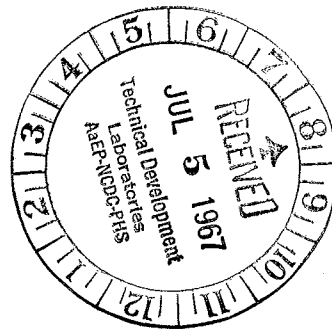


J. E. KEIRANS

443

**PARASITES OF *OVIS CANADENSIS CANADENSIS*
IN MONTANA, WITH A CHECKLIST OF THE
INTERNAL AND EXTERNAL PARASITES
OF THE ROCKY MOUNTAIN BIGHORN
SHEEP IN NORTH AMERICA**

Willard W. Becklund and Clyde M. Senger



Reprinted from THE JOURNAL OF PARASITOLOGY
Vol. 53, No. 1, February 1967, p. 157-165
Made in United States of America

PARASITES OF *OVIS CANADENSIS CANADENSIS* IN MONTANA, WITH A CHECKLIST OF THE INTERNAL AND EXTERNAL PARASITES OF THE ROCKY MOUNTAIN BIGHORN SHEEP IN NORTH AMERICA

Willard W. Becklund and Clyde M. Senger

Beltsville Parasitological Laboratory, Animal Disease and Parasite Research Division, ARS,
USDA, Beltsville, Maryland, and Department of Biology, Western Washington State College,
Bellingham, Washington

ABSTRACT: Eighteen Rocky Mountain bighorn sheep in Montana were examined for parasites at necropsy. Twelve came from the National Bison Range, five from Wildhorse Island (Flathead Lake), and one from the Sun River area. The parasites recovered were: *Cysticercus tenuicollis*, *Wyominia tetoni*, *Marshallagia marshalli*, *Ostertagia circumcincta*, *O. lyrata*, *O. occidentalis*, *O. ostertagi*, *Cooperia oncophora*, *C. surnabada*, *Nematodirus archari*, *N. davtiani*, *N. helveticus*, *N. lanceolatus*, *N. spathiger*, *Trichostrongylus* sp. (unidentified females), *Protostrongylus rushi*, *Dermacentor albipictus*, and *D. venustus*. Gastrointestinal nematodes recovered from the National Bison Range sheep ranged in number from 275 to 5,300 per host and those from the Wildhorse Island sheep from 670 to 3,510. The species recovered from the National Bison Range sheep were totally different from those recovered from the Wildhorse Island and Sun River sheep. The parasites recovered represent several new host and distribution records. Included in this report is a checklist of 51 species from *Ovis canadensis*, based on the present report, unpublished records of specimens in the U. S. National Museum Helminthological Collection, and from the literature. Seventy per cent of these 51 species are known parasites of domestic sheep and 35% of cattle in North America.

During a study of the Rocky Mountain bighorn sheep, *Ovis canadensis canadensis* Shaw, 1804, by the staffs of the Department of Zoology and the Montana Cooperative Wildlife Research Unit of the University of Montana, parasites were recovered from 18 animals. Twelve rams were obtained by P. L. Wright and V. B. May from the National Bison Range at Moiese, Montana, through the cooperation of John Schwartz and C. J. Henry, former managers of the Range. Five sheep were obtained from Wildhorse Island on Flathead Lake, Lake County, Montana, and one pregnant ewe was obtained from the Sun River area in Teton County, Montana, with the assistance of personnel of the Montana State Game and Fish Department. The Sun River ewe was trapped at Scattering Springs. It was killed and necropsied at the Rocky Mountain Laboratory, Hamilton, Montana, by W. Hadlow. Some of the parasites recovered from the 18 sheep have been the subject of previous reports; namely, lungworms (Forrester and Senger, 1964), *Bovicola jellisoni* (Emerson, 1962), and *Oestrus ovis* (Capelle, 1966). The remaining parasites collected are reported herein, together with a checklist of the external and internal parasites of *Ovis canadensis*.

MATERIALS AND METHODS

One ram was killed and necropsied each month for 12 consecutive months at the National Bison Range. The first ram was necropsied in May 1958, and the 12th in April 1959. The rams ranged in age from 2 to 7 years. They were first examined for ectoparasites, then the lungs, liver, omasum, abomasum, and small intestines were removed and taken to the laboratory for examination. The general method of recovering and estimating total numbers of gastrointestinal worms was similar to the procedure used by Porter (1942), with the exception that the fine plant debris in each container of organ contents and washings was reduced by means of a process of repeated suspensions in water, sedimentations, and decantations prior to taking samples. For most sheep, the total worm counts were determined from various small samples of the washings from the abomasums and small intestines of the sheep. In some instances, however, all the washings from the gastrointestinal tracts were examined and the total counts were made directly. Sheep 13, 14, and 15 from Wildhorse Island (Table II) were found dead or were accidentally killed in the field. They were not subjected to as thorough an examination for gastrointestinal parasites as were the other sheep from Wildhorse Island and the National Bison Range (Table I), and their worm counts are probably incomplete. Only qualitative determinations were made on the parasites recovered from sheep 18 from Sun River (Table II), as the procedures used in collecting these specimens are unknown.

