other pick-up paraphernalia.

Initial Dosages for Field Trials. Information already on hand (Crider and McDaniel, 1967) revealed that the degree of anesthesia with alpha-chloralose varied proportionately with the body weight and amount of bait ingested by an individual bird.

In pen tests, diazepam reacted similarly; therefore, this and information from previous experiences were the basis for the initial field trial of .16 g/cup (cup equals ½ liquid pint) diazepam and .16 g/cup alpha-chloralose combinations. Thereafter, results of varying combinations of these compounds were used to determine satisfactory drug to bait ratios in field trials in Maryland and Florida.

Bait Sites. On-shore locations within five to twenty-five feet of the body of water to which the birds were expected to resort after the morning feeding were selected for baiting. In one test, a bait mixture was placed under brackish, tidal water (see Results and Discussion).

Accessibility to the windward edge of the body of water to which anesthetized birds would drift improved pick-up activities on windy days.

Pre-Baiting. With few exceptions, pre-baiting was commenced far enough in advance of capture dates to allow birds to feed at the site for at least three days. Shelled, yellow corn was scattered across the bait station. Randomly scattered ear corn was sometimes used initially to attract the birds to the station. Stations were checked in the afternoon prior to the capture day to learn if the bait had been consumed; if much remained, the capture attempt was either postponed or all the bait was vacuumed or swept up. When too many birds were using the bait, diversionary baiting with ear corn dispersed some of the group away from the treated bait. On a particular capture day, surplus untreated ear corn was used to retain the group near the station until a desired number had eaten the drugged bait.

Preparing the Bait. The amount of bait to be prepared was governed by the number of geese to be caught. From one-fourth to one-half cup per bird was prepared. The bait was treated in the early evening the day before capture. Clean, shelled corn was measured in 12 to 20 cup batches and placed in a 10-gallon plastic tub. The apportionments of each drug were weighed on a triple beam balance. These compounds were stirred into ethyl alcohol at approximately 5 g per fluid once. This milky emulsion was slowly poured and thoroughly stirred into each batch of corn with a spatula. Then the tub was shaken to tumble the corn to assure a more homogeneous drug coating. The preparation was then placed in shallow containers and left at or slightly above room temperature for the alcohol to evaporate before morning.

Presenting the Bait. The bait was presented in the following manner:

1. In the afternoon preceding the capture, the station was cleared of any remaining pre-baiting corn.
2. Usually at dawn, treated bait was presented in an irregular line or scattered on the station. Occasionally, ear corn diversionary bait was presented.
3. Foreign objects, such as bait containers or pieces of paper were removed.
4. The observer retreated to the best observation point before the birds arrived.

Period of Observation. In view of the prolonged period of anesthesia, birds were permitted to remain on the station until a sufficient number became effected and voluntarily departed to nearby waters. The maximum time for this to occur was about one hour. Pick-up operations were commenced in about one hour after they had resorted to the water.

Pick-up Procedures. Small proportions of the birds were caught at the bait station. Most were captured on adjacent water or ice to which they had returned before becoming unconscious. Those that were anesthetized at the station were quietly picked up and placed in a holding cage which had been trucked to the station. Large burlap bags which could hold four geese were also used. Long-handled dip nets were used to capture lightly anesthetized birds that might have flown if they were approached too closely.

Birds which were on water when anesthesia began, held their heads up, but otherwise were incoordinated. They could be captured with a dip net either by wading or boating to them. Captures often were made when wind directions were favorable and anesthetized birds were windrowed against the windward shore where they were easily picked up.

When boats were used, they were 12 to 16 foot aluminum fishing skiffs powered by small outboard motors and ½ h.p. electric motors. Jon-type boats in choppy waters were not satisfactory because the noise they made alarmed the geese. Outboard motors were stopped approximately one hundred feet from the birds and paddles or the noiseless electric motor were used to approach more closely.

Waterfowl in Maryland resorted to sitting on the ice when fresh water ponds froze over. When the ice was not thick enough for us to walk on, captures were postponed. When anesthetized geese returned to ice of satisfactory thickness and safety, they could be easily approached and captured.

Post-capture activities. After capture activities were completed, the remaining treated bait was removed with an industrial-type vacuum cleaner powered by a gasoline AC alternator. Small quantities were usually retrieved with shovels and brooms. Bait removal was necessary to avoid the risk of grain-eating animals becoming accidentally anesthetized. The station was then rebaited with untreated bait.

