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SHEEP DISEASE REPORT

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Volume XV
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-7, Job 6.6R

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Carol Nielsen and Kenneth A. Neiland

Project No.: W-17-7 Project Title: Big Game Investigations

Job No.: 6.6R Job Title: Dall Sheep Disease and Parasites

Period Covered: July 1, 1974 through June 30, 1975

SUMMARY

Three of five Alaskan Dall sheep collected in the Granite Mountains in April 1973 have been examined for gastrointestinal helminths. The trichostrongylid numbers and species found are entirely consistent with previous findings (Nielsen and Neiland 1974) with the exception that a single specimen representing the genus *Cooperia* was encountered. Clear indications of the localization of mature *Nematodirus archari* and *N. davtianii* males, as well as of immature trichostrongylids were found in two of the three sheep. Pinworms (*Skrjabinema* spp.) were encountered in abundance in all three sheep and two sheep harbored several whipworms (*Trichuris* spp.).

A total of 45 trichostrongylid specimens representing ten species (four genera) were deposited in the U.S. National Museum Helminthological Collection.

Of three Dall sheep from the eastern Alaska Range which were examined for lump jaw lesions, two were positive.

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BACKGROUND

Investigation of the gastrointestinal helminth fauna of wild *Ovis* spp. has begun relatively recently. Few free-ranging populations have been examined on a continuing basis for these parasites and little quantitative information is available on the numbers of the various helminth species present and upon their seasonal dynamics.

A systematic investigation of wild populations of *Ovis dalli*, the Dall sheep, is continuing in Alaska. Sheep Disease Studies Progress Reports have provided data in previous years (Neiland 1962, 1965, 1968, 1969 and 1971, Jones 1964, Ericson and Neiland 1973) and a summary of information on the abundance and species identifications of gastrointestinal helminths recovered from 79 Dall sheep collected between 1964 and 1973 was presented last year (Nielsen and Neiland 1974). The study continued this year by the examination of three ewes from the Granite Mountains, a previously unstudied population.

We continue to accumulate other information on lump jaw occurrence, special pathology and various disease states of *Ovis dalli*.

OBJECTIVES

To identify the species and determine the incidence and distribution of potential pathogens in Dall sheep.

To develop efficient techniques for recovering, identifying and estimating the population of these potential pathogens.

To determine the extent to which these potential pathogens contribute to mortality or lower productivity of Dall sheep.

PROCEDURES

On April 5, 1973 five Dall sheep ewes were collected from the Granite Mountains in the Alaska Range east of the Richardson Highway. Five days later (April 10) five more ewes were collected at Dry Creek, also in the Alaska Range but approximately 70 miles northwest of the Granite Mountains site. The objective of two similar collections at the same time of year was to compare the general health status as well as the numbers and kinds of gastrointestinal helminths present in these two sheep populations, since they have probably been distinct since the last glaciation.

Results of gastrointestinal helminth investigations for the five 1973 Dry Creek ewes have already been given (Nielsen and Neiland 1974, pp. 16, 46-47, 66, 70 and 72). During this past year, three of the five April 1973 Granite Mountains ewes were similarly investigated: ewe #3889 (11 years old), ewe #3890 (11 years) and ewe #3892 (10 years). The methods used were those previously described (Ericson and Neiland 1973; Nielsen and Neiland 1974). There is, however, an error in the latter publication: on page 5 we state that "the entire small intestine of an adult Dall sheep is approximately 85 meters long", whereas at that time we had estimated it to be approximately 85 feet (i.e. 28 meters) long. We have since determined the actual length of a small intestine to be about 19 meters; the duodenum is approximately 400 cm long; and the gastrointestinal tract from the omasal-abomasal junction to the rectum was found to be 28 meters long.

