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STUDIES ON ENDOPARASITES OF THE BLACK BEAR *(Ursus americanus)* IN THE SOUTHEASTERN UNITED STATES [1]

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Abstract: Examination of 53 black bears *(Ursus americanus)* from six states in the southeastern United States revealed at least 17 species of endoparasites, including *Sarcocystis* sp., *Spirometra mansonoides* (spargana), *Macracanthorhynchus ingens, Ancylostoma caninum, Arthrocephalus lotoris, Baylisascaris transfuga, Capillaria aerophila, Capillaria putorii, Crenosoma* sp., *Cyathospirura* sp., *Dirofilaria immitis, Gnathostoma* sp., *Gongylonema pulchrum,* microfilariae, *Molineus barbatus, Physaloptera* sp. and *Strongyloides* sp. Twelve of these represent new host records for black bear, and two are considered to be new species. Data are presented on prevalence, intensity and geographic distribution of each species. Pathologic effects were associated with infections of spargana of *S. mansonoides* and adults of *C. aerophilia.*

INTRODUCTION

The black bear *(Ursus americanus)* once inhabited all forested areas of the eastern United States, but destruction of habitat and past indiscriminate killing by man have drastically reduced their numbers. Presently, the southeastern United States has scattered, remnant populations estimated at 7,000 to 8,000 animals[8] which are limited to rugged mountainous terrain and remote coastal plain swamps.[26] Fortunately, their decline in numbers has stimulated conservation efforts.

The desire to better manage bears has resulted in accelerated research to obtain basic data. Information on which to base management policy has been scarce, particularly in the area of covert mortality factors such as parasites and diseases. Although parasite studies have been conducted on black bears from northern and western regions of the United States,[13,17,18,30,33] information on bears in the Southeast is limited and fragmentary. Review of the literature revealed a survey for *Trichinella spiralis,* in which 1 of 28 animals from West Virginia was infected.[10] There are isolated case reports of *Dirofilaria immitis* in a bear from North Carolina[16] and *Baylisascaris multipapulata* in captive bears in Louisiana.[6]

The present study was conducted to obtain base-line data on endoparasites of black bears in the southeastern United States. Research objectives were: (1) identify endoparasite fauna; (2) determine the distribution, prevalence and intensity of infections; (3) evaluate the pathogenicity of each parasite to black bears and (4) detect parasites of public health and veterinary significance.

MATERIALS AND METHODS

Bears examined in this study came from several sources, including hunter

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harvests, victims of vehicle collisions, confiscated illegal kills and mortality associated with capture or crop damage control. Between July, 1973, and November, 1976, specimens from 53 bears were examined from 24 counties in six southeastern states. Bears originated from four general geographic regions within the mountain and coastal plain physiographic regions of the southeastern United States. These regions were as follows: Northern mountain (N=19) — Albemarle, Augusta, Greene, Nelson, Page and Rockbridge counties, Virginia, and Greenbrier, Pocahontas, Randolph and Tucker counties, West Virginia; Southern mountain (N=15) — Clarke, Hall, Union and Walker counties, Georgia, and Monroe and Polk counties, Tennessee; Northern coastal plain (N=14) — Beaufort, Bladen, Camden, Columbus, Pamlico and Pender counties, North Carolina; Southern coastal plain (N=5) — Liberty County, Florida and Charlton County, Georgia. Necropsies were performed at the central laboratory on 33 frozen viscera, 9 fresh intact bears and 6 intact frozen bears. Five hunter-killed bears were examined in the field.

Age determination was possible on 42 specimens by tooth eruption[20] and the cementum annuli techniques.[32] Pertinent data on viscera, viz., sex and age, often were supplied by state game biologists.

Whole carcasses were skinned, and subcutaneous tissues were examined for parasites. Viscera were separated into anatomical components and examined for lesions and helminth parasites. The gastrointestinal tract was divided into stomach, small intestine and large intestine. Each viscus was opened, scraped and the contents washed separately through a series of graduated screens (6 mm^2, 3 mm^2, and 0.149 mm^2). All retained material was preserved in 10% formalin. Complete parasite counts were made and the parasites identified. Larval cestodes were fed to cestode-free domestic cats to obtain adult tapeworms.