Fecal samples were collected from sheep 1 to 11 (Table I) from the National Bison Range, but not from the other seven sheep, and the nematode

Received for publication 18 July 1966.

TABLE I. *Gastrointestinal nematodes recovered at necropsy from Rocky Mountain bighorn sheep at the National Bison Range.*

SHEEP												
Number	1	2	3	4	5	6	7	8	9	10	11	12
Sex	M	M	M	M	M	M	M	M	M	M	M	M
Age (years)	6	7	2	7	6	3	6	3	3	4	6	4
Month necropsied	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
NEMATODES RECOVERED												
Abomasum												
<i>Ostertagia lyrata</i> —M			7	10								20
<i>Ostertagia ostertagi</i> —M			67	100		59	11	10	70	110	20	280
<i>Ostertagia</i> spp.—F	2		181	510	60	189	11	120		160	345	490
Intestine												
<i>Cooperia oncophora</i> —M	23	350		730	385	133	11	10	130	20	923	330
<i>Cooperia surnabada</i> —M	9	87		70	110	44	11		20		219	160
<i>Cooperia</i> spp.—F	101	745		1,380	1,080	326	287	80	390	40	1,718	1,300
<i>Nematodirus helvetianus</i> —M	3	4		40	205							
<i>Nematodirus spathiger</i> —M	30	70		300	345	1,391	356	420	250	1,510	936	690
<i>Nematodirus</i> sp.—M				10	44			10	10		36	
<i>Nematodirus</i> spp.—F	139	299		420	845	1,746	471	1,110	810	1,110	1,103	670
<i>Nematodirus</i> spp. (larvae)		10		90	20	133	184	10	20	40		60
<i>Trichostrongylus</i> sp.—F		1	20	50						100		60
Totals	307	1,566	275	3,710	3,050	4,065	1,342	1,770	1,700	3,090	5,300	4,060

M = Male.
F = Female.

eggs were counted by various methods. In the counts, the eggs were differentiated as *Nematodirus* and other trichostrongylid eggs.

RESULTS

National Bison Range Sheep (Table I)

All 12 rams examined harbored gastrointestinal nematodes. The total number of nematodes recovered ranged from a minimum of 275 to a maximum of 5,300 per host. The average number was 2,520. The species, arranged in descending order of their incidence in the 12 rams, are as follows: *Cooperia oncophora* (Railliet, 1898) Ransom, 1907, and *Nematodirus spathiger* (Railliet, 1896) Railliet and Henry, 1909, both 92%; *Ostertagia ostertagi* (Stiles, 1892) Ransom, 1907, and *Cooperia surnabada* Antipin, 1931, both 75%; *Nematodirus helvetianus* May, 1920, 33%; and *Ostertagia lyrata* Sjöberg, 1926, 25%. Unidentified males of *Nematodirus* sp., thought to represent an undescribed species, were found in 42% of the rams. Unidentified females of *Cooperia* and *Nematodirus* were both found in 92% of the rams; of *Ostertagia*, in 83%; and of *Trichostrongylus*, in 42%. Unidentified larvae of *Nematodirus* were found in 75%. Besides nematode parasites, the thin-necked bladder worm, *Cysticercus tenuicollis* Rudolphi, 1810, was found in numbers ranging from one to five in the liver or other viscera of 10 of the rams. The winter tick, *Dermacentor albipictus* (Packard, 1869) Banks, 1908, and the

Rocky Mountain wood tick, *Dermacentor venustus* Marx in Neumann, 1897 (= *D. andersoni*) were each found separately on the bodies of two rams and together on one ram. Fecal samples collected from sheep 1 through 11 contained from six to 127 eggs per gram. *Nematodirus* egg counts ranged from zero to 40 and other trichostrongylid egg counts ranged from six to 101 eggs per gram of feces.

Wildhorse Island Sheep (Table II)

All five sheep examined harbored gastrointestinal nematodes. The total number of nematodes recovered ranged from 670 to 3,510. The average number per animal was 2,124. The species, arranged in descending order of their incidence in the five sheep, are: *Nematodirus lanceolatus* Ault, 1944, 100%; *Marshallagia marshalli* (Ransom, 1907) Orloff, 1933, 80%; *Ostertagia circumcincta* (Stadelmann, 1894) Ransom, 1907, and *Nematodirus archari* Sokolova, 1948, both 60%; *Ostertagia occidentalis* Ransom, 1907, 40%; and *Nematodirus davtianii* Grigorian, 1949, 20%. Unidentified females of *Nematodirus* were recovered from all of the sheep, and of *Ostertagia* from 40%. Besides the nematode parasites, one thin-necked bladder worm, *Cysticercus tenuicollis*, was collected in each of three sheep.

