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Does adaptation to harsh environments provide protection against parasites?

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Summary

Parasite-host relationships may be impacted by variation in the abiotic environment, particularly when the host species' range includes both moderate and extreme climates. Parasites might not be able to tolerate both climates, resulting in adaptation by the host to harsh environments being a potential strategy to reduce parasitization. We studied parasitization of snowberry flies by a specialist parasitoid, the braconid wasp *Diachasma sp.*, in both western and eastern Washington populations. In the relatively harsh environment east of the Cascades, desiccation resistance is a necessary trait for snowberry flies to survive. In order to investigate the success of the parasitic wasp in this harsh environment, we measured rate of parasitization and compared initial and final weights after a desiccation experiment. We found that parasitization rate is more variable in Eastern WA sites, despite the observation that parasitoids parallel the flies' adaptations against water loss. Parasitization appears to result in smaller fly puparia which are expected to be less desiccation resistant, potentially explaining the more variable success in arid environments.

Introduction

- The Cascade mountain range divides Washington into the western wet and mild climate and the eastern relatively harsh and dry climate
- Snowberry flies infest snowberry plants on both sides of the Cascades; previous work showed that eastern flies are more desiccation resistant
- The specialist braconid parasitoid *Diachasma* lays its eggs inside of snowberry larva while it is still in the fruit (Figure 2)
- It was unknown if the parasitoid matches the fly's adaptation to dry conditions or whether WA east of the Cascades presents a refuge for the dry adapted flies

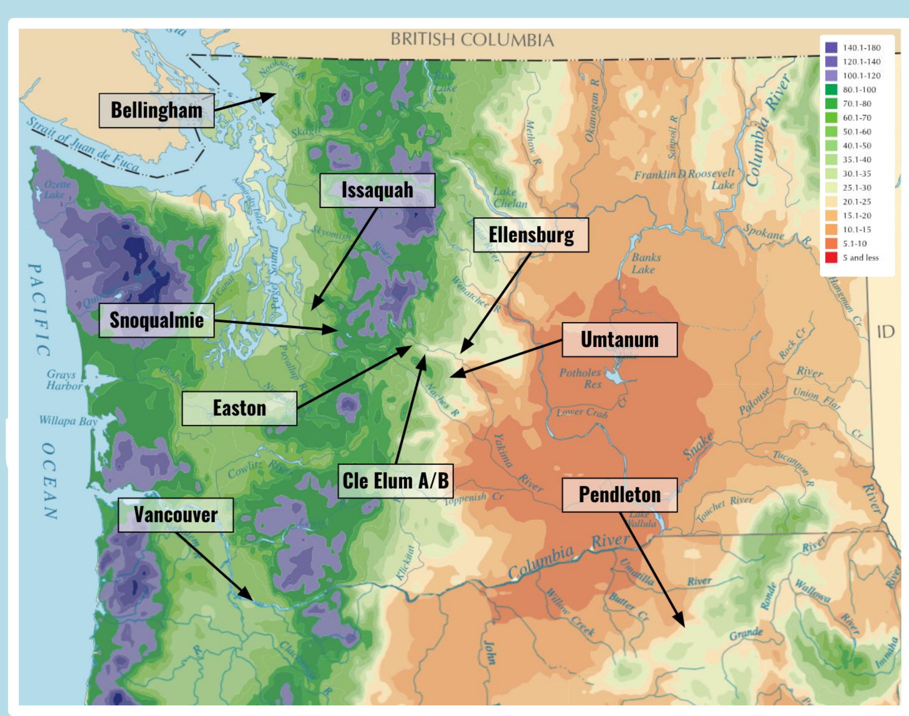

Figure 1. Heat map of average annual precipitation marked with each experimental site. Cooler colors represent higher precipitation, warmer colors represent lower precipitation, indicating a drier climate.

