Who Wins When Worms Compete?

Evaluating the Effects of Competition on Gastrointestinal Helminths Co-Infecting the Same Host

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Introduction

Competition is an ecological phenomenon that occurs when organisms vie for the same limited resources, such as food and space. Competition can occur among individuals of the same species (intraspecific competition) or between species (interspecific competition) and plays a large role in the formation of natural communities. Although much is known about how free-living plants, animals, and microbes compete for resources in natural environments, little is known about how co-occurring parasites share resources within a single host or how one parasite copes with host immune responses triggered by other parasites. These types of competitive interactions can drive adaptations within parasite populations, influence the probability of disease transmission, and alter overall pathogenicity of a parasite. For these reasons, parasite competition has become a topic of interest and its implications for host fitness and disease severity are of increasing importance. In this study, we examined competition between gastrointestinal helminthes of the same and different species co-infecting African buffalo hosts.

Research Questions

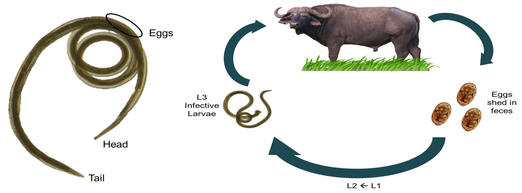
I. Are parasite fecundity and body length correlated, and does habitat (the host) influence this relationship?

II. Is there evidence of intraspecific competition occurring between parasites?

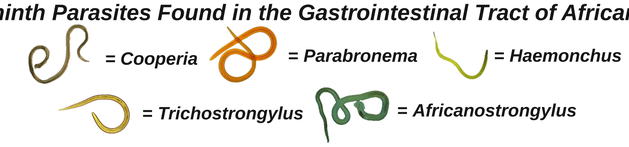
III. Is there evidence of interspecific competition occurring between parasites?

Methods

Study Organisms - Cooperia (Helminth) & African Buffalo (Host)



Helminth Parasites Found in the Gastrointestinal Tract of African Buffalo

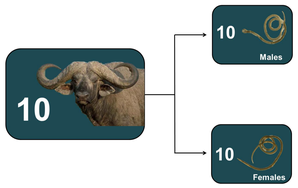


Metrics of Parasite Fitness & Competition

- **Parasite fitness:** Total eggs (fecundity) & body length
- **Intraspecific competition:** Total number of *Cooperia* present in a host buffalo
- **Interspecific Competition:** Total number of non-*Cooperia* worms present in a host buffalo

Sampling Protocol

- Adult *Cooperia* collected from buffalo were photographed using a camera and dissecting microscope. Length measurements were taken for 10 male and 10 female *Cooperia* per buffalo. For all female worms, the total number of eggs present in the reproductive tract were counted.



Statistical Analyses

- General linear mixed models (GLMM) were used to evaluate worm length *vs.* fecundity relationships and competition. In all models, buffalo ID was included as a random effect to account for repeated measures of worms from the same host. Models of worm length included the interaction between worm gender and total number of worms was included as an independent variable to examine whether male and female worms show different responses to competition. Graphs display mean parasite fitness ± 2 standard errors.

I. Worm Length *vs.* Fecundity

Worm length and fecundity were not significantly correlated.
Buffalo host identity seemed to influence the relationship between fecundity and length.

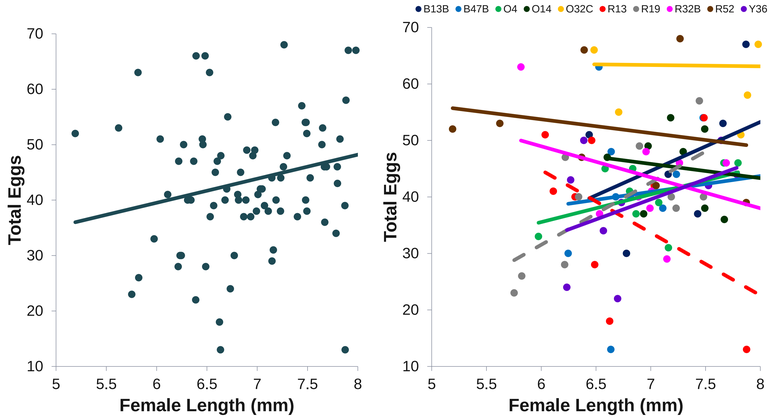


Figure 1 (Left). Accounting for the effects of repeated subsampling from individual buffalo, there was no correlation between female fecundity and body length (p=0.42).

Figure 2 (Right). Worm length was not significantly correlated with *Cooperia* fecundity (p=0.55). Fecundity was affected by the identity of the host buffalo (p<0.01), and relationships between length and fecundity varied by buffalo. For example, for buffalo R13 , as worm length increased, fecundity decreased (Estimate=-12.20 p=0.010); for buffalo R19, as worm length increased, fecundity increased (Estimate=9.89, p=0.07).

II. Intraspecific Parasite Competition

Cooperia fecundity and worm length were not affected by intraspecific competition.

