Bienn. Symp. North. Wild Sheep
and Goat Council 8:202-212.

GASTROINTESTINAL PARASITES OF BIGHORN SHEEP IN WESTERN MONTANA AND THEIR RELATIONSHIP TO HERD HEALTH.

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Abstract: Gastrointestinal parasites of bighorn sheep (Ovis canadensis canadensis) from 11 western Montana herds were investigated by postmortem examination of 68 animals over an 18-year period. Necropsy findings were supplemented by fecal examination data from additional sheep for which postmortem material was not available. Sixteen helminth and coccidian species were found, of which 64% also parasitize domestic sheep. Major enteric parasites included nematodes (10 species), cestodes (2 species) and coccidia (4 species). The abomasal nematode Marshallagia marshalli was the most prevalent species overall, occurring in all herds and in 62% of the sheep examined statewide. The thread-necked strongyle Nematodirus was next in order of frequency, occurring in 9 herds with a composite prevalence of 40%. The whipworm Trichuris was found in 7 herds, in which 26% of the sheep were infected. Low prevalence nematodes, characterized by restricted geographic distribution and usually by low numbers, included the pinworm Skrjabinema, 3 herds; the intestinal threadworm Trichostrongylus, 2 herds; and the stomach worm Ostertagia, 2 herds. Genera limited to 1 herd were the small intestinal roundworm Cooperia, the large-mouthed bowel worm Chabertia and the nodular worm Oesophagostomum. Cestodes were present in 6 of the herds examined: the bighorn tapeworm Wyominia tetoni was found in 5 herds, and the double-pored tapeworm Moniezia was recovered from 2 herds, 1 in which Wyominia also occurred. Four species of coccidia were identified in sheep from 4 herds. Eimeria crandallis was the most common type and occasionally occurred in association with Eimeria ahsata. Oocyst counts suggestive of clinical coccidiosis were seen infrequently but in several instances were superimposed on mixed intestinal helminth populations. Management implications of these findings suggest that enteric parasites as a group may constitute a recognizable stress factor in Montana sheep, particularly the Wildhorse Island, National Bison Range and Sun River herds.

Among the variety of disease agents having a recognized impact on bighorn sheep populations, protostrongylid lungworms have received extensive attention (Pillmore 1957, Forrester 1971, Spraker 1979). Other parasite-related problems such as psoroptic scabies (Lange et al. 1980, Boyce et al. 1990, Foreyt et al. 1990) have been identified as factors responsible for periodic declines of wild sheep in western United States. In some instances recognition of parasites as etiologic agents associated with field outbreaks of disease has stimulated the development of control programs which have demonstrated management value (e.g., Schmidt et al. 1979).

On the other hand, limited information is available on the prevalence in wild sheep of parasites other than lungworms, and their potential role as disease agents in free-ranging bighorn populations is virtually unknown. Available data indicate that many worm parasites and coccidia reported from Ovis canadensis are recognized pathogens of domestic sheep (Honess and Winter 1956, Becklund and Senger 1967, Nielsen and Neiland 1974). However, their impact on the health of bighorn sheep exposed to a variety of environmental stresses is unclear. The purpose of this report is to present retrospective data on the occurrence of enteric parasites in 11 western Montana bighorn herds. The ultimate goal is to help clarify existing uncertainties about the management implications of this type of parasitism, particularly in view of its frequent association with acute and/or chronic disease problems in domestic sheep.

METHODS

Animals for postmortem examination were obtained from a variety of sources including road-killed specimens, field mortality cases, hunter-killed rams, and sheep provided by the Montana Department of Fish, Wildlife and Parks. At necropsy, the gastrointestinal tract from the abomasum to the lower colon was removed intact. Most animals were processed within 48 hrs, although in some instances viscera were frozen for later examination. Fecal analysis was used to supplement postmortem data in a limited number of sheep for which necropsy material was not available. Of the 11 herds represented in the study, 7 were located west of the Continental Divide in extreme western Montana and 4 herds were situated east of the Divide in or around Yellowstone or Glacier National Parks. Population estimates and the number of sheep examined from each herd at postmortem are listed in Table 1.

