CANADIAN WILDLIFE SERVICE

PATHOLOGY SECTION

BIGHORN SHEEP INVESTIGATION

Part 1 - Field study (Kootenay National Park)

Part 2 - Laboratory study (Section's laboratory Ottawa)

Bighorn Sheep Investigation

Part 1

Field study -- Kootenay National Park

On October 11, 1966, Dr. Eric Broughton, with Mr. John Stelfox, proceeded from Edmonton, Alberta, to Kootenay National Park to investigate apperent disease in the bighorn sheep of the Sinclair Pass area. Dr. Broughton spent eight days in the area.

Recent reports from the residents of the area indicated many of the sheep were coughing and appeared to be in poor health.

There were approximately 30 sheep in the Radium area when Dr. Broughton and Mr. Stelfox arrived. A few of these sheep did have a cough - harsh, dry and unproductive - almost a bark. These animals were also in poor body condition.

It was decided to attempt the capture of some of the worst looking individuals using the CO2 gun and succinylcholine chloride ("Anectine") as a tranquilizer. Following capture they were to be taken to the sheep trap and held in a shed adjecent to the trap and given a course of treatment with antibiotics ("Combiotic" - Pfizer).

A heavy snowfall prevented Dr. Broughton and Mr. Stelfox from taking any animals the first day they were in the Park (Wednesday, October 12). The next day the first attempt resulted in the death of the animal as a result of too high a dosage of the tranquilizer. The animal was taken to the Park compound where Dr. Broughton conducted the autopsy. The animal was a lactating female weighing 127 pounds in fair body condition.

The thoracic cavity was examined first. There was little normal lung tissue left. There was a large amount of hepatization in the dependent lobes of the lung. Large areas of consolidation involved much of the remaining lung tissue and a few area of emphysema. There were many adhesions between the lungs and the rib cage.

The extensive lung damage was probably the reason for the animal dying from the tranquilizer. "Anectine" depresses the respiratory center and with so little normal lung the animal was unable to prevent anoxia.

No lungworms were seen in the portion of the lung examined.

The liver was normal except for the presence of a few scars as a result of parasitic infection.

A few petechial haemorrhages were observed on the heart and the borders of the spleen.

The remaining body organs showed no abnormalities.

The following tissues were retained for laboratory examination: lung, liver lesions, blood, nasal and tracheal mucous.

Four animals were caught and treated. Three were captured following tranquillization and one in the sheep trap.

Initial temperatures were taken of all animals and then the temperature of each animal was taken daily. The initial temperature of all animals was around 104oF. probably due to excitation of being captured. Subsequent temperatures ranged from 100.5 to 101.5oF.

Based on the approximate weight of the animal the dosage of "Combiotic" was 6 to 7 ml given intramuscularly. "Combiotic" is a penicillin-streptomycin combination containing 200,000 units of penicillin per ml and 0.25 gm of streptomycin per ml. The above dosage was administered twice per day for a period of four days.

The animals were tagged to permit identification if they should be caught again following their release.

A total of five animals, one ram, three ewes and one lamb died as a result of tranquilization. The effect of the drug ("Anacotine") was no doubt compounded by the chronic lung condition. These animals were all in poor condition and had frequent coughing spasms.

Except for the first dead animal which was examined in the Park compound, the remaining animals were skinned and the heart and limbs removed and the carcasses frozen.

In view of the high mortality associated with the use of the tranquilizer "Anacotin" it was felt that trapping would be a better method of capturing the sheep. An enclosure was constructed within the trap connected to the shed so that the animals being treated would act as decoys to bring other sheep into the trap.

The effectiveness of this plan was not determined before Dr. Broughton and Mr. Stelfox returned to Edmonton because of power and telephone or ws replacing storm disrupted lines in the immediate area of the trap.

The carcasses were packed in ice for the trip to Edmonton. On arrival there they were placed in a freezer until shipped to Ottawa.

A report from the Department of Agriculture laboratory at Lethbridge, Alberta, where three carcasses had been sent prior to Dr. Broughton's visit to Kootenay was available upon his return to Edmonton. The result of the sensitivity test indicated that the bacterial organism (Pasteurella sp.) isolated was r sistant to "Combiotic". Chloromycetin was sent to the Park warden at Sinclair Pass for administration to the sheep. Park warden Winkler had been shown how to administer th antibiotics and had been giving the treatment to the sheep under Dr. Broughton's supervision before he and Mr. Stelfox left the Park.