There were some variations in the analysis of the three Granite Mountains sheep. First, there were some differences in where estimation and direct counts were used. For #3890, the parasite contents of the entire digestive tract from the abomasum through the posterior small intestine were determined by direct examination, while the contents of the caecum and colon were estimated from a partial sample. For #3889, the fundus, pylorus, anterior small intestine segments 3 and 4, jejunum, posterior small intestine, caecum, and colon parasite contents were analyzed by using the 20 percent estimation technique, while the duodenum and anterior small intestine segments 1a, 1b, 2a and 2b were analyzed in their entirety. Similarly, for ewe 3892 the abomasum, caecum and colon were analyzed by the 20 percent estimation technique, while the contents of the duodenum, anterior small intestine segments 1a, 1b, 2, 3 and 4, jejunum and posterior small intestine were analyzed in their entirety.

The second variation in analysis of the three 1973 Granite Mountains sheep was, as implied above, that the small intestine between the duodenum and the ileocaecal valve was divided and subdivided slightly differently in the three animals. The gastrointestinal tract contents of ewe #3890 were analyzed by division into only the six major sections (abomasum, duodenum, anterior and posterior halves of the small intestine, caecum and colon), while the tracts of ewes 3889 and 3892 were analyzed by dividing and subdividing the tracts as described and illustrated previously (Nielsen and Neiland 1974, pp. 3-6). The contents of the abomasum of ewe 3892 were analyzed as a whole, while those of ewe 3889 were analyzed

separately as the fundic and pyloric portions. For further analysis, the first meter of the small intestine posterior to the duodenum (AS 1) was subdivided in half (the anterior segment being AS 1a) for both ewes 3889 and 3892, and the second meter (AS 2) was also subdivided in ewe 3889. These subdivisions were made so as to more precisely localize which species of *Nematodirus* Ransom 1907 occurred in which segment as well as to determine the areas of concentration of immature trichostrongylid forms.

As previously described, male trichostrongylids (with the exception of those of the genera *Cooperia* Ransom 1907 and *Nematodirella* Yorke and Maplestone 1926), were identified to species (Nielsen and Neiland 1974). Female trichostrongylids, *Nematodirella* (and *Cooperia*) males, pinworms (*Skrjabinema* spp. Versesichagin 1926) and whipworms (*Trichuris* spp. Roederer 1761) were not identified beyond the generic level.

In addition to the examination of these three ewes, a collection of representative trichostrongylid specimens from Alaskan Dall sheep was selected and deposited in the U.S. National Museum Helminthological Collection. Dr. J. Ralph Lichtenfels has graciously agreed to confirm the species identifications previously reported (Nielsen and Neiland 1974). The sample of 45 trichostrongylids representing 10 species (4 genera) was selected from 24 Dall sheep from the Kenai Peninsula, Dry Creek and the Granite Mountains. Measurements of each specimen deposited in the USNM were taken with a calibrated ocular micrometer incorporated in the 12.5x eyepiece of a Zeiss Standard GFL compound microscope using either 16x or 40x objectives.

FINDINGS

A. Granite Mountains Sheep

Since only three Dall sheep out of the total of five collected in the Granite Mountains in April 1973 have been examined, it is inappropriate to prepare summary tables for comparative purposes at this time. However, the species and numbers of gastrointestinal helminths encountered will be given.

Trichostrongylids were abundant from the abomasum through the small intestine, with a definite degree of species localization in certain gastrointestinal segments. Numbers, species and distribution of trichostrongylids in the three ewes are given in Tables 1, 2 and 3.

Immature trichostrongylids were collected only incidentally from ewe 3890, but a concerted effort was made to estimate their numbers and distribution for ewes 3889 and 3892 (Tables 1 and 3). These estimates, however, are necessarily crude approximations of actual infections because larvae embedded within the mucosa of the tract were not recovered. Thus, these estimates represent the number of larvae either in the lumen ante-mortem or which migrated into the lumen immediately post-mortem. This recovery problem has been discussed previously (Nielsen and Neiland 1974, p. 60).

