

Exploring Larval Rejection Behavior in Bumble Bees

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Abstract

Bumble bees are important pollinators in commercial and natural settings. Understanding behavioral patterns of bumble bees can provide a baseline for understanding how they will react to environmental stressors. Bumble bees experience increasing levels of carbon dioxide (CO₂) in both commercial rearing facilities, where it is used as a management technique, and in the wild, due to climate change. We aimed to understand how increased CO₂ exposure affected larval rejection behavior in worker bumble bees. We initially started with 41 individual microcolonies that were derived from 3 main colonies of bumble bees (*Bombus impatiens*). Microcolonies were fed pollen and given sugar water and kept until they laid eggs. Worker bees were then switched out with a single young worker bee. Experimental groups of new worker bees were exposed to CO₂ on days 5 and 7. Larvae rejections were recorded twice. After evaluating the rejection results, we determined that there were no significant differences between the two groups. On day 9 there was an increase in larval rejection for the experimental group. Future modifications will be made to allow more time to observe rejections.

Methods

Microcolonies

- Used to generate brood needed for the experiment
- 3 workers from a single source colony
- Sugar water and pollen *ad libitum*
- Workers lay unfertilized eggs
- Brood patches were removed from microcolonies and placed into a new cage with treatment bees (see below)

Experimental Bees

- Bees used for data collection
- 2 treatment groups: CO₂ exposure and the control (no exposure)
- Collected as newly emerged bees from the source colony (< 24 h old)
- Aged for 5 days with sugar water and pollen
- Day 5: bees were randomly assigned to either the CO₂ or control group
 - CO₂ bees were exposed to their first burst of CO₂
- Day 7: first recording of larvae rejections (counts of rejected larvae)
 - CO₂ bees were exposed to their second burst of CO₂
- Day 9: second recording of larvae rejections (counts of rejected larvae)

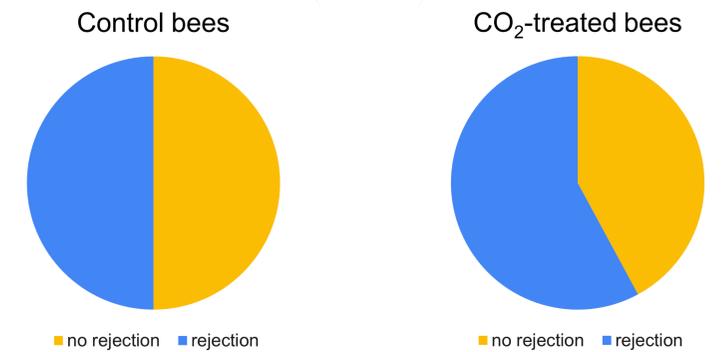


Figure 6: Pie chart representing larvae rejection percentages

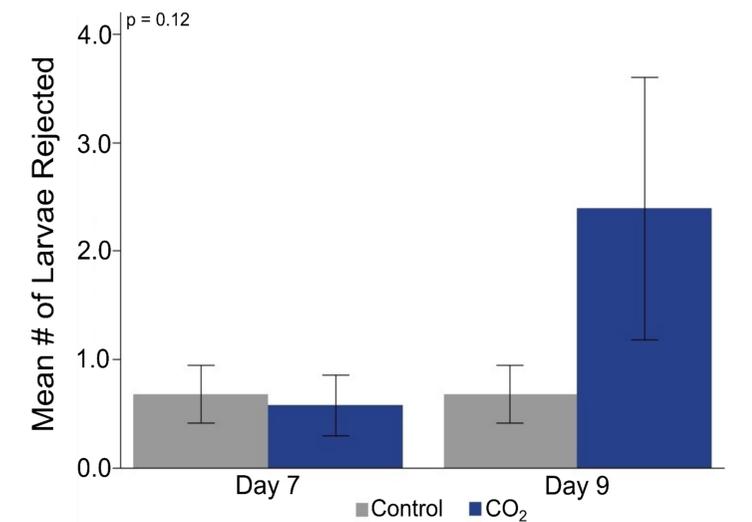


Figure 7: F-statistic: 2.023 on 3 and 77 DF, p-value: 0.1177. One way anova compares control day 7(gray), control day 9(gray), CO₂ day 7(blue), CO₂ day 9(blue).