Discussion and conclusion

Dr. Broughton reports that from his observation of some 30 sheep in the Radium Hot Springs area the majority of the animals appeared to be in good condition. Several animals were in poor physical condition and these were the animals which were usually observed coughing. The cough is dry, non-productive, somewhat like a bark in quality. The coughing spasm may last two to three minutes and causes the animal a great deal of distress.

On the basis of the result of postmortem examinations, Dr. Broughton does not believe that this is a new disease outbreak. He is of the opinion this is probably a chronic pneumonic condition probably initiated last winter.

Dr. Kelsall arranged a meeting with the Director of the Alberta Fish and Wildlife Division, Mr. J. B. Smith, and two of his biologists, Mr. G. Kerr and Mr. W. Wishart. Representing the Canadian Wildlife Service were Dr. Kelsall, Mr. Stelfox and Dr. Broughton. Dr. E. Gilchrist represented the Alberta Veterinary Laboratory of the provincial department of agriculture.

Mr. Smith was quite concerned about the health status of the bighorn in the Kootenay National Park area in particular and in the rest of the adjacent National parks in general. He was worried that the condition may involve th bighorn sheep

in Alberta. He felt there was an immediate need for transmission trials to prove or disprove the contagiousness of the condition.

Dr. Broughton pointed out that at the present time a specific disease agent could not be incriminated and until we had one, transmission trials would be worthless.

Dr. Broughton suggested that it might be of value to conduct postmortem examination on a number of bighorn sheep from various parts of Alberta. The animals could be brought alive to the Alberta Veterinary Laboratory where they could be examined to determine their general health status.

Bighorn Sheep Investigation

Part II

Laboratory examinations

A total of six intact carcasses and two sets of lungs were examined at the Canadian Wildlife Service Pathology Section laboratory in Ottawa.

All of these animals were taken in the Radium Hot Springs area of the Kootenay National Park. Death in all cases was due to accidental or deliberate overdosage with succinylcholine chloride ("Anectine").

The examinations were done by Dr. Eric Broughton, D.V.M., M.Sc., and Dr. G.G. Gibson, Ph.D.

1- First ewe killed and examined at Kootenay National Park

See Part I of report for result of postmortem examination.

Material examined: lung tissue

Bacteriology: No bacteria of pathogenic significance were isolated from the lung portion.

Parasitology: A few lungworm larvae were found in the tissue.

2- Ewe

Case history: Observed coughing. Animal failed to recover from tranquilization. Died October 15, 1966.

Postmortem findings: Extensive pleural adhesions involving the right diaphragmatic lobe of the lung. Multipl areas of congestion and emphysema involving both major lobes of the lungs. Hepatization along the ventral borders of both diaphragmatic lobes and almost complete hepatization of the apical and cardiac lobes.

No abnormalities were seen in the rest of the cadaver.

The carcass was in good general condition with a fair amount of body fat.

Bacteriology: No significant bacteria were isolated from the lungs, liver, spleen or kidney.

Parasitology:

Organs	Parasitic load	Species
Liver, heart, serosae, reticulum	negative	
Lungs	Numerous fragments of nematodes	Protostrongylus stilesi
	Lungworm larvae (abundant)	P. stilesi
Omasum and Abomasum	611 nematodes	Marshallagia marshalli Nematodirus spathiger
Small intestine	1250 nematodes	N. spathiger N. davtiani N. filicollis M. marshalli
Colon and caecum	15 whipworms	Trichuris sp. (probably T. ovis)
Faeces	coccidian oocysts	Eimeria arloingi

3- Ewe

Case history: Animal in very poor shape, frequent spells of coughing. Was nursing a lamb also in poor shape. Failed to recover from tranquilization. Died October 15, 1966.

Postmortem findings: Extensive areas of con estion and emphysema present throughout the lungs. There was a marked border of hepatization along the ventral margins of the diaphragmatic lobes.

A large abscess occupied most of the apical lobe.

There was an increased amount of fluid in the pericardial sac.

Two fibrotic lesions were noted in the liver.

No abnormalities were seen in the rest of the carcass.

The carcass was extremely thin with very little body fat present.

Bacteriology: Examination of the lung tissue, pericardial fluid, liver, spleen and kidney were negative for pathogenic bacteria.

A Gram stained smear of the abscess material revealed many Gram positive rods and cocci. Corynebacterium pyogenes and Micrococci spp. were isolated from the lung abscess.

