The Perfect Storm: Factors that lead to increased transmission and resistance emergence of heartworm in the United States

Paige Miller¹, A.W. Park²
1. Gustavus Adolphus College; 2. Odum School of Ecology, University of Georgia

Overview
Macroparasites cause devastating human and animal diseases yet there is limited research concerning basic parasite biology, testing procedures, and disease transmission. Knowledge in these areas could lead to novel worm control treatments and possibly disease eradication. Heartworm disease, caused by Dirofilaria immitis, is observed globally but distributed heterogeneously. Distribution is thought to be affected by factors such as climate, pet and owner demographics, and mosquito habitat. Recent concerning evidence has suggested the establishment of drug resistant worms. Because only one class of drugs exists to treat heartworm, resistance would present a large problem. Two of the first models for heartworm disease dynamics and drug resistance emergence were developed in order to identify factors that could lead to higher rates of transmission and increased rates of resistance emergence.

Heartworm incidence is high around the Mississippi delta

Motivational Data
Median salary is lower in the South

Higher Percentage of Dog Owners are in the South

Conclusions
• We developed some of the first heartworm specific transmission models
• Collectively, these models help to identify factors and regions that are associated with successful and rapid establishment of drug resistant heartworm populations
• High vector abundance and low coverage levels lead to higher average worm burdens
• Large populations of initially resistant microfilariae are more likely to persist
• Drug alternation strategies present a way to keep resistance at low levels in the population
• Anthelmintic resistance has already become a major problem for many animal populations and is a looming threat for both heartworm and human diseases
• These models could apply to understanding mechanisms of human anthelmintic resistance emergence

Questions
• Can we model a vector-borne macroparasite population?
• Which factors lead to faster rate of resistance emergence?
• Will drug resistance ever become a problem in heartworm populations?
• What areas are most at risk for the emergence of drug resistance?
• Would drug alternation reduce the level of resistance allele fixation?

Model

Model Results
How does vector abundance affect worm burden?

How do coverage levels affect worm burden?

How does the size of initially resistant population affect probability of invasion?

How does drug alternation affect level of resistant allele fixation?

Future Research
• How do refugia populations and proximity of domestic dogs affect transmission dynamics?
• How does gene flow between subpopulations of heartworm lead to higher rates of resistance emergence?
• How does seasonality, drought, and climate affect worm transmission?
• Present management programs for resistance emergence control (e.g. benefit of improved compliance, mosquito control programs)
• Make predictions about human anthelmintic resistance

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References
• American Veterinary Medical Association, U.S. Pet Ownership Demographics Scorecard. 2012.