Handling During Recovery. Captured birds were transported to a holding station. Anesthetized birds were easily aged, sexed and banded.

After banding, birds were held overnight and released the next morning. A few birds exhibited leg paralysis, but, if released on water, they usually recovered within an hour.

RESULTS AND DISCUSSION

Tables 1 through 4 present results of 33 different dosage combinations of diazepam and alpha-chloralose in 50 field tests in which 3,233 waterfowl of 11 species were captured. Dosage results varied according to the season of the year, wintering latitudes, size, age, fat deposition, and species.

TABLE 1
Results of tests to capture waterfowl with mixtures of diazepam and alpha-chloralose during winter periods 1966 and 1968 in Florida.

Dosages (g/cup)			*Canada Geese*		*Ducks*	
Diazepam	*Alpha-Chloralose*	*No. of Tests*	*No. Caught*	*Percent Mortality*	*No. Caught*	*Percent Mortality*
.10	.16	1			48*	0.0
.16	.16	1			16**	0.0
.16	.16	1			10***	10.0
.20	.20	2	48	6.2		
.25	.25	1	4	0.0		
.75	.16	1			29****	0.0
Totals		7	52	5.8	103	1.0

* mallards, ring-necked ducks, pekin ducks, muscovy ducks
** lesser scaup (Aythya affinis)
*** muscovy ducks
****mallards

TABLE 2
Results of tests to capture Canada geese with mixtures of diazepam and alpha-chloralose during October 1967 in Maryland.

Dosages (g/cup)		*Canada Geese*		*Mallards & Black Ducks*	
Diazepam	*Alpha-Chloralose*	*No. Caught*	*Percent Mortality*	*No. Caught*	*Percent Mortality*
.50	.25	86	17.4	1	0.0
.50	.25	12	25.0	0	
.40	.25	41	26.8	70*	30.0
.40	.25	136	28.7	0	
Totals		275	24.7	71	29.6

*includes 2 American widgeons

TABLE 3
Results of Tests to Capture Canada geese with mixtures of diazepam and alpha-chloralose during February 1968 in the Cheseapeake Bay Area.

Dosages (g/cup)			*Canada Geese*		*Mallards & Black Ducks*	
Diazepam	*Alpha-Chloralose*	*No. of Tests*	*no. Caught*	*% Dead*	*No. Caught*	*% Dead*
.30	.12	2	64	0.0	48	6.2
.30	.15	2	218	4.1*	109	6.4
.40	.15	1	154	1.3	6	83.3
Totals		5	436	2.5	163	9.2

*Many of these birds may have been both crippled and diseased.

TABLE 4

Results of tests to capture waterfowl with mixtures of diazepam and alpha-chloralose during winter-spring periods of 1967-68 in Maryland

Gms Mixture			*Canada Goose*		*Mallard and Black Duck*		*Am. Widgeon and Pintail*		*G. W. Teal*		*Coot*		*Whistling Swan*		*Total Birds Captured*		
Diazepam	*Alpha-Chloralose*	*No. of Tests*	*No. Caught*	*% Mort.*	*No. Caught*	*% Mort.*	*No. Caught*	*% Mort.*	*No. Caught*	*% Mort.*	*No. Caught*	*% Mort.*	*No. Caught*	*% Mort.*	*No. Caught*	*No. Dead*	*% Mort.*
0.05	0.15	1			1	100.00									1	1	100.0
0.12	0.12	1			16	0.0	23	4.3							39	1	2.7
0.15	0.15	1			30	3.3	6	50.0							36	4	11.1
0.25	0.18	1	14	28.6	3	66.7									17	6	35.3
0.30	0.12	2	64	0.0	48	6.2									112	3	0.5
0.35	0.12	2	21	0.0	10	10.0	15	33.3					29	13.8	75	10	13.3
0.30	0.15	2	218	2.1	109	5.4									327	8	2.4
0.40	0.12	1	68	0.0	8	0.0	5	40.0							81	2	2.5
0.40	0.13	1	110	2.7	35	17.1									145	9	6.2
0.40	0.15	1	154	1.5	6	83.3									160	6	3.8
0.50	0.05	1			93	3.2*									93	3	3.2
0.50	0.10	2	125	2.4	12	8.3	4	0.0					1	0.0	142	4	2.8
0.50	0.12	5	148	0.0	80	2.5	4	0.0			3	0.0	16	0.0	251	2	0.8
0.50	0.13	2	26	0.0	9	11.1									35	1	2.8
0.50	0.15	2	16	6.2	24	0.0									40	1	2.5
0.50	0.20	1	11	9.0	7	14.2			3	66.7	4	25.0			25	5	20.0
0.50	0.22	2	201	0.5	5	0.0									206	1	0.5
0.50	0.25	1	124	4.3	8	12.5									132	6	4.5
0.64	0.17	2	61	0.0											61	0	0.0
0.70	0.22	1	7	0.0											7	0	0.0
0.75	0.15	1			75	4.0									75	3	4.0
0.75	0.20	1	9	0.0											9	0	0.0
0.75	0.25	2	22	0.0											22	0	0.0
0.76	0.17	1	10	0.0											10	0	0.0
0.89	0.27	1	6	0.0											6	0	0.0
1.13	0.12	1			26	7.7									26	2	7.7
Totals		39	1415	1.5	605	6.4	57	19.3	3	66.7	7	14.3	46	8.7	2133	78	3.7

