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Author: Foreyt, William J.

Source: Journal of Wildlife Diseases, 29(1) : 85-89

Published By: Wildlife Disease Association

URL: https://doi.org/10.7589/0090-3558-29.1.85

Journal of Wildlife Diseases, 29(1), 1993, pp. 85–89

EFFICACY OF IN-FEED FORMULATION IVERMECTIN AGAINST *PSOROPTES* SP. IN BIGHORN SHEEP

William J. Foreyt

Department of Veterinary Microbiology and Pathology, Washington State University, Pullman, Washington 99164-7040, USA

ABSTRACT: Four Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) were experimentally inoculated with *Psoroptes* sp. of bighorn sheep origin by placing approximately 50 mites into each ear. Two sheep developed reproducing mite colonies and lesions consisting of alopecia, and exudative dermatitis with scabs on ears, face and neck. Three months after inoculation, all four sheep were treated with an in-feed formulation of ivermectin at a dosage of 1 mg/kg of body weight in a pelleted ration daily for seven consecutive days. Mites could not be detected on any of the sheep 1, 2, or 3 mo after treatment, and lesions on the affected sheep resolved within 6 to 8 wk after treatment. Thus, under these conditions, ivermectin was completely effective in eliminating the mites; it also was palatable and nontoxic. Use of ivermectin in pelleted feed for field treatment of psoroptic mange is encouraged.

Key words: *Psoroptes* sp., psoroptic mange, scabies, drug trial, ivermectin, Rocky Mountain bighorn sheep, *Ovis canadensis canadensis*, experimental infestation.

INTRODUCTION

Psoroptes spp. are surface-feeding mites that cause psoroptic mange or scabies in bighorn sheep (*Ovis canadensis*). During the last decade, prevalence of *Psoroptes* sp. in bighorns has increased dramatically, and mites have been recovered from bighorn sheep in several states including Arizona, California, Idaho, New Mexico, Nevada, Oregon, Washington, and Wyoming (USA) (Boyce, 1990a; Foreyt et al., 1990; Muschenheim et al., 1990b). Sheep affected by *Psoroptes* sp. often exhibit alopecia, exfoliated epidermis and dried serous crusts. Lesions usually are most prominent on ears, face and neck, but in severe infestations, lesions are extensive on many body areas, and sheep mortality may result (Lange et al., 1980; Welsh and Bunch, 1983; Foreyt et al., 1990). Psoroptic mange of bighorn sheep is aesthetically unacceptable; it also can affect game management program objectives. Control of psoroptic mange in bighorn sheep is difficult under field conditions, but can be a management objective for herd health and bighorn transplant programs. The purpose of this experiment was to evaluate the efficacy of in-feed formulation ivermectin against experimental infestations of *Psoroptes* sp. in bighorn sheep under controlled conditions.

MATERIALS AND METHODS

Four 2-yr-old castrated male Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) were raised in captivity from birth. Estimated weight of each bighorn was 60 kg. Sheep were acclimated and maintained in an indoor pen (10 m × 10 m) with concrete floor for 2 mo before initiation of the experimental infestation. Bedding consisted of wood shavings and was changed weekly. Original source of the mites was from naturally infested wild Rocky Mountain bighorn sheep captured near Troy, Oregon (45°57′N, 117°27′W) (Foreyt et al., 1990). These wild sheep then were maintained in captivity for 6 mo before the trial began and appeared well acclimated to captivity. Mites were obtained from the ears of two donor-infested bighorn sheep by scraping the ears with a dull knife. Mites were counted using a dissecting microscope (40×) and approximately 50 live mites (larvae, nymphs, and adults) were transferred along with sloughed epithelium (scabs) manually with a gloved hand deep into the auditory canal of both ears of each recipient sheep.

The two infested donor sheep, a ewe lamb and yearling ewe, were maintained in a separate building as positive infested controls, and two uninfested bighorns, 3-yr-old castrated males, were maintained in a third building as noninfested controls.

All sheep were examined for mites a minimum of three times before mite inoculation, on the day of inoculation and at one month inter-

vals until 3 mo after treatment. Control sheep were examined at the same times as the treated sheep. For examinations, all eight sheep were restrained physically, and ears were examined for mites by gently inserting a cotton-tipped swab into the ear canal and rotating several times with firm pressure. One swab was used in each ear. Swabs and debris were withdrawn, transferred to glass vials, and all swabs and vials were examined for mites using a dissecting microscope (40×). Mites were not counted, but were recorded as present or absent.