Parasitology:

Organs	Parasitic load	Species
Left ear	4 ticks	
Right ear	11 "	Ornithodoros megnini (syn. of Otobius megnini)
Liver, heart brain, serosae, sinuses, reticulum	negative	
Lungs	few lungworm larvae	Protostrongylus stilesi
Abomasum	157 nematodes	Marshallagia marshalli
Omasum	a few nematodes	Marshallagia marshalli
Small intestine	327 nematodes	Nematodirus spathiger N. davtiani N. filicollis M. marshalli
Caecum	1 nematode	Skrjabinema ovis
Colon	4 nematodes	Trichuris sp. (T. ovis ?)
Faeces	coccidian oocysts	Eimeria ahsata E. crandallis E. arloingi

4- Lamb (of preceding ewe)

Case history: Animal in very poor shape - frequent coughing spells. Failed to survive tranquilization. Died October 15, 1966.

Postmortem findings: Extensive pleural adhesions involving both diaphragmatic lobes. Multiple areas of congestion and emphysema. Extensive hepatization along the ventral borders of the major lobes.

A large abscess involved the entire apical lobe. There was another large abscess in the dorsal tip of the right dia-

phragmatic lobe. Numerous small abscesses were present throughout the lung tissue.

The pericardial sac was thickened and was fused to the apical lobe of the lung. The pericardial fluid was increased in amount and was sero-sanguineous in appearance.

The rest of the carcass was free of other abnormalities.

The carcass was emaciated with very little body fat present.

Bacteriology: A Gram stained smear of the abscess material revealed many Gram positive short rods.

Corynebacterium pyogenes was isolated from a number of abscesses and also from normal appearing lung tissue. Escherichia coli was isolated from the kidney.

No bacteria were isolated from the liver, spleen or pericardial fluid.

Parasitology:

Organ	Parasitic load	Species
Heart, liver, serosae, reticulum, omasum	negative	
Lungs	fragments nematodes	probably P. stilesi
	few nematode larvae	" "
Abomasum	6 nematodes	Marshallagia marshalli
Small intestine	6 nematodes	N. filicollis
	12 nematode larvae	Nematodirus sp.
Caecum	2 whipworms	Trichuris sp. (T. ovis ?)
Colon	1 "	" " "
Faeces	coccidian oocysts	Eimeria arloingi

5- Ram

Case history: Died October 18, 1966, as a result of a fall following tranquilization.

Postmortem findings: Several areas of congestion nd emphysema involved the apical and diaphragmatic lobes. There was a narrow border of hepatization along the ventral edge

of the major lobes.

Several large blood clots were present in the thoracic cavity.

There were extensive haemorrhagic areas on the diaphragm and serosal surface of the intestinal tract. There was a large blood clot in the abdominal cavity. The right kidney was ruptured and was the source of the blood in the abdominal cavity.

Liver: Two small fibrotic areas.

Except for numerous bruises in the subcutaneous tissues the rest of the carcass was norm l.

The carcass was well fleshed with a good deposition of body fat.

Bacteriology: No significant bacteria were isolated from the lungs, liver, spleen, kidney or pericardial fluid.

Parasitology:

Organ	Parasitic load	Species
Liver, heart, serosae, reticulum	negative	
Lungs	few nematode larvae	Protostrongylus stilesi
Omasum and abomasum	155 nematodes	Marshallagia marshalli
Small intestine	several hundred nematodes	Nematodirus spp.
Caecum and colon	4th stage larval nematode	Capillaria sp.
Faeces	coccidian oocysts	Eimeria parva E. arloingi
	amoeba cysts	Entamoeba sp.

6- Ewe

Case history: This animal had been observed for 10 days in the area of Blakely's Motel, Radium Hot Springs. The ewe had frequent severe spells of coughing and also had a profuse nasal discharge. Because the animal was in very poor physical shape it was killed by a deliberate overdose of tranquilizer on November 1, 1966.

Postmortem examination: This examination was done at Radium Hot Springs and from the description given it would appear that the lungs were similar in appearance to the other animals examined.

The lungs were sent to Ottawa but were in very poor shape when they were examined because of postmortem degeneration.

Bacteriology: Escherichia coli was isolated from the lungs but because of their condition it is probably a postmortem tissue invader and of little significance in this particular case.

Parasitology: Because of the objectionable odour the lung was not thoroughly examined for lungworms, larvae or adults. However, a few nematode larvae identified as *P. stilesi* larvae were noted.