When possible, samples of diaphragm, loin, masseter and tongue were collected and examined for *T. spiralis* by (1) compression of a thin slice of muscle between 2 glass slides viewed under a 3-30x dissecting microscope; (2) digestion of a minimum of 50 g of muscle tissue in a solution of 0.5% pepsin and 0.7% concentrated hydrochloric acid incubated at 37 C for 24 hr. and (3) standard histological examination.

Thin blood smears were made, when feasible, from peripheral blood or lung tissue, fixed in 100% methanol and stained with Giemsa stain. Tissue samples for histologic study were collected from major organs and gross lesions, processed according to standard procedures, cut at 6 μm and stained with Delafield's hematoxylin and Eosin Y.

RESULTS AND DISCUSSION

At least 17 species of parasites, comprised of 1 protozoan, 1 larval cestode, 1 acanthocephalan and 14 nematodes were recovered (Table 1). Although methods of collecting specimens induced limitations on statistical analysis, general trends were revealed by inspection of the data. Salient features of each parasite are discussed in order of prevalence within each phylogenetic group.

Protozoa: Sporozoan cysts tentatively designated as *Sarcocystis* sp. were detected histologically in cardiac and skeletal muscle. Generic determination was made using characteristics compiled by Frenkel;[9] however, transmission studies would be required to confirm this diagnosis and to differentiate species.[12] The observed prevalence of *Sarcocystis* sp. was considered minimal since additional muscle sections undoubtedly could have revealed more infected hosts.

Cestoda: One bear had approximately 200 viable spargana in muscle and subcutaneous tissue, plus multiple small pustules associated with degenerating worms. Microscopically, pustules con-

TABLE 1. Endoparasites recovered from black bears *(Ursus americanus)* collected from the southeastern United States.

Parasite	Number of Bears Examined	Percent Prevalence	Number Per Infection		Distribution
			Mean	Range	
PROTOZOA					
Sarcocystis sp. (h)*†	53	11	—	—	1,3††
CESTODA					
Spirometra mansonoides (h)† (Spargana) (74645)**	15	7	Approx. 200	—	4
ACANTHOCEPHALA					
Macracanthorhynchus ingens (c)† (74646)	54	21	5	1-14	1,2,3,4
NEMATODA					
Ancylostoma caninum (c)† (females only)	53	6	1	1	2,4
Arthrocephalus lotoris (c)† (74647)	53	23	4	1-17	1,2,3,4
Baylisascaris transfuga (c) (74648)	53	53	11	1-73	1,2,3
Capillaria aerophila (e)† (74650)	52	10	158	11-684	2,4
Capillaria putorii (b)† (74651)	53	38	7	1-90	1,2,3,4
Crenosoma sp. (e)	52	8	13	1-34	1,2
Cyathospirura sp. (b)† (74652)	53	2	8	8	1
Dirofilaria immitis (f) (74649)	52	8	3	1-6	3
Gnathostoma sp. (d)† (immature)	51	4	1	1	1
Gongylonema pulchrum (a) (74653)	50	54	4	1-25	1,2,3,4

TABLE 1. (continued)

Microfilariae (g)	24	17	—	—	2
Molineus barbatus (c)† (74654)	53	28	19	1-240	1,2,3,4
Physaloptera sp. (b)† (immature)	53	8	11	1-41	1,3,4
Strongyloides sp. (c)† (74655)	53	47	148	1-2098	1,2,3,4

*The letter in parentheses indicate locations in the host. (a) tongue and esophagus, (b) stomach, (c) small intestine, (d) liver capsule, (e) lung, (f) heart and pulmonary artery, (g) blood, and (h) musculature.