Sun River Sheep (Table II)

Only a few nematodes were collected from the one ewe for the purpose of identification,

TABLE II. *Wildhorse*

SHEEP												
Number	1	2	3	4	5	6	7	8	9	10	11	12
Sex	M	M	M	M	M	M	M	M	M	M	M	M
Age (years)	6	7	2	7	6	3	6	3	3	4	6	4
Month necropsied	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April
NEMATODES RECOVERED												
Abomasum												
<i>Ostertagia lyrata</i> —M			7	10								20
<i>Ostertagia ostertagi</i> —M			67	100		59	11	10	70	110	20	280
<i>Ostertagia</i> spp.—F	2		181	510	60	189	11	120		160	345	490
Intestine												
<i>Cooperia oncophora</i> —M	23	350		730	385	133	11	10	130	20	923	330
<i>Cooperia surnabada</i> —M	9	87		70	110	44	11		20		219	160
<i>Cooperia</i> spp.—F	101	745		1,380	1,080	326	287	80	390	40	1,718	1,300
<i>Nematodirus helvetianus</i> —M	3	4		40	205							
<i>Nematodirus spathiger</i> —M	30	70		300	345	1,391	356	420	250	1,510	936	690
<i>Nematodirus</i> sp.—M				10	44			10	10		36	
<i>Nematodirus</i> spp.—F	139	299		420	845	1,746	471	1,110	810	1,110	1,103	670
<i>Nematodirus</i> spp. (larvae)		10		90	20	133	184	10	20	40		60
<i>Trichostrongylus</i> sp.—F		1	20	50						100		60
Totals	307	1,566	275	3,710	3,050	4,065	1,342	1,770	1,700	3,090	5,300	4,060

M = Male
F = Female
1 = Number

and these
Other spe
trial tract
todirus a
Protostron
moved fro
collis fro
Wyominia
intestine

Previou
minths of
to naming
is an atten
estimate
ber of ho
draw any
worm pop
tain sheep
nematode
Nematodi
are limite
tween the
year, and

A comp
covered fr
Range wi
Island an
totally dif
was unex
Range is c
moreover,

TABLE II. *Gastrointestinal nematodes recovered at necropsy from Rocky Mountain bighorn sheep at Wildhorse Island and Sun River.*

SHEEP	Wildhorse Island					Sun River
	13	14	15	16	17	18
Number	13	14	15	16	17	18
Sex	F	M	M	M	M	F
Age (years)	> 2	< 1	< 1	> 1	> 1	> 2
Month necropsied	May	Oct.	Oct.	Nov.	Nov.	May
NEMATODES RECOVERED						
Abomasum		10	10	1,040	840	— ¹
<i>Marshallagia marshalli</i> —M and F		10	10		10	
<i>Ostertagia circumcincta</i> —M				20	10	— ¹
<i>Ostertagia occidentalis</i> —M		60	50			
<i>Ostertagia</i> spp.—F						
Intestine	40			90	50	— ¹
<i>Nematodirus archari</i> —M				70		
<i>Nematodirus davtianii</i> —M				420	620	— ¹
<i>Nematodirus lanceolatus</i> —M	1,690	90	90	780	1,850	— ¹
<i>Nematodirus</i> spp.—F	1,780	500	480			
Totals	3,510	670	640	2,420	3,380	

M = Male.

F = Female.

¹ = Number undetermined.

and these were largely *Marshallagia marshalli*. Other species recovered from the gastrointestinal tract were *Ostertagia occidentalis*, *Nematodirus archari*, and *N. lanceolatus*. Some *Protostrongylus rushi* Dikmans, 1937, were removed from the lungs, two *Cysticercus tenuicollis* from the liver, and approximately 12 *Wyominia tetoni* Scott, 1941, from the small intestine and bile duct.

DISCUSSION

Previous reports on the gastrointestinal helminths of mountain sheep are largely confined to naming the species recovered. This study is an attempt to ascertain the species and also estimate their numbers. Although the number of hosts in this study is not sufficient to draw any definitive conclusions concerning worm populations, it does suggest that mountain sheep in Montana harbor relatively small nematode populations largely composed of *Nematodirus* and *Cooperia*. Because the data are limited, no correlation can be made between the helminth populations, seasons of the year, and ages of the hosts examined.

