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Use of Fenbendazole for Long-term Control of Protostrongylid Lungworms in Free-ranging Rocky Mountain Bighorn Sheep

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ABSTRACT: In an effort to control *Protostrongylus* spp. in a Rocky Mountain bighorn sheep herd (*Ovis canadensis canadensis*) of approximately 30 animals, fenbendazole-medicated salt was placed on the Stillwater bighorn winter range in southcentral Montana (USA) for four consecutive winters, 1990 to 1993. Sheep of all age and sex classes were observed using the medicated salt throughout the study period. Prevalence and average number of lungworm larvae per gram of bighorn feces declined significantly ($P < 0.05$) from pretreatment levels (1987 to 1989), and remained low throughout the study period. Free-choice availability of fenbendazole-medicated salt is a potentially effective management tool for long-term control of protostrongylid lungworm.

Key words: Anthelmintic, fenbendazole, lungworms, *Protostrongylus* spp., Rocky Mountain bighorn sheep, *Ovis canadensis canadensis*.

A gradual decline in populations of Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) in North America has often been attributed to a lungworm-pneumonia disease complex, and the role of lungworms (*Protostrongylus* spp.) as a contributor to pneumonia has been recognized for many years (Forrester, 1971). Recent studies have led to the discovery of several pathogens involved in this disease complex; however, protostrongylid lungworms may be a significant predisposing or stress factor in many cases (Spraker et al., 1984; Foreyt et al., 1990).

Although the exact role of the pathogens involved have not been established, lungworms are probably the easiest to manage in free-ranging bighorn populations. Since repetitious patterns of habitat use result in constant re-exposure to lungworms, potential management techniques for controlling lungworms include controlling population levels or assuring that herds remain migratory (Hibler et al., 1982; Huschle and Worley, 1986). However, current conditions of land use and degradation by humans result in range restriction and sometimes loss of migration routes. Therefore, a parasite control program using anthelmintic drugs may benefit some bighorn populations.

Many types of anthelmintic drugs have been tested for use against lungworms in bighorn sheep; however, three compounds have received the most attention from researchers: ivermectin, cambendazole, and fenbendazole. All three drugs have limited long-term efficacy when given in single or multiple doses (Easterly et al., 1992). Injectable ivermectin presents a logistical problem, requiring capture and handling; cambendazole has problems with potential toxicity (Miller et al., 1987). Fenbendazole, recently approved by the U.S. Food and Drug Administration for use in Rocky Mountain bighorn sheep (Federal Register, 1994), is highly efficacious against adult *Protostrongylus* spp. on a short-term basis; is non-toxic to pregnant ewes or lambs, even in extreme doses; and is palatable to sheep when incorporated into salt or a pelleted feed (Huschle and Worley, 1986; Foreyt et al., 1990). Our objective was to attempt to control *Protostrongylus* spp. in a free-ranging Rocky Mountain bighorn herd in Montana (USA) through long-term use of fenbendazole in salt.

The Stillwater bighorn herd (winter range: 45°22′N, 109°53′W) in Montana, contained approximately 30 sheep during the study period from 1987 to 1993. Since the herd was small, it was possible to identify many individual sheep and record their usage of medicated salt. Fenbendazole-medicated salt (0.5%, Safe-Guard®,

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Hoechst-Roussel Agri-Vet, Somerville, New Jersey, USA) was placed on the Stillwater bighorn winter range for four consecutive winters, from February 1990 until April 1993. Apple pulp was used as an attractant during the first two winters of the study. The same salt location was used consistently throughout the study, placed in a frequently used foraging area. Two more stations were added in the winter of 1991 to 1992, and were also used throughout the rest of the study. Salt stations were simply shallow depressions in the ground, into which medicated loose salt was poured. Stations were restocked as needed to maintain medication availability during the entire period of winter range use by sheep.