A 6% in-feed formulation of ivermectin (Merck, Sharp and Dohme Research Laboratories, Rahway, New Jersey, USA) was obtained on an experimental basis and was mixed and formed into pellets with a ration of alfalfa (65%) and barley (35%), at the Washington State University Feed Plant, Pullman, Washington. Final concentration of ivermectin was estimated as 60 mg/kg of pelleted feed. Therefore, based on an allotment of 1 kg of medicated feed per animal per day, each treated sheep theoretically consumed 60 mg of ivermectin, or 1 mg of ivermectin per kg of body weight. Sheep were acclimated to nonmedicated feed of the same composition for the 5 mo prior to treatment; then 3 mo after mite inoculation, ivermectin-medicated feed was substituted for seven consecutive days in early May 1991. The allocated 4 kg of medicated feed was fed in the morning (0800) by dividing the medicated feed between two feed troughs, and if all medicated feed was consumed, additional nonmedicated feed of the same composition was given free choice in the afternoon. Remaining feed was removed in the afternoon (1700) to ensure the sheep were hungry each day. After the treatment period, nonmedicated feed of the same composition was fed for the 3-mo posttreatment period. Nonmedicated feed of the same composition was fed to the infested and noninfested control sheep throughout the experiment.

RESULTS

Mites were not detected in the ears of the four inoculated sheep before exposure. Two of the four sheep inoculated with *Psoroptes* sp. developed severe mite infestations and clinical mange during the 3 mo postinoculation period. Mites were not recovered from the other two inoculated sheep in the same room. The infested sheep had hundreds of mites in the ears; hair loss on the ears, face, and neck was obvious. Lesions were most severe on and in the ears, and consisted of alopecia, and serous exudation with scab formation. Concentric rings of sloughed epidermis completely filled the auditory canals of both sheep.

Medicated feed was eaten within 2 hr each day, and signs of unpalatability or drug toxicity were not observed. Based on observation, each sheep ate similar amounts of medicated feed. Mites were not recovered from any of the four treated sheep 1, 2, or 3 mo after treatment. Lesions of the two clinically affected treated sheep resolved and new hair replaced the lost hair within 6 to 8 wk after treatment.

The donor-infested control sheep retained mites and lesions throughout the experimental period, and mites were not recovered from the two unexposed, uninfested control sheep at any time. Lesions on the infested control sheep were similar to the infested treated sheep at the time of treatment, and remained throughout the experiment.

DISCUSSION

When fed in pelleted feed at an approximate dosage of 1 mg/kg of body weight for seven consecutive days, ivermectin was palatable, nontoxic, and completely effective against *Psoroptes* sp. in the two severely infested bighorn sheep. No deleterious effects associated with ivermectin were observed. Although only two infested sheep were evaluated for drug efficacy, all mites were killed and all lesions resolved. Reasons why the two other inoculated sheep remained free of mites, even though they were given mites and were maintained in the same room with the infected sheep, were not clear. However, these two treated sheep also served as additional drug safety monitors at this drug level. Although the exact amount of feed each sheep ate could not be determined, based on personal observation, each sheep ate approximately equal amounts of alloted feed per day.

Usual treatment for psoroptic mange in ruminants is a subcutaneous or intramus-

cular injection of ivermectin at dosages between 0.2 and 1.0 mg/kg of body weight (Kinzer et al., 1983; Drummond, 1985; Fink and Porras, 1989). Parenteral administration of ivermectin results in higher serum and longer residual serum concentrations, and higher efficacy against blood sucking arthropods than oral administration (Drummond, 1985; Fink and Porras, 1989). Therefore, oral ivermectin dosages should be higher than parenteral dosages to achieve high efficacy against these arthropods in ruminants.

From previous reports in bighorn sheep, single doses of ivermectin administered parenterally at dosages of 0.2 to 1.0 mg/kg of body weight do not consistently kill all mites and several treatments may be necessary for efficacious results (Kinzer et al., 1983; Muschenheim et al., 1990a; Foreyt, unpubl.). Lack of efficacy of ivermectin at 0.2 mg/kg of body weight has been noted in many other species as well (Meleney et al., 1982; Wright and Guillot, 1984a, b; Guillot et al., 1986; Garris et al., 1991; Bates and Groves, 1991). This lack of efficacy of ivermectin at 0.2 mg/kg of body weight is why I increased the concentration of ivermectin and the length of feeding time in the present experiment.