At necropsy the gastrointestinal tract was opened and the contents of each area were washed separately onto 20-, 40-,80- or 100-mesh screens to separate worms from ingesta. The entire gut mucosa was scraped and washed to remove attached parasites. Washed ingesta and mucosal scrapings were examined in illuminated trays and with a dissecting microscope to facilitate recovery of worms. Fecal samples were collected routinely during postmortem processing of sheep viscera. In some instances, random pellet collections were also made in the field to obtain additional data on parasite prevalence in specific herds for which limited postmortem data were available. A modified version of the Wisconsin centrifugal flotation technique was used to estimate the prevalence and intensity of helminth ova and coccidian oocysts (Lane 1928). Nematodes were fixed in a mixture of 95 parts 70% ethanol and 5 parts glycerin for microscopic examination. Tapeworms were fixed in 10% buffered formalin. Total worm counts were estimated from the number of parasites present in aliquots of washed gut contents. Intensity of coccidial infections was ranked from + to + + + according to the relative number of oocysts observed in fecal flotations.

RESULTS

Gastrointestinal helminths were noted in 10 of the 11 herds surveyed between 1973 and 1991 (Table 2.) Ten species of nematodes were found in 68 sheep examined. The most common parasite was the abomasal nematode Marshallagia marshalli, which occurred in all herds and in 62% of the sheep examined overall. The thread-necked strongyle Nematodirus was found in 9 herds in which 40% of the animals sampled were infected. Third in order of frequency was the whipworm,

TABLE 1. Demographic summary of 11 western Montana bighorn herds examined for gastrointestinal parasites (1973-91)*

Herd	Total no. sheep	Present status*	No. sheep examined
Sun River	1,100	Decreasing?	27
Thompson River	481	Growing	4
Ural - Tweed	100	Growing	7
Kootenai Falls	175	Stable	2
Lost Creek	180	Decreasing	5
Spanish Peaks	150	Stable	1
Bitterroot (East Fork)	100	Stable	4
Yellowstone	300 - 350	Decreasing	4
Stillwater	33 - 38	Stable/ Decreasing	4
Wildhorse Island	50	Stable	7
National Bison Range	60	Stable	2

*(Thorne et al, 1985:78-79)

Table 2. Prevalence and distribution of gastrointestinal parasites in 11 bighorn sheep herds from western Montana, with an estimate of their clinical significance.

Parasite	Prevalence %	Herds infected	Clinical signs/ pathogenesis
Marshallagia	62	Lost Creek, Kootenai Falls, Sun River, Wildhorse Island, National Bison Range, Ural-Tweed, Thompson River, Spanish Peaks, Bitterroot (E. Fork), Yellowstone Park, Stillwater	Damage abomasal mucosa; destroy gastric glands; reduce feed efficiency
Nematodirus	40	Kootenai Falls, Sun River, Wildhorse Island, National Bison Range, Ural-Tweed, Thompson River, Spanish Peaks, Yellowstone Park, Stillwater	Diarrhea and weakness resulting from destruction and necrosis of intestinal mucosa
Trichuris	26	Sun River, Wildhorse Island, National Bison Range, Ural-Tweed, Thompson River, Yellowstone Park, Stillwater	Probably insignificant
Skrjabinema	5.8	Sun River, Ural-Tweed, Stillwater	Probably nonpathogenic
Trichostrongylus	7.3	Wildhorse Island, National Bison Range	Loss of appetite with profuse watery diarrhea
Ostertagia	4.4	Wildhorse Island, National Bison Range	Nodule formation and destruction of gastric glands in abomasum
Cooperia	1.4	National Bison Range	Necrotic inflammation of duodenum
Chabertia	2.9	Wildhorse Island	Mucoid diarrhea; edema and ulceration of colon
Oesophagostomum	2.9	National Bison Range	Nodular lesions in bowel lining

Table 2. Continued.

