ABSTRACT

A Survey of Parasites of the Black Bears in Southwestern Colorado

Billy Neal Horstman*

Introduction

The realization of the importance of animal parasites as etiological agents of various diseases has stimulated investigation in all fields of parasitology. Inasmuch as bears are used to a limited extent in certain areas as food for human consumption, and inasmuch as they also live together with domestic and game animals on the summer range, the question arises as to whether they might serve as reservoir hosts for parasites of public health and veterinary importance.

In view of the few species of parasites known to occur in bears, this problem was undertaken to ascertain if additional ones might not be found in these animals in southwestern Colorado. Moreover, it was also the object of this study to learn if bears do serve as reservoir hosts for parasites that are pathogenic to game and domestic animals, to man, and to the bears themselves.

The problem

A survey of parasites of the black bears in southwestern Colorado.

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* [illegible] partial fulfillment for the degree of Master of [illegible], Colorado A & M College, Fort Collins, Colorado. July, 1949.

Problem analysis.--To collect bears from southwestern Colorado, examine them for parasites, and classify the parasites found.

Delimitation.--This problem is limited to the collection, identification, and classification of all the parasites obtained from five black bears which were collected on the Uncompahgre, Cimarron, and Blue Mesa areas on the western slope in southwestern Colorado between 20 June 1948 and 15 September 1948.

Methods and Materials

A temporary laboratory was set up in Montrose, Colorado and equipped to conduct examinations of the bears for parasites.

Five bears were examined for parasites by the decantation method, which consisted of a thorough washing of the individual parts of the various systems and organs in separate containers and a subsequent macro- and microscopic examination of the residue for parasites.

The technique used in collecting the parasites was tested prior to examination of the bears and found to be efficacious, thereby assuring recovery of all the parasites that might be present.

All parasites collected were prepared for study and classification in the zoology laboratory in Fort Collins. The parasites were stained, sectioned, and mounted according to standard methods.

Analysis of data and Summary

Examination of five bears showed only three of them to be infected with parasites. One animal was infested with ticks and two were infected with cestodes. No other parasites were found.

Ectoparasites.--Wood ticks, Dermacentor andersoni, were the only ectoparasites found. Ten adult specimens, including nine males and one female, were obtained from the neck and chest regions of one bear.

Endoparasites.--Two of the five bears were infected with cestodes, which were the only internal parasites found. One bear had five small tapeworms in the small intestine. These specimens represented two different genera. Two specimens of them were identified as immature forms of Taenia pisiformis and three as an undescribed species of Mesocestoides. This species is designated as Mesocestoides krulli n. sp.

Thirty-six fragments of a diminutive cestode belonging in the family Taeniidae, were found in the small intestine of one animal. These tapeworms do not conform to the description of any of the genera or species of the family. It is designated as Anacanthotaenia olseni n. gen., n. sp.

Insofar as known the parasites in these five bears are not of medical or veterinary importance, with the exception of D. andersoni, which is the vector of Rocky Mountain spotted fever, Colorado tick fever, tularaemia, and tick paralysis.

T H E S I S

A SURVEY OF PARASITES OF THE BLACK BEARS IN SOUTHWESTERN COLORADO

Submitted by

Billy Neal Horstman

In partial fulfillment of the requirements

for the Degree of Master of Science

Colorado

Agricultural and Mechanical College

Fort Collins, Colorado

July, 1949

COLORADO AGRICULTURAL AND MECHANICAL COLLEGE

25 July 1949

WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY BILLY NEAL HORSTMAN

ENTITLED A SURVEY OF PARASITES OF THE BLACK BEARS IN SOUTHWESTERN COLORADO

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

CREDITS 10

Committee on Graduate Work

Major Professor — Minor Professor

Head of Department — Dean of Division

Committee on Final Examination

Examination Satisfactory

David F. Morgan
Dean of the Graduate School

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TABLE OF CONTENTS

TABLE OF CONTENTS.--continued.

Chapter I

INTRODUCTION

The realization of the importance of animal parasites as etiological agents of various diseases has stimulated investigation in all fields of parasitology. Inasmuch as bears are used to a limited extent in certain areas as food for human consumption, and inasmuch as they also live together with domestic and game animals on the summer range, the question arises as to whether they might serve as reservoir hosts for parasites of public health and veterinary importance.

In view of the few species of parasites known to occur in bears, this problem was undertaken to ascertain if additional ones might not be found in these animals, especially those in southwestern Colorado. Moreover, it was also the object of this study to learn if bears do serve as reservoir hosts for parasites that are pathogenic to game and domestic animals, to man, and to the bears themselves. In addition, a list of the parasites known to occur in bears, insofar as it has been possible to ascertain, is given in the appendix.

The problem

A survey of parasites of the black bears in southwestern Colorado.

Problem analysis.--To collect bears from southwestern Colorado, examine them for parasites, and classify the parasites found.

Delimitation.--This problem is limited to the collection, identification, and classification of all the parasites obtained from five black bears which were collected in the Uncompahgre, Cimarron, and Blue Mesa areas on the western slope in southwestern Colorado between 20 June 1948 and 15 September 1948.

Setting

The bears were obtained from the following locations:

1. Blue Mesa: one animal taken one half mile west of the headwaters of Pine Creek in Gunnison County.

2. Cimarron Ridge: one animal taken from Lou Creek on the western side in Ouray County.

3. Uncompahgre Plateau: three animals taken from Escalante Creek area in Montrose County.

All the bears were taken in the Canadian Life Zone which is characterized by Engelmann spruce, Picea engelmanni, which is the predominate type of vegetation. The elevation at which the bears were taken ranged from approximately 8,500 feet to 9,500 feet above sea level.

Chapter II

REVIEW OF LITERATURE

Although bears are more or less cosmopolitan in distribution, comparatively little information is available on the parasites infecting them, as indicated by the following review of the literature.

Gmelin (18), 1790, reported the roundworm, Nematoideum ursi, from bears of the genus, Ursus, which he designated as the type host for this parasite. Diesing (9:1:551), 1851, also reported the occurrence of Nematoideum ursi in the European brown bear, Ursus arctos. Molin (39:331-358), 1860, reported the threadworm, Gongylonema contortum, from the same species of bears.

The ascarid worm, Toxascaris transfuga, has been reported from the European brown bear (9:2:330-331, 24:449, 15:35-36), the polar bear, Thalarctos maritimus, (9:2:330-331, 30:410-418, 16:351-354), the American black bear, Euractos americanus, (9:2:330-331), and the sloth bear, Melursus ursinus, (9:2:330-331).