Bighorn fecal pellets were collected from feeding and bedding areas on the winter range from December 1987 through April 1993. Pellets estimated to be older than a few weeks were not collected. Pellets were refrigerated at 4 C before examination. The Baermann technique (Baermann, 1917) was used to extract larvae from 5-g samples (1987 to 1991) and 7-g samples (1991 to 1993) of feces from each pellet group. We collected 325 pellet group samples during the study period. Larvae were counted directly under a 25× dissecting scope, and results were expressed as first-stage larvae per gram (LPG) of feces. The prevalence data were analyzed with a student's *t*-test (SAS Institute, 1990) and the intensity data were analyzed using a chi-square test (Lund, 1992). We used data from the same herd prior to medication availability as a control to determine the effect of the fenbendazole.

Sheep were first observed using the medicated salt in August 1990, and sheep of all age and sex classes used the salt each subsequent winter. Individual consumption rates varied, as some individuals were seen consuming salt several times a week for multiple weeks, while others were only recorded using the salt once or twice during the winter. Generally, ewes and lambs

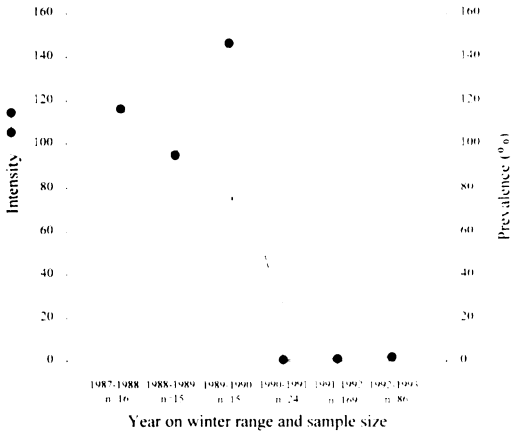


FIGURE 1. Prevalence and intensity of *Protostrongylus* spp. larvae in feces of Stillwater bighorn sheep, 1987 to 1993. Arrow indicates initiation of the free-choice fenbendazole-medicated salt program on the winter range.

used the salt most consistently while older rams were sometimes not recorded on the winter range for weeks at a time. Based on studies of penned bighorn, intake of fenbendazole incorporated into a pelleted feed may vary widely, taking from 1 to 30 hr to consume one dose (5 to 10 mg/kg) (Huschle and Worley, 1986; Foreyt et al., 1990). In a separate study using penned bighorn sheep, consumption of nonmedicated salt by mature ewes averaged 25.5 g/animal/day over 14 days (D. E. Worley, unpubl).

The prevalence and mean LPG of *Protostrongylus* spp. in bighorn feces declined significantly from pretreatment winters (1987 to 1990) to treatment winters (1990 to 1993) (chi-square = 93.99, $P < 0.01$; $t = 7.88$, $P = 0.016$; respectively) (Fig. 1). Additionally, the maximum LPG in pretreatment years was 1540, compared to 12.7 during treatment years. No animals observed consuming the medicated salt were known to have suffered toxic effects. One ram that died of unknown causes contained no lungworms upon necropsy.

Pneumonia in bighorn sheep is a multipathogen disease complex that limits bighorn populations. However, lack of information concerning the involved pathogens

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other than lungworm limit management response to this disease. Therefore, in an attempt to maintain bighorn populations in North America, anthelmintic programs may be used to control lungworm infection. Although others have clearly demonstrated the short-term benefits of fenbendazole for bighorn sheep (Foreyt et al., 1990), we found that this drug may be used safely and efficiently for long-term control of *Protostrongylus* spp. in bighorn sheep. The free-choice salt program used for the Stillwater herd required little time to administer, and was relatively stress-free for the sheep. Because of the safety and efficacy of fenbendazole, managers should consider using free-choice fenbendazole programs, reducing the level of lungworms present in bighorns herds. By controlling lungworm numbers, pneumonia epizootics may be reduced in frequency or intensity in free-ranging Rocky Mountain bighorn sheep.

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