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SECONDARY TOXICITY OF COYOTES KILLED BY 1080 SINGLE-DOSE BAITS

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ABSTRACT: Carcasses and viscera of coyotes poisoned by Compound 1080 (sodium fluoroacetate) in single-dose tallow baits (SDBs) were fed to 3 coyotes, 3 domestic dogs, 4 striped skunks, and 15 black-billed magpies to determine if these species would be poisoned secondarily. Test subjects received no food other than tissues from poisoned coyotes for periods of 14 to 35 days. Total amounts of contaminated coyote tissues consumed by dogs, coyotes, skunks, and magpies, respectively, averaged 67, 152, 117, and 371% of body weight. Except for one skunk that refused to eat, no mortalities occurred and no evidence of poisoning was seen.

The average 1080 residue in tissues fed to nontarget animals from coyotes poisoned by one to three SDBs (5 to 15 mg 1080 per coyote) was 0.29, 0.30, and 0.31 ppm in muscle (n = 15 coyotes), small intestine (n = 13), and stomach tissue (n = 8), respectively. Highest residue levels observed were 0.66 ppm in muscle, 0.79 ppm in small intestine, and 0.76 ppm in stomach tissue. These concentrations were apparently too low to cause secondary poisoning in the species tested.

INTRODUCTION

In 1981 the Fish and Wildlife Service (FWS) initiated a program of laboratory, pen, and field research to evaluate the efficiency of single-dose coyote (Canis latrans) baits (SDBs) containing Compound 1080[1/] for taking coyotes that prey on sheep, and to evaluate the hazards of SDBs to nontarget animals. Studies were conducted with Environmental Protection Agency (EPA) Experimental Use Permits. Most work has been reported to EPA by Burns et al. (1985) and the U.S. Fish and Wildlife Service (1983a, 1983b, 1985), or published in scientific journals by Okuno et al. (1982, 1984). This report describes pen studies designed to determine possible secondary nontarget hazards presented by coyotes that had ingested and died from 1080 SDBs placed near nontoxic draw stations. The carcasses of poisoned coyotes were obtained from pen studies because we anticipated that finding coyotes poisoned by 1080 SDBs in the field would be extremely difficult.

METHODS

Coyote Baiting

During January and February 1983, small (4 to 5 g) sheep-tallow SDBs containing a single lethal dose of 1080 for coyotes (5 mg) and 2 markers (100 mg rhodamine 8 and 5 mg iophenoxic acid) were placed around nontoxic draw stations (DSs) made from a sheep or deer carcass. The 5-mg dose was chosen for SDBs because it was the lowest dose that would kill all coyotes tested (Burns et al. 1985). The DS and SDBs were placed in two 15-acre pens in an arrangement that simulated baiting strategies used in field tests in Idaho and Montana (U.S. Fish and Wildlife Service 1985). Each pen contained either eight or nine coyotes with well-established dominance relationships. SDBs were buried under loose sod 55 to 60 feet in different directions from DSs and were marked with small rock piles to facilitate observations and relocating baits that were not taken by coyotes. One drop of abbreviated synthetic fermented egg (SFE) attractant (Turkowski et al. 1983) was placed about 10 to 15 cm from each SDB. On occasion some coyotes began avoiding baits, possibly because of the markers, and bait collars (designed for a different control application) were used in the tests. Bait collars were 2 x 6-inch pieces of sheep hide impregnated with sheep tallow and 10 mg of 1080. They contained no markers. Coyote behavior near DSs was observed during daylight hours, and times of bait take, 1080 symptoms, and death were recorded.

Among the main objectives of the work were to record times to symptoms and death, and to provide 1080 poisoned coyote carcasses for residue analysis and nontarget hazard assessments. The study was conducted at a predator research site of the Denver Wildlife Research Center (DWRC) near Logan, Utah. Coyotes for the study came from a captive colony kept at the site. Coyotes were fed commercial mink feed when not under test and had continuous access to water. Carcasses of poisoned coyotes were

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[1/] Compound 1080 is a trade name of Tull Chemical Co., Oxford, AL. Use of trade names does not imply endorsement by the United States Government.

examined under long-wave UV light (366 NM) for signs of the markers, and samples of muscle, stomach, and intestine were saved for 1080 residue analysis (Okuno et al. 1982, 1984).