Abbreviations used in the tables

Trichostrongylids:

Mm	-	<i>Marshallagia marshalli</i> Ransom 1907 males
Ooc	-	<i>Ostertagia occidentalis</i> Ransom 1907 males
Cspp	-	<i>Cooperia</i> Ransom 1907 males
Nanc	-	<i>Nematodirus archari</i> Sokolova 1948 males
Ndav	-	<i>N. davtiani</i> Grigorian 1949 males
Noir	-	<i>N. oiratianus</i> Rajewskaya 1929 males
Nspa	-	<i>N. spathiger</i> (Railliet 1896) Railliet and Henry 1909
Nlla	-	<i>Nematodirella</i> Yorke and Maplestons 1926 males
M/O F	-	<i>Marshallagia</i> and <i>Ostertagia</i> females
N F	-	<i>Nematodirus</i> females
imm	-	immature trichostrongylids (primarily fourth) and early fifth stage larvae)

Gastrointestinal locations:

ABO	-	Abomasum	<u>Distance from pyloric sphincter</u>
DUOD	-	Duodenum	0 - 0.40m
ANT SM 1a	-	Anterior small intestine 1a	0.40 - 0.90m
ANT SM 1b	-	Anterior small intestine 1b	0.90 - 1.40m
ANT SM 2a	-	Anterior small intestine 2a	1.40 - 1.90m
ANT SM 2b	-	Anterior small intestine 2b	1.90 - 2.40m
ANT SM 3	-	Anterior small intestine 3	2.40 - 3.40m
ANT SM 4	-	Anterior small intestine 4	3.40 - 4.40m
Jejunum	-	Anterior half of remaining small intestine	
Post SM	-	Posterior half of remaining small intestine	
Caecum	-	To approximately 30 cm posterior to ileocaecal valve	
Colon	-	From 30 cm posterior to ileocaecal valve to beginning of formed pellets	

Table 1. Number and species of gastrointestinal trichostrongylids of ewe 3889 (11 yrs.) collected April 11, 1973, Granite Mountains.

	Mm	Ooc	Cspp	Narc	Ndav	Noir	Nspa	Nlla	Total Males	M/O Females	N Females	Total Females	Total Mature	Imm.
Fundus	95	--	--	--	5	--	--	--	100	90	10	100	200	15
Pylorus	15	--	--	--	--	--	--	--	15	50	--	50	65	40
Duod	1	--	--	110	190	--	--	--	301	1	231	232	533	460
Ant Sm 1a	--	--	--	88	14	--	--	--	102	--	147	147	249	240
Ant Sm 1b	--	--	--	203	2	--	--	--	205	--	207	207	412	350
Ant Sm 2a	--	--	--	4	2	--	--	--	6	--	4	4	10	5
Ant Sm 2b	--	--	--	3	--	1	--	--	4	--	6	6	10	20
Ant Sm 3	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Ant Sm 4	--	--	--	--	--	--	5	--	5	--	10	15	15	--
Jejun	--	--	--	--	--	--	--	--	--	--	--	--	--	10
Post Sm	--	--	--	--	--	--	--	--	--	5	--	5	5	--
Caecum	--	--	--	5	--	--	--	--	--	--	--	--	5	--
Colon	--	--	--	--	--	--	--	--	--	1	--	1	1	--
Total	111	--	--	413	213	1	5	--	743	147	615	762	1505	1140

Table 2. Number and species of gastrointestinal trichostrongylids of ewe 3890 (11 yrs.) collected April 11, 1973, Granite Mountains.

	Mm	Ooc	Cspp	Narc	Ndav	Noir	Nspa	Nilla	Total Males	Total Females	Total Mature	Imm.
Abo	252	--	--	4	17	1	--	--	274	399	673	35
Duod	6	--	--	69	35	7	--	--	117	165	282	14
Ant Sm	4	--	1	144	61	73	214	6	503	525	1028	(50*)
Post Sm	1	--	--	--	--	1	9	--	11	14	25	--
Caecum	--	--	--	--	--	--	--	--	--	1	1	--
Colon	1	--	--	--	--	--	--	22	23	20	43	--
Total	264	--	1	217	113	82	223	28	928	1124	2052	(99*)

*Method of recovery used was not adequate for estimating number of immature forms present.