*Birds were in very poor condition.

Initial test. A mixture of .75 g/cup diazepam and .16 g/cup alpha-chloralose was presented to 68 tame, free-ranging mallards, ringnecked ducks *(Aythya collaris)*, moscovy ducks *(Cairina moschata)* and pekin ducks (domestic variety of mallard) on May 23, 1966, at a small pond in Gainesville, Florida. Ten cups of bait were presented on shore about two feet from the water. Some aggressive individuals became tranquil within three to five minutes after they began feeding. After all of the bait had been eaten the group walked back to the water where forty-eight ducks were later captured. An additional 20 individuals underwent varying stages of sedation but remained conscious. These initial observations provided the basis for tests in wild birds.

The next attempt to capture waterfowl with a diazepam and alpha-chloralose mixture was in Maryland on March 14, 1967 using 1.13 g/cup and .12 g/cup of the respective drugs. Twenty-six mallards were caught on a small pond. One drowned and one died of an overdose. Three more tests were run on Canada geese using .64 g/cup diazepam to 0.17 g/cup alpha-chloralose (twice) and .76 g/cup diazepam to 0.17 g/cup alpha-chloralose. These mixtures caught 45, 16 and 10 birds respectively without mortalities. Larger captures at Remington Farms, Maryland, in April 1967 totaled 354 Canada geese and 13 mallards with a mortality of six geese and one duck. At this time the best dosage tried was .50 g/cup diazepam to .22-.25 g/cup alpha-chloralose, but amounts of bait ingested may have been relatively low due to the mild weather that prevailed. Crider and Stotts (unpublished) reported these data in mimeographed form for preliminary distribution. Pertinent data from that report are included here.

Resumption of tests on Canada geese in Maryland in October 1967, using .50 g/cup diazepam to .25 g/cup alpha-chloralose (Table 2) revealed the need for a smaller dose of alpha-chloralose during this period of the year to prevent excessive mortality among immature and lean adult birds. Reduced dosage rates were tried in December, 1967 and dosage adjustments continued through March 25, 1968.

Our tests indicated that during the fall, winter and early spring in Maryland the best overall dosages were between .40-.50 g/cup diazepam to .10-.12 g/cup alpha-chloralose. Dosages within this range successfully caught whistling swans *(Olor columbianus)*, Canada geese, most puddle ducks and several diving duck species with insignificant mortality. In Florida, preliminary findings with slightly higher dosages of alpha-chloralose indicate that optimum dosages will be slightly higher farther south.

Physiological Responses. The pharmacological symptoms of different proportions of diazepam to static amounts of alpha-chloralose were obvious only in the speed of induction and duration of anesthesia. Excessive oral and nasal secretion of body fluids was noted in ducks with diazepam at or above 1.0 g/cup. Weight losses in mallards approached 50% in one experiment.