Parasite	Prevalence %	Herds infected	Clinical signs/ pathogenesis
Capillaria	1.4	Sun River	Probably nonpathogenic
Wyominia	23.5	Lost Creek, Sun River, Ural-Tweed, Thompson River, Bitterroot (E. Fork)	Unknown
Moniezia	5.8	Sun River, Stillwater	Mechanical blockage of intestine; may interfere with digestion and absorption
Eimeria	33.8	Sun River, Wildhorse Island, Spanish Peaks, Yellowstone Park	Diarrhea and electrolyte imbalances, damage intestinal lining

Trichuris, which occurred in the cecum and upper colon of 40% of the sheep examined in 7 herds.

Other nematode infections encountered included 6 genera of stomach and intestinal roundworms which were limited geographically and typically were present in low numbers. The intestinal threadworm Trichostrongylus and the medium stomach worm Ostertagia occurred in 2 and 3 herds, respectively, in limited numbers. The pinworm Skrjabinema parasitized the lower colon of sheep from 3 herds. Intensity of individual infections ranged from less than 10 to more than 2,000 worms per animal. The intestinal nematodes Cooperia, Oesophagostomum, and Chabertia had the most limited geographic distribution of the roundworms identified in the study. Two animals were infected with the nodular worm Oesophagostomum and the large-mouthed bowel worm Chabertia; the intestinal roundworm Cooperia was limited to a single individual.

Cestode infections of 2 types were found. The bighorn tapeworm, Wyominia tetoni, occurred in 5 herds. It was particularly prevalent in the Sun River herd, where 12 of 27 sheep were infected. Infection intensity varied from 1 to 25 tapeworms/animal, with adult worms located in the gall bladder and bile ducts. The double-pored tapeworm, Moniezia, was present in the Sun River and Stillwater herds, where 3 positive sheep were found.

Four species of coccidia were identified in a total of 40 sheep originating from the Wildhorse Island, Sun River, Yellowstone, and Spanish Peaks herds. Prevalence was highest in Sun River sheep, where approximately 52% of the animals sampled were infected, and on Wildhorse Island, where 43% were positive. The predominant species in all instances was Eimeria crandallis, which was originally described from bighorn sheep in Wyoming (Honess 1942). Other coccidian species that occurred sporadically in 1 or more of the infected herds were E. ahsata, E. granulosa and E. ovina.

Frequency of infections with 2 or more parasite species existing concurrently in the same animal is shown in Table 3. Multiple infections were most frequent in the Wildhorse Island and Ural-Tweed herds, but occurred at all locations except the Bitterroot East Fork herd. All 7 Wildhorse sheep examined were concurrently infected with Marshallagia and Nematodirus. Three of 7 animals from this herd had 3 gastrointestinal nematode infections concurrently. One sheep from this herd had mixed populations of 5 nematode species and in another instance, 6 different roundworm species were found.

A comparison of the prevalence of gastrointestinal parasites in native vs. introduced bighorn herds in western Montana indicated that, in general, native sheep had fewer parasites than transplanted animals (Table 4). An average of 6 species of helminths were found in sheep grazing ancestral ranges, whereas 9 species were recovered from introduced herds. Coccidian infections were acquired by sheep on both types of range.

DISCUSSION

Aside from providing basic information on the nature and extent of parasitism of the gastrointestinal tract in wild sheep, data derived from the present study have several potential applications for bighorn management. For example, it is possible to

Table 3. Prevalence of gastrointestinal parasites in 10 Montana bighorn herds.[a]

Herd	Gastrointestinal Helminths[b]			Parasite Prevalence		Coccidia	Total species	Frequency of multiple infections
	Mar.	Nem.	Trich.					
Wildhorse Island	100%	100%	43%	Ostertagia	28%	+	7	100%
				Trichostr.	43%			
				Chabertia	28%			
Sun River	52%	37%	26%	Skrjabin.	04%	+	7	44%
				Wyominia	37%			
				Capillar.	1.4%			
National Bison Range	14%	100%	50%	Ostertagia	50%	-	6	50%
				Trichostr.	50%			
				Cooperia	50%			
				Oesophag.	100%			
Lost Creek	40%	0	0	Wyominia	20%	-	2	20%
Kootenai Falls	50%	50%	0	----------		-	2	50%
Ural-Tweed	86%	14%	43%	Wyominia	29%	-	4	71%
Thompson River	75%	25%	25%	Wyominia	50%	-	4	50%
Bitterroot (E. Fork)	75%	0	0	Wyominia	25%	-	2	0
Yellowstone	75%	75%	25%			+	4	50%
Stillwater	25%	25%	25%	Skrjabin.	25%	-	5	50%
				Moniezia	25%			

