Winter-Active Parasitoids and Pollinators: Using a Metabolomic Approach to Uncover Potential Resource Competition Between *Aphidius ervi* and *Bombus terrestris*

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Background

Climate change is causing many beneficial insects to become **winter-active** (Stelzer *et al*., 2010; Tougeron *et al*., 2017) e.g.

- the buff-tailed bumblebee *Bombus terrestris* (pollinator)
- the parasitoid wasp *Aphidius ervi* (pest control agent)

This winter activity is occurring at a time when resources e.g. food, shelter, are scarce, putting increased pressure on beneficial insects and the ecosystem services they provide.

To better support winter-active insects, wildflower strips can be planted to provide a food source to nectar-feeding insects (Ouvrard *et al*., 2018).

- However, competition over floral resources can impact the health and longevity of beneficial insects (Jeavons *et al*., 2022).
- Novel competition between **winter-active** parasitoids and pollinators over floral resources in wildflower strips could impact the nutritional status and parasitism rate of parasitoids such as *A. ervi*.
- Previous research into **competition** found no effect of bee presence on the ability of *A. ervi* to parasitise aphids, which suggests a lack of competition over floral resources (Alford *et al*., 2024). However, it is possible that **exploitative competition** or **interference competition** was occurring but could not be detected by the experimental setup.

AIM: to provide a thorough investigation into potential **exploitative** or **interference competition** between parasitoid wasps and bumblebees using cameras and metabolomic analysis.

Overview of experiments

Research questions

Does **competition** over floral resources occur between *Aphidius ervi* parasitoids and *Bombus terrestris,* impacting natural biological control?

Is **exploitative competition** occurring, limiting nutrient acquisition and impacting parasitoid nutritional state?

Is **interference competition** occurring, forcing parasitoids to forage at difference times of day or on less profitable resources?

Experiment

Number of mummies that form under different treatments is counted to calculate the **parasitism rate**

Metabolomics analysis using GC-MS

Nutritional status of parasitoids is determined

Motion detection videos over 24-hour period to observe *Aphidius ervi* behaviour under different treatments

Methods

Buckwheat (*Fagopyrum esculentum*)

White mustard (*Sinapis alba*)

Cage set up:

- **Floral treatment** or control
- 0 or 1 *Bombus terrestris* worker
- 2 virgin female *Aphidius ervi* wasps <24 hours old

Pot of wheat with 50 *Sitobion avenae* aphids added after 24 hours

After 24 hours, parasitoids flash frozen in liquid nitrogen for metabolomic analysis

After 24 hours, wheat bagged up and left for 3 weeks for mummies to form

Camera experiments have a simplified version of the cage set up above

Results

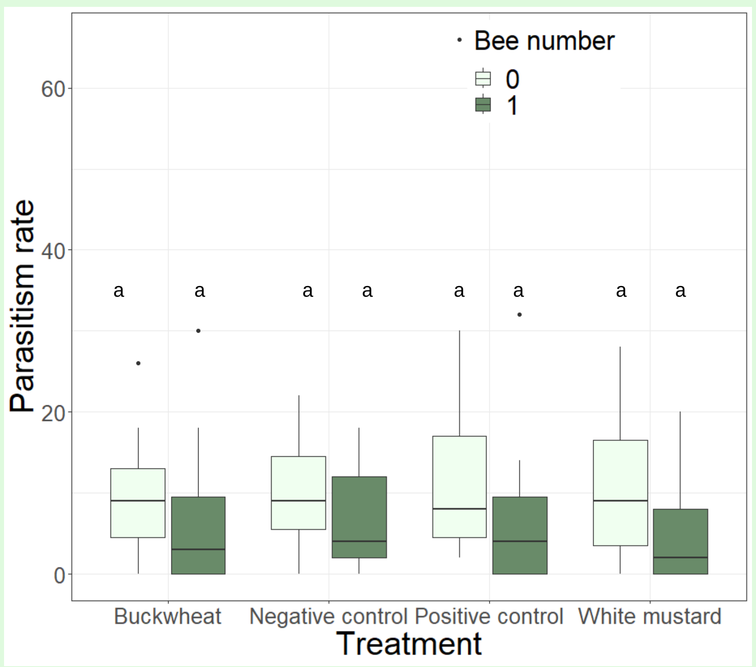

Figure 1: Percentage parasitism rate of *Sitobion avenae* by *Aphidius ervi* in the presence of buckwheat (*Fagopyrum esculentum*), a negative control (water), a positive control (1M sucrose solution), and white mustard (*Sinapis alba*) under two different bee treatments (0 bees and 1 bee).

- The ANOVA indicated a significant difference between group means for bee treatment ($F_{1,99} = 8.851$, $P = 0.00360$). However, the Tukey post-hoc test could not confirm any significant differences between the group pairs.
- No significant effect of floral treatment on parasitism rate was found ($F_{3,99} = 0.512$, $P = 0.675$)

Discussion

- Parasitism rate may be slightly lower in the presence of *Bombus terrestris*. This suggests that competition may be taking place between the two nectar-feeding insects, impacting the ability of *A. ervi* to perform natural biological control of aphids.
- The discrepancy between the results of the ANOVA and the post-hoc test may be due to the differences being too small to be detected by the more conservative Tukey test.
- We are currently in the process of analysing the metabolomic data and camera data to investigate if exploitative or interference competition is occurring.
- If competition is occurring this should be considered in the design of wildflower strips; parasitoids and bumblebees have different preferences, with the former benefitting from plots predominately composed of flowers with short corollas (Campbell *et al*., 2012).

Aphidius ervi

Sitobion avenae

References

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