Our preliminary pen tests with mallards force-fed specific quantities of diazepam in gelation capsules showed that full anesthesia (i.e., complete unconsciousness) is impossible to achieve with diazepam up to 200 mg/kg of body weight. This indicates that alpha-chloralose is mainly responsible for the anesthetic effects. Therefore, in comparing varying amounts of diazepam with that of alpha-chloralose, we considered more the physiological influences of the later compound. But due to diazepam's rapid onset and slight central nervous system depression, dosages of alpha-chloralose found satisfactory earlier in Florida (Crider and McDaniel, 1966; and Crider and McDaniel, 1967) were reduced when these compounds were combined.

Induction Time. Diazepam at .40-.50 g/cup depressed activity and produced tranquilization in all species within 10 minutes. However, complete suppression of voluntary control appeared dependant upon the level of alpha-chloralose administered. Therefore when amounts of diazepam were determined sufficient for tranquilization within about 10 minutes, alpha-chloralose rates were increased according to the desired anesthetic condition required for safe unconsciousness.

During the first 10 to 20 minutes that birds fed on the bait, various degrees of tranquilization were evident, because not all began to feed at the same time, and some did not progress beyond mild sedation, regardless of the time they arrived at the station and began to feed.

Departure Impulse. Departure of birds from the station was drug induced in most instances. To what extent awkward movements alarmed the more conscious individuals was difficult to determine but on several occasions aggressive behavior toward staggering individuals caused segments of the groups to leave the station. Frequently, when geese began leaving, mass departure occurred. Mass departure was significantly reduced when bait stations were located near water rather than in open fields. Birds appeared to sense the onset of sleep and showed a desire to return to water where they roost at night. Birds struggling to fly to water when drugged in open fields alarmed more conscious individuals, sometimes precipitating mass departure. Conversely, partially anesthetized birds at shore-side bait sites could walk to water, where they swam normally, rarely causing suspicion and/or fright in undrugged birds. The latter either remained feeding on the site or departed to swim with the drugged individuals. Favorable winds further reduced the possibility of alarm by slowly drifting sleeping birds away from unaffected specimens. Consequently, we consider bait site selection as important as drug dosage in the efforts to increase capture success.

Overdosage. Overdose mortality only occurred when a bird, insufficiently tranquilized due to a sub-effective dose of diazepam, was able to ingest more alpha-chloralose than its system could tolerate. Death from respiratory depression resulted. Proportionately higher rates of diazepam (.40 g or more per cup) to alpha-chloralose increased the speed of induction and thus reduced the feeding time. In Maryland when rates of alpha-chloralose were decreased below .20 g/cup however, rates of diazepam were more satisfactory if reduced no less than .40 g/cup. This practice limited mortality while diazepam at this rate did not cause excessive secretion of body fluids.

The physical condition of birds played a role in physiological responses. Healthy, fat birds were not as susceptible to drug effects, probably because their fat absorbed some of the drugs and reduced central nervous system depression. The lack of fat probably contributed to mortalities in birds captured during fall migration (Table 2). Birds with less body fat due to malnutrition, disease, or gunshot wounds were likewise more prone to overdosage. In flocks containing unhealthy birds, initial dosages of .50 to .70 g/cup diazepam and less than .10 g/cup alpha-chloralose safely caught these birds prior to efforts to catch normal birds there for banding.

Other Mortalities. The range of dose rates for any one species was broad and mortality, except for birds captured in October (Table 2), was primarily a result of drowning or suffocation in burlap bags. Most drownings occurred when the investigator delayed pick-up activities too long in an attempt to allow more birds to come on the bait station or when birds scattered to locations which were difficult and time-consuming to reach.

A few deeply anesthetized birds choked when, due to complete loss of coordination, their head or neck became lodged beneath their own body or under another bird. A few drownings occurred in whistling swans for unexplained reasons.

One Canada goose under anesthesia was killed by an adult bald eagle *(Haliaeetus leucocephalus).* Vulture *(Cathartes aura)* predation has been observed. To alleviate diurnal predator problems, field men kept affected birds under observation at all times. Pickup operations were finished before sunset and captured birds were penned overnight to avoid nocturnal predation.

Seasonal and Latitudinal Dosage Adjustments. Doses of .50 g diazepam and .25 g alpha-chloralose per cup (Tables 2 and 3) suggest a difference in drug effects between fall and winter-spring captures in Canada geese and possibly other species. This result may lie in the normal fat deposition in the winter which absorbs the highly fat soluble alpha-chloralose thus reducing its pharmacological activity.