Nontarget Hazard Tests

The coyotes killed by the SDBs were saved for later feeding to 3 coyotes, 3 dogs (*Canis familiaris*), 4 striped skunks (*Mephitis mephitis*), and 15 black-billed magpies (*Pica pica*) in order to assess the secondary hazard posed by carcasses of coyotes killed by 1080 SDBs. Coyotes came from our captive colony, dogs were obtained from a nearby animal shelter, and skunks and magpies were live-trapped within about 3 miles of the research site. Test animals were held in 3.6 m long x 1.2 m wide x 1.9 m-high pens containing a wooden den box and providing free access to water. Mammals were held one per pen, and magpies were held five per pen. The SDB-killed coyotes were skinned and eviscerated; and unless otherwise stated, test animals received viscera first followed by muscle tissue and bones. After feeding on poisoned coyotes, muscle samples from the test subjects were saved and analyzed for 1080 residue. Samples included about 100 g of hip muscle from each mammal, and the complete breast muscle and gizzard from three of the five birds held in each test pen. All samples were analyzed at the Denver Wildlife Research Center, Denver, Colorado, using recently developed technology (Okuno et al. 1982, 1984).

RESULTS

Coyote Baiting

A DS with 3 SDBs was established in pen 1 on 1/26/83. Several of the nine coyotes in the pen approached the rock piles, but no baits were taken during daylight. In the morning, three SDBs were missing and four coyotes were found dead. One coyotes probably died from eating poison vomitus or part of a bait left by another coyote. No other deaths occurred and another DS with six SDBs was established on 1/31/83. Again, no baits were taken during daylight, but during the following 2 nights five baits were taken and three coyotes were killed. Four days later one of the two coyotes remaining in this pen was found dead, and fluorescence in its gastrointestinal track indicated that it consumed a SDB. The bait had probably been cached 3 days earlier. The remaining coyote refused to take baits with markers, and was finally killed (2/16/83) by two baits without markers hidden in mink feed, the coyotes' usual maintenance diet.

In pen 2, a DS with three SDBs was set up on 1/27/83. All three SDBs were taken and three of the eight coyotes in the pen died. No more deaths occurred and another DS with six SDBs was established on 2/1/83. Overnight, five SDBs were taken and two coyotes were killed. Thereafter, three surviving coyotes avoided SDBs or the DS, so three SDBs and three bait collars were placed elsewhere in the pen with mink food scattered nearby. The coyotes each took a SDB, a bait collar, or both, and all three died.

The complete sequence from bait take to time-of-death was observed in only four coyotes, all in pen 2. Time-to-death for coyotes 2945, 2971, 2977, and 2981 was about 5 hours 13 minutes, 4 hours 3 minutes, 5 hours 6 minutes, and 4 hours 47 minutes, respectively. Average time-to-death for these four coyotes was 4 hours 48 minutes. The time from onset of symptoms to death was observed only in coyotes 2971, 2977, and 2981 that showed times of 17 minutes, 17 minutes, and 18 minutes, respectively.

During the study, 20 SDBs were placed around DSs and 16 of them were taken by coyotes resulting in 12 coyote deaths. Approximately three coyotes were killed for every four baits taken and the coyotes usually died overnight in less than 16 hours (4:00 pm to 8:00 am). The other five coyotes were killed by SDBs or bait collars placed with mink feed.

Coyotes commonly cached baits and vomitus, and they or other coyotes frequently ate the cached material. The caching behavior made it difficult to assess how much 1080 was ingested by each coyote; but based on direct coyote observation and subjective judgment of the amount of fluorescence in coyote gastrointestinal tracts, a judgment was made on 9 of the 15 coyotes showing residues. It appeared that six coyotes each took one bait (5 mg 1080), one coyote took two baits (10 mg 1080), and two others took two to three baits or a bait collar (10 to 15 mg 1080) (Table 1).

Sodium fluoroacetate residues were isolated from 15 of the 17 coyotes studied; and of the 15 showing residues, all samples except one small intestine sample showed 1080 residue (Table 1). Tissues of coyotes killed by one to three SDBs or a bait collar (total dose 5 to 15 mg 1080) showed average 1080 residues of 0.29 ppm in muscle, 0.30 ppm in small intestine, and 0.31 ppm in stomach tissue. The highest residues observed were 0.66 ppm in muscle, 0.79 ppm in small intestine, and 0.76 ppm in stomach tissue (Table 1).

Table 1. Sodium fluoroacetate (1080) residues in 15 captive coyotes that were killed with 1080 baits at Logan, Utah, 1983.