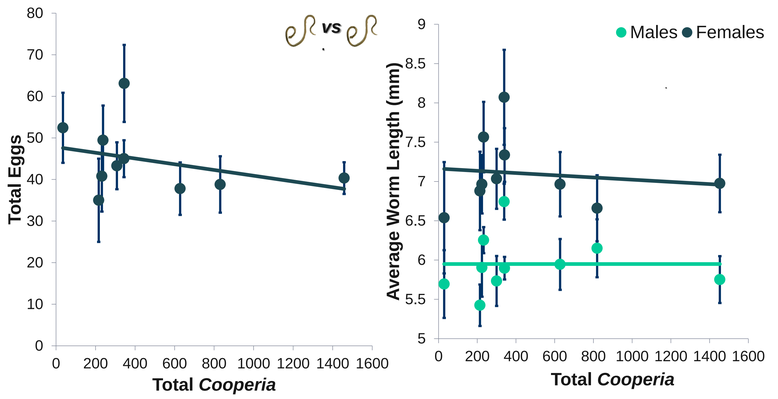


Figure 3 (Left). There was no significant relationship between total *Cooperia* and fecundity (p=0.34).

Figure 4 (Right). The total number of *Cooperia* present in the host did not significantly affect worm length (p=0.81), but worm length was affected by parasite gender (p<0.01). There was no significant interaction between total *Cooperia* present in the host and parasite gender (p=0.41).

Acknowledgements

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III. Interspecific Parasite Competition

Interspecific competition did not affect *Cooperia* fecundity, but competition and gender interacted to affect worm length. This effect emerged for *Parabronema*, but not *Haemonchus*.

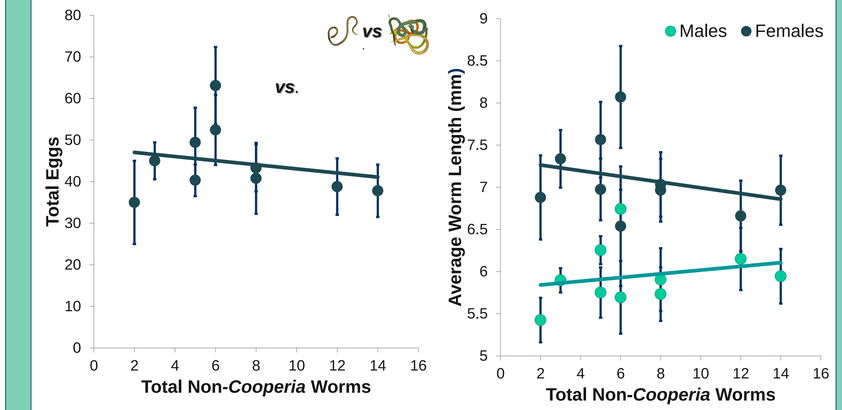

Figure 5 (Left). There was no significant relationship between total other worms present in the host and fecundity (p=0.54).

Figure 6 (Right). There was a significant interaction between worm gender and the total number of non-*Cooperia* worms present in the host (p=0.01), in which female length and male length responded differently to interspecific competition. There was no main effect of total non-*Cooperia* worms on worm length.

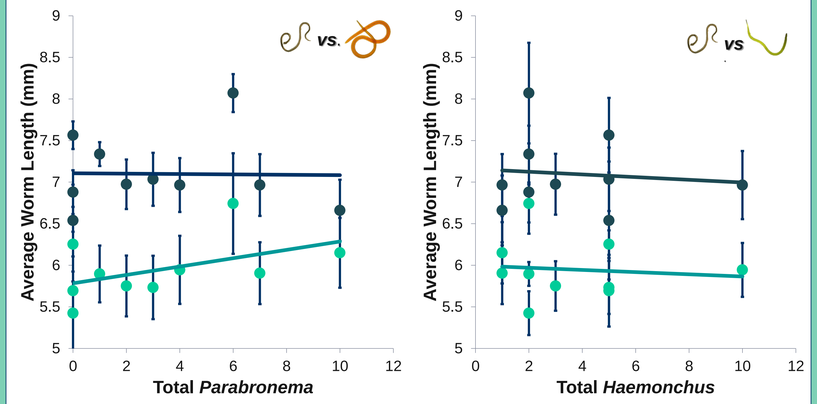

Figure 7 (Left). There was a significant interaction between worm gender and the total number of *Parabronema* present in the host (p=0.03), but there was no main effect of total *Parabronema* worms on worm length.

Figure 8 (Right). There was no significant effect of total number of *Haemonchus* present in the host, worm gender, or their interaction on worm length.

Conclusions & Future Directions

Length vs. Fecundity

- The relationship between parasite length and fecundity varies with host identity. Future work will explore whether metrics of host habitat quality can explain differences in the worm length-fecundity relationships observed across hosts.

Intraspecific & Interspecific Competition

- There was no evidence that *Cooperia* worms were subject to intraspecific competition within buffalo hosts, but evidence of interspecific competition was found (Figure 6).
- Worm gender influenced the response to interspecific competition, and the effects of interspecific competition were most apparent between *Cooperia* and *Parabronema* (Figure 7).
- Future work will include obtaining worm samples from a larger number of buffalo hosts and increasing the number of worms measured per buffalo.