Methods

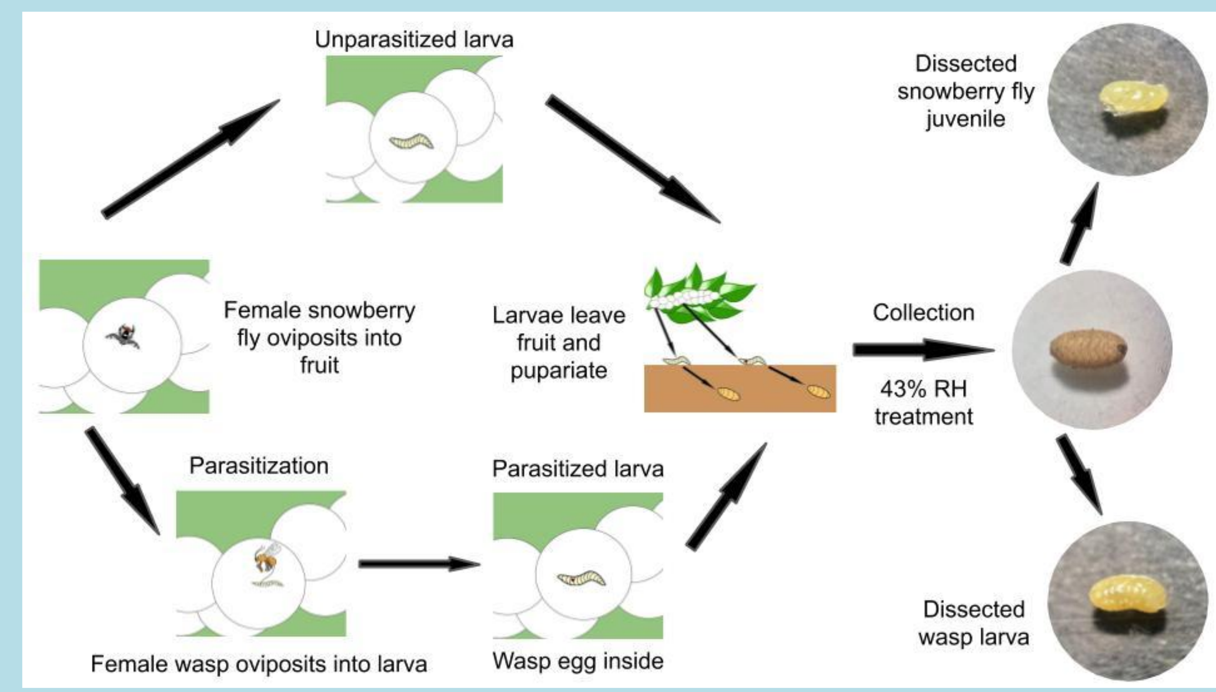

Figure 2. Life cycle diagram and methods schematic. Snowberry life cycle is shown with both unparasitized and parasitized larvae emerging from the fruit. After emergence, larvae were subjected to an 8-day, 43% relative humidity (RH) treatment at 21°C. The photos show actual images of pre and post dissected puparia, the upper photo showing a snowberry fly and the lower photo showing a braconid wasp larva.

1. Collection
   - The female snowberry fly oviposits eggs into the fruit; larvae may or may not become parasitized by the braconid wasp as they feed on and grow inside the berries
   - Larvae emerge and burrow into the soil to pupariate
   - We collect the fruit before emergence in order to immediately capture emerged larvae
2. Treatment
   - Pupariating larvae (collected <12 hrs after leaving the fruit) are subjected to an 8-day, 43% relative humidity (RH) treatment at 21°C directly after emergence
   - Individuals are weighed before and after treatment
   - Pupae are frozen post treatment
3. Dissection
   - Pupae are dissected to determine whether or not they had been parasitized; Figure 2 shows a dissected puparium with the developing parasitic wasp inside (bottom photo) and an unparasitized developing fly (top photo)

