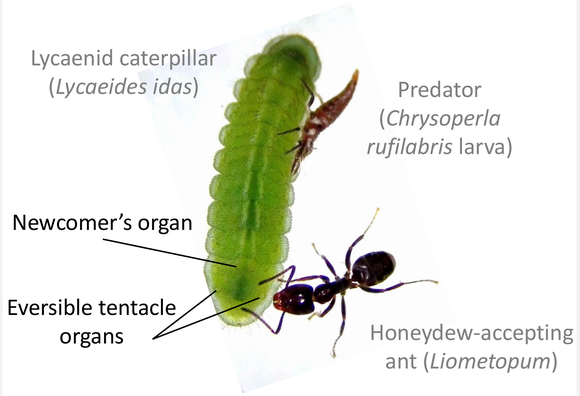
Student-designed experiments fill knowledge gaps about caterpillar-ant symbiosis

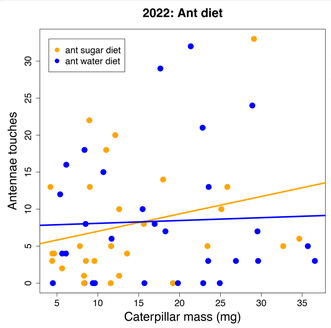
Introduction

Our introductory Biology lab courses revolve around multi-week course-based research experiences (CUREs) to ensure students learn science is process-based. We have had success with instructor-research collaborations to develop meaningful projects.

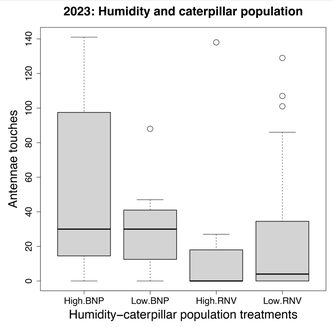
- **Larger context**. The NSF CAREER program funds a project to understand the causes and consequences of evolution in real time, specifically when selection varies in direction or intensity over space or time. Traits involved in caterpillar-ant interactions are hypothesized to experience this fluctuating selection.
- **Specific goal**. Over four years, Honors students filled knowledge gaps about biotic or abiotic factors that affect a mutualistic relationship between *Lycaeides idas* caterpillars and ants.



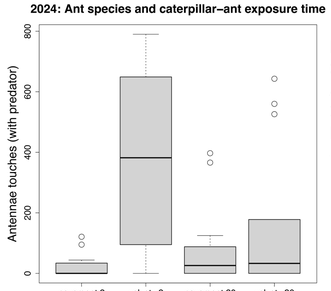
Sugar-consuming ants protect organisms like lycaenid caterpillars from predators and parasitoids in exchange for the honeydew released from the Newcomer's organ.



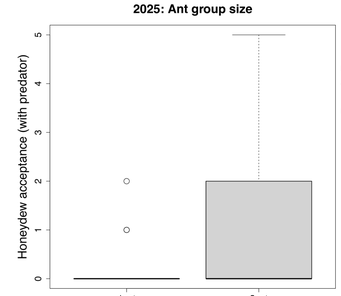
R^2:
0.03 (p-value 0.64)



R^2:
0.16 (p-value 0.02)
Caterpillar population effect:
-35.08 (p-value 0.009)
Mass effect:
2.62 (p-value 0.008)



R^2:
0.32 (p-value 0.0002)
Ant species effect:
347.9 (p-value 0.00004)
Interaction effect:
-268.0 (p-value 0.02)



R^2:
0.15 (p-value 0.0001)
Treatment effect:
0.94 (p-value 0.0001)

The independent variable(s) and main patterns found across four years of caterpillar-ant interaction experiments. Linear regression results with statistical significance are highlighted.

CURE structure

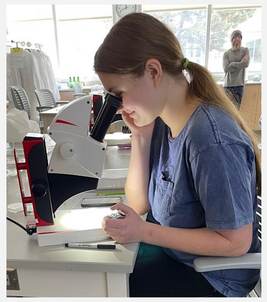
After six weeks of learning about the scientific method, collaboration, and written and oral communication, we conduct the 7-week CURE:

Week 1. Observe the study system
Week 2. Group research proposal draft
Week 3. Proposal review panel
Week 4. Background information for the chosen proposal; Presentation introduction draft
Week 5. Data collection using **stereoscopes**; Presentation methods draft
Week 6. Data analysis using **R**; Presentation results and conclusion draft
Week 7. Incorporate instructor feedback on drafts; individually record 5-min research presentation

Scientific results

In 2022 we learned: We did not have evidence that 24 hours of sugar deprivation led ants to seek out or receive more honeydew.
In 2023 we learned: Ants sensed caterpillar populations differently ('BNP' was touched more than 'RNV', despite being smaller).
In 2024 we learned: The Velvety tree ant (*Liometopum* sp.) interacted with the caterpillars more than the Pavement ant (*Tetramorium immigrans*), but interactions decreased with time
In 2025 we learned: Caterpillars release more honeydew from their Newcomer's organ when more ants are present (3 ants vs. 1 ant).

"There's just something so amazing about being able to do work to answer your own questions and go through the process of science and understand something that hasn't been understood before."



Brenna Sullivan, first-year student, 2024 cohort

Application to other institutions

Obtaining and maintaining the live organisms for this project, as well as ensuring sample sizes are decent for the day of data collection, are the most challenging parts of this CURE.

- You can request *Lycaeides idas* eggs and alfalfa seeds (the caterpillars eat fresh alfalfa leaves per day) from the authors by June of each year. Use an incubator to rear the **caterpillars** for 16-19 days before students collect data.
- **Caterpillar predators**, green lacewing larvae, can be ordered online.
- **Aphids** and their **ladybug larvae predators** could be used instead of caterpillars and green lacewing larvae.
- We have had luck collecting **honeydew-eating ant** pests from a local greenhouse.

UtahStateUniversity



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