For bighorn sheep management, it is unlikely a single dose of ivermectin can achieve 100% efficacy against *Psoroptes* sp. in a herd under field conditions; some treated sheep will retain live mites for several days after treatment, resulting in potential transmission to other sheep. Any untreated sheep act as reservoirs. *Psoroptes ovis* was introduced accidentally into several bighorn populations in Oregon and Washington with mite-infested sheep captured in Idaho, treated with a single subcutaneous dose of ivermectin at 0.2 mg/kg on the day of transport, and released into a population of uninfested sheep (Foreyt et al., 1985, 1990). For sheep to be transplanted, elimination of mites before trapping and moving is more rational than treating only on the day of transport because of the potential for transmission to uninfested herds in new areas. Treatment of individual animals with injectable or topical drugs requires excessive labor, and can result in stress, capture myopathy, injury, or death to treated animals. It also is difficult to capture or treat all individual animals in an entire herd of sheep at one time. Use of a subcutaneous ivermectin implant designed to release therapeutic levels of ivermectin over time has been investigated on a limited number of bighorns (Boyce et al., 1992), and may eliminate mites from sheep populations if implants can be delivered to all sheep in the population. Long-term resistance to reinfestation with *Psoroptes* sp. did not occur when treated and cured animals were reexposed to mites 2 to 5 mo later (Guillot, 1981). Thus, it is unlikely that resistance to reinfestation occurs in bighorn sheep, and because reinfestation is possible, the elimination of all mites on a herd basis rather than an individual basis is important.

Other wildlife species, such as mule deer (*Odocoileus hemionus hemionus*) can potentially be reservoirs for *Psoroptes* sp. (Boyce et al., 1990b), further complicating eradication efforts in bighorn sheep. In my laboratory, four uninfested mule deer fawns placed on common pasture with infested bighorns developed reproducing colonies of *Psoroptes* sp. in their ears only, and the mites were retained for several months after acquisition, indicating their potential reservoir status for transmission (Foreyt, unpubl.) The role of other wildlife and domestic species in the epizootiology of *Psoroptes* sp. has not been investigated thoroughly (Wright et al., 1981), but it is likely that *Psoroptes* sp. from bighorn sheep can survive on several sympatric hosts (Boyce and Brown, 1991).

One pragmatic approach to treating wild bighorn sheep with psoroptic mange is to incorporate therapeutic concentrations of an efficacious drug in a feed that is readily eaten. Based on the results of this experi-

ment, one may achieve complete elimination of *Psoroptes* sp. with in-feed formulation ivermectin. With a pelleted medicated ration, the drug cannot separate from the feed by settling, rain, wind, or avoidance by selective sheep. Calculation of drug intake is based on total consumption of supplemental feed by animals in the herd. In field situations, efficacy of drugs fed orally will be contingent on palatability, amount of drug eaten, length of time the medicated ration is consumed, and sufficient consumption by all animals in the herd. Supplemental feed medicated with ivermectin also could be used to potentially reduce *Psoroptes* sp. infestation in ruminant reservoir hosts, thereby minimizing cross-transmission to bighorn sheep in sympatric populations. Oral ivermectin, as used in this study, appeared to be efficacious against *Psoroptes* sp. by resulting in adequate, sustained bioavailability in plasma to kill all feeding mites, and the larval mites that hatch after treatment. Ivermectin also is effective against a broad spectrum of arthropods and internal nematodes; thus, strategic use of ivermectin in feed as part of a comprehensive management plan could potentially improve overall herd health, reproductive rates and survival of bighorn populations, especially in areas where parasites significantly affect population growth. Similar trials with larger numbers of naturally infested sheep must be conducted to verify results obtained from the experimental sheep before final conclusions and recommendations can be made.

Representative specimens of *Psoroptes* sp. were deposited in the U.S. National Museum Parasite Collection, Beltsville, Maryland 20705, as Number 82194.

ACKNOWLEDGMENTS

The author thanks Ernie Smith, Pete Johnson, and John Lagerquist for their skillful animal handling, V. Coggins, P. Matthews, L. Marks, and W. Van Dyke for their assistance capturing wild infested bighorns, and C. Leathers for providing helpful review comments. Merck, Sharp and Dohme Research Laboratories supplied the ivermectin for this investigation. The Oregon Department of Fish and Game provided partial support for this project.

LITERATURE CITED

BATES, P. G., AND B. A. GROVES. 1991. Failure of a single treatment with ivermectin to control sheep scab (*Psoroptes ovis*) on artificially infested sheep. The Veterinary Record 128: 250–253.

BOYCE, W. M., AND R. N. BROWN. 1991. Antigenic characterization of *Psoroptes* spp. (Acari: Psoroptidae) mites from different hosts. The Journal of Parasitology 77: 675–679.

