

1994

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Published in *Transactions of the Illinois State Academy of Science*, Vol. 87 No. 3 and 4 (1994)

Recommended Citation

Birch, Gary L., Feldhamer, George A. and Dyer, William G. "Helminths of the Gastrointestinal Tract of Raccoons in Southern Illinois with Management Implications of *Baylisascaris procyonis* Occurrence." (Jan 1994).

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Helminths of the Gastrointestinal Tract of Raccoons in Southern Illinois with Management Implications of *Baylisascaris procyonis* Occurrence

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ABSTRACT

The gastrointestinal tracts of 60 raccoons (*Procyon lotor*) were examined for helminths. Six species were found: four species of nematodes (*Arthrocephalus lotoris*, *Physaloptera rara*, *Gnathostoma procyonis*, and *Baylisascaris procyonis*); one species of cestode (*Mesocostoides variabilis*); and one species of acanthocephalan (*Macracanthorhynchus ingens*). *Baylisascaris procyonis* has been implicated in the decline of woodrat populations throughout the northeast United States. As such, this parasite also may have been a factor in the extirpation of the eastern woodrat (*Neotoma floridana*) throughout most of southern Illinois. The frequency occurrence of *Baylisascaris procyonis* in our sample was unexpectedly low, 3 of 60 raccoons (5.0%), and suggests that reintroduction of eastern woodrats to formerly occupied sites in southern Illinois may not be adversely affected by this parasite.

Key Words: *Baylisascaris procyonis*, eastern woodrat, helminths, raccoon, parasites, *Procyon lotor*, southern Illinois

INTRODUCTION

Raccoons (*Procyon lotor*) are common throughout the contiguous United States. They are adapted to a variety of habitats and are economically important, as they are trapped and hunted for sport and pelts. Because they are omnivorous and widely distributed, raccoons have been the subject of numerous parasite surveys. Depending on the geographic region, a variety of parasite species may occupy the gastrointestinal tract of raccoons. In Illinois, Barnstable and Dyer (1974) found 9 species of helminths from 36 raccoons from 7 southern Illinois counties. Snyder and Fitzgerald (1985a) found 14 species of helminths in 245 raccoons trapped within a 161 km radius of Farmington, Fulton County, Illinois.

Baylisascaris

Among the helminths reported in raccoons, one species of special interest is *Baylisascaris procyonis* (Nematoda: Ascarididae) (Sprent 1968). Barnstable and Dyer (1974) found this species (reported as *Ascaris columnaris*) in 64% of 36 raccoons. Snyder and Fitzgerald (1985b) considered these to be *B. procyonis*. Snyder and Fitzgerald (1985b, 1987) found

that approximately 93% of juvenile raccoons in northern Illinois contained *B. procyonis* in the gastrointestinal tract, as did 55.3% of adults. *Baylisascaris procyonis* is the only ascarid species found in raccoons. Ascarid nematodes previously reported in raccoons, including *Ascaris alienata*, *Ascaris columnaris*, *Ascaris procyonis*, and *Toxascaris procyonis* are considered synonyms of *Baylisascaris procyonis* (Sprent 1968). Most *B. procyonis* found in adult raccoons are immature and it is believed that adult worms are expelled (Kidder et al. 1989). All developmental stages of the parasite occur in juvenile raccoons (Snyder and Fitzgerald 1985b). Besides being potentially fatal to humans, this parasite has been reported as a possible cause in the decline of woodrat (*Neotoma floridana*) populations (Eastern Woodrat Workshop 1986).

Woodrats as an Intermediate Host

Woodrat populations have been declining in Virginia, West Virginia, Pennsylvania, New York, Connecticut, New Jersey, Ohio, Indiana, and Illinois. Recent population reductions of woodrats have been attributed to possible infection by *B. procyonis* (Eastern Woodrat Workshop 1986). Woodrats ("packrats") collect a variety of material, including animal feces, and bring it back to their nests. This behavior could make them more susceptible to *B. procyonis*, for which they are an intermediate host. Infection leads to lethargy, loss of muscle control, decreased head control, torticollis, ataxia, and nystagmus, progressing to stupor, extensor rigidity, coma, and death (Kazacos et al. 1981; Kazacos 1983a, 1986; Kazacos and Boyce 1989). Besides woodrats, *B. procyonis* has been shown to cause central nervous system disease in 19 species of mammals and 13 species of birds (Kazacos and Boyce 1989).