Several species of hookworms have been reported from bears in various parts of the world. Dujardin (10:277), 1845, reported Uncinari ursi and U. ursi-maritimi, from European brown bears, and polar

bears respectively. Looss (35), 1911, reported the ursine hookworm, Ancylostoma malayanum, from bears. In 1916 Fantham, et al (12:838), and Lane (29:74-92), reported Ancylostoma malayanum from the Malayan bear, Helarctos malayanus, and from an unidentified species of bears, respectively. Stiles and Baker (49:1188), 1935, reported 2 species of hookworms, A. brasiliense and A. ceylanicum, from the sloth bear, Melursus ursinus.

The trichina worm, Trichinella spiralis, occurs in bears, as well as in other mammals, including swine and man. It was reported first in 1888 by von Bockum-Dolffs (2:167), in the "ham muscles" of a naturally infected bear killed in Germany. While von Bockum-Dolffs did not identify the species of bear in which he found the trichina, it may be presumed that it was the European brown bear, inasmuch as it is the common species on the continent. Subsequent to von Bockum-Dolffs' paper, a number of reports have been published on the occurrence of the trichina worm in polar bears, both captive and wild.

Freund (16), 1913, Böhm (3:67), 1913, and Parnell (42:111), 1934, reported the trichina worm from polar bears. It was not possible in this study, however, to determine whether the bears examined by them were captive or wild animals. Leiper (31:13),

1938, found trichina worms in 4 polar bears and Ratcliffe, according to Brown, Cronk, de Sinner, Green, Gibbons and Kuitunen-Ekbaum (5:20), 1949, found them in 6 of 7 polar bears that died in the London and Philadelphia Zoos, respectively.

Recent studies on wild polar bears showed them to be naturally infected with trichina. Thorborg, Tulinius and Roth (50:778), 1948, working in Greenland, found them in 6 of the 16 animals which they examined. Seven polar bears from Svalbard, a northern possession of Norway, examined at the Norwegian Veterinary Institute were infected with trichina (1:144). Brown, et al (5:20-21), 1949, working in the Canadian Northwest Territories, found that 2 of the 3 polar bears examined were infected with trichina. In both instances the infections were reported to be light. The latter group of workers commented on the paucity of information pertaining to the parasites of bears.

Four additional nematode parasites have been reported for bears. Stiles and Baker (49:1187), 1935, recorded the common stomach worm, Haemonchus contortus, of sheep from a polar bear in the Philadelphia Zoo. These same authors (49:1189), 1935, recorded the tracheal worm, Cyathostoma bronchiale, of ducks and geese, from a European brown bear that died in the Philadelphia Zoo.

Ruppert, according to Hutyra, Marek, and Manninger (23:446), 1938, found the large kidney worm, Dioctophyme renale, free in the abdominal cavity of a bear. Herman (22), 1944, listed bears as a host for the eyeworm, Thelazia californiensis.

The only trematode reported from bears resulted from an experimental infection with the salmon poisoning fluke, Troglotrema salmincola, of dogs, as recorded by Stiles and Baker (49:1188), 1935.

Six species of tapeworms are recorded in the literature from bears. The earliest report was that of Gmelin (18), 1790, who found in the European brown bear a parasite which he designated as Taenia ursi. Diesing (9:2:330-331), 1851, however, pointed out that this parasite was not a tapeworm but the nematode, Nematoideum ursi.

Two species of Cyclophyllidean tapeworms, namely, Taenia ursi-maritimi and T. ursina have been reported from bears. Diesing (9:1:551), 1850, and von Linstow (32:42), 1878, reported T. ursi maritimi from polar bears. Von Linstow (33:442-447, 34:772-773), 1893 and 1894, Leuhe (36:42), 1894, and Braun (4:1236), 1895, reported T. ursina from European brown bears. One of these bears (33:442-447), 1893, originated in Russia but

died later in the Copenhagen Zoological Gardens; the origin of the other bears was not given in the literature available.

Several species of Pseudophyllidean tapeworms have been reported from bears. These species include members of the families Ptychobothriidae and Diphyllobothriidae. Foot (14:201-207), 1865, and von Linstow (32:42), 1878, reported Bothriocephalus sp. (Ptychobothriidae) from polar bears. Foot's specimen died in the Dublin Zoo; although information on the source of von Linstow's specimen was not available, it is probable that it too, was a captive bear. Landois (28:281-290), 1877, found in the European brown bear a tapeworm which he named Bothriocephalus ursi.

The broad fish tapeworm, Diphyllobothrium latum, (Diphyllobothriidae), has been found in bears in Yellowstone National Park, according to Scott and Honess (47:76), 1934. Scott (46:77), 1934, also found D. cordatum in bears from the same locality. These authors did not state what species of bears were examined. Skinker (48), 1935, reported D. latum from American black bears in Yellowstone Park. Olsen (41), 1949, collected segments of a Pseudophyllidean cestode, which he identified as D. latum, from a polar bear in Como Park, St. Paul, Minnesota.

Another cestode, Pentorchis sp., of the family Dilepididae, was recorded by Stiles and Baker (49:1186), 1935, from the Malayan bear, Helarctos malayanus.

The only protozoan parasite known to occur in bears is Babesia sp., which infects the red blood cells. This parasite was recorded by Stiles and Baker (49:1190), 1935, as having been found in a bear Ursus sp., in the St. Petersburg Zoo.

Seven species of ectoparasites, each belonging to a separate genus, are known to occur on bears. They include ticks, lice, and fleas. Henshaw and Birdseye (21), 1911, found adult wood ticks, Dermacentor andersoni, on bears of undetermined species in the Bitter Root Valley in Montana. Cooley (7:34), 1938, listed the grizzly bear, Ursus horribilis, as a host for D. andersoni. Stiles and Baker (49:1188-1190), 1935, recorded six other species of ectoparasites from bears. They include: 3 genera of ticks, Ripicephalus sp., Haemaphysalis sp., and Hyalomma sp.; one biting louse, Trichodectes sp.; and 2 genera of fleas, Arctopsylla sp., and Trichopsylla sp. Rothchild (45:62), 1902, proposed the name of Pulex ursi for a flea from the European brown bear. Wagner later (51:40), 1930, designated this flea as Arctopsylla ursi (Rothchild). Ewing and Fox (11:18), 1943, found a single male specimen of A. ursi

(Rothchild) on a grizzly bear killed at Calgary, Alberta, Canada.

