TREATMENT FOR LUNGWORMS (*PROTOSTRONGYLUS* SPP.) IN ROCKY MOUNTAIN BIGHORN SHEEP (*OVIS C. CANADENIS*) WITH ALBENDAZOLE

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ABSTRACT

Eight rocky mountain bighorn sheep (*o. c. canadensis*) were transported from Wildhorse Island, Montana to Twisp, Washington in January, 1979. The two rams and six ewes were administered *Clostridium* vaccine, selenium, Vitamin E, long acting penicillin, and bicarbonate of soda prior to transport. Four of the sheep were administered albendazole at 20 mg/kg of body weight.

Albendazole was effective against *Protostrongylus* spp. and other nematodes present in the treated sheep, indicating the usefulness of albendazole in eliminating parasites.

INTRODUCTION

The lungworm-pneumonia complex is a major mortality factor for Rocky Mountain bighorn sheep (*Ovis c. canadensis*) populations in North America (Buechner 1960, Forrester 1971, Uhazy et. al., 1973, Schmidt et. al., 1979). Mortality is the result of bacterial invasion of lungs that have been damaged by lungworm infections (Forrester 1971). The pneumonia that precedes death is generally due to a combination of lungworms (*Protostrongylus* spp.), bacteria (*Corynebacteria* or *Pasteurella* spp.) and a virus (Parainfluenza 3) (Forrester, 1971).

Mortality most frequently occurs in lambs because prenatal lungworm infection occurs and maturing lungworms in young lambs overwhelm them before they are 3 months of age (Schmidt et. al. 1979). In populations where lungworm infection produces high mortality, recruitment of lambs into the population is less than the natural mortality of adults, resulting in population extirpation.

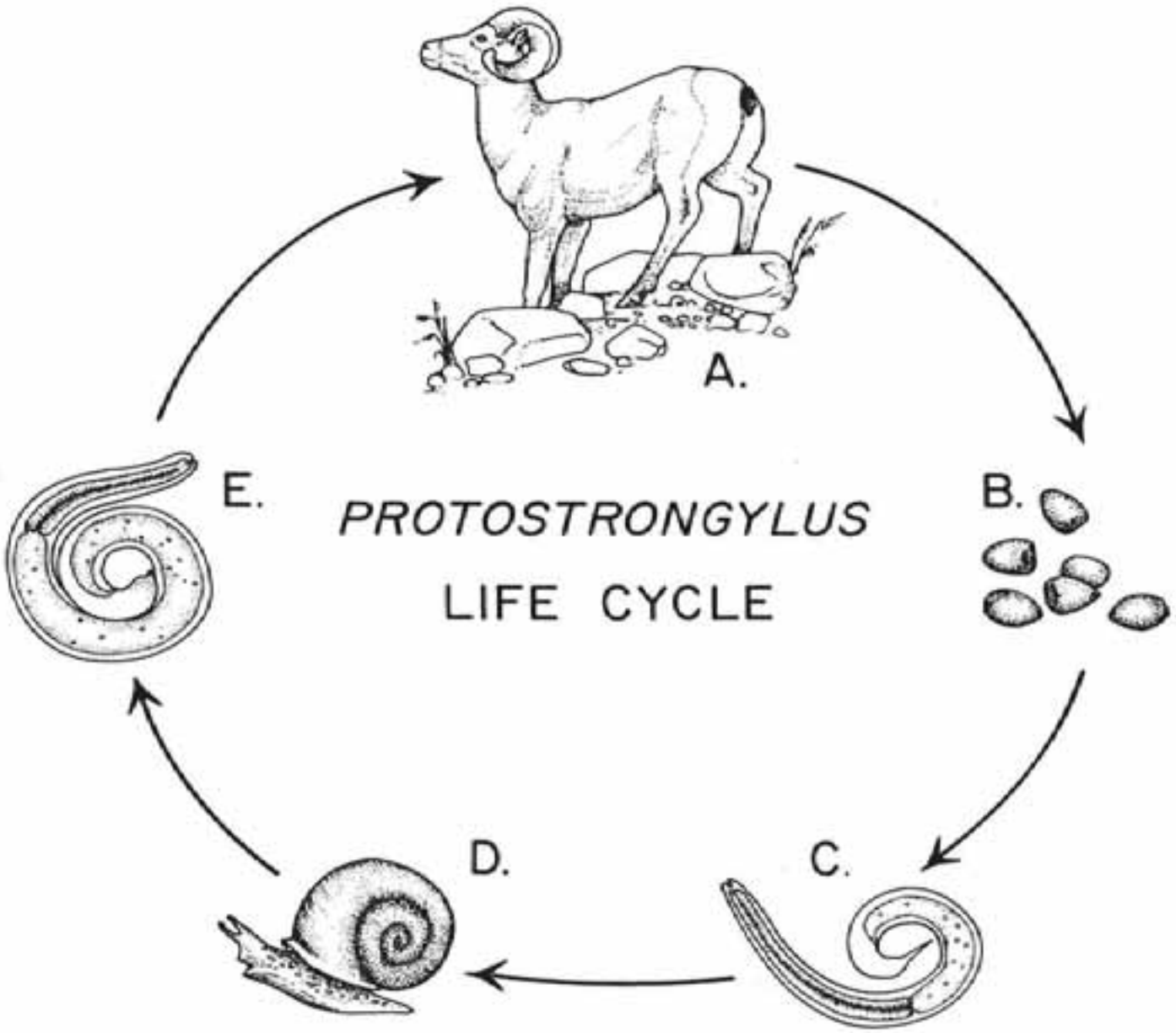
The life cycle of Protostrongylus spp. is indicated in Figure 1. It involves the intermediate land snails of the families Pupillidae, Valloniidae, and Zonitidae. Transplacental transmission of larvae stored in somatic tissues of the pregnant ewe also occurs (Schmidt et. al., 1979).