A comparison of the nematode species recovered from the sheep at the National Bison Range with those from sheep at Wildhorse Island and Sun River reveals that they are totally different (Tables I, II). This finding was unexpected, because the National Bison Range is only 40 miles from Wildhorse Island; moreover, these two wildlife preserves are only

140 miles from Sun River. A possible explanation of this finding may be the prior origin of the sheep. Those at the National Bison Range came from Canada; whereas, the Wildhorse Island sheep, at least in part, came from Sun River. The present sheep population at the National Bison Range was started in 1922 with 12 sheep from Banff National Park, Canada. The Wildhorse Island population was started in 1939 with two yearlings of undetermined origin. In 1947, the island's population of six was supplemented with seven animals obtained at Sun River. Apparently, the species of gastrointestinal nematodes can vary greatly between separate mountain sheep populations in the same state.

The parasites recovered represent several new host and distribution records. *Ostertagia lyrata*, *Cooperia surnabada*, *Nematodirus helvetianus*, *N. archari*, and *N. davtianii* are new host records. The last two species have not previously been reported in North America and their distribution and hosts will be discussed subsequently. *Ostertagia circumcincta*, *O. ostertagi*, *Cooperia oncophora*, *Nematodirus lanceolatus*, *N. spathiger*, *Wyominia tetoni*, *Dermacentor albipictus*, and *D. venustus* have been reported from *Ovis canadensis* in some states, but not in Montana.

During the last few years the senior author has identified several collections of parasites of *Ovis canadensis* from various localities. These determinations prompted the prepara-

TABLE III. (Continued).

Parasites	Geographic distribution
(<i>Cooperia mcmasteri</i>)	
<i>Nematodirus abnormalis</i>	Wyoming (Hones and Winter, 1956).
<i>Nematodirus archari</i>	Montana (present work).
<i>Nematodirus davtiani</i>	Montana (present work).
<i>Nematodirus filicollis</i>	Alberta (Cowan, 1951).
<i>Nematodirus helveticus</i>	Montana (present work).
<i>Nematodirus lanceolatus</i>	Colorado (Pillmore, 1961c).
	Montana (present work).
<i>Nematodirus spathiger</i>	Colorado (Pillmore, 1961c).
	District of Columbia, Nat. Zool. Pk. (USNM Helm. Coll. 38936).
	Montana (present work).
	New Mexico (Allen and Kennedy, 1952).
	Wyoming (Hones and Winter, 1956).
<i>Nematodirus</i> n. sp.	Montana (present work).
<i>Trichostrongylus colubriformis</i>	District of Columbia, Nat. Zool. Pk. (USNM Helm. Coll. 31385).
<i>Trichostrongylus rugatus</i>	District of Columbia, Nat. Zool. Pk. (Price, 1930).
<i>Trichostrongylus</i> sp.	Montana (present work).
<i>Oesophagostomum venulosum</i>	District of Columbia, Nat. Zool. Pk. (USNM Helm. Coll. 56895).
? <i>Oesophagostomum</i> sp. (larva)	New Mexico (Allen, 1954, 1955).
<i>Skrjabinema ovis</i>	Colorado (Olsen and White, 1949; Schad, 1959).
	Idaho (Schad, 1959).
	Montana (Schad, 1959).
	Nevada (Allen, 1964).
	New Mexico (Allen, 1955; Schad, 1959).
<i>Skrjabinema</i> ? <i>ovis</i>	British Columbia (Blood, 1963).
<i>Skrjabinema</i> sp.	Arizona (Allen, 1954; Allen and Erling, 1964).
<i>Trichuris</i> ? <i>discolor</i>	British Columbia (Blood, 1963).
	Nevada (Allen, 1964).
	New Mexico (Allen, 1955).
<i>Trichuris</i> sp.	District of Columbia, Nat. Zool. Pk. (USNM Helm. Coll. 29190, 56896).
	Idaho (Quortrup and Sudheimer, 1944).
	Montana (Couey, 1950).
	Wyoming (Hones and Scott, 1942; Hones and Winter, 1956).
Lungworms	
<i>Dictyocaulus viviparus</i>	Alberta (Cowan, 1951).
<i>Protostrongylus frosti</i>	Wyoming (Hones, 1942b; Hones and Winter, 1956).
<i>Protostrongylus rushi</i>	Colorado (Pillmore, 1959, 1961a, b).
	Montana (Couey, 1950; Marquardt and Senger, 1956).
	Wyoming (Dikmans, 1943; Hones, 1942b; Hones and Scott, 1942; Hones and Winter, 1956).
<i>Protostrongylus stilesi</i>	Alberta (Cowan, 1951).
	British Columbia (Cowan, 1951; Blood, 1963).
	Colorado (Dikmans, 1931, 1935; Pillmore, 1959, 1961a, b).
	Idaho (Quortrup and Sudheimer, 1944).
	Montana (Rush, 1932; Marsh, 1938; Couey, 1950; Marquardt and Senger, 1956).
	Wyoming (Dikmans, 1935; Mills, 1937; Hones and Scott, 1942; Hones and Winter, 1956).
	Nevada (Allen, 1962, 1964).
<i>Protostrongylus</i> ? <i>stilesi</i>	
Abdominal worm	
<i>Setaria cervi</i>	District of Columbia, Nat. Zool. Pk. (USNM Helm. Coll. 29193).
ARTHROPODS	
<i>Psoroptes equi</i> var. <i>ovis</i>	See text.
(<i>P. cervinae</i> , <i>P. communis ovis</i> , <i>Psoroptes</i> sp.)	
<i>Dermacentor albipictus</i>	Arizona (Bishopp and Trembley, 1945; Allen, 1960; Allen and Erling, 1964).
	British Columbia (Cowan, 1951; Blood, 1963).
	Colorado (Spencer, 1943).
	Montana (present work).
	New Mexico (Allen and Kennedy, 1952; Allen, 1954, 1955).
	Wyoming (Mills, 1937; Hones and Winter, 1956).
<i>Dermacentor hunteri</i>	Arizona (Bishopp, 1912; Bishopp and Wood, 1913; Bishopp and Trembley, 1945; Cooley, 1938; Allen, 1954; Allen and Erling, 1964).
	Nevada (Allen, 1962; Brinton and Kohls, 1963).
	Sonora (Cooley, 1938).
<i>Dermacentor venustus</i> (<i>D. andersoni</i>)	British Columbia (Cowan, 1951).
	Colorado (USNM Helm. Coll. 31162).
	Montana (present work).
	Wyoming (Hones and Winter, 1956).
<i>Otobius megnini</i>	British Columbia (MacNay, 1955, 1956; Gregson, 1956; Blood, 1963).
(<i>Ornithodoros megnini</i>)	Colorado (Pillmore, 1961c).
	Montana (Cooley and Kohls, 1944).
<i>Bovicola jellisoni</i>	New Mexico (Allen and Kennedy, 1952; Allen, 1954, 1955).
	Alberta (Emerson, 1962).
	Montana (Emerson, 1962).
	British Columbia (Hopkins, 1960).
<i>Bovicola ovis</i>	Idaho (Quortrup and Sudheimer, 1944).
<i>Oestrus ovis</i>	Montana (Couey, 1950; Capelle, 1966).
	Wyoming (Scott, 1942; Hones and Scott, 1942; Hones and Winter, 1956).