†New host record

††1 = Northern Mountain, 2 = Southern Mountain, 3 = Northern Coastal Plain, 4 = Southern Coastal Plain

**Numbers in parentheses represent USNM Helm. Coll. Numbers.

sisted of focal areas of caseous necrosis surrounded by a granulomatous border, and a diffuse infiltration of eosinophils was present in adjacent interfascicular connective tissue. Tract-like lesions infiltrated with lymphocytes and plasma cells were seen in which adjacent muscle fibers were undergoing granular degeneration and fibrosis. Muscle fibers surrounding viable spargana were hyalinized and infiltrated by eosinophils. When fed to cestode-free cats, larvae developed to adults and were identified as *Spirometra mansonoides*.

The occurrence of spargana of *S. mansonoides* may be of public health significance. Corkum[7] suggests that human sparganosis may result occasionally from consuming meat of wild animals containing viable spargana.

Acanthocephala: *Macracanthorhynchus ingens* was more prevalent in the coastal plain (50%) than the mountains (8%) but occurred in all study areas. *M. ingens* was attached on the serosal side of the intestine of one bear, but evidence of inflammatory reaction was not noted. Small white nodules scattered in the wall of the small intestine were found in one additional bear infected with *M. ingens*. On histologic examination, some nodules consisted of a focal granuloma with moderate eosinophil infiltration, while others were small ulcerative lesions infiltrated with mononuclear cells and extending into the submucosa.

M. ingens is a common parasite in raccoons *(Procyon lotor)* of the southeastern United States.[11,15] Higher prevalences of *M. ingens* in black bears from the coastal plain could be a function of cross transmission from high density raccoon populations in the coastal plain and/or numbers of available scarabaeid beetle intermediate hosts.[23]

Nematoda: *Gongylonema pulchrum* was the most frequently encountered and widely distributed parasite. When both

esophagus and tongue were present for examination, the esophagus was more commonly infected. *G. pulchrum* was the only parasite recovered from the single bear taken from the den, which possibly supports previous evidence of intestinal helminth expulsion at the onset of denning.[27,28,30] The intermediate hosts of *G. pulchrum* (various Blattaria and Coleoptera) may be consumed readily by bears. Chandler[5] reported *G. pulchrum* in a black bear from Pennsylvania. The nematodes were located in the tongue, a site believed to be an indication of an unnatural host. From his review of the literature, Chandler[5] concluded that *G. pulchrum* was rare in bears. Our results refute his assumptions, at least for bears in the southeastern United States.

Baylisascaris transfuga was encountered in all regions except the southernmost coastal plain and was markedly less prevalent in the northern coastal plain (7%) than in mountain areas (79%). While *B. transfuga* has been reported as the most common parasite of the black bear elsewhere,[31] this is the first report in the Southeast.

Although pathogenic effects were not evident, the consequences of infection with certain members of the genus *Baylisascaris* warrant consideration. Mozgovoi[24] reiterated a recorded death of a bear from parasitism with *Baylisascaris*. Larvae of a related species, *B. procyonis*, caused epizootic cerebrospinal nematodiasis in small mammals in the Southeast,[14,25] and experimental studies have demonstrated that larvae of *B. transfuga* have similar neurotropic affinities in laboratory mice.[21]

Strongyloides sp. was the third most prevalent nematode. Coastal plain areas represented the highest rate of infection where 13 of 19 bears were found infected. Two of five cubs (≤1.5 years) harbored *Strongyloides* sp., but adult bears (≥3.75 years) had a higher prevalence (68%). The shape of the stoma and ovaries of the parasitic females closely resembled *S. procyonis* and *S. stercoralis*;[19] however, culture attempts to obtain free-living stages failed, making species identification uncertain.

Capillaria putorii was recovered frequently and from all regions. *C. putorii* has been reported from raccoons in the Southeast,[11] and from weasel *(Mustela frenata)*, mink *(Mustela vison)*[29] and raccoons[4] in other parts of North America.