No information was found in the literature on parasites of bears in Colorado.

Chapter III

METHODS AND MATERIALS

The description of the methods and materials consists of (1) methods of collecting parasites, (2) preliminary preparations for the collection in the field of parasites from bears, (3) collection and preservation of the parasites found, and (4) preparation of the parasites for study and classification.

Methods of collecting parasites

Parasites may be collected by various means. The methods vary, depending on the animals and the parasites involved. Some parasites are readily found, such as ticks, which because of their large size, are easily seen with the naked eye, and readily recovered by means of a pair of forceps. The same condition is true for some of the larger helminths, which may be seen when the intestine is opened. The collection of small parasites, such as the tapeworm Echinococcus granulosus, for example, can be accomplished only by proper handling of the material.

The usual procedure followed for collecting helminths from the various organs, and the one employed

in this study, is as follows: (1) each organ was opened and washed together with its contents in a separate pail of water, (2) after allowing the worms and heavier material to sink to the bottom of the container, the supernatant fluid containing much fine debris and coloring matter was decanted, (3) the washing was repeated until the water was clear, and (4) the residual material was examined for parasites.

The examination of the residue was made as follows: a moist chamber dish, having a diameter of 240 mm, was inverted on a dark background, and a similar dish containing the sample to be examined was placed on it. By adjusting the light on the background, the larger worms could be located readily with the unaided eye. Following the gross examination, small amounts of the residue were placed in petri dishes and examined with the aid of a binocular dissecting microscope, to collect parasites too small to be seen with the naked eye.

Preliminary preparations for the collection of parasites

Because of the difficulty in obtaining bears, the scarcity of these animals, and the rugged country out of which they must be fetched for examination, it was important that all procedures be worked out

beforehand in order that none of the material would be lost or wasted through inadequate techniques. To this end the method, described above, was developed for the collection and preservation of parasites under field conditions (27).

In order to obtain skill in the recovery of various types and sizes of worms, the technique described above was practiced by collecting parasites from: (1) chickens, (2) turkeys, (3) chinchillas, (4) rabbits, (5) cats, (6) dogs, (7) sheep, (8) deer, (9) swine, (10) cattle, and (11) horses. Following development of the collecting method, it was checked for efficacy by placing a given number of worms 4 to 5 mm in length of a known species, in 1000 cc of a mixture of water and ingesta from the stomach and intestine of ruminants, horses, and swine. The material was then cleaned by the decantation method described above and examined for the worms which had been placed in it. In each instance all of the worms used for the test were recovered. The results of this test indicated that these methods were satisfactory for recovering worms of the kind used and would be suitable for examining the bears.

A temporary laboratory for the examination of the bear carcasses was set up in Montrose, Colorado,

which is located in the area where the bear population is greatest. The laboratory equipment and supplies used in this study consisted of:

Glassware

4 moist chamber dishes, 240 mm in diameter

2 dozen specimen jars

1 graduate, 100 cc

1 dozen pipettes

1 dozen petri dishes

1 pyrex dish 10 x 18 inches

Metalware

2 buckets of 3 gallon size

2 cream cans of 3 gallon size

1 aluminum cup of 1 pint size

1 aluminum funnel of small size

2 enameled pans 8 x 10 inches

Instruments

1 dissecting kit, complete

1 enterotome

1 hunting knife

1 hatchet

Optical equipment

1 hand lens, 20x magnification

1 binocular dissecting microscope

Reagents

70 per cent ethyl alcohol; 12 fluid ounces

40 per cent formaldehyde; 1 gallon

Miscellaneous

6 camel hair brushes

6 teasing needles

1 pack sack

Collection and preservation of the parasites

The bears (Figs. 11-17) were killed by professional hunters and trappers employed by the United States Fish and Wildlife Service. Two methods were used to obtain them: (1) they were caught in steel traps and shot, or (2) they were bayed with hounds and shot.

Due to the rough terrain in which the bears were killed, it was not always feasible to transport the entire carcass to the field laboratory. In these cases the head and viscera, including the respiratory, digestive, and urinary systems were carried out in the cream cans provided for this purpose. The remaining parts of the carcass were examined where they lay. Whenever conditions permitted, however, the animals were

removed intact to the laboratory, where they were prepared for examination for parasites. The skin was taken off and the viscera were removed through a ventral midline incision. The digestive tract, including the esophagus, stomach, large and small intestines, was dissected free from the mesenteries and other organs. Each portion of the digestive tract was isolated by means of double ligatures. This procedure prevented post mortem migration of the parasites into sections of the digestive tract other than that normally occupied by them. It also prevented loss of the contents, which might contain parasites, when the digestive tract was separated into its natural parts. The other organs and systems, including the respiratory and urinary systems, were removed and placed in individual containers until examined.

Each system of organs was examined separately in order to ascertain the natural location of each species of parasite that might be found. The systems and organs examined were (1) skin, (2) respiratory system, (3) digestive system, (4) blood-vascular system, (5) genito-urinary system, (6) musculature, and (7) the eyes. In addition, the peritoneal and thoracic cavities were examined.

Skin.--The examination of the skin consisted of (1) a general examination for large arthropods, such as ticks, followed by (2) a more critical examination, using a hand lens, of the flanks, ventral parts, and the area around the neck and ears where smaller arthropod parasites and their eggs commonly occur on mammals. Samples of skin were scraped from scabby areas and preserved in 70 per cent alcohol for subsequent examination for mites. The ectoparasites found were killed and preserved in cold 70 per cent alcohol.

Respiratory system.--The lungs were placed in water, slit open, and thoroughly washed, and the sediment in the pail examined for parasites. The larynx and trachea also were opened in water, washed, and examined. The nasal cavities were examined as thoroughly as possible without washing.

Digestive system.--An especially critical examination was made of the digestive system, because in general, a greater variety of species of parasites inhabit it than any other part of the body.

The digestive tract was divided into its various parts, such as the esophagus, stomach, duodenum, jejunum, ileum, small and large colon, and rectum, and each part was examined separately for the reasons

stated above. Each section was opened in a pail, thoroughly scraped, and washed several times by the decantation method. When sufficiently washed, the sediment was examined for helminths.