Table 3. Number and species of gastrointestinal trichostrongylids of sheep 3892 (10 yrs.) collected April 11, 1973, Granite Mountains.

	Mm	Ooc	Cspp	Narc	Ndav	Noir	Nspa	Nlla	Total Males	M/O Females	N Females	Total Females	Total Mature	Imm.
Abo	645	10	--	110	95	--	--	--	860	1010	220	1230	2090	20
Duod	1	--	--	1	1	--	--	--	3	--	11	11	14	2
Ant Sm 1a	--	--	--	8	2	--	--	--	10	--	6	6	16	--
Ant Sm 1b	1	--	--	109	7	13	--	--	130	1	108	109	239	300
Ant Sm 2	--	--	--	4	--	--	--	--	4	--	7	7	11	--
Ant Sm 3	--	--	--	--	--	--	--	--	--	--	3	3	3	--
Ant Sm 4	--	--	--	--	--	--	--	--	--	--	1	1	1	--
Jejun	41	--	--	10	22	--	1	--	74	91	19	110	184	--
Post Sm	2	--	--	--	--	--	7	--	9	2	1	3	12	--
Caecum	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Colon	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	690	10	--	242	127	13	8	--	1090	1104	376	1480	2570	322

Pinworms (*Skrjabinema* spp.) were by far the most abundant helminth encountered, but their distribution was limited to the caecum and colon (Table 4).

Whipworms (*Trichuris* spp.) were not observed in ewe 3890, but were found in the colon of both other sheep. Ewe 3889 harbored six *Trichuris* there, and ewe 3892 had two.

B. Specimens Deposited in USNM Helminthological Collection

A total of 45 trichostrongylid specimens representing 10 species (4 genera) from 24 Dall sheep were selected from among those identified last year (Nielsen and Neiland 1974). They were deposited in the U.S. National Museum Helminthological Collection and assigned the numbers listed in Table 5. As of April 15, 1975 the species identifications have not been confirmed.

C. Lump Jaw Infections

Only three Dall sheep were examined for the "lump jaw" condition during 1974-75. Two animals came from the Johnson River area of the eastern Alaska Range. One, a six-year-old ram, had normal jaws but the other, a seven-year-old ram had a lumpy swollen area on the ventral aspect of the right mandible directly below the molars. A third animal, also a ram of approximately six to seven years of age, had lumpy areas on the ventral aspects of both mandibles under the molars, with an additional small affected area near the proximal part of the ventral left mandible, as well as bilaterally loosened molars. This third ram was from the Nabesna River area of the Alaska Range, approximately 100 miles southeast of the Johnson River.

The non-sterile condition of the affected jaws precluded further bacteriological investigation of the lesions.

D. Other Infections

Examination of the collection of Dall sheep lungs and fecal pellets described previously (Nielsen and Neiland 1974, p. 73) for evidence of lungworm infection, coccidia and nematode eggs remains to be done.

DISCUSSION

A. Granite Mountains Sheep: Gastrointestinal Helminths

Analysis and comparison of gastrointestinal helminth findings for the three April 1973 Granite Mountains sheep should be delayed until the remaining two sheep collected at the same time and place are analyzed. It should only be noted at this time that the species and abundances of trichostrongylids, pinworms, and whipworms are entirely consistent with our previous findings for Dall sheep from the Kenai Peninsula, the Alaska Range and a few miscellaneous locations (Nielsen and Neiland

Table 4. Estimated numbers of pinworms (*Skrjabinema* spp.) in Granite Mountains Dall sheep collected April 11, 1973.

Sheep	Location	Male	Female	Total
3889	caecum	1625	1820	3445
	colon	7845	4415	12260
	total	9470	6235	15705
3890	duodenum	--	1	1
	ant. sm.	---	1	1
	post. sm.	--	---	---
	caecum	765	1170	1935
	colon	725	1005	1730
	total	1490	2175	3665
3892	caecum	5195	3050	8245
	colon	1160	1475	2635
	total	6355	4525	10880

Table 5. Specimens collected from Alaskan Dall sheep taken 1964-1973, deposited in USNM Helminthological Collection.