Molineus barbatus was present in all regions. This trichostrongylid is not particularly host specific and occurs commonly throughout the Southeast in raccoons,[11,15] skunks *(Mephitis mephitis)*[2] and bobcats *(Lynx rufus)*.[22] In addition, dogs and cats have been experimentally infected with *M. barbatus*.[3]

Arthrocephalus lotoris, the raccoon hookworm, occurred in bears from all regions. Similar to *M. ingens*, a higher prevalence of *A. lotoris* was noted in the coastal plain areas (42%) than in the mountain areas (12%), which may reflect cross transmission between raccoons since the latter are far more common in the coastal plain than mountains.

Microfilariae were detected in blood and lung smears, and all infected animals were from the southern mountain region. Only viscera were available for examination from infected bears, and adult filarial worms were not found. Microfilariae were similar in morphology to the subcutaneous filarid *Dirofilaria ursi*.[1] *D. ursi* occurs throughout the northern United States and Canada.[31]

Capillaria aerophila occurred only in the southern mountain and southern coastal plain regions. Lesions attributed to *C. aerophila* were severe in one bear. This animal had large amounts of viscous yellow to gray exudate in the trachea, bronchi and bronchioles. Some of the smaller air passages were completely occluded. Numerous *C. aerophila* and eggs were found in the exudate from the trachea and bronchi. Histologic examination of the lungs revealed a catarrhal bronchitis characterized by the

partial occlusion of the bronchi and bronchioles with mucus containing occasional neutrophils.

Crenosoma sp. was found in small bronchioles and was encountered only in the mountainous areas. *Crenosoma* sp. has been reported previously from black bears in Ontario [2] and New York.[18] Verminous pneumonia has been associated with this lungworm in a bear from New York.[18] The *Crenosoma* sp. found in black bears of the Southeast appears to be an undescribed species.

Dirofilaria immitis was recovered from the right ventricle and pulmonary artery of bears only from the coastal plain of North Carolina where it occurred in 4 of 13 animals. All infected animals were ≥2.5 years old. The black bear was considered an unsuitable host for *D. immitis* because adult female worms do not produce microfilariae.[16] In the present survey, however, an adult female *D. immitis* recovered from a 3.75 year old black bear contained microfilariae. Unfortunately, evidence of a microfilaremia was not ascertained.

Cyathospirura sp., immature stages of *Physaloptera* sp., *Gnathostoma* sp. and infertile females of *Ancylostoma caninum* were found, but based on the low prevalence of infection and infectivity for other hosts, the black bear probably is an accidental host.

Trichinella spiralis was not detected in 25 bears examined by both artificial digestion and compression techniques or in 25 examined only by histologic examination of the diaphragm. The absence of *T. spiralis* in the present study may be a result of the use of frozen tissue and/or a low prevalence in the black bear populations of the Southeast. The probability that it is low in prevalence is supported by the lack of reports of human *T. spiralis* infection in the Southeast.

One bear had multiple, roughened plaques on the intimal surface of the aorta and anterior mesenteric artery. These vessels and ramifications of the anterior mesenteric artery were sclerotic and had tract-like areas of pigmentation. Histologic examination revealed proliferation and erosion of the endothelium associated with fibrosis, eosinophil infiltration and focal necrosis of the tunica media. The lesions were multifocal in distribution and, on one occasion, a cross section of a nematode was found in the tunica adventitia adjacent to a tract-like lesion. The lesions contained eosinophils and hemosiderin-filled macrophages. However, the origin of the lesions is uncertain since this particular bear also was infected with approximately 200 spargana of *S. mansonoides*.

The results of this survey reveal a greater prevalence and variety of parasites in black bears from the Southeast than in comparable studies conducted in northern and western ranges. Many parasites harbored by black bears in the Southeast also are found commonly in other hosts occupying the same area. Cross transmission, particularly from the raccoon, may be of considerable consequence in the abundance and distribution of parasites of black bears in the Southeast.

Associated with an increase in prevalence and variety of parasites one would anticipate a greater morbidity due to parasitism to exist. Although most parasite infections found in this study were apparently subclinical, at least one, *C. aerophila*, was observed to produce morbidity.

From a public health standpoint, parasites of black bears in the southeastern United States appear to be of little consequence, possibly excepting sparganosis.

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