

BIGHORN LAMB MORTALITY INVESTIGATIONS IN COLORADO

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The Sangre de Cristo mountain range in south-central Colorado is a long, narrow chain of rugged peaks and steep rocky slopes. The portion lying in Colorado is over 100 miles long, and rarely more than 12 miles wide at any point along its length. This range contains 8 of Colorado's 54 mountain peaks over 14,000 feet high. Rocks are largely of sedimentary origin, not highly mineralized, and for this reason the area has not suffered the impact of mining activity so common in other parts of the state. Only a very few roads exist, and with the exception of one major east-west highway, all are quite primitive.

The earliest explorers documented the presence of bighorn sheep in this range, and throughout the latter part of the 19th Century, up to the present date, it has been the location of one of the major bighorn herds of the state. At one time, sheep could be found the entire length of the range, but during the past two or three decades, the herd has become more or less concentrated in one portion not over 15 miles long. With this concentration has come a decrease in total numbers, but as recently as ten years ago the herd was judged to be healthy on the basis of population age-class structure.

Starting some time in the early 1960's, a drastic change in age-class structure began to occur. Survival of lambs to reach the yearling age-class diminished to a very low level, resulting in almost no recruitment and replacement. The herd continued to decline in numbers, and of course became dominated by old age-class members. By 1968, it became obvious that the annual lack of herd increment was a persistent and recurrent problem that showed no indication of abatement.

The first investigation aimed at identifying the cause of the problem was a two-year study done by Woodward, then a graduate student in the Dept. of Fishery and Wildlife Biology, Colorado State University, and initiated in the spring of 1969. Objectives of this study were to: (1) ascertain herd composition, (2) determine breeding success in terms of conception and live births, (3) follow the herd from time of lamb drop through the summer and fall, and document lamb survival, and (4) assess the importance of predation, trauma, weather, and disease in mortality of lambs.

It became evident early in the investigation that the problem did not involve lack of conception or failure to bear live lambs. By mid-June of 1969, most breeding-age females in the herd were accompanied by seemingly healthy and active lambs. The same pattern was repeated in 1970. Also, during both years the ewe:yearling ratio was exceptionally low (100:11 and 100:17, respectively) reflecting the lack of lamb survival from the previous year.

Loss of lambs in the herd began to occur generally in late July and early August during both summers. The rate of loss reached peaks in early September of both years, and by mid-September most lambs had succumbed. The ewe:lamb ratio dropped from 100:83 on July 3, 1969 to 100:17 on September 10, 1969; and from 100:72 on June 30, 1970 to 100:22 on September 18, 1970.

At no time during the course of this two-year study could any lamb mortality be ascribed to predation or accidents. Physical appearance and observed coughing in lambs, beginning in late July, 1969, indicated that disease was the most likely factor in mortality and when the pattern was repeated in the summer of 1970, it was decided to collect lambs in an attempt to learn something about this phenomenon. Accordingly, two lambs were collected, one on August 6, 1970 and another on September 9, 1970. The first one collected exhibited early stages of two different types of pneumonia, a verminous proliferative type and a purulent bacterial bronchopneumonia. Although not clinically ill at the time of collection, it appeared to be host to elements that could bring about its eventual demise.

The second lamb collected exhibited the classic pattern of advanced respiratory illness, diagnosed as verminous pneumonia. It was in extremely poor body condition, and at the time of collection appeared not to have the strength to accompany the herd in its flight from danger. It stood without moving while the rest of the herd ran out of sight.

The peak in lamb losses during both summers, but particularly during the summer of 1969, appeared to coincide with a period of cold, wet weather, more or less typical of the Colorado Rockies during August. Critical analysis of the combination of circumstances and conditions encountered by these bighorns, seemed to support the conclusion that high lamb mortality was the result of respiratory disease caused by lung parasitism, enhanced by inclement weather at critical periods, with possible nutritional deficiencies or imbalances contributing.

This general conclusion formed the basis for a greatly expanded research effort, initiated in the spring of 1971, involving a team approach by personnel in the Departments of Pathology, Microbiology, and Anatomy, College of Veterinary Medicine, Colorado State University and personnel of the Colorado Division of Game, Fish and Parks. This investigation aimed at precise identification of the factors or combination of factors responsible for a high rate of mortality of lambs in certain bighorn sheep herds in the state.

A collection schedule, to take lambs from a herd known to have a high rate of lamb mortality, and from a herd known to have a high rate of lamb survival, at two-week intervals through the summer and fall, was established. Initially, the Buffalo Peaks herd, located in approximately the geographic center of the state, was selected as the herd having a high mortality rate. This selection was based on work done three years previously by graduate student Robert G. Streeter, and also on the fact that the terrain lends itself to ease of collection. The herd selected for the control was the Saguache Creek - Trickle Mountain herd, located about 60 miles southwest of Buffalo Peaks. Five animals were taken from the Buffalo Peaks herd, and five from the Saguache Creek - Trickle Mountain herd.

According to previous experience, the classic symptoms of respiratory illness should have appeared by mid-July in lambs from Buffalo Peaks. When they did not appear, it was decided by members of the team that collections should immediately begin in the Sangre de Cristo Range, in spite of the handicap of almost impossibly difficult terrain. Ultimately, all collections made in the Sangre de Cristos in 1971 were done by helicopter. By early August, lamb mortality began to appear on Pikes Peak, approximately 75 miles east of Buffalo Peaks. The Pikes

Peak herd has previously been considered to be a very healthy herd, having a high rate of recruitment and replacement.

The Sangre de Cristo and the Pikes Peak herds thus became the collection locations for sick lambs. By the end of September, five lambs had been taken from each of these two herds, and mortality of remaining lambs was almost complete.