mite

ticks

soft bodied ticks

Mallophagan species

sheep lice

tion of a detailed checklist (Table III) indicating the geographic distribution, with references, of the parasites of *O. canadensis*. Two relatively recent reports listed 34 species of parasites from this host (Allen, 1961; Buechner, 1960). These reports do not consider distribution and are largely based on Honess and Winter (1956), with the exception of lungworms which are historically covered in great detail by Buechner (1960). A checklist, such as the one included herein, indicating distribution of the parasites is valuable in making specific determinations and ascertaining the local role *O. canadensis* may play in parasitic diseases of domestic and wild ruminants.

The information in the checklist was obtained from (1) the Host Catalogue and the Parasite-Subject Catalogue of the Index-Catalogue of Medical and Veterinary Zoology; (2) the U. S. National Museum Helminthological Collection; (3) published papers; and (4) the heretofore mentioned findings. The references cited for a few parasites in the geographical distribution column are incomplete and additional articles exist reporting these parasites from the same state. The U. S. National Museum Helminthological Collection Numbers are used as the authority for reporting some parasites and localities. These indicate that specimens of the parasites have been collected in the localities named, are on deposit in the Collection, and that no published reports giving this information were known to the authors. The common names of most of the parasites in the checklist and their specific locations in the host are indicated elsewhere (Becklund, 1964).

Two parasites were omitted from the checklist. *Eimeria pallida* Christensen, 1938, was reported from *Ovis canadensis* in Wyoming by Honess and Scott (1942), but was not included in subsequent reports on the parasites of this host (Honess, 1942a; Honess and Winter, 1956); therefore, it was omitted. *Ostertagia grühneri* Skrjabin, 1929, was reported in *Ovis canadensis* in Idaho by Dikmans (1942) and by Quortrup and Sudheimer (1944). These reports are apparently based on one flattened male, USNM Helm. Coll. 46560, which was reexamined in the light of finding *Ostertagia ostertagi* in *Ovis canadensis* in British Colum-

bia and Montana and found to be *Ostertagia ostertagi*.

Nematodirus archari Sokolova, 1948, was described from males collected from the argali, *Ovis ammon*, in the Chu-Iliskie Mountains, Alma-Atinskaia Oblast, Kazakhstan, USSR. According to the Index-Catalogue of Medical and Veterinary Zoology, *Nematodirus archari* has been reported from *Ovis ammon* and "kozerog," probably *Capra sibirica*, in Kirghiz, from sheep in the Dzhabbul Region, Betpak-Dala, and Kzyl-Ordinsk Oblast, and from sheep and goats in Alma-Atinskaia and Caspian region. These localities are between the Caspian Sea and China. The specimens recovered during this study correspond with the description of *Nematodirus archari*, except that the bursal margin between the dorsal rays is greatly indented and the spicule lengths in 10 males from four hosts ranged from 0.73 to 0.83 mm. The illustration with the description of *N. archari* indicates that the bursal margin between the dorsal rays is not indented and the spicule lengths are given in the description as 0.813 to 0.936 mm. Spicules of *N. archari* are curved ventrally to almost a right angle near the terminal end and this characteristic makes this species relatively easy to distinguish under low magnification from the other species of *Nematodirus* reported from *Ovis canadensis*.