In 1972, Rocky Mountain bighorn sheep, while once native to Washington, were reintroduced. Presently there are two wild populations which include a total of approximately 45 animals in the eastern part of the state (Johnson 1980, these proceedings). The majority of these sheep are infected with lungworms (Unpublished observation). Therefore the potential exists for this infection to be a factor predisposing to mortality. This report presents the results of testing a drug, albendazole, to determine efficacy against lungworms in bighorn sheep and the survival rates of lambs from treated and untreated ewes.

MATERIALS AND METHODS

Eight Rocky Mountain bighorn sheep were obtained from Wildhorse Island on Flathead Lake in Montana during January, 1979. Two rams and 6 ewes (Table 1) were flown by helicopter to the mainland and then

Figure 1 Life cycle of Protostrongylus spp. lungworms in bighorn sheep; (A) adult worms in lungs, (B) first stage larvae are passed in feces, (c) first stage larvae infect snails, (D) snails are intermediate hosts, (E) sheep accidentally ingest snails with infective third stage larvae (drawn by K.M. Foreyt).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PROTOSTRONGYLUS
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transported by truck to a 5 acre enclosure at the Methow Wildlife Recreation Area, Twisp, Washington. Five ml of four-way Clostridium vaccine to prevent Clostridial infections, 3ml of selenium and Vitamin E (Bo-Se) to prevent white muscle disease, 7ml of long active penicillin to prevent secondary infection from transport, 15 g of bicarbonate of soda to prevent acidosis (capture myopathy) were given. All sheep were tagged with large, colored ear markers, aged, and sexed. Fecal samples were collected at the time of release to determine parasite burdens. At that time, 4 sheep (1 ram and 3 ewes) were treated orally with albendazole paste at approximately 20 mg/kg of body weight and 4 sheep were left untreated (Table 1). Subsequent fecal samples were collected 6 and 16 weeks after treatment by observing each marked sheep until defecation occurred and then collecting the fresh fecal pellets. A final sample was collected from 7 of 8 adults and 4 of 6 lambs 32 weeks after treatment.

Fecal samples were analyzed for lungworm larvae with a Baermann funnel as described by Forrester and Senger (1964) and for nematode eggs with a modified sugar flotation technique (sp. gr. 1.27). Serum samples collected at the time the sheep were captured were tested for antibodies against PI-3, infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD) and bluetongue (BT) viruses, by Dr. J. Evermann, Department of Veterinary Microbiology and Pathology, Washington State University, Pullman, Washington.

RESULTS

All sheep were passing lungworm larvae at initiation of the experiment (Table 1). Number of larvae per gram (LPG) of feces ranged from 3-104

TABLE 1. RESULTS OF TESTS OF ALBENDAZOLE PASTE (20 mg/kg) FOR ELIMINATION OF PROTOSTRONGYLUS SPP. IN BIGHORN SHEEP

Sheep Number	Sex	Age	Number of Protostrongylus spp. larvae per gram of feces			
			0 weeks[a]	6 weeks[a]	16 weeks[a]	32 weeks[a]
TREATED GROUP						
Y18	F	2 1/2	66[a]	0	0	NS[b]
Y20	F	8 1/2	3	0	2	10
Y23	F	3 1/2	6	0	2	1
Y78	M	1 1/2	9	0	0	0
(Average)			21.0	0.0	1.0	3.7
UNTREATED GROUP						
G51	F	2 1/2	3	6	19	2
G34	F	2 1/2	4	28	12	33
G37	F	3 1/2	104	46	53	24
G42	M	1 1/2	23	82	40	1
(Average)			33.5	40.5	31.0	15.0

[a]Week of experiment.