The amounts of bait ingested per bird was greater in Maryland than in Florida. Results of slightly higher amounts of alpha-chloralose to diazepam used in Florida to that in Maryland are shown in Tables 1, 3, and 4. There are insufficient data to statistically show the difference in drug reactions at different latitudes but best results were obtained in Florida from slightly increased dosage rates above the optimum for Maryland.

Dosage Variations Among Species. Our tests indicate that with any dosage Canada geese and swans were more readily anesthetized than ducks. This was probably due to more rapid oxidization of the drugs in smaller species which have higer rates of metabolism. Mallards and black ducks *(Anas rubripes)* were initially more resistant to capture than geese, but their food intake per unit of body weight was much greater, thus eventually, they reached deeper, more critical anesthesia. They also recovered more slowly than geese. With relatively higher dosages of alpha-chloralose, they occasionally required 36 to 48 hours for recovery. Other puddle ducks and all diving ducks were as readily anesthetized as geese and swans, but their recoveries were more rapid. American coot *(Fulica americana)* were more tolerant of dosages used than Anatidae.

Unless a bait site was used by only one species or by several species of similar sizes and feeding characteristics, compromise dosages were adjusted to capture the various species without undue mortality. Table 4 presents dosages on which various species were caught.

Solvents for Applying Drugs. Ethyl (grain) alcohol was a better solvent than water for applying drug on the corn. The alcohol solution coated the bait more efficiently and probably provided some drug absorption into the kernels. Bait mixtures prepared in this manner were reused successfully even after they had been rained on or presented under water. In one test, 5 whistling swans were caught on a mixture of .50 g/cup diazepam to .12 g/cup alpha-chloralose presented under brackish, tidal water. For this reason, bait was deeply buried and never discarded in a stream or lake.

CONCLUSION AND RECOMMENDATIONS

Combinations of alpha-chloralose and diazepam generally produced capture anesthesia in about one third the time required by alpha-chloralose alone. The rapid action of the diazepam led to reductions in the amounts of alpha-chloralose required to immobilize most species of waterfowl. Thus, the span between effective capture anesthesia and the lethal threshold was broadened.

When bait is prepared and presented in the manner described in this report, recommended dosages for certain species in winter-spring periods are listed in Table 5.

Because the reactions of alpha-chloralose per cup in the species listed in Table 5, progressively decreased southward and increased northward for Maryland and Florida latitudes, preliminary tests should be run at significantly different latitudes before large captures are attempted. For example, in North Carolina trial dosages of alpha-chloralose should be mid-way between those recommended for Maryland and Florida latitudes.

While results with various combinations of diazepam and alpha-chloralose compounds were favorable, there are many questions related to their uses in wildlife capture. Primary among these is whether or not diazepam will be made available for wildlife capture by Hoffman-LaRoche, Inc. if it is cleared for such use by the U.S. Food and Drug Administration. The FDA currently lists this drug as experimental in farm animals and wildlife. Even assuming it will be approved by the FDA for wildlife usage eventually, it may not be economically feasible to market it for this purpose.

Fortunately, there are many tranquilizers and anesthetics available which offer equal or better possibilities than those used thus far to capture wildlife. The effects of many such compounds are currently being studied in humans and laboratory animals. Many have already been approved by the FDA for use in human and veterinary medicine.

A recent regulation of the U. S. Bureau of Sport Fisheries and Wildlife requires a permit to capture migratory birds with drugs. Application for this permit should be made to the Bureau's Migratory Bird Population Station, Laurel, Maryland.

Other permits are required by Game and Fish Departments of certain states.

TABLE 5

Effective dosage ranges of diazepam[1] and alpha-chloralose for capturing certain species of waterfowl.

Species	*Dosage Ranges (g/cup) Alpha-chloralose*
Whistling Swan	.10 to .20
Canada Goose	.10 to .20
Muscovy Duck	.10 to .20
Black Duck	.05 to .15
Mallard	.05 to .15
Pintail	.05 to .12
American Widgeon	.05 to .12
Blue-Winged Teal	.05 to .12
Green-Winged Teal	.05 to .12
American Coot	.10 to .20
Ring-necked Duck	.10 to .15
Lesser Scaup	.10 to .15
Canvasback *(Aythya valisineria)*	.10 to .15

[1] Dosage range for diazepam in all effective tests was .40 to .60 g/cup.

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