

TREATMENT OF BIGHORN SHEEP FOR LUNGWORM

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INTRODUCTION

Intensive research on bighorn sheep herds in Colorado was initiated in 1970 to determine the nature and cause of excessive lamb mortality. Research revealed that lambs were dying of pneumonia beginning when they were about 6 weeks old. Some herds, such as the Pike's Peak, Rampart, and 4-Mile herds were suffering roughly 95 percent mortality. As a result these herds stagnated and began to decline from old age die-off. A collection of bighorn sheep lambs was initiated to determine the cause of this pneumonia. Gross and histologic study, together with parasitologic, virologic, bacteriologic, and serologic examination revealed the pneumonia was caused by Pasteurella sp. However, further examination revealed that lambs with pneumonia had extremely heavy burdens of the lungworm, Protostrongylus stilesi. Considering the age of these lambs, the only means by which they could have become so heavily infected was either by means of transplacental or transmammary infection. Subsequently, intensive research revealed that these lambs became infected via the transplacental route. In summary, ewes ingested infected snails from the range, stored the third-stage larvae in their lungs until the last trimester of pregnancy, and then transmitted these larvae to the fetus. Larvae remained stored in the fetal liver until birth, at which time they entered the lungs and began maturation. Lungworms matured in about 20 days and began to produce eggs. Shortly thereafter, these eggs hatched into larvae, and the larvae began the journey towards the mouth, to be swallowed and passed out with the feces. Collection and examination of lambs revealed that the animals were born with extremely heavy burdens; burdens of sufficient size to predispose the lambs to a fatal pneumonia by species of Pasteurella

We reasoned that control of the lungworm would offset the possibility of pneumonia by Pasteurella and give the lambs a chance to live. Observation indicated that adult ewes, once infected, were immune to superimposed infection. Therefore, we reasoned that if the lamb had the opportunity to acquire lungworm following birth (without overwhelming burdens), they too would develop an acquired immunity. We were fully aware that there were no medications on the market considered effective against species of Protostrongylus. Obviously, we sought a medication which would eliminate adult lungworm and third-stage larvae stored in the ewes' lungs

as well as first-stage larvae. In the event that this was unsuccessful, we had hoped to find a medication effective against the third-stage larvae stored in the ewes' tissues to give the lambs a chance at life.

A number of compounds were evaluated on captive sheep prior to going into the field. However, the true trial of an effective medication is not in a captive situation, but in the field; therefore, the results presented deal only with the field trials.

MATERIALS AND METHODS

Although one of us (Schmidt) had developed and proven "Apple Mash" was an extremely good vehicle for baiting, trapping, and treating bighorn sheep, logistics dictated that in the early phases of the field trials, we treat sheep individually with each of the compounds under consideration. Therefore, in the winter of 1974, the modified drop net (modified by Schmidt) was set up on Pike's Peak for the purpose of capturing bighorn sheep ewes. The approach was to capture bighorn sheep, place a color-coded and numbered neck band on each one, and treat them with a specific medication. They were then released into the environment. Thereafter, collared sheep were to be observed as often as was feasible to determine if they did or did not have a lamb which survived. Previous observations revealed that patient observation would eventually result in pairing of the ewes and lambs as the lambs nursed.

During the period of February through April, 1974 a total of 52 bighorn sheep ewes were treated with various drug combinations. These drug treatments were evaluated during the 1974-75 segment by observing and recording lamb natality and survival of collared treated ewes versus lamb natality and survival of collared and uncollared untreated ewes. Natality and survival of lambs was determined by pairing each lamb with its dam every time population composition classifications were conducted. These pairings were done by observing from a distance groups of bighorn sheep containing ewes and lambs until every lamb in the group had nursed a ewe.

Based on previous experience and trials with captive bighorn sheep, four drugs were chosen: Tramisol, Cambendazole, Thiabendazole, and Dichlorvos.

The following year, the objective was to treat bighorn sheep ewes with the medication of choice determined during 1974. However, during 1975, the Pike's Peak bighorn sheep were treated with drugs administered in apple mash bait without capturing the animals. The method of evaluation was to determine the efficacy of treatment on the previously collared ewes. We felt that most of the collared ewes (obviously along with the uncollared ewes) would "self-treat" themselves through the apple mash. Thereafter, the same procedure of pairing adults and lambs (see above paragraph) would be employed.

RESULTS

The results of the 1974 treatment (evaluation of the best medication) is presented in Tables 1 and 2. Untreated ewes on Pike's Peak during 1974 experienced a 95 percent lamb mortality, as opposed to the treated ewes (Table 1) during that year. The major period of lamb mortality on Pike's Peak occurred sometime between July and August, 1974.