1080 consumed (mg)	Coyote no.	Sex	Weight[a] (kg)	Date of death	1080 concentrations (ppm) Muscle Rep 1/Rep 2	Muscle Mean	Small intestine[b] Rep 1/Rep 2	Small intestine[b] Mean	Stomach[b,c] Rep 1/Rep 2	Stomach[b,c] Mean
5	2617	M	13.4	2/9/83	0.10/0.14	0.12	ND/ND	ND[g]	0.20/0.20	0.20
U[f]	2657	M	12.7	1/27/83	0.07/0.08	0.08	0.18	--	0.16	--
U	2749	F	12.0	1/27/83	0.18/0.18	0.18	0.38/0.42	0.40	--	
10	2761	M	12.0	2/17/83	0.36/0.41	0.38	0.21/0.21	0.21	0.18/0.16	0.17
5	2945	M	12.6	2/4/83	0.36/0.36	0.36	0.52/0.52	0.52	--	--
5	2947	F	12.7	2/2/83	0.17/0.17	0.17	0.17/0.18	0.18	--	--
U	2949	M	12.3	1/27/83	0.38/0.41	0.40	0.13/0.16	0.14	--	--
U	2953	M	13.2	1/27/83	0.26/0.28	0.27	0.30/0.30	0.30	--	--
5	2971	M	11.4	1/27/83	0.33/0.32	0.32	0.27	--	0.78/0.74	0.76
U	2973	F	10.6	2/2/83	0.26/0.24	0.25	0.72/0.86	0.79	--	--
10 to 15	2975	F	11.0	2/2/83	0.62/0.66	0.64	0.43/0.43	0.43	--	--
5	2977	M	14.8	1/27/83	0.10	--	0.20/0.18	0.19	0.21/0.13	0.17
U	3089	F	8.2	2/1/83	0.29/0.29	0.29	--		0.54/0.48	0.51
5	3091	F	6.4	1/27/83	0.15/0.17	0.16	0.25/0.33	0.29	0.13/0.13	0.13
10 to 15	3093	M	7.0	2/1/83	0.64/0.69	0.66	--	--	0.36/0.38	0.37
Average			11.4			0.29[e]		0.30[e]		0.31[e]
Sample Size			15			15		13		8
Standard deviation			5.28			0.18		0.20		0.22

[a] Whole body weight after death.

[b] Tissues were collected only from animals for which data are shown.

[c] Stomach tissue only. Most stomachs were empty at necropsy.

[d] These animals were observed to have consumed only one SDB. Some of the other coyotes may have taken more than one.

[e] Includes single values where no mean was available. Includes a value of 0.0 for samples in which FAC was not detected.

[f] Quantity of 1080 unknown (U) and not estimated.

[g] ND = not detected. Concentration of 1080 if present, was below 0.10 ppm.

Nontarget Hazard Tests

To begin secondary hazard tests, three dogs (a hound x, terrier x, and yellow labrador x) were each offered a coyote viscera that weighed about 1.8 kg. The dogs had no other food and fed on viscera for 5 to 7 days. Subsequently, the dogs were offered one to three skinned, eviscerated carcasses (about 4 to 5 kg each), upon which they subsisted for an additional 2 weeks or more. Food intake varied (the hound consumed about three times as much as the terrier), but each dog subsisted for about 18 to 20 days on coyote viscera, flesh, and bones. The dogs weighed an average of 14.6 kg and consumed an average of about 9.5 kg of SDB-killed coyote. Only the hound ate well; the other two dogs ate lesser amounts (Table 2). At the end of the test the dogs were euthanized and a muscle sample was taken from each and analyzed for 1080 residue. No 1080 residue was found.

Table 2. Results of secondary hazard tests in which tissues of coyotes killed by Compound 1080 SDBs were fed to selected scavenger species at Logan, Utah, 1983.

Dates tests began	Animal and number	Sex	Weight[a] (kg)	Days on coyote viscera	Viscera consumed (kg)[b]	Days on skinned coyote carcass	Carcass parts consumed (kg)[b]	Days on coyote tissues[c]	Coyote tissues consumed (kg)[b]	Consumption as percent of weight
2/4	Domestic dog (n=3)									
	Hound X #6	F	21.6	4	1.8	14	13.6	18	15.4	71%
	Terrier X #7	M	6.4	6	.6	14	4.5	20	5.1	80%
	Yellow Lab X #8	M	15.7	6	1.2	14	6.8	20	8.0	51%
	Averages		14.6	5	1.2	14	8.3	19	9.5	67%
1/28	Coyote (n=3)									
	3087-88 (pup)	F	7.3	19	3.6	17	4.5	19	8.1	111%
	D-257	F	10.7	19	3.6	25	13.5	27	17.1	160%
	2567-68	F	10.2	19	5.4	25	13.5	27	18.9	185%
	Averages		9.4	19	4.2	22	10.5	24	14.7	152%
2/27	Striped skunk (n=4)									
	K-79 #1	F	1.6	0	-	7	0	7	0	0
	K-80 #8	ND[e]	3.0	11	1.8	16	1.5	16	3.3	110%
	K-78 #9	ND	3.2	15	1.8	31	2.3	31	4.1	128%
	K-79 #10	ND	2.2	27	1.4	35	1.1	35	2.5	114%
	Averages[d]		2.8	18	1.7	27	1.6	27	3.3	117%
2/18	Magpie (n=5 per cage)									
	Cage #1	ND	0.9	14	1.8	13	1.6	14	3.4	378%
	Cage #2	ND	0.9	13	1.8	14	1.6	14	3.4	378%
	Cage #3	ND	0.9	--	---	14	3.2	14	3.2	356%
	Cage #4	ND	0.9	--	---	--	---	--	---	---
	Averages		0.9	13.5	1.8	14	2.1	14	3.3	371%

[a]Weight taken at end of trial; total weight for magpies was estimated at .9 kg per cage.