Because of the advanced stage of decomposition, the digestive tract was not examined.

7- Ewe

Case history: This animal had only one eye and was in poor physical condition. It was killed by a deliberate dosage of tranquilizer.

Postmortem findings: Extensive pleural adhesions involving both diaphragmatic lobes of the lungs. There were many areas of congestion and emphysema in all lobes of the lungs. There was a zone of hepatization along the ventral borders of the diaphragmatic lobes.

A large abscess occupied almost all of the apical lobe.

No abnormalities were observed in the rest of the carcass.

The carcass was in poor condition with very little body fat present.

Bacteriology: A Gram stained smear of the abscess material yeilded a few Gram negative rods and a few Gram positive rods.

Pseudomonas aeruginosa was isolated from the lungs, pericardial fluid, liver, spleen, kidney and the lung abscess. In addition, Corynebacterium pyogenes was also isolated from the lung abscess.

Parasitology:

Organ	Parasitic load	Species
Heart, liver, brain, sinuses reticulum	negative	
Left ear	31 ticks	Ornithodoros megnini
Right ear	49 "	
Omentum	1 cysticercus	Cysticercus tenuicollis
Lungs	fragments nematode numerous larvae	Protostrongylus stilesi P. stilesi
Omasum	5 nematodes	Marshallagia marshalli
Abomasum	331 nematodes	Ostertagia circumcincta Marshallagia marshalli
Duodenum	1447 nematodes	Nematodirus filicollis Marshallagia marshalli
Jejunum-ileum	41 nematodes	Nematodirus, Ostertagia and Marshallagia
Caecum	5 nematodes	as above
Colon	2 nematodes	Trichuris sp. (T. ovis ?)
Faeces	coccidian oocysts (abundant)	Eimeria parva E. crandallis E. faurei E. arloingi Eimeria sp. (E. ninakohlyakimovi (?)

8- Ewe

Case history: This animal was in good condition but had frequent bouts of coughing. It failed to recover from tranquilization and died Nov. 4, 1966.

Postmortem findings: There were areas of congestion and emphysema in all lobes of the lungs. There was almost complete hepatization of the apical lobe.

There were no abnormalities in the rest of the carcass which was in good condition with large deposits of body fat.

Bacteriology: No significant bacteria were isolated from the lungs, liver, spleen or kidney.

Parasitology:

Organ	Parasitic load	Species
Heart, liver, reticulum, omasum, caecum		
Lungs	numerous nematode fragments	Protostrongylus stilesi
	nematode larvae abundant	P. stilesi
Abomasum	386 nematodes	Marshallagia marshalli Ostertagia circumcincta Nematodirus davtiani Nematodirus spathiger
Small intestine	80 nematodes	Nematodirus filicollis Marshallagia marshalli
	600 larval nematodes	Nematodirus sp.
Colon	1 nematode	Trichuris sp. (?T. ovis)
Faeces	coccidian oocysts (abundant)	Eimeria ahsata E. arloingi E. crandallis E. (?ninakohlyakimovi) E. parva

Discussion

Postmortem findings

The lung lesions in the majority of the sheep examined indicate a chronic long standing pneumonia. This suggests that the lung damage was initiated sometime before they came down to the winter range this fall.

Bacteriology

The bacteriological examination of bighorn sheep by various laboratories (in British Columbia, the Animal Diseases Research Institute (Nester,) at Lethbridge, Alberta, the Alberta Veterinary Services laboratory at Edmonton, and Canadian Wildlife Service pathology laboratory in Ottawa) has resulted in the isolation of a diverse group of organisms. Results of these examinations are listed in Table I.

The isolation of such a varied group of bacteria from the lungs of these sheep demonstrates the fact that many bacteria can be implicated in primary pneumonias and also as secondary invaders following previous insult to the lung by other agents such as viruses or parasitic helminths. This would appear to indicate that following an initial stress or adverse conditions resistance may be reduced thus permitting the initiation of lung infection by any number of bacteria. There are many circumstances under which this could happen, e.g., stress (a physiological response) due to overpopulation, competition with other ungulates, malnutrition due to food deficiency either qualitative or quantitative.

It should be borne in mind that many bacteria isolated from pneumonic lesions can be frequently isolated from the lungs of apparently healthy animals, just as undoubtedly many bighorn sheep harbour lungworms without apparent ill-effect. This emphasizes the danger of naming a condition after a bacterial isolate when we do not have proof of its role as initiator of the condition.