The results of the 1974 treatment (Table 1) revealed that Cambendazole, Thiabendazole, or Dichlorvos were all potentially good compounds for the removal of third-stage larvae, either from the ewes' lungs or the fetal liver. Fecal samples obtained from lambs born to treated ewes indicated a very low level of infection (0-100 larvae/gram of feces). All lambs were extremely healthy, grew faster, and were much larger than any lamb seen previously on most sheep ranges in Colorado.

The 1974 results indicated that Cambendazole was the drug of choice. Several reasons prompted this decision: 1) the drug was relatively non-toxic, 2) the drug was palatable, and 3) the drug showed high efficacy against third-stage larvae. Therefore, in 1975, Cambendazole was delivered in apple mash. The goal was to deliver 8.4 cc of Cambendazole and 3200 milligrams of Diethylcarbamazine to each adult bighorn sheep utilizing the bait stations. Drugs were mixed with apple mash baits on 5 dates: March 14, April 10, April 12, April 16, and April 17. Seven drug delivery stations were selected within the winter habitat frequented by various segments of the Pike's Peak bighorn population. Baiting with apple mash (without drugs) was initiated the first week in January. Bait was delivered twice daily and observations were kept on the amount of bait, the number of sheep using each bait site after bait placement, and the amount of bait consumed. These data were used to compute the average daily consumption per individual bighorn per day. From these data it was estimated by one of us (Schmidt) that each adult sheep consumed about 5 pounds of apple mash per day during those days they visited the bait station. Therefore, medication (at a therapeutic level) was mixed within the apple mash on the assumption that an adult sheep would consume 5 pounds per day, lambs would eat about 2 pounds, while yearlings would consume about 4 pounds. The results of the 1975 treatment with Cambendazole revealed that treated ewes had an 85 percent lamb survival, whereas untreated ewes had a 15 percent lamb survival.

DISCUSSION

The medication applied to the bighorn sheep on Pike's Peak (and in other herds) does not eliminate the adult lungworm, but it does suppress larval production (the first-stage larvae) for periods of up to 6 weeks. However, it has been observed that the larvae/gram output posttreatment is considerably lower than the pretreatment output, indicating that some of the adult lungworms are eliminated. Most important, the results of medication in captive as well as free-ranging bighorn sheep indicate that the third-stage larva is practically eliminated from the ewe (or the fetal liver). Fecal collections and examination from lambs born of ewes during 1974 and again during 1975 revealed very low numbers of first-

Table 1. Summary of 1974-75 Pike's Peak bighorn sheep lamb survival comparing various drug treatments.

Drug	No. ewes treated	No. of ewes individually identified at least once after Sept. 1974	Lambs positively identified with a treated ewe from Oct. 1974-Mar. 1975	Percent lamb survival
Tramisol ^{1/}	9	8	4	50
Cambendazole ^{1/}	13	7	7	100
Thiabendazole	10	6	5	83
Dichlorvos	20	14	12	86

^{1/} Treatment contained diethylcarbamazine.

Table 2. Comparisons of 1974-75 Pike's Peak bighorn sheep lamb survival from ewes treated with drugs in 1974 and ewes not treated (treated ewes include all drug treatments).

Period	No. untreated ewes ^{1/}	No. lambs	Lambs: 100 ewes	No. treated ewes	No. lambs	Lambs: 100 ewes
June-Aug. 1974	53	38	72:100	41	40	98:100
Sept.-Dec. 1974	80	4	5:100	67	46	69:100
Jan.-April 15, 1975	122	6	5:100	93	62	67:100

^{1/} Some of the ewes listed as untreated were treated in 1973 but did not receive treatment in 1974.

stage larvae in the feces. Moreover, all of the lambs were much larger and healthier than previously observed on Pike's Peak or in other herds throughout the state. These lambs did not have paroxysms of coughing, rough hair coat, nor did they lag behind when the herd was frightened and caused to run. Additionally, we observed that treatment of large numbers of sheep on Pike's Peak (over the 2-year period), accompanied by a die-off of the older more heavily infected animals, resulted in a major reduction in the number of larvae/gram of feces among individuals in the herd. Larval levels averaged about 3000/gram of feces among adult sheep on Pike's Peak prior to treatment, and larval levels of 7-9000 per gram of feces were present among the lambs. Following the 2 years of medication on Pike's Peak, the average dropped to about 500 larvae/gram of feces among adult sheep and approximately 50 larvae/gram among lambs.

However, since the medication does not eliminate adult lungworm, lungworm levels will develop once again to the burdens observed in 1970 through 1974 unless treatment is applied on an annual basis. Hopefully, the future will bring a medication which will eliminate the adult lungworm as well as the first and third-stage larvae.