The eastern woodrat historically has occupied the Shawnee Hills region of southern Illinois. Nawrot and Klimstra (1976) found evidence of past woodrat occupation at 24 sites in southern Illinois. The species has only recently been extirpated from several sites and the only existing population in Illinois currently is in Pine Hills, Union County. This is an isolated, remnant population isolated from populations in other states, as the Shawnee Hills are bordered by the Mississippi and Ohio rivers. The eastern woodrat is listed as endangered in Illinois (Herkert 1992). The U.S. Forest Service has recently discussed the possibility of reintroducing the eastern woodrat into the eastern portion of the Shawnee National Forest where historic woodrat sites exist. Because *B. procyonis* may be a problem in future reintroductions of the woodrat in southern Illinois, it is important to assess the prevalence of this parasite in raccoons from southern Illinois.

Objectives

The purpose of this study was to determine the prevalence of helminths in the gastrointestinal tract of raccoons - with emphasis on *Baylisascaris procyonis*. Data on the occurrence of *B. procyonis* in Pope County was needed to determine the feasibility of reintroduction of woodrats to one or more historic sites. Information from Pine Hills was collected to determine whether this parasite could be a factor in the decline of the remaining woodrat population in Illinois.

MATERIALS AND METHODS

Raccoons were collected from 19 November to 18 December 1992 from two sites in Pope County - the Benham Hill area (n = 23), approximately 6 km southeast of the Lusk Creek Canyon Wilderness Area, and the Dixon Springs Recreation Area (n = 7). Thirty raccoons were taken immediately adjacent to Pine Hills, Union County, from 20 April to 21 July 1993, to provide a total sample of 60 raccoons.

Laboratory Procedures

All raccoons were sacrificed in a humane manner, weighed to the nearest 0.1 kg, and stored (1 to 5 days) in a refrigerator at 7 degrees C. Age estimation (juvenile or adult) was calculated using body weight, and the degree of ossification of the epiphyseal cartilage of the radius and ulna (Sanderson 1961). An incision from the throat to the anal region was made and the gastrointestinal tract removed (esophagus, stomach, small intestine, and large intestine/ rectum). Each component of the gastrointestinal tract was separated, transferred to a container of physiological saline solution (8g/L), opened longitudinally, scrapped with a glass slide, and examined for helminths with the aid of a dissecting microscope. Helminths were isolated and prepared for fixation and storage in ethanol or formalin.

Nematodes were fixed by placing them in a solution of hot 70% ethanol and glycerin. They were then transferred to a glass dish containing alcohol-glycerine. The cover was placed on top with a paper towel between the cover and the glass dish. The alcohol was allowed to evaporate, leaving the nematodes in pure glycerine ready for observation as temporary mounts. Cestodes were fixed in formalin for 1 hour, washed in distilled water for 1 hour, and placed in Harris' hematoxylin solution overnight, followed by a rinse in distilled water. Specimens were then placed in 35%, 50%, and 70% alcohol successively for 1 hour each, destained in acid alcohol, placed in alkaline alcohol, and dehydrated in 85%, 95%, and 100% alcohol successively for 1 hour each. These were then transferred to a clearing agent and mounted on glass slides. Acanthocephalans were placed in distilled water until the proboscis was fully extended. They were then fixed in an alcohol-formalin mixture or Boulin's fluid for a few hours or overnight. They were then transferred to 70% ethanol where the body wall was pricked and left overnight. Prevalence (number of individuals of a host species infected with a particular parasite species divided by the number of hosts examined) of parasites was recorded for Pope County, Pine Hills, and for the overall sample.

RESULTS AND DISCUSSION

Six species of helminths - *Physaloptera rara*, *Arthrocephalus lotoris*, *Gnathostoma procyonis*, *Baylisascaris procyonis*, *Mesocestoides variabilis*, and *Macracanthorhynchus ingens* - were found. All have been reported previously from raccoons. No trematodes were found.

Nematoda

Physaloptera rara Hall and Wigdor, 1918 was the most prevalent parasite found and occurred in 32 (53.3%) raccoons; 19 (63.3%) from Pope County and 13 (43.3%) from Union County. It was found in the esophagus, stomach, and small intestine. Barnstable

and Dyer (1974) found 69.4% of 36 raccoons were infected by *P. rara* in Illinois, and it has been reported in equally high frequencies in previous studies (Bafundo et al. 1980; Cole and Shoop 1987; Robel et al. 1989; Richardson et al. 1992).

