

Prevalence of *Baylisascaris procyonis* in intermediate host populations as a function of landscape attributes

Abstract

Parasite transmission dynamics can be affected by factors including host species' habitat characteristics^{6,7}. The transmission dynamics of *Baylisascaris procyonis*, a common intestinal roundworm of raccoons, can be affected by anthropogenic factors such as altered food sources^{5,7,8}. The presence of anthropogenic food sources may reduce predation behavior in raccoons⁸, leading to an interruption of the *B. procyonis* transmission cycle and reduced prevalence in urban areas^{6,7}. Less is known about changes in the transmission of *B. procyonis* to small vertebrate intermediate hosts caused by anthropogenic alteration of the landscape. We measured prevalence of *B. procyonis* in *Peromyscus* ssp. populations in Chicago-area forest preserves located in two land-use classifications. In Summer 2006, prevalence was significantly greater populations ($\chi^2= 10.826$, $p=0.0010$). We sampled the sites again a year later and found no significant differences between the two land-use classes (). Our results support the hypothesis that prevalence in intermediate host populations may be impacted by changing raccoon behaviors. Reduced predation in urban areas may allow for longer lifespan in small vertebrate populations, increasing chance of infection and accumulated burden. The reduced prevalence observed the second year at several locations may be the result of the removal of infected individuals in the previous year.

Introduction

Life Cycle of *B. procyonis*

- Prevalence is 68-82% in Midwest¹
- *B. procyonis* shed eggs in raccoon feces (20,000 eggs/g)¹
- Millions of eggs may accumulate at raccoon latrines⁴
- Point of transmission to small vertebrate intermediate hosts that forage in and ingest eggs from the latrine^{4,5}
- Raccoons prey on small vertebrates, completing the cycle¹



Fig. 1. *Baylisascaris procyonis* transmission involves predation and scavenging, and requires that intermediate host to have contact with raccoon feces^{1,4,5}



Fig. 2. Raccoon latrine

Landscape as a Factor

- Prevalence may be influenced by landscape attributes including human land-use^{6,7}
- Presence of anthropogenic food sources can alter raccoon feeding behavior⁸, reducing predation and interrupting the transmission cycle of the parasite⁷



Fig. 3. Land-use gradient (rural-urban)

- Prevalence of *B. procyonis* in raccoons greater in urban landscapes^{6,7}
- Effects of habitat attributes on *B. procyonis* prevalence in small vertebrate intermediate hosts not well understood



Fig. 4. White-footed mouse (*Peromyscus leucopus*), a common intermediate host of *B. procyonis* in the Midwest^{1,4}

Kenneth F. Kellner, Mark G. Downey, and Peter P. Girgis

Dr. Kristen Page, Advisor

Department of Biology, Wheaton College, Wheaton, Illinois 60187

Methods

Land-Use Classification

- Eight DuPage and Cook County forest preserves were sampled in this study in the summers of 2006 and 2007

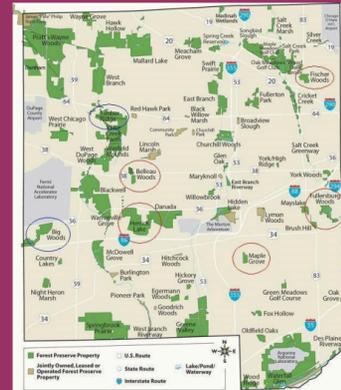


Fig. 5. DuPage County IL Forest Preserve district map, with sampling locations circled (Crabtree preserve in Cook County also sampled)
Red – Sampled Summer 2006/2007
Blue – Sampled Summer 2007

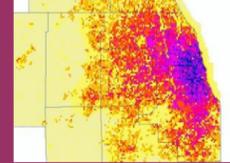


Fig. 6. GIS land-use classification model of the Chicago region

- Classified as relatively urban or relatively rural using satellite images and aerial photographs
- A GIS model synthesizing human population density, road density, and land cover data will refine the classification in the future