Assigned USNM HC No.	<i>Ovis Dallii</i> Host					Trichostrongylid Specimen	
	Id. No.	Age	Sex	Collection Locality	Collection Date	Location in Host	Specimen
73873	7002	3	M	Kenai Penn.	9/23/64	Abomasum	<i>Marshallagia marshalli</i>
73874	3263	1	M	Kenai Penn.	3/18/71	Abomasum	" "
73875	3271	1	M	Kenai Penn.	3/18/71	Abomasum	" "
73876	3579	7	F	Dry Creek	5/5/72	Abomasum	" "
73877	3896	8	F	Dry Creek	4/10/73	Abomasum	" "
73878	3623	1	F	Dry Creek	6/5/72	Abomasum	<i>Ostertagia circumcincta</i>
73879	3624	13	F	Dry Creek	6/5/72	Abomasum	" "
73880	3696	11	F	Dry Creek	7/9/72	Abomasum or Ant. Sm.	" "
73881	3697	4	F	Dry Creek	7/9/72	Abomasum	" "
73882	3697	4	F	Dry Creek	7/9/72	Abomasum	" "
73883	3271	1	M	Kenai Penn.	3/18/71	Abomasum	<i>Ostertagia occidentalis</i>
73884	3339	10	M	Granite Mts.	8/11/71	Abomasum	" "
73885	3579	7	F	Dry Creek	5/5/72	Abomasum	" "
73886	3695	1	M	Dry Creek	7/9/72	Abomasum	" "
73887	3697	4	F	Dry Creek	7/9/72	Abomasum	" "
73888	3695	1	M	Dry Creek	7/9/72	Abomasum	<i>Ostertagia ostertagi</i>
73889	3695	1	M	Dry Creek	7/9/72	Abomasum	" "
73890	3624	13	F	Dry Creek	6/5/72	Abomasum	<i>Ostertagia trifurcata</i>
73891	3695	1	M	Dry Creek	7/9/72	Abomasum	" "
73892	3695	1	M	Dry Creek	7/9/72	Abomasum	" "
73893	3697	4	F	Dry Creek	7/9/72	Abomasum	" "
73894	3697	4	F	Dry Creek	7/9/72	Abomasum	" "
73895	3623	1	F	Dry Creek	6/5/72	Abomasum	<i>Teladorsagia davitiani</i>
73896	3624	13	F	Dry Creek	6/5/72	Abomasum	" "
73897	3697	4	F	Dry Creek	7/9/72	Abomasum	" "
73898	3254	11	F	Kenai Penn.	3/18/71	Abomasum	<i>Nematodirus archari</i>
73899	3331	1	F	Kenai Penn.	4/27/71	Abomasum	" "
73900	3580	7	F	Dry Creek	5/5/72	Abomasum	" "
73901	3894	2	F	Dry Creek	4/10/73	Ant. Sm. 1	" "
73902	3896	10	F	Dry Creek	4/10/73	Ant. Sm.	" "

Table 5. Continued.

Assigned USNM HC No.	<i>Ovis Dalli</i> Host					Trichostrongylid Specimen	
	Id. No.	Age	Sex	Collection Locality	Collection Date	Location in Host	Specimen
73903	3235	3	F	Kenai Penn.	2/26/71	Sm. Int.	<i>Nematodirus davtiani</i>
73904	3258	6	F	Kenai Penn.	3/18/71	Sm. Int.	" "
73905	3870	5	F	Dry Creek	11/17/72	Duodenum	" "
73906	3894	2	F	Dry Creek	4/10/73	Abo., Duod., or Ant. Sm. 1	" "
73907	3896	10	F	Dry Creek	4/10/73	Duod. or Ant. Sm.	" "
73908	3253	3	F	Kenai Penn.	11/13/70	Sm. Int.	<i>Nematodirus oiratianus</i>
73909	3256	1	F	Kenai Penn.	3/18/71	Sm. Int.	" "
73910	3581	1	F	Dry Creek	5/4/72	Duod., Post. Sm., Caecum or Colon	" "
73911	3330	5	F	Kenai Penn.	4/27/71	Sm. Int.	" "
73912	3870	5	F	Dry Creek	11/17/72	Ant. Sm. or Post. Sm.	" "
73913	3242	1	F	Kenai Penn.	4/27/71	Sm. Int.	<i>Nematodirus spathiger</i>
73914	3271	1	M	Kenai Penn.	3/18/71	Sm. Int.	" "
73915	3870	5	F	Dry Creek	11/17/72	Ant. Sm.	" "
73916	3894	2	F	Dry Creek	4/10/73	Jeju. or Post. Sm.	" "
73917	3895	7	F	Dry Creek	4/10/73	Post. Sm.	" "