Results

Parasitization Rate

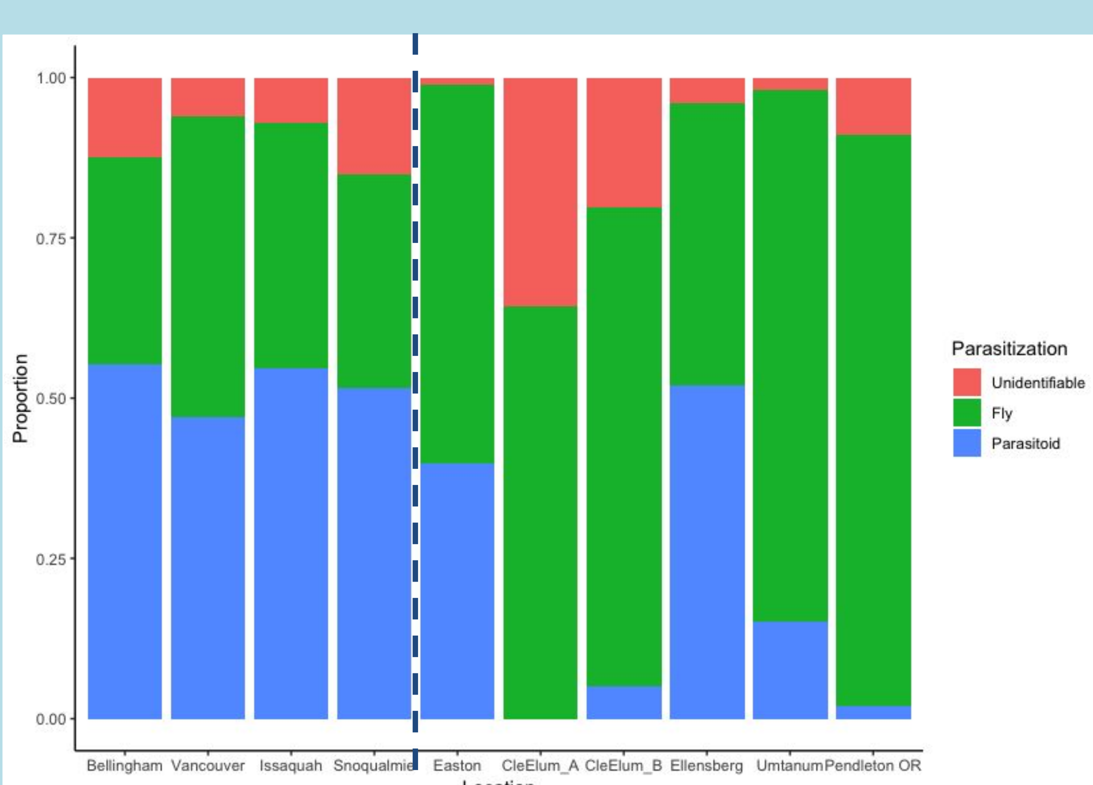

Figure 3. Parasitization rate across Washington sites from west to east, followed by one Oregon site. Dotted line separates sites west and east of the Cascades.

- Parasitization rate appears to be more variable and lower on average in the relatively harsh environment east of the Cascades

Comparing Weights: Pre and Post Desiccation Treatment

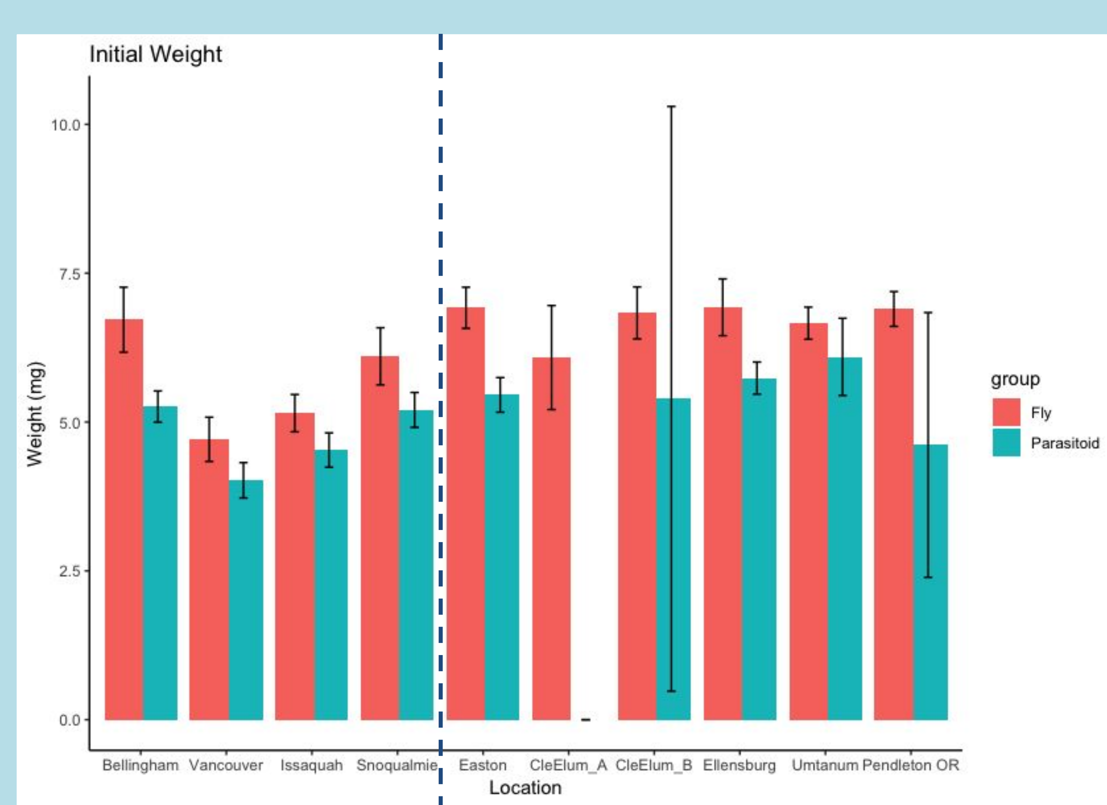

Figure 4. Weights of unparasitized and parasitized fly larvae immediately after egression from the fruit. Dotted line separates sites east and west of the Cascades.

