The Role of Priority Effects on Host-Parasite Interactions

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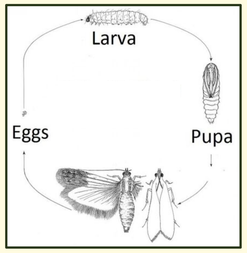
Introduction

Parasitism is the practice of living in or on another organism for resources, usually causing harm to the host organism. To understand how parasitism impacts the host, experiments are typically done observing interactions between a single host and a single parasite species. However, in many real-world ecosystems, organisms have to defend from multiple parasites at once. This places unique constraints on the host to allocate immune resources and on the parasites who now face interspecific competition.

My research project investigated the host-parasite interactions between one host species, *Galleria mellonella*, and two of its natural parasites, *Steinernema carpocapsae* and *Heterorhabditis indica*, to see how the timing and order of infections affected host mortality and parasite success.

Galleria mellonella

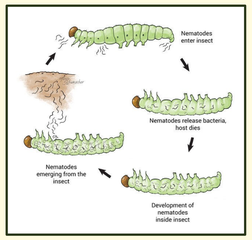


Life cycle of *Galleria mellonella*

- Also known as the Greater Wax Moth, *Galleria mellonella* is a moth species commonly studied in host-parasite systems.
- *Galleria* are also a major agricultural pest, acting as a parasite to honeybees and damaging hives by consuming wax and honey.

Parasitic Nematodes: *Steinernema carpocapsae* and *Heterorhabditis indica*

- Parasitic nematodes reproduce by infecting a host organism and laying their eggs inside the cadaver. Once the eggs hatch, the juvenile nematodes will stay inside the host body growing and reproducing until it's time to leave the cadaver and find another host.



Life cycle of parasitic nematodes

- Competition between different species of parasitic nematodes, like *S. carpocapsae* and *H. indica,* shapes parasite virulence.

Methods

To investigate how the timing and order of infections alters host mortality and parasite virulence, I did a full factorial experiment using the two nematode species, *S. carpocapsae* and *H. indica*, plus a control treatment without nematodes.

Table 1 shows the all the treatment groups for the experiment.

Each treatment group contained two replicates of 25 *Galleria mellonella* larvae housed on standard food mix. The first infection took place on day 1 of the experiment and the second infection took place on day 3. Host mortality was counted and recorded each day.

Photo of all treatment groups replicates

Photo of larvae in a single replicate

Treatments			
Early Infection		Late Infection	
First Species	Second Species	First Species	Second Species
S. carpo	control	control	S. carpo
S. carpo	H. indica	H. indica	S. carpo
control	H. indica	H. indica	control
control	control	control	control

On day 10, all dead *Galleria mellonella* hosts were collected from each treatment and placed in water traps to recover the nematodes.

The traps are set up by placing a smaller petri dish inside of a larger one and covering it with a filter paper cut into a star. The lower petri dish is covered in water and the insect cadavers are placed on top of the filter paper. Over time, the nematodes leave the host body and are washed into the water at the bottom of the trap.

After two to three days, the water from the traps is collected and the nematodes are counted under the microscope.

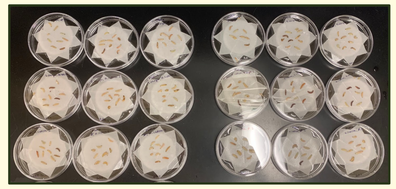


Photo of water traps set up to recover nematodes

Results

- The probability of host mortality increases over time for across all treatment groups
- Risk of host mortality is higher for co-infection treatments following the order of *S. carpocapsae* first then *H. indica* second
- *H. indica* is more successful and produces more offspring compared to *S. carpocapsae* except when in competition with *S. carpocapsae*

Figure 1: Probability of Mortality in Co-Infected Treatments

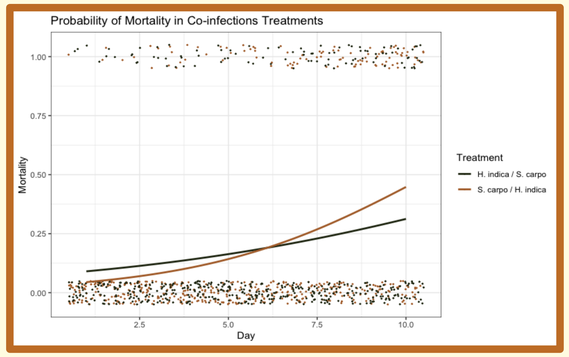


Figure 2: Probability of Mortality in Early Infected Treatments

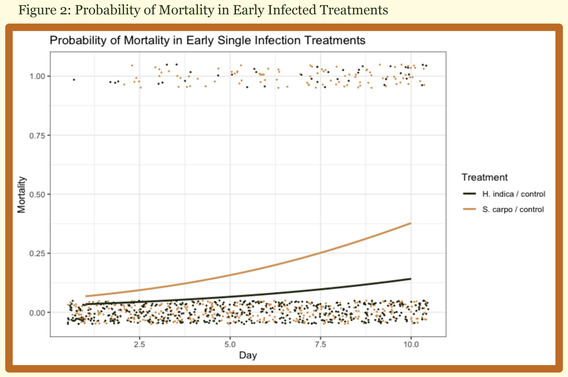
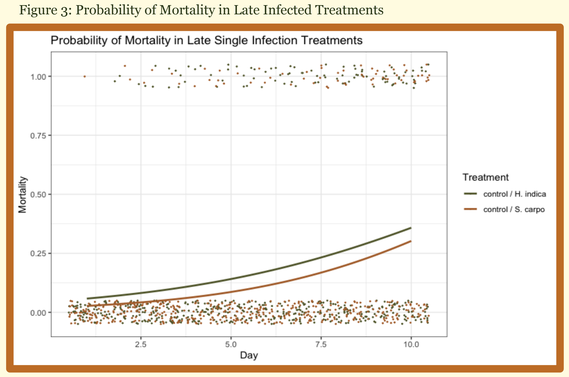


Figure 3: Probability of Mortality in Late Infected Treatments



Discussion

The results of this experiment support the hypothesis that priority effects exist for the host-parasite system involving *Galleria mellonella* and two of its nematode parasites, *Steinernema carpocapsae* and *Heterorhabditis indica*.

This adds to the growing body of research considering the importance of the order and timing of infections in interactions involving more than one parasite species.

H. indica seems to be the more successful parasite of *Galleria mellonella,* as it increases the risk of host mortality and produces more infective juveniles. However, the *H. indica* produces fewer offspring when competing with *S. carpocapsae,* showing the negative impact competition has on parasite success and virulence.

Photo of adult *Galleria mellonella* moth

Future Directions

- The control treatments of this project were found to have nematodes in them due to contamination. This experiment therefore needs to be replicated to prove significant differences in mortality caused by infection
- Using genetic information from each parasite to identify them by species would help establish which parasite successfully colonizes the host and how priority effects impact the probability of colonization
- Future experiments looking at the priority effects of infections on host species might benefit from investigating co-infection with more than two species of parasite or parasites of more different genetic backgrounds to see how the competitive interactions play out
- Understanding how the timing and order of infections impacts host mortality and parasite success will serve in future application of biopesticides to control populations of pests like the Greater Wax Moth

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