Re-examination of parts of the digestive tract and of the decanted fluids was made from time to time to ascertain if any worms were being overlooked. In no case were any parasites found and it was concluded that the method of examination was efficacious, as indicated in the preliminary preparation.

The parasites collected from the digestive tract were killed in hot 10 per cent formalin and transferred to a cold solution of 10 per cent formalin for preservation. This method of handling did not prove advantageous, however, because it made the specimens very brittle, and subsequent handling of them difficult. It is believed that the concentration of the formaldehyde was too great.

Blood-vascular system.--Blood smears were made of the peripheral and central blood for subsequent examination for parasites. They were air dried, labeled, and packed in a slide box. In addition a gross examination was made of the heart for parasites, and of the larger blood vessels for verminous aneurysms. The larger lymphatic ducts and glands were inspected grossly for parasites.

Genito-urinary system.--The kidneys, ureters, bladder, and urethra, together with the testicles, ovaries and uterus were examined grossly for parasites.

Musculature.--Cut surfaces of the skeletal muscles were examined grossly for large parasites, particularly cysticerci, the larval stages of tapeworms. Samples of tissue from the diaphragm, intercostal, and masseter muscles were preserved in 10 per cent formalin and examined later in the laboratory at the college for trichina worms.

Eyes.--The eyes were removed, dissected and examined for worms. In addition the conjunctival sac was examined.

Peritoneal and thoracic cavities.--The serosa of the visceral, and pleural cavities, and the omentum were checked for parasites.

Preparation of the parasites for study and classification

Ectoparasites.--The ticks were cleared, stained, and mounted as whole specimens. The procedure was as follows: (1) they were macerated for 48 hours in 10 per cent KOH, (2) stained for 12 hours in an aqueous solution of acid fuchsin (26), (3) dehydrated by passing through a series of alcohols of increasing strength (35, 50, and 70 per cent), (4) destained in a solution

of 1 per cent HCl in 70 per cent alcohol, (5) rinsed in 70 per cent alcohol, (6) dehydrated by passing through 85 and 95 per cent alcohol, (7) cleared in beechwood creosote, and (8) mounted in balsam. Each slide was labeled, according to the host, the stain used, and the name of parasite.

Endoparasites.--In order to conduct critical studies of the helminths, it was necessary to make properly prepared mounts of entire worms, as well as sections of them.

In order to prevent excessive breakage, because of brittleness as mentioned above, the worms were handled by means of pipettes, and manipulation was kept at a minimum.

Specimens for whole mounts were stained for 24 hours in one of the following: alum cochineal, Mayer's acid carmine, or Ehrlich's acid hematoxylin. Of the stains used, alum cochineal proved to be the best for these particular worms. Following the usual methods of rinsing, dehydrating, and destaining, the worms were cleared in beechwood creosote and mounted in balsam. The finished slides were labeled with the date, stain used, and host number.

The specimens used for the sectioned mounts were stained in Delafield's hematoxylin or Ehrlich's acid hematoxylin for 24 hours, rinsed in distilled

water, and wrapped in lens tissue to facilitate subsequent handling. Following the rinse they were dehydrated by passing through a series of alcohols (35, 50, 70, 85, 95 per cent and absolute), and cleared in xylol. The cleared specimens were infiltrated with molten paraffin (52 degrees C.) for 2 hours. Following infiltration they were imbedded by placing them in small paper boxes containing molten paraffin. When the paraffin hardened, the material was ready for sectioning. Sections 7 to 15 micra thick were cut with a microtome and affixed to slides by means of Mayer's albumin fixative. When thoroughly dry, the slides were placed in xylol to remove the paraffin from the tissues and then passed down through the series of alcohols to the 70 per cent strength. They were destained in 70 per cent alcohol containing 1 per cent hydrochloric acid. The destaining was done under a microscope so the process could be controlled and stopped by rinsing the sections in an alkaline solution of 70 per cent alcohol when they had reached the desired density.

The sections were then counterstained in eosin, run back through the dehydrating alcohols, cleared in xylol, and mounted in balsam. They were labeled with the date, stain, and counterstain, plane of section, thickness of section, and host number. This procedure is given in detail by Guyer (20:38-52), 1946.

The blood films were prepared for examination by staining according to Giemsa's method, as recommended and outlined by Gradwohl (19:1831), 1943.

Small samples of the muscle tissue collected from the bears at the time of autopsy were pressed between heavy glass slides and examined under the microscope for trichina larvae, according to standard methods, as given by Gradwohl (19:1802), 1943.

Chapter IV

ANALYSIS OF DATA

The purpose of this problem is to determine the kinds of ecto- and endoparasites infecting black bears in southwestern Colorado.

Data regarding the age, sex, date and place collected for each bear examined are as follows:

Bear H2, two year old female killed 10 July 1948 on Blue Mesa, Gunnison County.

Bear H3, adult male killed 16 July 1948 on the Uncompahgre Plateau, Montrose County.

Bear H4, adult male killed 18 July 1948 in same location as H3.

Bear H5, one year old male killed 27 July 1948 in same place as H3.

Bear H8, adult male killed 5 August 1948 on the Cimarron Ridge, Ouray County

Examination of the bears showed only 3 of them to be infected with parasites. One animal, bear H2, was infested with ticks and two bears H3 and H8, were infected with cestodes. No other parasites were found.

Ectoparasites.--Wood ticks, Dermacentor andersoni, were the only ectoparasites found. Ten adult specimens, including nine males and one female, were obtained from the neck and chest regions of bear H2.

Endoparasites:--Two of the five bears were infected with cestodes, which were the only internal parasites found. Bear H3 had five small tapeworms in the duodenum. These specimens represented two different genera. Two specimens of them were identified as immature forms of Taenia pisiformis Bloch, 1780, and three as an undescribed species of Mesocestoides. The description of the new species of Mesocestoides appears elsewhere in this thesis.

Thirty-six fragments of a diminutive cestode belonging in the family Taeniidae, were found in the small intestine of bear H8. These tapeworms do not conform to the description of any of the genera or species of the family, and are described elsewhere in this paper.

Summary.--Five black bears killed in southwestern Colorado during the summer of 1948 and examined for parasites showed one to be infested with the wood tick, Dermacentor andersoni, and two to be infected with 3 species of tapeworms, 2 of which are new to science. No other parasites were found.