[b]NS = No sample.

(mean, 48). Other parasite eggs or oocysts namely Trichuris spp., Nematodirus spp., strongyles, and Eimeria spp., were present (Table 2).

Fecal samples collected 6 weeks after treatment indicated total absence of eggs and larvae from the feces of treated animals, suggesting good efficacy against adult Protostrongylus spp., Trichuris spp., Nematodirus spp. and strongyles (Tables 1 and 2). In nontreated animals the numbers of larvae were comparable to those at initiation of the experiment (Table 1). No adverse effects from treatment were noted.

Serologic tests showed 4 of the 8 sheep had titers against parainfluenza-3 virus of 1:10 to 1:80. However, none had antibodies against bluetongue, bovine virus diarrhea, and infectious bovine rhinotracheitis viruses.

Two lungworm larvae each were found in fecal samples collected 16 weeks posttreatment in 2 of 4 treated sheep. Feces of untreated sheep contained essentially similar levels of lungworm larvae to those seen at the beginning of the trial (Table 1). At 32 weeks after initiation of the experiment, all untreated sheep continued to pass larvae (average, 15.0 LPG), whereas only 2 of 3 treated sheep shed larvae and at low levels (average, 3.7 LPG) (Table 1). Also, 1 adult sheep (Y 20) had four Parelaphostrongylus spp. LPG of feces.

Coccidia (Eimeria spp.) were present in large numbers in 6 of 7 adult and 4 of 4 lambs sampled (Table 2). No efficacy against Eimeria spp. was apparent. One lamb of the four sampled had 1 Protostrongylus spp. LPG of feces; the others were negative.

Single lambs were born to all 6 ewes between May 10 and 18, 1979. All eight adult sheep and six lambs survived the experiment.

TABLE 2. PARASITE EGGS AND OOCYSTS PRESENT IN FECES OF EXPERIMENTAL SHEEP

Parasite	Week of Experiment			
	0[a]	6	16	32
TREATED GROUP (4 ADULTS)				
Trichuris spp.	2/4[a]	0/4	0/4	0/3
Nematodirus spp.	4/4	0/4	0/4	0/3
Strongyles	4/4	0/4	3/4	2/3
Eimeria spp.	4/4	4/4	4/4	2/3
UNTREATED GROUP (4 ADULTS)				
Trichuris spp.	4/4	4/4	2/4	1/4
Nematodirus spp.	4/4	4/4	2/4	2/4
Strongyles	4/4	4/4	4/4	4/4
Eimeria spp.	4/4	4/4	4/4	4/4
LAMBS[b] (6 TOTAL)				
Strongyles	-	-	NS	3/4
Eimeria spp.	-	-	NS	4/4

[a]Numbers indicate infected/total.

[b]Born between 10-18 May, 1979 (Experimental week 17).

DISCUSSION

Two subspecies of bighorn sheep are present in Washington, the California bighorn (*C. c. californiana*) and the Rocky Mountain bighorn. Both were extirpated from the state, but have been successfully reintroduced since 1956.

Large scale mortalities of bighorn sheep have been recorded in British Columbia, Colorado, Idaho, Montana, and Wyoming, and pulmonary disorders have been implicated as a factor in most of these incidents (Hunter and Pillmore 1954, Buechner 1961, Forrester 1971, Johnson 1975, Schmidt et. al., 1979). It was not determined if lungworms were responsible for the earlier population decline in Washington, however lungworms (*Protostrongylus* spp.) were present in more than 50 percent of both subspecies of bighorns in Washington that we have sampled during the last two years (unpublished observation). The numbers of larvae in those samples were not as high as those indicated in the studies in Colorado where up to 95 percent of bighorn lambs die annually from the lungworm pneumonia complex (Schmidt et. al., 1979). Neverthe-less the potential for this complex to cause mortality in the Northwest exists, and it cannot be overlooked in view of the lungworm prevalence in Washington bighorns, and the presence of the intermediate snail hosts in sufficient numbers to maintain the transmission cycle. As bighorn populations increase, the lungworm-pneumonia complex could become an important component in the dynamics of bighorn populations.

One method of preventing lungworm infestations or reducing their numbers would be to use an efficacious anthelmintic. The drug could be mixed in feed, salt, or given individually to animals when they are

captured for other reasons. Recent tests by Schmidt et. al. (1979) showed that treating pregnant ewes with cambendazole or fenbendazole resulted in significant survival of lambs from treated ewes. Cambendazole appeared to be effective against somatic larvae in the tissues of pregnant ewes and against larvae in the unborn fetus while fenbendazole was highly efficacious against adult Protostrongylus spp.

