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Preliminary Evaluation of Ivermectin for Control of *Psoroptes ovis* in Desert Bighorn Sheep[1,2]

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During October 1978 all of five desert bighorn sheep (*Ovis canadensis mexicana*) harvested by hunters in the San Andres National Wildlife Refuge (in south central New Mexico) had scabies lesions in their ears and/or on their bodies. Mites associated with these lesions were collected by personnel of the New Mexico Department of Game and Fish and subsequently identified as *Psoroptes ovis* (Hering) (Lange et al., 1979, J. Wildl. Dis. 16: 77–82). This was the first report of *P. ovis* from Mexican bighorn sheep in New Mexico. Representative specimens have been deposited in the Rocky Mountain Laboratory Reference Collection of Ticks and Parasitic Mites, Hamilton, Montana 59840, USA.

The herd was observed closely during 1978–1979. Although no deaths were confirmed, fewer than normal sheep were counted. During January and February of 1979, emaciated sheep were seen. Aerial surveys conducted in March and June of 1979 recorded fewer than half the numbers seen in previous surveys, confirming the suspicion that a major scabies epizootic was underway, that a high level of sheep mortality was occuring, and that emergency control measures were needed.

In November 1979 the majority of the surviving sheep were tranquilized from helicopter, and transported to a central treatment facility where they received two consecutive plunge dip treatments of 0.5% toxaphene (Cooper, Wellcome Animal Health Division, Burroughs Wellcome Co., 520 West 21st Street, Kansas City, Missouri 64108, USA) at 14 day intervals.

After treatment they were transported to the wildlife area at Red Rock, New Mexico, where they were held for return to the San Andres Refuge when it was successfully cleared of *Psoroptes* infected animals.

Considerable mortality was experienced during the capture-treatment-relocation operation. The desirability of an effective, injectable acaricide treatment that could be administered by an impact activated dart shot from a helicopter into free ranging animals, thus eliminating the need to capture animals, was obvious.

Injection of various materials, particularly tranquilizers, by remote delivery systems is widely practiced. The missing factor for control of *Psoroptes* in free ranging bighorn sheep was an effective injectable acaricide. Ivermectin (22-23 dihydroavermectin B_1) is a macrocyclic lactone that irreversibly blocks postsynaptic potentials at the neuromuscular junction (Fritz et al., 1979, Proc. Nat. Acad. Sci. U.S.A. 76: 2062–2066). It is manufactured by Merck and Co., Rahway, New Jersey 07065, USA. Ivermectin is an experimental drug and is not approved by the U.S. Food and Drug Administration for the use in food animals. It had been shown to be an effective injectable (200 μg/kg) acaricide against *P. ovis* in cattle (Barth and Sutherland, 1980, Zentralbl. Bakteriol. Parasitenkd. Infektionskr. Hyg. Abt. 1 Orig. 267: 319), but was

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[2] Mention of a pesticide does not constitute a recommendation by the state of New Mexico, nor does it imply registration under FIFRA as amended.

TABLE 1. Number of live *Psoroptes ovis* in ears[a] of desert bighorn sheep prior to and following treatment with two levels of ivermectin.

Examination interval	Untreated controls		Treated (500 μg/kg)		Treated (1,000 μg/kg)	
	Sheep 1	Sheep 2	Sheep 3	Sheep 4	Sheep 5	Sheep 6
Pretreatment	171	100	88	229	265	8
7 days post-treatment	670	157	0	0	0	0
14 days post-treatment	810	197	0	0	0	0
35 days post-treatment	300	603	0	0	—[b]	0

[a] Number of mites per 2.5 cm^2 sample taken inside the ear.

[b] No samples on this date because ewe had died. Necropsy indicated cause of death was due to cerebral hemorrhage caused probably by mechanical injury at initial capture.

believed to be ineffective against *Psoroptes* in sheep at that dosage. Subsequently, intramuscular injections of ivermectin were evaluated to determine if they possessed activity against *P. ovis* in bighorn sheep.

Six desert bighorn ewes naturally infected with *P. ovis* were supplied by the New Mexico Department of Game and Fish for this study. All were obtained from the San Andres Wildlife Refuge. These animals were fitted with individually numbered ear tags, transported to New Mexico State University, and isolated by placing two animals per pen in each of three pens. On 9 December 1979, pretreatment populations of mites were determined by taking six 2.5 cm^2 scrapings from each animal. Sample locations were the ear, poll, withers, rump, brisket and neck.

Body samples were subjected to a vacuum assisted seperation process to assure that mites, even in very low numbers, were not overlooked. The scrapings, immersed in detergent water were shaken vigorously to separate the mites from the debris, then spray agitated while being pulled by vacuum through a series of filters which left the mites and some small debris on the surface of black filter paper. After separation the samples were examined and mites counted microscopically. Ear samples, which contained very little debris were examined directly, under magnification.

Two ewes in one pen were injected with ivermectin (10 mg/ml, Lot Number L-646, 471-46B OZ) at the rate of 500 μg/kg. Two ewes in a second pen were injected at 1,000 μg/kg. The ewes in the third pen remained untreated to serve as controls.