Chapter V

DESCRIPTION OF NEW MATERIAL

This chapter of the thesis is concerned with the description of the two undescribed tapeworms found in the bears. They include one undescribed species of the family Mesocestoididae belonging to the genus Mesocestoides and one belonging to the family Taeniidae. The species belonging to the Taeniidae does not fit into any of the known genera of this family. It will be necessary, therefore, to erect a new genus to receive this species.

For the specimens of Mesocestoides from bear H3, the name Mesocestoides krulli, in honor of Dr. Wendell H. Krull, is proposed.

Mesocestoides krulli n. sp.

(Figs. 7-10)

Specific diagnosis.--Mesocestoides: Length of strobilus 0.900 - 1.200 cm, width 0.700 - 1. mm; number of proglottides 22-30. Scolex 0.360 mm in diameter by 0.275 mm long, distinctly set off from neck. Suckers 0.144 mm long by 0.180 mm wide. Neck distinct, 1.5 mm long; segmentation begins 4.120 mm from anterior end,

mature segments 0.600 mm long by 0.550 mm wide; ripe segments 0.970 mm to 1.700 mm long by 0.700 to 1. mm wide, indistinctly divided.

Genital anlagen first seen 3.150 mm from anterior end and fully developed at 11th segment. Testes 27-31 in number, oval to round in shape and distributed throughout length of proglottid between external borders of longitudinal excretory canals.

Ovaries bilobed, located in posterior third of proglottid, lobes oval to round in shape, 0.030 mm apart and 0.075 - 0.090 mm in diameter. Vitelline glands in apposition to posterior portion of ovaries, 0.055 mm in diameter. No eggs seen.

Host:--American black bear, Euractos americanus.

Location:--Small intestine

Locality:--Colorado, U. S. A.

Type specimen: No. U. S. National Museum Helminthological Collection.

Three specimens of Mesocestoides krulli were obtained from the small intestine of an adult male black bear killed 16 July 1948 on the Uncompahgre Plateau in Montrose County, Colorado. M. krulli is smaller than any other described species of the genus except M. bassarisci MacCallum, 1921. M. krulli and M. bassarisci differ

from all the other described species of Mesocestoides in being much smaller in size and having the testes limited to the region between the longitudinal excretory canals. M. manteri Chandler, 1942 (6:227-231), which approaches M. krulli and M. bassarisci most closely in size, differs from them in that the testes extend laterad from the longitudinal excretory canals. Because of the inadequate description and figure of M. bassarisci (37: 247-248), however, it is not possible to determine accurately its relationship with M. manteri and M. krulli. Chandler (6:229), 1942, stated that M. bassarisci and M. manteri might be identical, but in view of the incomplete description of M. bassarisci he concluded that the worms from the lynx should be designated as a different species. M. krulli differs from M. bassarisci in being larger, especially in length, which is three times greater, and having the neck proportionately longer. M. bassarisci was found in a ring-tailed cat, Bassarica astuta Rhoads from Mexico, that died in the New York Zoological Gardens, and M. krulli was found in black bears in Colorado. It is not known whether these host differences are significant, but in view of the limited information available on these 2 parasites, this fact is pointed out.

The specimens of Taeniidae from bear H8 do not fit into any of the known genera of this family (38:81, 25:78, 17:163, 13:202). It becomes necessary, therefore, to erect a new genus to receive this undescribed species. The name Anacanthotaenia olseni is proposed. The generic name Anacanthotaenia is derived from the Greek "an" meaning without, "acanth" meaning thorn, plus "tainia" meaning band, as suggested by the unarmed scolex. This characteristic distinguishes it from the other genera of Taeniidae. All the other genera have the scolex armed with hooks. The specific name olseni is used in honor of Dr. O. Wilford Olsen.

Anacanthotaenia n. gen.

(Figs. 1-6)

Generic diagnosis.--Taeniidae: Strobilus small, scolex unarmed, without rostellum. Genital pores irregularly alternate. Genital ducts dorsal to excretory vessels, transverse excretory vessels absent. Testes located anterior, lateral, and posterior to ovary. Adults in Carnivora.

Type and only species.--Anacanthotaenia olseni.

Unfortunately the absence of any gravid proglottides made a diagnosis of the family difficult. Evidence based on the definite sacciform uterus in the oldest segments, however, indicates that this species belongs in the family Taeniidae. Morphologically

Anacanthotaenia appears to be more closely related to Cladotaenia than to any other genus of the family (38:81, 25:78, 17:163). Anacanthotaenia differs from Cladotaenia, however, in that the former has an unarmed scolex, and lacks transverse excretory canals, whereas the latter has an armed scolex and transverse excretory canals.

Anacanthotaenia olseni n. sp.

(Figs. 1-6)

Specific diagnosis.--Anacanthotaenia: Strobilus 25 - 30 mm long, by 0.675 - 0.750 mm wide. Scolex unarmed, 0.260 mm long by 0.350 - 0.375 mm wide. Suckers oval, 0.105 - 0.115 mm long by 0.105 - 0.110 mm wide, orifice 0.045 - 0.052 mm in diameter. Neck approximately one eighth the length of entire strobilus. Genital pores in anterior third of proglottid, irregularly alternate. Dorsal and ventral longitudinal excretory vessels small, approximately equal in size, lateral to the testes.

Anlagen of genitalia appear 0.700 - 0.750 mm from scolex. Testes scattered throughout length of proglottid, lying between excretory canals, but with larger proportion of them posterior to ovary; number 60 to 84; irregularly ovoid in shape, vary from 0.022 - 0.037 mm in diameter. Vas deferens turns laterally from median line at level of genital pore and proceeds to genital atrium, passing dorsal to excretory canals.

Ovary bilobed, butterfly-shaped; located at junction of anterior and middle thirds of proglottid, width 0.225 mm, length 0.120 mm. Vagina extends postero-medially from genital atrium to ovary, passing dorsal to excretory canals. Vitelline gland ovoid to round 0.132 mm in diameter, located median and at posterior margin of ovary. Immature uterus sacciform, median, parallel with longitudinal axis of proglottid, and extends anteriorly from vitelline gland. Eggs not seen.

Host:--American black bear, Euractos americanus

Location:--Small intestine

Locality:--Colorado, U. S. A.

Type specimen:--No. U. S. National Museum Helminthological Collection.