Arthrocephalus lotoris (Schwartz, 1925) was found in the small and large intestine of 19 (31.7%) raccoons of both sexes and close to equal proportions in Pope County (30.0%) and Union County (33.3%). This parasite is widely distributed throughout the contiguous United States. In Illinois, Leigh (1940) found this species in 2 of 6 raccoons, while Barnstable and Dyer (1974) found it in 52.8% of their sample.

Gnathostoma procyonis Chandler, 1942 was found in 7 (11.7%) raccoons. This parasite was often found in groups embedded in the mucosa of the stomach. Barnstable and Dyer (1974) reported it from only 2 of the 36 raccoons (5.6%) they examined.

Baylisascaris procyonis was not conclusively identified due to the absence of males. All ascarids found were females, which do not possess perianal roughened patches. These roughened patches are present only in males and are diagnostic of the genus *Baylisascaris* (Sprent 1968). However, as noted, the only ascarid nematode known in raccoons is *B. procyonis*. Therefore, we are confident that the ascarids found in the small intestine of 3 juvenile raccoons (2 males and 1 female) from Pope County were *B. procyonis*. The 5% occurrence in our study was substantially lower than the 63.9% incidence (reported as *Ascaris columnaris*) found by Barnstable and Dyer (1974).

Cestoda

One species of tapeworm was recovered. *Mesocestoides variabilis* Mueller, 1927 was found in the small intestine of 20 (33.3%) raccoons; 12 from Pope County and 8 from Union County. *Mesocestoides variabilis* is the only species in this genus found in raccoons. In Illinois, Barnstable and Dyer (1974) recovered *Mesocestoides* in 9 of 36 (25.0%) raccoons, and Snyder and Fitzgerald (1985a) found it in 71 of 245 (29.0%) raccoons.

Acanthocephala

Macracanthorhynchus ingens Meyer 1932 was the only acanthocephalan found in the raccoons examined. It occurred in the large and small intestines of 20 (33.3%) raccoons of both sex and age categories. It was present in 40.0% of the Pope County sample and in 26.7% of the Union County sample. In Illinois, Barnstable and Dyer (1974) recovered this species in 5 of 36 (13.9%) raccoons, and Snyder and Fitzgerald (1985a) recovered it in 11 of 245 (4.5%) raccoons.

Of the 60 raccoons sampled, 1 (1.7%) had no parasites, 28 (46.7%) had a single species of parasite, 21 (35.0%) had 2 parasite species, and 10 (16.7%) raccoons had 3 parasite species. Considering the 28 raccoons with only one species of parasite, *P. rara* occurred in 15 (53.6%).

Variation in *Baylisascaris procyonis* Occurrence and Management Implications

Based on previous studies with sample sizes ≥ 60 raccoons, there appears to be a latitudinal gradient in the frequency of occurrence of *B. procyonis*, with low or no occurrence in more southern latitudes (Jordan and Hayes 1959; Harkema and Miller 1964; Johnson 1970; Schaffer et al. 1981). Also, the success of some parasitic helminths depends on the variety of intermediate and paratenic hosts available (Cheng 1973). Diversity of hosts depends on the extent of habitat diversity available. Thus, variation in occurrence of *B. procyonis* also may depend on local habitat conditions and topography (Bafundo et al. 1980; Schaffer et al. 1981; Jones and McGinnes 1983). Both latitude and local conditions could be factors in the low frequency occurrence of *B. procyonis* in this study.

Based on our results, *B. procyonis* does not currently appear to be a factor in the population dynamics of the Pine Hills woodrat population. Also, it would appear feasible to reintroduce eastern woodrats into one or more historic sites of the Shawnee National Forest. However, the eggs of *Baylisascaris* can be viable for several years with adequate moisture (Kazacos and Boyce 1989). Therefore, if and when a reintroduction site is designated, raccoon latrine sampling should be done (Kazacos 1983b) to determine the prevalence of *Baylisascaris* eggs in the reintroduction area. This would be less expensive and time consuming than collecting raccoons, and would give more site-specific information.

ACKNOWLEDGMENTS

Funding for this study was provided through a contract with the U. S. Forest Service. We thank Mike Spanel and Steve Widowski, Shawnee National Forest, for their assistance and support of this project. We also thank Dean Corgiat and David Blumenstock for assistance trapping raccoons, and Kris Alden for help in the laboratory. George Waring provided helpful comments on an earlier draft on the manuscript.

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