The effectiveness of the treatments was established at 7, 14 and 35 day post-treatment intervals by determining the number of living mites in scrapings taken from the animals, as described for pretreatment counts.

All the sheep were infected with *P. ovis* at the time of the pretreatment evaluation (Table 1). Mite populations on the two control ewes increased in both ear and body locations after that time, indicating that the treatments were administered at a time when mite populations were naturally increasing on the animals.

At 7 days post-treatment no live mites were found in ear samples taken from either 500 or 1,000 μg/kg treated animals. However, live mites were found on the poll and withers on one sheep examined at this interval, suggesting that mites may not be killed as readily on body locations as in the ears. No live mites were found on either ear or body location at 14 or 35 days post-treatment on any of the treated animals. The failure to achieve complete control until after the 7 day post-treatment interval suggests that ivermectin is rather slow acting against *P. ovis* in desert bighorn sheep.

In addition to the scrapings taken from the locations indicated, the 35 day post-treatment examination included examination of the scent gland and the areas between the hooves. Additionally, the entire animal was examined to detect any areas of rough hair that are often an indication of mite activity. Suspect areas were examined with a hand lens. Live mites were found between the hooves and in the scent glands of both untreated sheep, however none were found in these locations on ivermectin-treated sheep.

Ivermectin injected intramuscularly at either 500 or 1,000 μg/kg appeared to be extremely effective and perhaps completely effective in controlling *P. ovis* in desert bighorn sheep. Further research, involving additional dosages, more animals and longer periods of evaluation is

desirable to confirm conclusively that one injection is completely effective in eliminating psoroptic mites from bighorn sheep.

The high degree of acaricidal effectiveness demonstrated indicate that injectable ivermectin has a strong potential for management of *P. ovis* infections in bighorn sheep. Of particular interest is the possibility of using aerial delivery systems that may allow efficient injection of this acaricide without the necessity of capturing the animals for treatment.

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Helminths of the Coyote (*Canis latrans* Say) in Montana[1]

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The helminth fauna of coyotes varies between regions studied (Custer and Pence, 1981, *In* Worldwide Furbearer Conf. Proceedings, Vol. II, J. A. Chapman and D. Pursley (eds.), The Worldwide Furbearer Conf., Inc., Frostburg, Maryland, pp. 730–759). Several studies (Freeman et al., 1961, Can. J. Zool. 39: 527–532; Holmes and Podesta, 1968, Can. J. Zool. 46: 1193–1204) have indicated that the helminth fauna is related to the food habits of the host in any particular region. The purpose of this study is to determine the helminth fauna of coyotes of Montana and to compare the findings with similar studies in other northern regions.

During the fall and winter of 1977–1978, 219 coyotes from Montana were collected and examined for helminths. Tongue tissue was digested in pepsin-HCl for recovery of larvae of *Trichinella spiralis* (Owen, 1835). Intestines were scraped and washed on a standard USDA No. 100 sieve for recovery of *Echinococcus multilocularis* Leuckart, 1863 and other helminths. Cestodes and trematodes were fixed in 10% buffered formalin, stained in Semichon's carmine or Delafield's hematoxylin, and mounted in Canada balsam. Nematodes were fixed in 70% ethanol, cleared in glycerine, and mounted in glycerine jelly. Representative specimens were deposited in the U.S. National Parasite Collection, Beltsville, Maryland (USNM Helm. Coll. Nos. 77188 to 77199).

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The results are presented in Table 1. Seven cestode, nine nematode, and one trematode species were found. *Taenia taxidiensis* Skinker, 1935 represents a new host record. All of the helminths except *T. spiralis* and *E. multilocularis* are new locality records.

Echinococcus multilocularis occurred in six widely separated counties in Montana, suggesting that it is enzootic throughout the state. Prevalence was highest in Gallatin County in southwestern Montana. Coyotes from west of the Continental Divide were negative for *E. multilocularis*. *Echinococcus multilocularis* has also been found in coyotes in North Dakota (Leiby et al., 1970, J. Parasitol. 56: 1141–1150) and southwestern Manitoba and Alberta (Samuel et al., 1978, Can. J. Zool. 56: 2614–2617).

Trichinella spiralis occurred in 8% of the coyotes in Montana. This was only one third of the prevalence reported by Worley et al. (1974, *In* Proc. Third Int. Conf. Trichinellosis, C. W. Kim (ed.), Intext Press, New York, pp. 597–602). This suggests that *T. spiralis* varies within a region. Prevalences of *T. spiralis* in coyotes from Alaska (Rausch et al., 1956, J. Parasitol. 42: 259–271), Iowa (Zimmermann and Hubbard, 1963, Proc. Am. Vet. Med. Assoc. 100: 194–199), and Quebec (Frechette and Panisset, 1973, Can. J. Public Health 64: 443–444) were 13%, 5%, and 1%, respectively.

The prevalence (18%) of *Taenia pisiformis* in coyotes from Montana was much less than that reported in coyotes from Manitoba (67%) (Samuel et al., 1978, op. cit.); Alberta (31%) (Holmes and Podesta, 1968, op. cit.); and Minnesota (39%) (Erickson, 1944, Amer. Midl. Nat. 32: 358–372). This suggests that the coyotes in