Parasitology

As shown in Table II, 18 species of zooparasites were recorded in bighorn sheep examined at the Service's laboratory in Ottawa. Some of these parasites were also found examined in sheep examined in British Columbia as well as at Lethbridge and Edmonton.

Coccidian oocysts were found in the faeces of the six intact animals we examined. Five species of coccidia were identified; a six species could not be identified with certainty. Eimeria arloingi was the commonest species recorded. The finding of coccidian oocysts was reported from bighorn originating in the Bull River range in British Columbia (1) as well as from one of the three sheep examined at Edmonton.

The occurrence of coccidian oocysts is not sur-

prizing as most terrestrial mammals harbour one or more coccidian species. While many species of coccidia do not seem to be pathogenic others are definitely harmful to th ir hosts. However, in the latter case the surviving hosts develops a lasting immunity. This is particularly true of animals on pasture. Clinical coccidiosis occurs in penned (or stabled) animals (e.g. dogs, cattle) exposed for the first time to a massive infection before they develop an immunity from living in a heavily contaminated environment. If coccidian species are pathogenic in bighorn sheep, it would be when they are young, and when their habits favour a heavy contamination in a relatively short period of time.

The finding of a species of amoeba in one sheep is most nteresting though undoubtedly without pathological significance.

The larval stage (Cysticercus tenuicollis) of the tapeworm Taenia hydatigena (which matures in carnivores) was found in the omentum of one animal. A similar larva was also found in the omentum of one of the sheep examined at the Edmonton laboratory of the Alberta Veterinary Services. By no means could these two animals be considered heavily contaminated.

The tapeworm Wyominia tetoni was reported as being common in bighorn in British Columbia (1). This relatively large parasite lives in the bile ducts and the small intestine of its hosts. It was not found in the sheep from Kootenay National Pa k. The presence of this parasite in the host's bile ducts can result in lesions somewhat similar to those observed in liver fluke infection in the domestic sheep, though much less severe. It is doubtful that such lesions would severely affect the health of bighorn at th t W. tetoni is an important factor in bighorn die-off.

"Heavy" infection with a species of whipworm, probably Trichuris ovis, has been reported in bighorn in British Columbia (1). Whipworm eggs were also noted in the faeces of sheep examined at Lethbridge and Edmonton. However, no attempt was made to evaluate the "weight" of the infection through an actual count of the worms present in the intestine. Trichuris sp. was found in five of the six sheep examined in Ottawa. In all cases the parasitic load was extremely light, the heaviest infection being 15 worms. Other animals (e.g. dog, domestic sheep, goat, pig) may ha bou many times this number of worms without apparent ill-effect. However, there is evidence that in some species at least, extremely heavy infections are detrimental to the host.

A species of the nematode genus Capillaria (a relative of Trichuris) and the pinworm Skrjabinema ovis were found in two sheep. In each case only one worm was found.

As shown in Table II, five species of Trichostrongyles (nematodes) were found in some of the gastric compartments (omasum, abomasum) and the small intestine of all the sheep examined. The commonest species encountered was Marshallagia marshalli which was found in all the sheep. Ova of Trichostrongyles were noted in the faeces of animals examined at Lethbridge and Edmonton but no attempts were made to determine the species involved nor the "weight" of the parasitic load. The Edmonton laboratory also reported their finding "numerous" Trichostrongyles in one of the sheep but no attempt was made to assess the parasite load. The Edmonton laboratory also reported their findging of "numerous" Haemonchus contortus (a trichostrongyle) in two of three sheep they examined but did not attempt to establish the number of worms present.

In domestic sheep, Haemonchus contortus is definitely pathogenic when present in sufficient numbers. Thus, in Eastern Canada, clinical haemonchosis occurs when sheep harbour 1,000 or more worms. This is often a fatal condition of domestic sheep in which it is the result of a "built-up" infection through grazing on heavily contaminated pastures. H. contortus is known to occur in the bighorn (2) but not in large numbers. This is undoubtedly related to their grazing over large areas thus preventing "built-up" of heavy infections. Haemonchosis does not seem to be an important factor in bighorn die-off, though it is conceivable that occasionally, under certain conditions, animals could be adversely affected.

Nothing is known of the significance of other Trichostrongyles in bighorn. It is known that domestic sheep may harbour thousands of these worms without apparent ill-effect though, under certain conditions, a verminous gastroenteritis may develop. In the bighorn examined in Ottawa, the parasitic load recorded could not be termed a heavy one when compared with the load that domestic sheep can harbour without apparent ill-effect.