Chapter VI
DISCUSSION

Knowledge of the parasites of bears is meager, as evidenced by the limited amount of information in the literature on this subject. Moreover, according to the literature, less parasitological work has been done on bears killed in their natural habitat than on bears from Zoological gardens. Because much of the available information has been obtained from captive bears, it is difficult to differentiate between natural infections and those occurring as the result of the artificial environment in which the animals were kept. Some of the parasites reported from bears are of known medical and veterinary importance. Although it is not known whether bears are infected naturally with some of the parasites reported in the literature, the presence of parasites of medical and veterinary importance in them is of significance and should not be overlooked.

Parasites of public health importance occurring in bears include (1) the trichina worm, Trichinella spiralis, (2) the broad fish tapeworm, Diphyllobothrium latum, (3) the hydatid worm, Echinococcus granulosus, and (4) the wood tick, Dermacentor andersoni.

One parasite of great public health importance occurring in bears, is the trichina worm, Trichinella spiralis (8:284, 40:150). It is the etiological agent of trichinosis, and is transmitted to man by eating improperly cooked meat containing infective larvae. Reports show that wild bears are infected naturally with these parasites (5). This condition presents (1) a possible source of trichina infection to persons who eat bear meat occasionally, and (2) a serious public health problem in arctic areas where polar bear meat is an important part of the Eskimos' diet. Recent investigations showed a high incidence of trichinosis among Eskimos who had acquired the disease by eating polar bear meat containing viable larvae of trichinae (50:778).

There are two possible sources of infection with trichina worms for wild bears in the Rocky Mountain region. They are (1) offal from infected hogs slaughtered on remote farms and ranches, and (2) uncooked garbage containing infected pork scraps fed to them in National Parks. The source of natural infection with trichinae, as in the case of the polar bears mentioned above, is unknown (5).

Although no trichina worms were found in the five bears studied, an examination of more animals would be necessary before any conclusions could be made

regarding natural infection among them. Inasmuch as bears are known to be a source of trichinosis in man, their flesh should be thoroughly cooked before it is eaten, as a safeguard against infection with these parasites.

The broad fish tapeworm, Diphyllobothrium latum, is another parasite of public health importance that occurs naturally in bears of the Rocky Mountain and other regions (40:83). Infection with this parasite is acquired by ingesting fish containing the live infective larvae. Infected bears may serve as a reservoir host for this parasite by contaminating the waters of lakes and streams with feces containing the worm eggs, and thereby provide a source of infection for fish.

Another helminth of medical importance known to occur in bears is Echinococcus granulosus (49:1190). The larval stage of E. granulosus develops into a hydatid cyst which when present in man produces grave results. While the public health significance of this parasite in bears is unknown, its presence in the single infection reported for this species cannot be passed without notice.

The wood tick, Dermacentor andersoni, is an ectoparasite occurring naturally on bears in the Rocky

Mountain region (7:34). These ticks are important medically as vectors of (1) Rocky Mountain spotted fever, (2) Colorado tick fever, (3) tularaemia, and (4) tick paralysis (7:2). Although the ticks are found on bears, it is doubtful if these animals are important as hosts, in view of their small numbers as compared with the numerous other mammals, including rodents, that serve equally well in this role. It is questionable, therefore, if bears play an important part in the dissemination of the tick-borne diseases mentioned above.

Parasites of veterinary significance reported to occur in bears include (1) the common stomach worm, Haemonchus contortus, of sheep, (2) the salmon poisoning fluke, Troglotrema salmincola, (3) the dog hookworm, Ancylostoma caninum, (4) the hydatid worm, Echinococcus granulosus, and (5) the wood tick, Dermacentor andersoni. The two latter species are also of medical importance, as discussed above.

One reference occurs in the literature on the infection of a captive bear with the common stomach worm, Haemonchus contortus, of sheep (49:1187). The presence of this nematode in bears is of doubtful significance, because this animal may have eaten an infected sheep stomach shortly before the examination. Moreover, these parasites are not known to occur normally in carnivores.

Troglotrema salmincola, the fluke that carries the virus causing "salmon poisoning" in dogs and foxes of the Pacific northwest, has been recovered from black bears under experimental conditions (49:1188). The infection was established in them by feeding salmonid fish containing living metacercariae of the fluke (40: 63). Being pisciverous bears may act as natural carriers of the fluke and help spread the disease by contaminating streams and lakes with their feces which contain eggs of the parasite. Future studies made on the bears in the Pacific coast mountains would help determine the significance of them as natural hosts for Troglotrema salmincola.

The dog hookworm, Ancylostoma caninum, was reported in a sloth bear in India (49:1187). Although this worm is an important parasite of dogs, it is doubtful if bears in North America are significant in its dissemination.

The hydatid worm, Echinococcus granulosus, has been reported on one occasion from bears (49:1190). The adult of this parasite occurs naturally in the small intestine of coyotes, foxes, wolves, and dogs (43:171, 44:256, 40:117). Inasmuch as Echinococcus is known to occur in bears, this report is of significance in that it adds another host of this medical and veterinary important parasite.

The wood tick, Dermacentor andersoni, in addition to being a vector of diseases of medical importance, has been shown, under experimental conditions, to be capable of transmitting two diseases of veterinary significance, namely, equine encephalomyelitis, and bovine anaplasmosis (7:2). Although this experimental work did not involve bears directly, they should be considered, inasmuch as they do serve to a limited extent, as pointed out above, as hosts for these ticks. D. andersoni is the only parasite that is of both medical and veterinary importance that was found on the bears examined in this study.

Although bears are able to serve as hosts for several parasites that are of medical and veterinary importance, as shown above, their true role in this capacity, with the exception of trichina, however, is unknown at this time.

In addition to the part played by bears in transmitting parasites of medical and veterinary importance, the writer was interested in learning whether the bears themselves suffered untoward effects from parasitism. No reference could be found in the literature stating that parasitism contributed to the ill health or death of any bears. Moreover, insofar as could be determined in this study, the parasites found

produced no detrimental effects on the health of the bears examined. In the case of the intestinal parasites, there was no macroscopic evidence of damage to the tissue as a result of their presence. The reason for this condition is probably due to the few small parasites present. Moreover, the same, or closely related species of parasites, do not produce untoward effects on domestic animals when present in such small numbers as found in these bears. Although the ticks showed evidence of having produced a dermatitis, the condition was localized to the site of attachment and appeared to be of little significance in the cases observed.

Because of the limited number of bears examined in this study the picture of parasitism in them in this region is admittedly incomplete. It is desirable, therefore, that further studies be made to obtain more knowledge about the parasites that infect bears, and their importance in the public health and veterinary picture.