Nematodirus davtiani Grigorian, 1949, was identified from one sheep (No. 16, Table II) from Wildhorse Island. Becklund (1966) recently determined that *N. rufaevastitatis* Durbin and Honess, 1951, which was collected from *Ovis aries* in Wyoming, is a synonym of *N. davtiani*. This species was first collected from the bezoar goat, *Capra aegragrus*, in Armenia, and has also been reported from *Ovis ophion armeniana* in Armenia, from *Capra cylindricornis* and *Rupicapra caucasica* in Azerbaidzhan, and from sheep and goats in the Aktyubinsk region of Kazakhstan.

Although *Nematodirus archari* and *N. davtiani* are also parasites of domestic sheep and goats in the USSR, and these animals apparently have given several species of nematodes a cosmopolitan distribution, it is unlikely that the occurrence of these two nematodes in North America can be attributed to the transportation of domestic ruminants from Eurasia. More than likely, these nematodes came with

the ancestor across the land period. One also occurs in *O. dalli* which was introduced into British Columbia.

The common name of *Nematodirus ovis* (Hering, 1907) is reported under several names on maps during the last century. It is the same species or whether more than one (Buechner, 1960) coincided with sheep. Early reports of the parasite from domestic mountain sheep reported from Colorado. Additional localities found are in Wyoming (Ward, 1911; National Museum Coll. 15142, 24996, 26581, 27900) (Honess and Winter, 1956).

A comparison in the checklist of domestic sheep parasites (Becklund, 1966) shows that although different parasites of sheep concurrently range forage the same field of the year. The depletion of sheep by drought in summer was reduced the range of the latter by where the land at different times that some

the ancestors of *Ovis canadensis* from Eurasia across the land bridges during the Pleistocene period. On this basis, these nematodes may also occur in other wild sheep in Eurasia, and in *O. dalli* which ranges from Alaska southward into British Columbia.

The common scab mite, *Psoroptes equi* var. *ovis* (Hering, 1838) Gervais, 1841, has been reported under various scientific and common names on mountain sheep in several localities during the last century. It is uncertain whether the species which occurs on mountain sheep is the same as the species on domestic sheep, or whether mountain sheep are infested with more than one species. Based on early reports (Buechner, 1960), the first occurrence of scabies on mountain sheep in several localities coincided with the introduction of domestic sheep. Early workers concluded that the scabies of the mountain sheep was contracted from domestic sheep, and that the scabies was responsible for observed mortality losses in mountain sheep populations. Early workers reported scabies on mountain sheep in California, Colorado, and Oregon. Supplementary information supporting these early reports and additional localities where the disease has been found are Alberta (Cowan, 1951), Colorado (Ward, 1915; Potts, 1938), District of Columbia, National Zoological Park (USNM Helm. Coll. 15142 and 15571), Idaho (USNM Helm. Coll. 24996), Montana (USNM Helm. Coll. 26581, 27907, and 55217, and Wyoming (Honest and Winter, 1956).

A comparison of the 51 species of parasites in the checklist with those reported from domestic sheep and cattle in North America (Becklund, 1964), reveals that 70% are also parasites of domestic sheep and 35% of cattle. Although domestic sheep and cattle do not concurrently compete with mountain sheep for range forage, they do apparently compete for the same forage separately at different times of the year. According to Buechner (1960), the depletion of the winter forage of mountain sheep by domestic sheep and cattle during the summer was one of the main factors that reduced the mountain sheep populations during the latter half of the last century. In regions where the animals graze on the same range land at different times of the year, it is likely that some species of nematodes are inter-

changed between mountain sheep and domestic sheep and cattle. It is also possible that the interchange of parasites may enhance the worm populations in all three hosts. Range forage, contaminated with helminth eggs from domestic sheep and cattle during the summer, may be ingested with the resulting infective larvae by mountain sheep in the fall as they migrate to their winter areas over land recently grazed by domestic sheep and cattle. Conversely, nematodes overwintering in mountain sheep may, in the spring, contaminate forage that is eaten by domestic sheep and cattle during the summer.