The Lethbridge laboratory reported their finding of eggs of Strongyles and of Strongylus (nematodes) in the faeces of two bighorn sheep they examined. We are at a loss to explain this finding of Strongylus for as far as we know no species of this genus occur in ovines. On the other hand, the Edmonton laboratory reported "what appear to be Chabertia" in the large intestine of one sheep. This is a Strongyle which occurs in domestic sheep in which it is often associated with other nematodes, particularly hookworms, in a form of enteritis (verminous enteritis). By itself and in the relatively small number in which it usually occurs, it is doubtful that Chabertia is very significant in the domestic sheep. In the present case this finding may be an indication of contact between bighorn and domestic sheep.

Lungworms are undoubtedly important parasites of bighorn and there are probably few bighorn sheep free of these nematodes. Protostrongylus was found in all the sheep examined at Ottawa, Lethbridge and Edmonton. Lungworms have been implicated as a predisposing factor to bacterial infections resulting in pulmonary involvement and subsequent poor health or death. However, as has been pointed out, epizootiological facts and postmortem findings have not always supported the widely accepted theory regarding the aetiological role of lungworms. A recent report indicated that viruses may be involved in the bighorn pneumonic complex (3).

Conclusion

It is realized that bighorn die-offs result in pressure being brought on provincial game and park agencies to do something about a situation which many deem as catastrophic.

In our opinion the care and treatment of sick animals would be, in most cases, an undertaking which would yield very little result from the standpoint of salvaging individual animals.

We are also of the opinion that the bighorn problem is one of an ecological nature and that its solution rests with management. Dr. Bandy has already pointed out the necessity of determining the number of sheep any range can support (through an estimation of the available forage supply), the necessity of determining to what extent bighorn sheep ranges are used by other species of ungulates (domestic and wild) and the effect of such competition on the bighorn. When the carrying capacity of a range has been determined, reduction of the population excess could be undertaken either by using surplus animals to stock other ranges or by selective elimination of individuals least likely to enhance population stability. Similarly, the reduction, removal or exclusion of competing species may also be indicated. We are convinced that management based on a knowledge of bighorn ecology will be the best approach to remedy the situation.

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TABLE I

BIGHORN SHEEP - BACTERIOLOGY

Laboratory

Organ	Canadian Wildlife Service	Alberta Veterinary Services	Animal Diseases Res. Institute	British Columbia
Trachea		Pasteurella spp.		
Lungs	Corynebacterium pyogenes Pseudomonas aeruginosa Escherichia coli Micrococci	Pasteurella spp. ∝ haemolytic strepto.	P. multocida C. pyogenes	C. pyogenes P. multocida-like
Liver	Pseudomonas aeruginosa	∝ haemolytic strepto. Coliforms	Clostridium septicum	
Pericardial fluid	Pseudomonas aeruginosa Corynebacterium pyogenes	∝ haemolytic strepto.		
Spleen	Pseudomonas aeruginosa	∝ haemolytic strepto. Coliforms		
Kidney	Pseudomonas aeruginosa Escherichia coli	∝ haemolytic strepto.		Clostridium sordellii Clostridium perfringens

TABLE II

BIGHORN SHEEP - PARASITOLOGY

Canadian Wildlife Service

Species	Organ	Number of sheep
Protozoa		
Coccidia		
Eimeria arloingi	Intestine (faeces)	6
E. crandallis	" "	3
E. parva	" "	3
E. ashata	" "	2
E. faurei	" "	1
Eimeria sp. (? *ninakohlyakimovi*)	" "	1
Amoebae		
Entamoeba sp.	" "	1
Helminths		
Cestoda		
Cysticercus tenuicollis	Omentum	1
Nematoda		
Skrjabinema ovis (pinworm)	Caecum	1
Trichuris sp. (whipworm)	Caecum, colon	5
Capillaria sp.	Caecum	1
trichostrongyles		
Nematodirus filicollis	Small intestine	5
N. spathiger	Small int. Omasum and Abomasum	3
N. davtiani	Small int., Omasum	3
Marshallagia marshalli	Omasum, Abomasum, Small intestine	6
Ostertagia circumcincta	Abomasum, Small int.	2
lungworms		
Protostrongylus stilesi	Lungs	8
Arthropoda		
Ornithodoros (Otobius) megnini (spinose ear tick)	Ear	1