———, R. K. CLARK, AND D. A. JESSUP. 1990a. Recent advances in the diagnosis and treatment of psoroptic scabies in bighorn sheep. Biennial Symposium of the Northern Wild Sheep and Goat Council 7: 125–128.

———, L. ELLIOTT, R. CLARK, AND D. JESSUP. 1990b. Morphometric analysis of *Psoroptes* spp. mites from bighorn sheep, mule deer, cattle, and rabbits. The Journal of Parasitology 76: 823–828.

———, J. A. MILLER, D. A. JESSUP, AND R. K. CLARK. 1992. Treatment of psoroptic scabies in free-ranging bighorn sheep with ivermectin implants. Journal of Zoo and Wildlife Medicine 23: In press.

DRUMMOND, R. O. 1985. Effectiveness of ivermectin for control of arthropod pests of livestock. Southwestern Entomologist 7(Supplement): 34–42.

FINK, D. W., AND A. G. PORRAS. 1989. Pharmacokinetics of ivermectin in animals and humans. *In* Ivermectin and avermectin, W. C. Campbell (ed.). Springer-Verlag, New York, New York, pp. 113–130.

FOREYT, W. J., V. COGGINS, AND T. PARKER. 1985. *Psoroptes ovis* (Acarina: Psoroptidae) in a Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) in Idaho. Journal of Wildlife Diseases 21: 456–457.

———, ———, AND P. FOWLER. 1990. Psoroptic scabies in bighorn sheep in Washington and Oregon. Biennial Symposium of the Northern Wild Sheep and Goat Council 7: 135–142.

GARRIS, G. I., J. B. PRULLAGE, J. L. PRULLAGE, F. C. WRIGHT, AND J. A. MILLER. 1991. Control of *Psoroptes cuniculi* in captive white-tailed deer with ivermectin-treated corn. Journal of Wildlife Diseases 27: 254–257.

GUILLOT, F. S. 1981. Susceptibility of Hereford cattle to sheep scab mites after recovery from psoroptic scabies. Journal of Economic Entomology 74: 653–657.

———, F. C. WRIGHT, AND D. OEHLER. 1986. Concentration of ivermectin in bovine serum and its effect on the fecundity of psoroptic mange mites. American Journal of Veterinary Research 47: 525–527.

KINZER, H. G., W. P. MELENEY, R. E. LANGE, JR., AND W. E. HOUGHTON. 1983. Preliminary evaluation of ivermectin for control of *Psoroptes ovis* in bighorn sheep. Journal of Wildlife Diseases 19: 52–54.

LANGE, R. E., A. V. SANDOVAL, AND W. P. MELENEY. 1980. Psoroptic scabies in bighorn sheep (*Ovis canadensis mexicana*) in New Mexico. Journal of Wildlife Diseases 16: 77–82.

MELENEY, W. P., F. C. WRIGHT, AND F. S. GUILLOT. 1982. Residual protection against cattle scabies afforded by ivermectin. American Journal of Veterinary Research 43: 1767–1769.

MUSCHENHEIM, A. L., D. R. KWIATKOWSKI, AND E. T. THORNE. 1990a. Ivermectin for treatment of psoroptic scabies in Rocky Mountain bighorn sheep. Biennial Symposium of the Northern Wild Sheep and Goat Council 7: 129–134.

———, E. T. THORNE, E. S. WILLIAMS, S. H. ANDERSON, AND F. C. WRIGHT. 1990b. Psoroptic scabies in Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) from Wyoming. Journal of Wildlife Diseases 26: 554–557.

WELSH, G. M., AND T. D. BUNCH. 1983. Psoroptic scabies in desert bighorn sheep (*Ovis canadensis nelsoni*) from northwestern Arizona. Journal of Wildlife Diseases 19: 342–344.

WRIGHT, F. D., AND F. S. GUILLOT. 1984a. Effect of ivermectin in heifers on mortality and egg production of *Psoroptes ovis*. American Journal of Veterinary Research 45: 2132–2134.

———, AND ———. 1984b. Infestation potential of *Psoroptes ovis* (Hering) from cattle injected with ivermectin. American Journal of Veterinary Research 45: 228–229.

———, ———, AND W. P. MELENEY. 1981. Transmission of psoroptic mites from bighorn sheep (*Ovis canadensis mexicana*) to domestic sheep, cattle and rabbits. Journal of Wildlife Diseases 17: 381–386.

Received for publication 20 December 1991.