LITERATURE CITED

- ALLEN, R. W. 1954. Parasites harbored by bighorn sheep in New Mexico and Arizona. Rept. Conf. Parasites and Parasitic Dis. Domestic Ruminants. (State College, Montana, Sept., p. 15.)
- . 1955. Parasites of mountain sheep in New Mexico, with new host records. *J. Parasit.* **41**: 583-587.
- . 1960. Diseases and parasites of Barbary and bighorn sheep in the Southwest. 4 Ann. Meet. Desert Bighorn Council, Las Cruces, N. M., 5-8 April, p. 17-22.
- . 1961. Methods of examining bighorn sheep for parasites. 5 Ann. Meet. Desert Bighorn Council, Hermosilla, Mexico, 4-7 April, p. 75-79.
- . 1962. Parasitism in bighorn sheep on the Desert Game Range in Nevada. 6 Ann. Meet. Desert Bighorn Council, Grand Canyon, Ariz., 3-5 April, p. 69-71.
- . 1964. Additional notes on parasites of bighorn sheep on the Desert Game Range in Nevada. 8 Ann. Meet. Desert Bighorn Council, Mexicali and Puerto San Felipe, Mex., 7-9 April, p. 5-9.
- , AND H. G. ERLING. 1964. Parasites of bighorn sheep and mule deer in Arizona, with new host records. *J. Parasit.* **50** (3, sec. 2): 38.
- , AND C. B. KENNEDY. 1952. Parasites in a bighorn sheep in New Mexico. *Proc. Helm. Soc. Wash.* **19**: 39.
- BECKLUND, W. W. 1964. Revised check list of internal and external parasites of domestic animals in the United States and possessions and in Canada. *Am. J. Vet. Res.* **25**: 1380-1416.
- . 1966. Suppression of *Nematodirus rufae-vastitatis* Durbin and Honest, 1951, a nematode described from *Ovis aries*, as a synonym of *Nematodirus davtiani* Grigorian, 1949. *Proc. Helm. Soc. Wash.* **33**: 199-201.
- BISHOPP, F. C. 1912. A new species of *Derma-centor* and notes on other North American Ixodidae. *Proc. Biol. Soc. Wash.* **25**: 29-37.
- , AND H. L. TREMBLEY. 1945. Distribu-