Chapter VII

SUMMARY

1. Five black bears, Euractos americanus, were killed in southwestern Colorado during the summer of 1948, and examined for external and internal parasites.

2. One bear was infested with the wood tick, Dermacentor andersoni, which was the only species of ectoparasite found.

3. Two of the five bears were infected with 3 species of cestodes which were the only internal parasites found.

4. Two new species of cestodes, Mesocestoides krulli (Mesocestoididae), and Anacanthotaenia olseni (Taeniidae) were found.

5. Immature Taenia pisiformis Bloch, 1780, was the third species found.

6. All three species of cestodes found in this study constitute new records for bears, insofar as can be ascertained at this time.

7. Thirty-six fragments, including 4 scoleces and mature segments but no ripe segments, of A. olseni were found in the small intestine of one bear. The

other infected bear had 2 immature strobilae of T. pisiformis, and 3 strobilae of M. krulli in the small intestine.

8. Insofar as known the parasites in these five bears are not of medical or veterinary importance, with the exception of Dermacentor andersoni, which is the known vector of Rocky Mountain spotted fever, Colorado tick fever, tularaemia, and tick paralysis.

A P P E N D I X

EXPLANATION OF PLATES

All drawings, unless stated otherwise, were made with the aid of the camera lucida and details have been filled in at the same magnification.

Abbreviations used

c	Cirrus
cp	Cirrus pouch
cut	Cuticle
elm	Internal longitudinal muscle
gp	Genital pore
lec	Longitudinal excretory canal
lm	Internal longitudinal muscle
oot	Oötype
ov	Ovary
suc	Sucker
t	Testicle
ut	Uterus
vag	Vagina
vd	Vas deferens
vit	Vitelline gland

EXPLANATION OF PLATE I

Fig. 1.-- *Anacanthotaenia olseni*, scolex. (Head in toto.)

Fig. 2.-- *Anacanthotaenia olseni*, mature proglottid.

Fig. 3.-- *Anacanthotaenia olseni*, photomicrograph of mature proglottid.

Fig. 4.-- *Anacanthotaenia olseni*, cross section through anterior third of mature proglottid.

Fig. 5.-- *Anacanthotaenia olseni*, cross section through middle third of proglottid.

Fig. 6.-- *Anacanthotaenia olseni*, cross section through posterior third of mature proglottid.

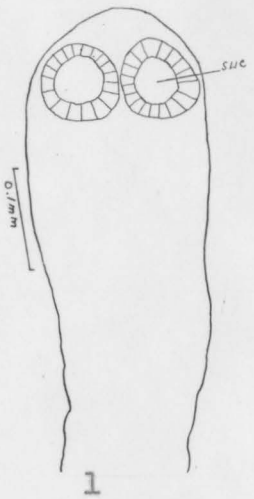
Fig. 7.-- *Mesocestoides krulli*, scolex. (Head in toto.)

Fig. 8.-- *Mesocestoides krulli*, mature proglottid.

Fig. 9.-- *Mesocestoides krulli*, terminal proglottid.

Fig. 10.- *Mesocestoides krulli*, free hand drawing showing incomplete division of terminal proglottid.

PLATE I



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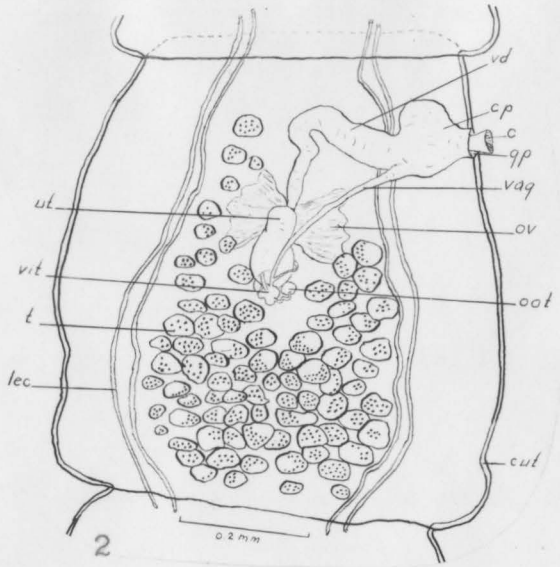

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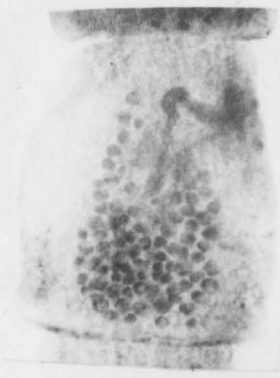

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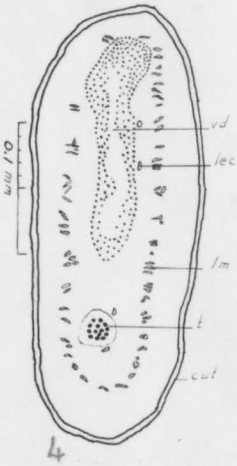

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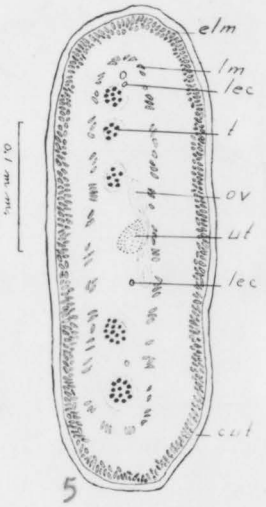

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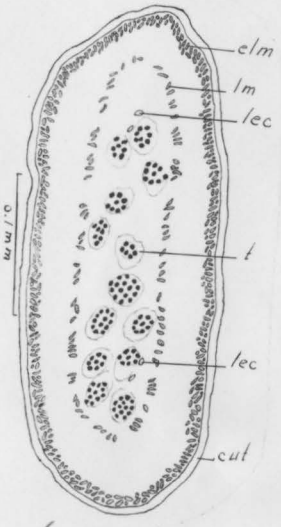

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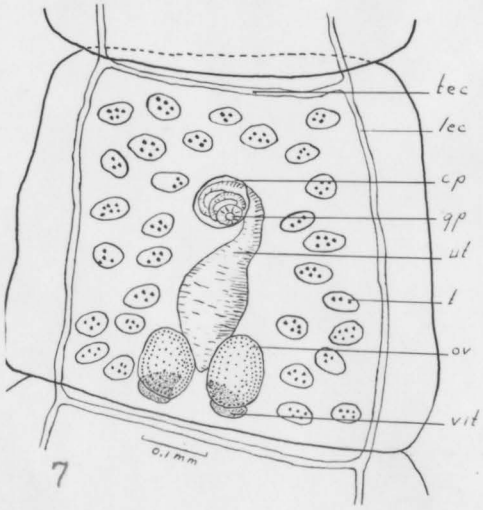