- Before treatment parasitized fly larvae weigh less than unparasitized larvae ($p < 0.001$)
- This results in smaller puparia which are less resistant to desiccation due to their unfavorable surface area to volume ratio

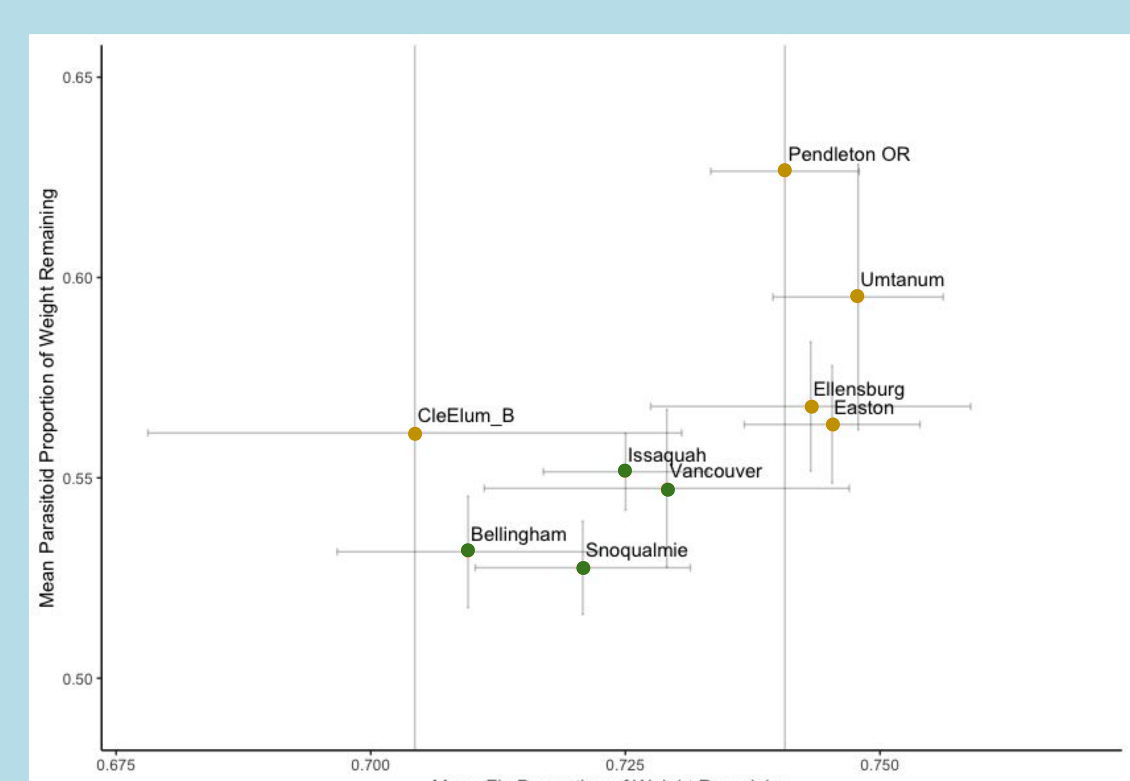

Figure 5. Mean proportion of weight remaining after 8-day desiccation experiment of unparasitized fly larvae (x-axis) and parasitized fly larvae (y-axis). Green dots mark sites west of the Cascades, brown dots mark sites east of the Cascades.

- Confirming previous findings, flies east of the Cascades lose proportionally less weight during the desiccation experiment
- Parasitoid proportional weight remaining correlates with the trend seen in flies

Acknowledgements

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Conclusions

- Parasitization rate is less uniform and on average lower at sites east of the Cascades
- Parasitized larvae are initially smaller and may therefore provide less protection from desiccation to the parasitoids
- Desiccation resistance of flies and parasitoids is correlated, suggesting that parasitoids are similarly adapted to more arid climates