1974)*. There is, however, a single exception: ewe 3890 harbored in its anterior small intestine one male specimen of *Cooperia*, possibly *C. oncophora* (Railliet 1898) Ransom 1907. Representatives of the genus *Cooperia* have been entirely lacking in the 79 sheep examined previously and were also not seen in the other two April 1973 Granite Mountains ewes. It is possible that the appearance of this rare specimen is due to the accidental acquiring of the parasite by indirect contact between the sheep and a small herd of bison (*Bison bison*) whose range they occasionally overlap. Further discussion of this interesting topic will be delayed until the remaining two Granite Mountains sheep are examined for *Cooperia* specimens.

For the two sheep (3889 and 3892) whose gastrointestinal tract contents were subdivided into sections, the localization of *Nematodirus* species is particularly striking. In ewe 3892, *Nematodirus archari* Sokolova 1948 male specimens were almost equally divided between the abomasum and anterior small intestine segment 1b (i.e. approximately 0.90 to 1.40m distal to the pyloric sphincter). In ewe 3889, however, nearly half of the total *N. archari* males were within the duodenum and anterior small intestine 1a (i.e. approximately the first 0.90m distal to the pyloric sphincter) and slightly more than half were in anterior small intestine 1b. Thus, in these two ewes the *N. archari* males were distributed not more than 1.40m beyond the pyloric sphincter.

In comparison, ewe 3892 harbored nearly all of its *Nematodirus davtianii* Grigorian 1949 males in the abomasum, while ewe 3889 had nearly all of this species in the duodenum. Thus in ewe 3892 the two species *N. archari* and *N. davtianii* were sympatric in the abomasum, while in ewe 3889 they were also sympatric but this time in the duodenum. In both ewes, the remaining (approximately half), *N. archari* male population was distributed slightly posterior to the area of sympatry.

Another interesting aspect of habitat selection is demonstrated by the localization of immature forms, i.e. primarily fourth or early fifth stage larvae occurring in the lumen (but not those in the mucosal crypts, as discussed above). Because ewe 3890's gastrointestinal tract was not subdivided beyond the major six sections, a precise localization for the few immature trichostrongylids that were incidentally recovered from the anterior small intestine could not be determined. In contrast, precise localization together with a concerted recovery effort revealed where immature trichostrongylids were most abundant in ewes 3889 and 3892. In the former, a moderate number of immatures were distributed in the duodenum and anterior small intestine segments 1a and 1b (i.e. 1.40m distal to the pyloric sphincter). Very few immature forms were found in the contents both anterior and posterior to this limited area. Even more sharply delimited was the small number of immature trichostrongylids in ewe 3892, where nearly all specimens were restricted to anterior small intestine segment 1b (i.e. from 0.90 to 1.40m distal to the pyloric sphincter). These findings are in contrast to data for the 1973 Dry

*There is a misprint on page 75 of this publication, i.e. Nielsen and Neiland 1974. In the third paragraph, the fourth line, Uhazy and Holmes (1971) reported 1-1270 male *Marshallagia marshalli* (\bar{x} = 145), not 1-382 males.