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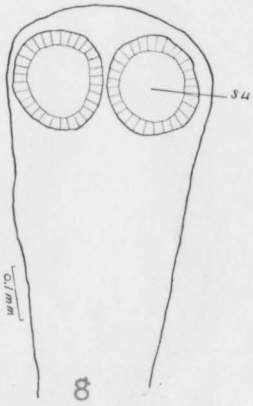

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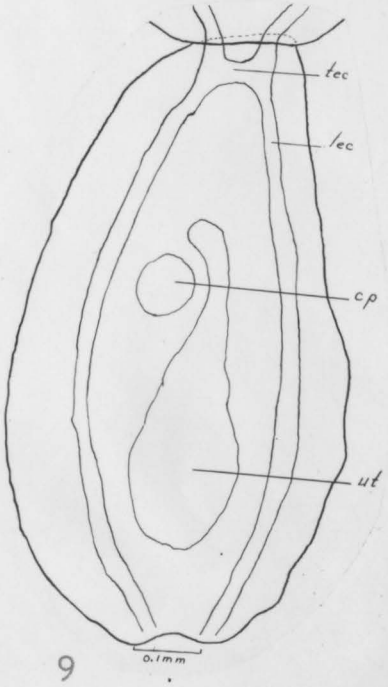

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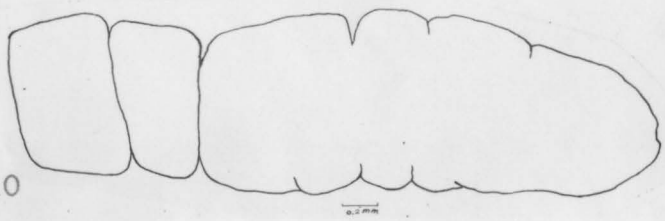

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EXPLANATION OF PLATE II

Fig. 11.--Bear H3, after skinning and removing head.

Fig. 12.--Bear H3, removing sections of digestive tract.

Fig. 13.--Bear H4, removing omentum.

Fig. 14.--Bear H5, removing stomach.

Fig. 15.--Bear H2, showing denuded areas in flank regions.

Fig. 16.--Using decantation equipment in the field.

Fig. 17.--Bear H4, making midline incision.

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LIST OF PARASITES REPORTED FROM BEARS

Parasite	Host	Authority
PROTOZOA		
Babesia sp.	*Ursus* sp.	Stiles and Baker, 1935.
TREMATODA		
Troglotrema salmincola	*Euractos americanus*	Stiles and Baker 1935.
CESTODA		
Echinococcus granulosus	*Ursus* sp.	Stiles and Baker 1935.
Taenia ursi-maritimi	*Thalarctos maritimus*	Diesing, 1850; von Linstow, 1878.
Taenia ursina	*Ursus arctos*	von Linstow, 1893, 1894; Leuhe, 1894; Braun, 1895.
Bothriocephalus ursi	*Ursus arctos*	Landois, 1877.
Diphyllobothrium latum	*Ursus* sp. *Euarctos americanus* *Thalarctos maritimus*	Scott and Honess 1934; Scott, 1934; Olsen, 1949.
Diphyllobothrium cordatum	*Ursus* sp.	Scott, 1934.
Pentorchis sp.	*Helarctos malayanus*	Stiles and Baker, 1935.

Parasite	Host	Authority
NEMATODA		
Nematoideum ursi	Ursus sp. Ursus arctos	Gmelin, 1790. Diesing, 1851.
Gongylonema contortum	Ursus arctos	Molin, 1860.
Toxascaris transfuga	Ursus arctos Thalarctos maritimus Euractos americanus Melursus ursinus Ursus horribilis Ursus syriacus	Diesing, 1851. Stiles and Baker, 1935.
Ancylostoma brasiliense	Melursus ursinus	Stiles and Baker, 1935.
Ancylostoma ceylanicum	Melursus ursinus	Stiles and Baker, 1935.
Ancylostoma malayanum	Helarctos malayanus	Looss, 1911; Fantham, 1916; Lane, 1916.
Uncinari ursi	Ursus arctos	Dujardin, 1845.
Uncinari ursi-maritimi	Thalarctos maritimus	Dujardin, 1845.
Trichinella spiralis	Ursus sp. Thalarctos maritimus	von Bockum-Dolffs, 1888. Freund, 1913; Bohm, 1913; Parnell, 1934; Leiper, 1938; Thorborg et al, 1948; Brown et al, 1949.
Haemonchus contortus	Thalarctos maritimus	Stiles and Baker, 1935.
Cyathostoma bronchiale	Ursus arctos	Stiles and Baker, 1935.
Dioctophyme renale	Ursus sp.	Hutyra, Marek, and Manninger, 1938.
Thelazia californiensis	Ursus sp.	Herman, 1944.

Parasite	Host	Authority
TICKS		
Dermacentor andersoni	Ursus sp.	Henshaw and Birdseye, 1911.
	Ursus horribilis	Cooley, 1938.
	Euractos americanus	Cooley, 1938.
Ripicephalus sp.	Ursus sp.	Stiles and Baker, 1935.
Haemaphysalis sp.	Ursus tibetanus	Stiles and Baker, 1935.
Hyalomma sp.	Ursus sp.	Stiles and Baker, 1935.
LICE		
Trichodectes sp.	Ursus tibetanus	Stiles and Baker, 1935.
FLEAS		
Arctopsylla setosa	Ursus horribilis	Hubbard*, 1947.
	Euractos americanus	
Arctopsylla ursi	Ursus horribilis	Ewing and Fox, 1943; Hubbard*, 1947.
Trichopsylla sp.	Ursus arctos	Stiles and Baker, 1935.
Thrassis spenceri	Ursus horribilis	Hubbard*, 1947.

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(This reference added after thesis was typed.)

ADDENDUM

Additional records of the broad fish tapeworm, Diphyllobothrium latum, from both grizzly and black bears in North America, are reported by M. S. Skinker in the Proceedings of the Helminthological Society of Washington. January 1931 and January 1932.

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