In the present experiment, albendazole was used as an oral paste. This broad spectrum anthelmintic has been reported to be efficacious against a wide variety of internal parasites in domestic ruminants and white-tailed deer (Odocoileus virginianus) (Theodorides et. al. 1976, Benz and Ernst 1977, Herlich 1977, Williams et. al. 1977, Foreyt and Drawe 1978). Albendazole has been reported effective against lungworms (Dictyocaulus viviparus) in ruminants (Theodorides et. al., 1976, Benz and Ernst 1977, Herlich 1977, Williams et. al. 1977), but no previous tests against Protostrongylus spp. in ruminants have been reported. Tramisol has been used in domestic ruminants for the control of D. viviparus, but it has been shown to be ineffective against Protostrongylus in bighorn sheep (Schmidt et. al. 1979).

We appreciate the limited number of expensive bighorns used in this study, but results showed that albendazole totally eliminated larvae from the feces of treated sheep 6 weeks after treatment. The few larvae which were recovered from treated animals 16 or 32 weeks after treatment may have resulted from new infections or maturation of inhibited stages of lungworm. These later possibilities could not be determined without killing the animals and examining the lungs and somatic tissues.

The presence of Parelaphostrongylus spp. (another related species of parasite) larvae in one ewe (Y-20) 32 weeks after treatment may corroborate the fact that reinfection was occurring since the worm was not detected in any sheep before this time in the experiment. Parelaphostrongylus spp. is prevalent in deer in the area (Unpublished observation), and its presence in one sheep possibly suggests posttreatment infection via snail intermediate hosts.

It is obvious that treatment with albendazole reduced the numbers of parasites in the bighorn sheep, and albendazole should be one anthelmintic to consider for use in bighorn sheep if they can be captured and handled. The strategic use of albendazole could also reduce the number and possible effects of Protostrongylus spp. and other parasites on bighorn populations. Further studies of penned and field populations are needed to evaluate the full impact of albendazole treatment.

ACKNOWLEDGEMENTS

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Lanny Wilson: Tom (Thorne), about 20 years ago the Wyoming Department Game and Fish crossed Rocky Mountain bighorn with domestic sheep to do, as I recall, lungworm work because they had so much difficulty handling the Rocky Mountain sheep, this was at Sybille, and they couldn't even get them to take lungworm, the hybrid vigor in those sheep was such that they couldn't even: isn't that right? There's never been a case in this cross.

Tom Thorne: It's not written up beyond some PR reports. It could be that Bill didn't find it.

Bill Foreyt: I couldn't find one.

Tom Thorne: We have crossed them; we've gone clear up to, what comes after 7/8, well 7/8 and then, you can as you finally approach mostly bighorn, you can get the Protostrongylus to take in them. And we have also learned pretty much what he did, that you shouldn't keep domestic sheep around bighorns if you can help it, but again we've never published on that beyond a few pretty remote PR reports.

Bill Foreyt: Our ewes did not breed.

Tom Thorne: Well, I think, we breed both ways I believe, but I'm not sure. But anyway its been done.

Lanny Wilson: Yes.

Bill Foreyt: Glad to hear that.

Nike Goodson: Seems like, I can't remember where I heard it; but maybe you know about this, but I heard that you could cross bighorn with domestic sheep that had horns, but they had trouble breeding them with hornless domestic sheep. Does that apply to all herds.

Tom Thorne: I've never heard on that one way or another.

Nike Goodson: Did the ones you were talking about, were the domestic sheep horned?

Tom Thorne: I really can't say, I know that the hybrid ewes had horns. But, I don't know whether the original domestic ewes did or not. I know you can cross them with Mouflon and they don't have horns, the ewe Mouflon don't have horns.

Anonymous: Was there any indication of CM in the herd that you took the sheep from?

Bill Foreyt: None at all.

Bill Wishart: Would you guess that cattle could be thrown in also, the same as domestic sheep?

Bill Foreyt: I don't think so. I think that the domestic sheep is a much more susceptible carrier as far as the bighorn is concerned. I don't, Tom do you want to comment on cattle; I don't think they would be as strong as susceptible carriers?

Tom Thorne: I kind of agree. It's all empirical, but I'd kind of agree too, based just on my own hunches.

Anonymous: What was that time period again, from the beginning of the initial loss, or introduction of domestic sheep to the loss of the 13 bighorns?

Bill Foreyt: It took 6 weeks.

Anonymous: Only 6 for all 13?

Bill Foreyt: It took 6 weeks for the out-break to be initiated and then in about less than a week they were all dead. There were two waves of the out-break, 7 died at once and then the next 6 died several days later.