Creek sheep (Nielsen and Neiland 1974), where the largest number of immature trichostrongylids were found in anterior small intestine segment 2 (i.e. from 1.40 to 2.40m beyond the pyloric sphincter). These differences in the distribution of immature forms could be related to differences in the trichostrongylid species compositions of the 1973 Dry Creek sheep as compared to those of the 1973 Granite Mountains sheep. In addition, there was a large difference in the total number of immature (and mature) specimens in the two groups of sheep, with the Dry Creek sheep being much more heavily infected. These qualitative, quantitative and localization differences, together with their important implications concerning population health and sites of larval maturation of different species, must await analysis until the Granite Mountains sheep material has been entirely examined.

B. Species Characteristics of Dall Sheep Trichostrongylids Identified in 1974

Size measurements for the 45 trichostrongylids deposited in the USNM Helminthological Collection were generally within or near the published size ranges given for each species, with the exception that specimens of both *Ostertagia trifurcata* Ransom 1907 and *Teladorsagia davtiani* Andreeva and Satubaldin 1954 averaged larger than previously reported in the literature. There were moderate variations in the measurements of different specimens of each species. This can be expected when examining nematodes of various ages taken from naturally infected sheep having varying degrees of immunity.

The specimens sent to the Helminthological Collection were chosen so as to best represent the thousands recovered and examined from Dall sheep (Nielsen and Neiland 1974). Thus specimens of *Ostertagia* Ransom 1907 and *Teladorsagia* Andreeva and Satubaldin 1954 included in the Collection only occasionally clearly display a gubernaculum because this was the general situation we encountered. Most frequently the gubernaculum was indistinct, with its shape and boundaries difficult to determine, and frequently it was not evident at all in specimens that otherwise were clearly *Ostertagia* (or *Teladorsagia*). It seems unlikely that these differences were caused by the procedure used in specimen preservation.

Some of the *Nematodirus oiratianus* Rajewskaya 1929 and most of the *N. spathiger* (Railliet 1896), Railliet and Henry 1909 specimens accumulated from Dall sheep during 1964-1973 were in relatively poor condition (i.e. somewhat shriveled, with the cuticle partially detached). This appeared to be a natural phenomenon and was not the result of faulty preservation methods used on these particular species.

Some specimens of *Nematodirus archari* clearly showed the prebursal papillae mentioned in Sokolova's (1948) original description, but many *N. archari* do not display these papillae. Small prebursal papillae were occasionally observed on *N. oiratianus* and *N. spathiger* specimens, although we can find no reports of this in the literature.

Finally, rare *Marshallagia marshalli* Ransom 1907 specimens examined (including one deposited in the Collection, USNM HC 73877) appeared to have a weakly chitinized gubernaculum. Skrjabin et al. (1954) divided *Marshallagia mongolica* Shumakovich 1938 from *M. marshalli* on the basis that the former has a weakly chitinized gubernaculum "in a majority of cases" (p. 189) and that the spicules split in the distal third (*M. mongolica*) rather than the distal quarter (*M. marshalli*). Using an ocular micrometer on the spicules *in situ*, the five *M. marshalli* specimens we deposited in the Collection appear to have a spicule split ranging between the distal third and the distal quarter (73873: $90/265 \approx 1/3$, 73874: $90/235 \approx 3/8$, 73875: $70/265 \approx 5/18$, 73876: $65/270 \approx 2/9$, and 73877: $65/250 \approx 1/4$). The distinction between *M. marshalli* and *M. mongolica* should be clarified, particularly since Gubanov (1964) has reported the latter species from *Ovis nivicola*, a geographically close relative of *O. dalli* (Nielsen and Neiland 1974, pp. 74-75). Unfortunately, Dr. J. Ralph Lichtenfels has informed us that the Helminthological Collection has no *M. mongolica* specimens which could be examined to resolve these uncertainties.

CONCLUSIONS AND RECOMMENDATIONS

The results obtained this year tend to substantiate some of our previous conclusions (Nielsen and Neiland 1974). We have no additional management recommendations at this time.

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*measurements in microns

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