Lambs collected from the Buffalo Peaks and Saguache Creek - Trickle Mountain herds were essentially healthy in appearance and of normal weight for their age. Postmortem examination of these lambs did not reveal any significant pathological changes (Tables 1 and 2). Five of the lambs were infected with Protostrongylus stilesi, but the level of infection was quite low and no significant lesions compatible with "verminous pneumonia" were present.

Lambs collected from the Sangre de Cristo and Pikes Peak herds were obviously ill, small for their age and light in color. Coughing and dyspnea were frequently observed. Postmortem examination revealed that all animals, except a yearling accidentally killed in the Sangre de Cristo herd, had pneumonia compatible with "verminous pneumonia". Protostrongylus stilesi was numerous in all of these animals (Tables 3 and 4).

One lamb from the Sangre de Cristo herd and one from the Pikes Peak herd had a species of Pasteurella and a gram negative diplococcus, thought to be a species in the genus Neisseria, in their lungs. An additional lamb from Pikes Peak also had this gram negative diplococcus in the lungs. Bacterial results are incomplete as yet, but thus far the results have not revealed any additional lambs infected with pathogenic species.

Virological studies are time-consuming and consequently, incomplete at this time. Low titers (1:2 to 1:64) against bovine PI-3 virus was demonstrated in two lambs from Buffalo Peaks, and four lambs from Pikes Peak.

Gastro-infectious parasitism was not a problem in any of these lambs. Very light infections with Marshallagia marshalli, Nematodirus spp. and six species of Eimeria were found in 10 of 20 lambs.

This research has been and is currently being investigated by a team consisting of William H. Rutherford, Wildlife Researcher; Thomas N. Woodard, Graduate Student, now Senior Research Technician; Ralph J. Gutierrez, Student Assistant; Gene Schoonveld, Wildlife Researcher Candidate; Robert Schmidt, Senior Conservation Aide; George Bear, Wildlife Researcher; Robert Keiss, Wildlife Researcher; Gordon Solomon, Associate Professor of Pathology; John Parks, Assistant Professor of Virology; Harold Breen, Professor of Pathology (Bacteriology); Jerry Adcock, Professor of Pathology; Charles P. Hibler, Professor of Parasitology; and Robert E. Lange, Graduate Student; and Carol J. Metzger, Research Assistant. Considerable assistance has come from George Post, Associate Professor of Microbiology.

Table 1. Bighorn Sheep collected from the Buffalo Peaks herd

<u>DATE</u>	<u>WT. (kg)</u>	<u>SEX</u>	<u>LESIONS</u>		
			<u>Bacterial</u>	<u>Viral</u>	<u>Parasitic</u>
6/16	12.5	F	-	-	Protostrongylus
6/29	9.0	F	-	-	-
7/27	20.0	F	-	-	Protostrongylus
8/10	38.6*	F	-	-	-
8/23	28.2	M	-	-	Protostrongylus

* yearling

Table 2. Bighorn Sheep collected from the Saguache Creek - Trickle Mountain herd

<u>DATE</u>	<u>WT. (kg)</u>	<u>SEX</u>	<u>LESIONS</u>		
			<u>Bacterial</u>	<u>Viral</u>	<u>Parasitic</u>
6/17	4.8	F	-	-	-
6/30	11.5	F	-	-	-
7/28	23.0	M	-	-	-
8/19	27.3	F	-	-	Protostrongylus
9/3	19.1	F	-	-	-
9/3	26.0	M	-	-	Protostrongylus

Table 3. Bighorn Sheep collected from the Sangre de Cristo herd

<u>DATE</u>	<u>WT. (kg)</u>	<u>SEX</u>	<u>LESIONS**</u>		
			<u>Bacterial</u>	<u>Viral</u>	<u>Parasitic</u>
8/26	12.7	M	-	-	Protostrongylus
8/28	-	M	-	-	Protostrongylus
8/30	49.0*	F	-	-	Protostrongylus
9/2	14.6	M	-	-	Protostrongylus
9/2	18.2	M	-	-	Protostrongylus

* yearling

** All animals except yearling had the classical "verminous pneumonia"

Table 4. Bighorn Sheep collected from the Pikes Peak herd

<u>DATE</u>	<u>WT. (kg)</u>	<u>SEX</u>	<u>LESIONS*</u>		
			<u>Bacterial</u>	<u>Viral</u>	<u>Parasitic</u>
9/13	21.0	F	-	-	Protostrongylus
9/13	19.0	F	-	-	Protostrongylus
9/16	17.3	M	-	-	Protostrongylus
9/16	14.0	M	-	-	Protostrongylus
9/16	18.2	M	-	-	Protostrongylus

* All animals had the classical "verminous pneumonia"

Dr. Hibler and Bill Rutherford - Question Period

Q. Did you find any mortality in adults or was it mostly in lambs?

A. I could be wrong, but as far as I recall we had no adult mortality or no adult illness. In fact, I should have pointed this out as I knew someone was going to ask about this. There were a couple of yearlings involved, but there were no gross lesions visible in any of these adults. However, the same type of bacteria was present, lung worm was present, but no pneumonia.

I might just add that we did learn something from those two accidental collection of yearlings which boils down in simple terms -- if they do survive these lesions to the one-year old class, they have it made.

Q. You mentioned that in order for the adults to suffer and to die from the disease these bacteria had to be transmitted?

A. Well, it is true, of course, that the lambs are more susceptible to all types of infection and is generally true, where a virulent or bacterial infection is involved, an animal develops an immunity upon exposure, especially if it is a healthy animal and can ward off the infection. The lungworm is something I would rather hedge upon as to whether an animal with age could really combat. Possibly they could because of the so-called pre-immune response. The presence of the worm in an animal, would insure that no extensive infection will occur in the future. With bacteria, once they have had some exposure to it, antibodies can develop.