[b]Coyote tissues consumed are estimates (viscera @ 1.8 kg, carcass @ 4.5 kg).

[c]Days do not always add up to total because feeding on viscera and carcasses sometimes overlapped.

[d]Averages for skunks 8,9, and 10 only.

[e]Not determined.

In another test, three coyotes (one pup, two adults) fed on coyote viscera for 3 days, but only small amounts were consumed. They were then given coyote carcasses. They fed on viscera and carcass for the next 8 days. Following this feeding period, another viscera was offered to each coyote, and 2 days later each adult was given another carcass. All three coyotes continued to feed. The pup was removed from the test because it was needed for another experiment. The pup weighed 7.3 kg and had consumed about 8.1 kg of SDB-killed coyote in 19 days. The adults remained on test for 8 more days. The adults weighed an average of 10.5 kg, and ate an average of 18.0 kg of coyote during the 27-day test (Table 2). They were euthanized and muscle samples were collected for 1080 residue analysis. No 1080 residue was found.

Four skunks (numbers 1, 8, 9, and 10) were offered carcasses- of SDB-killed coyote. Skunk 1, offered a carcass on 2/18, ate little or nothing and was found dead on 2/25; it may have been sick from time of capture. Muscle from this skunk showed no 1080 residue. The other three skunks went 5 to 7 days before they began to feed on coyote carcasses. They refused to eat viscera until later. Five to 16 days after they began to accept poisoned coyote carcasses, skunks 8, 9, and 10 fed on viscera. They averaged 2.8 kg in weight and ate an average of 3.3 kg of poisoned coyote tissue in an average of 27 days (Table 2). Muscle samples were taken from each euthanized skunk for 1080 residue analysis. No 1080 residue was found.

In the final test, 20 magpies were placed in four pens (five birds per pen) and tissue from SDB-killed coyotes was fed in three of the four pens. Viscera and one-half a carcass were offered in pens 1 and 2, and an eviscerated carcass only in pen 3. Commercial mink feed (no 1080) was offered to control birds in pen 4. The birds subsisted for 14 days on the experimental diets and showed little or no preference for muscle over viscera. Maximum possible food consumption was estimated at 3.3 kg per pen or about 48g/bird/day (Table 2). This rate is essentially the same as that previously determined for magpies on other diets (Burns et al. 1984b). Breast muscles and gizzards were taken from three magpies in each test pen for 1080 residue analysis. No 1080 residue was found.

In summary, 25 individuals of four nontarget species received no food other than tissues from SDB-poisoned coyotes for periods ranging from 14 to 35 days. Total amount of contaminated tissue consumed, expressed as a percent of species' body weights, averaged 67% for dogs, 152% for coyotes, 117% for skunks, and 371% for magpies. The 117% value for skunks excludes the skunk that died. It refused to eat coyote tissues and was not considered to have died from secondary poisoning. No test subject exhibited symptoms of 1080 poisoning or 1080 residue.

DISCUSSION

The use of 1080 SDBs for coyote control under field conditions presents potential primary hazards for animals that eat the SDBs, and potential secondary hazards for animals that scavenge carcasses of animals killed by the SDBs. This paper dealt with secondary poisoning and showed that no secondary poisoning occurred. Similar studies related to the development of the 1080 livestock-protection collar (LP collar) likewise showed no secondary poisoning to skunks and magpies (Connolly 1980, Burns et al. 1984a). The 1080 residues in coyotes killed in the LP collar tests were about the same as those found in coyotes killed by SDBs in this study. Secondary 1080 poisoning has been reported, but was experimentally produced by forcing animals to eat tissues from coyotes that received massive overdoses of 1080. In the overdose tests, one of two raccoons (*Procyon lotor*) showed symptoms after feeding on 200 g of muscle from a coyote killed with 400 mg of 1080. Muscle from a similarly dosed coyote killed three of three skunks, but not an opossum (*Didelphis marsupialis*) (TAMUS 1983).

In our test we purposely tested skunks, dogs, coyotes, and magpies because these species are quite sensitive to 1080 poisoning (Atzert 1971). None of the nontarget animals died despite challenges that were more severe than would usually occur in the field; i.e., penned animals were forced to eat nothing but contaminated coyote tissue for long time periods. Therefore, we believe it highly unlikely that coyotes killed by SDBs in the field would secondarily poison any nontarget animals.

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