[a]Spanish Peaks herd omitted because of insufficient postmortem data
[b]Mar. = Marshallagia; Nem. = Nematodirus; Trich. = Trichuris

Table 4. Comparative prevalence of gastrointestinal parasites in native and introduced bighorn sheep herds in western Montana.*

Herd	Abomasum		Small Intestine				
Status	Marshallagia	Ostertagia	Nematodirus	Trichostrongylus	Cooperia	Wyominia +	Moniezia
Native	+	-	+	-	-	+	+
Introduced	+	+	+	+	+	+	-

	Large Intestine					Total
	Trichuris	Chabertia	Oesophag.	Skrjabinema	Eimeria	Species
Native	+	-	-	+	+	7
Introduced	+	+	+	-	+	10

*After Stewart's 1985 classification of native and introduced herds in Montana.
+Technically a liver parasite

rank the relative severity of parasite burdens encountered in the survey area and to estimate their impact on the health of a specific herd. Two parameters that appear to be most useful for this purpose are (1) the total number of parasite species in a particular herd, and (2) the relative frequency of multiple infections. Using these criteria, Wildhorse Island sheep ranked as the most heavily parasitized herd studied, followed by the Bison Range and Sun River herds. Depending on the relative weight attached to total parasite inventory vs. frequency of multiple infections, Ural-Tweed, Thompson River and Stillwater herds ranked next in terms of severity of enteric parasitism. Sheep from the Kootenai Falls, Lost Creek, Bitterroot East Fork and Yellowstone herds showed the lowest levels of infection.

Attempts to estimate the relative pathogenicity of the helminths and coccidia identified in western Montana bighorns require extensive extrapolation from the veterinary literature. In most instances, relevant information on their disease-producing potential in wild sheep is lacking and must be inferred from studies with domestic sheep. Based on these sources and other supporting data on parasite prevalence and intensity, Marshallagia and Nematodirus appear to be the 2 most important enteric parasites (Table 2). Both genera are known to destroy intestinal epithelial tissue and interfere with digestion and absorption of nutrients (Soulsby 1965, Thorne et al. 1982). Four other nematode genera that occurred infrequently and in limited numbers--Trichostrongylus, Ostertagia, Chabertia and Oesophagostomum--are regarded as serious pathogens in domestic sheep. However, their absence in major herds such as the Sun River and Thompson River sheep suggests that they are not a current threat to the health of sheep in the region. The other nematodes (Cooperia and Capillaria) were recovered rarely and appear to be accidental in bighorn sheep in the study area. Neither of the tapeworms found during the survey is known to cause clinical illness in wild sheep, although Moniezia is thought to be a possible cause of retarded growth and decreased wool production in domestic sheep (Spasskii 1951).

The role of coccidian infections in producing disease in bighorn sheep has not been documented, although several species of Eimeria recovered during the present study are recognized pathogens in domestic sheep (Honess 1942). Eimeria ahsata is considered to be the most pathogenic species of domestic sheep, where it produces fatal infections in lambs (Smith et al. 1960). It occurred only in Wildhorse Island sheep in this study. Eimeria granulosa and E. ovina occurred sporadically in the Sun River and Spanish Peaks herds. Neither species is regarded as highly pathogenic in domestic sheep (Levine and Ivens 1970). Overall, the possibility that coccidiosis presently exists as a clinical problem in western Montana sheep seems remote. Nonetheless, the presence of moderate to high level coccidian infections in approximately half of the Sun River and Wildhorse Island bighorns examined indicates that the potential exists for symptomatic coccidiosis to occur where heavy range use occurs on a regular basis. Routine diagnostic testing involving periodic fecal analysis supplemented by necropsy data when available appear to be the best procedures for monitoring parasite levels and detecting significant accumulations of gastrointestinal parasites requiring management intervention.

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