- tion and hosts of certain North American ticks. *J. Parasit.* **31**: 1-54.
- , AND H. P. WOOD. 1913. The biology of some North American ticks of the genus *Dermacentor*. *Parasitology* **6**: 153-187.
- BLOOD, D. A. 1963. Parasites from California bighorn sheep in southern British Columbia. *Can. J. Zool.* **41**: 913-918.
- BRINTON, E. P., AND G. M. KOHLS. 1963. New distributional and host data for the tick *Dermacentor hunteri* Bishop. *Great Basin Nat.* **23**: 166.
- BUECHNER, H. K. 1960. The bighorn sheep in the United States, its past, present, and future. *Wildl. Monographs*, No. 4, 174 p.
- CAPELLE, K. J. 1966. The occurrence of *Oestrus ovis* L. (Diptera: Oestridae) in the bighorn sheep from Wyoming and Montana. *J. Parasit.* **52**: 618-621.
- COOLEY, R. A. 1938. The genera *Dermacentor* and *Otocentor* (Ixodidae) in the United States, with studies in variation. *Natl. Inst. Hlth. Bull.* No. 171, Washington, D. C., 89 p.
- , AND G. M. KOHLS. 1944. The Argasidae of North America, Central America, and Cuba. *Am. Midl. Nat. Monograph* No. 1, University Press, Notre Dame, Ind., 152 p.
- COUEY, F. M. 1950. Rocky Mountain bighorn sheep of Montana. *Bull.* No. 2, Montana Fish and Game Commission, 90 p.
- COWAN, I. MCT. 1951. The diseases and parasites of big game mammals of western Canada. *Proc. 5 Ann. Game Convnt*, 25-28 April, Vancouver, Canada, p. 37-64.
- DIKMANS, G. 1931. Two new lungworms from North American ruminants and a note on the lungworms of sheep in the United States. *Proc. U. S. Natl. Mus.* (2884), **79**: 1-4.
- . 1932. (Abstract of a report before *Proc. Helm. Soc. Wash.*) *J. Parasit.* **19**: 83-84.
- . 1934. New records of helminth parasites. *Proc. Helm. Soc. Wash.* **1**: 63-64.
- . 1935. A note on *Protostrongylus stilesi* (Nematoda: Metastrongylidae) from the mountain sheep, *Ovis canadensis*, in Yellowstone National Park, Wyoming. *Proc. Helm. Soc. Wash.* **2**: 84.
- . 1942. New host-parasite records. *Proc. Helm. Soc. Wash.* **9**: 65.
- . 1943. The lungworm, *Protostrongylus rushi* Dikmans, 1937, of the mountain sheep, *Ovis canadensis*. *Proc. Helm. Soc. Wash.* **10**: 8-9.
- EMERSON, K. C. 1962. A new species of *Mallophaga* from the bighorn sheep. *J. Kansas Ent. Soc.* **35**: 369-370.
- FORRESTER, D. J., AND C. M. SENCER. 1964. A survey of lungworm infection in bighorn sheep of Montana. *J. Parasit.* **28**: 481-491.
- GREGSON, J. D. 1956. The Ixodoidea of Canada. Publication 930, Canada Dept. Agr., Ent. Div., 92 p.
- HONESS, R. F. 1942a. Coccidia infesting the Rocky Mountain bighorn sheep in Wyoming with descriptions of two new species. *Univ. Wyoming Agr. Exp. Sta. Bull.* **249**, 28 p.
- . 1942b. Lungworms of domestic sheep and bighorn sheep in Wyoming. *Univ. Wyoming Agr. Exp. Sta. Bull.* **255**, 24 p.
- , AND J. W. SCOTT. 1942. *Zoology Dept. 51 Ann. Rept. Wyoming Agr. Exp. Sta.* 1940-1941, p. 27-28.
- , AND K. B. WINTER. 1956. Diseases of wildlife in Wyoming. *Bull.* 9, Wyoming Game and Fish Comm., 279 p.
- HOPKINS, G. H. E. 1960. Notes on some Mallophaga from mammals. *Bull. Brit. Mus. (Nat. Hist.) Ent.* **10**: 75-95.
- MACNAY, C. G. 1955. Summary of important insect infestations, occurrences, and damage in Canada in 1954. *85 Ann. Rept. Ent. Soc. Ontario* 1954, p. 61-91.
- . 1956. Summary of important insect infestations, occurrences, and damage in Canada in 1955. *92 Ann. Rept. Ent. Soc. Ontario* 1955 **86**: 104-127.
- MARQUARDT, W. C., AND C. M. SENCER. 1956. Lungworms in the bighorn sheep of Montana. *Proc. Helm. Soc. Wash.* **23**: 68-69.
- MARSH, H. 1938. Pneumonia in Rocky Mountain bighorn sheep. *J. Mammal.* **19**: 214-219.
- MILLS, H. B. 1937. A preliminary study of the bighorn of Yellowstone National Park. *J. Mammal.* **18**: 205-212.
- OLSEN, O. W., AND C. E. WHITE. 1949. Colorado bighorn sheep, a new host of the sheep pin worm *Skjabinema ovis*. *J. Colorado-Wyoming Acad. Sci.* **4**: 64-65.
- PILLMORE, R. E. 1959. The known distribution of lungworm (*Protostrongylus*) infections in Colorado. *J. Colorado-Wyoming Acad. Sci.* **4**: 60.
- . 1961a. Comparative studies of infection intensities in wild and laboratory populations. *Quar. Rept. Colorado Dept. Game and Fish, Oct.*, p. 87-97.
- . 1961b. Experimental transmission of lungworm infection. *Quar. Rept. Colorado Dept. Game and Fish, Oct.*, p. 71-73.
- . 1961c. General investigations of diseases and parasites. *Quar. Rept. Colorado Dept. Game and Fish, Oct.*, p. 101-102.
- PORTER, D. A. 1942. Incidence of gastrointestinal nematodes of cattle in the southeastern United States. *Am. J. Vet. Res.* **3**: 304-308.
- POTTS, M. K. 1938. Observations on diseases of bighorn in Rocky Mountain National Park. *Trans. 3 N. Am. Wildl. Conf.*, p. 893-897.
- PRICE, E. W. 1930. The occurrence of *Trichostrongylus rugatus* Mönnig in a mountain sheep. (Abst. of a rept. before *Helm. Soc. Wash.*, 19 Sept. 1929.) *J. Parasit.* **16**: 161.
- QUORTRUP, E. R., AND R. L. SUDHEIMER. 1944. Some wildlife cases of particular interest. *J. Am. Vet. Med. As.* **104**: 29.
- RUSH, W. M. 1932. Northern Yellowstone elk study. *M* 131 p.
- SCHAD, G. / America: (Nematoc) Wash. **2**
- SCOTT, J. W. / cies of Anat. Re

- study. Montana Fish and Game Commission, 131 p.
- SCHAD, G. A. 1959. A revision of the North American species of the genus *Skryabinema* (Nematoda: Oxyuroidea). Proc. Helm. Soc. Wash. **26**: 138-147.
- SCOTT, J. W. 1941. A new genus and new species of tapeworm from the bighorn sheep. Anat. Rec. **81** (Suppl.): 65-66.
- . 1942. *Oestrus ovis* in the Rocky Mountain bighorn, *Ovis canadensis*. J. Mammal. **23**: 345-346.
- SPENCER, C. C. 1943. Notes of the life history of Rocky Mountain sheep in the Tarryall Mountains of Colorado. J. Mammal. **24**: 1-11.
- WARD, H. B. 1915. Otacariasis in the bighorn. J. Parasit. **1**: 121-127.