Trapping

- Lines of ~30 Sherman live traps were used at each site to catch small vertebrate intermediate hosts
- About 20 total individuals of two mouse species (*Peromyscus leucopus*, *Peromyscus maniculatus*) were removed from each site
- Euthanized using carbon dioxide gas



Fig. 7/8. Handling *Peromyscus* ssp. in the field



Determining Infection Status

- Mice were skinned and blended in acid-pepsin solution¹
- Mimics digestive process in the raccoon stomach
- *B. procyonis* larvae settle to the bottom of resulting liquid
- Liquid examined under dissecting microscope to determine infection status and total parasite burden
- Mouse brains smashed between glass plates and examined for parasite larvae



Fig. 9. Larvae in brain of *P. leucopus*. Larvae that encyst in the CNS of intermediate host species often cause severe CNS disease and death³

Results

Prevalence as a Function of Land-use Classification

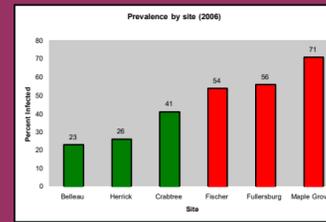
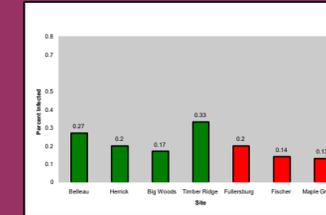


Fig. 10. Prevalence of *B. procyonis* in mouse populations at each sampling site in 2006
Green – Classified rural
Red – Classified urban

- Prevalence (2006 data) significantly greater in urban preserves (mean 29%) than in rural preserves (mean 59%; $\chi^2= 10.826$, $p=0.0010$)



of *B. procyonis* in mouse populations at each sampling site in 2007
Green – Classified rural
Red – Classified urban

- In 2007, prevalence in urban preserves (mean 16%) was not significantly different from prevalence in rural preserves (mean 24%; $\chi^2=$, $p=$)

Burden as a Function of Land-use Classification

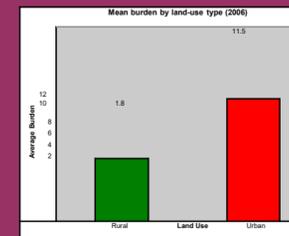


Fig. 12. Mean *B. procyonis* burden for each land-use classification in 2006

- Burden (2006 data) significantly greater in urban preserves (mean 11.5) than in rural preserves (mean 1.8; $F=5.423$, $p=0.0216$)

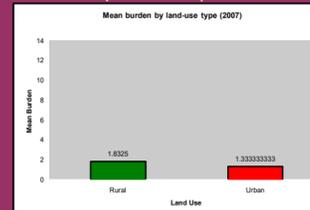


Fig. 13. Mean *B. procyonis* burden for each land-use classification in 2007

- In 2007, burden in urban preserves (mean 1.3) was not significantly different from burden in rural preserves (mean 1.8)

Discussion

- This study found that prevalence of *B. procyonis* in intermediate host populations was related to human land-use
- Urban forest preserves had a significantly higher prevalence of the parasite in 2006
- Opposite observed pattern of lower prevalence in raccoon populations in urban areas
- May be related to changing raccoon feeding behavior in urban areas due to increased anthropogenic food sources⁸
- Less predation by raccoons on intermediate hosts = longer intermediate host lifespan
- A longer lifespan increases the chance and frequency of contact with infective *B. procyonis* eggs
- The decrease in prevalence in several forest preserves observed in 2007 supports this hypothesis
- Removal of adult, infected individuals from the site in 2006 may have resulted in a younger population that hasn't had time to reach a high level of *B. procyonis* infection
- A study of average small vertebrate lifespans in a land-use gradient could test the accuracy of this hypothesis
- The change in prevalence we observed also emphasize the need for a continued and expanded study to validate the observed patterns

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