Conclusion

- CO₂ exposure is not an effective method for inducing larval rejection in worker bumble bees
 - No significant effect of CO₂ exposure on mean larval ejection
 - Both control and treatment bees consistently reject larvae
 - We controlled for age and diet, but are there additional confounds?
 - Implementing this method caused a lot of disturbance to bees, which could have potentially impacting the results
 - This could be good news for continued use of this management technique, suggesting it will not interfere with worker brood care behavior
- Try other approaches to induce rejection
 - More consistent (i.e., having a control that actually works)
 - Less invasive (find an approach that doesn't require constant interaction with and removal of treatment individuals).

Citations

(Kukuk et al 1997)

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Introduction

- Understanding the behavioral patterns of a species helps us better understand them
- Predicted behavioral patterns can help when certain treatments are applied
- The effects of CO₂ on larval rejection behavior were studied in bumble bees (*Bombus impatiens*).

Organism

Bombus impatiens (Common Eastern Bumble Bee)

- Workers can lay unfertilized eggs when contact with queen is inhibited
- Exhibit brood care behaviors and interact with colony young.
- Sometimes those caring for brood will actively reject larvae (i.e., stop caring for them and remove them from the brood patch)
- This occurs in colonies (queen present) and microcolonies (only workers present)
- It is unclear why the behaviors occurs



Figure 1: Assembled microcolony



Figure 2: *Bombus impatiens* attending to brood

Objective

- We wanted to explore methods that could induce larval rejection behaviors in workers.
- Pilot data for a project targeting brain gene expression associated with this rejection behavior

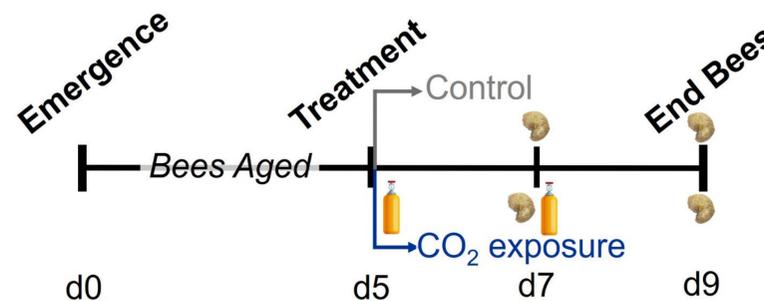


Figure 3: Time chart of exposure to CO₂ to experimental group

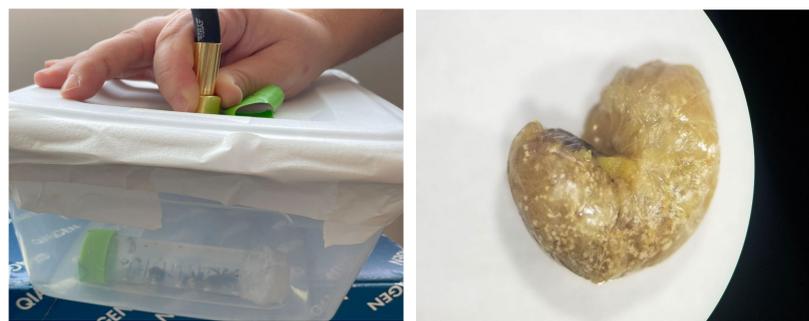


Figure 4: Experimental group receiving exposure to CO₂

Figure 5: Depicts a rejected *Bombus impatiens* in larval stage under microscope

CO₂ Application

- Place bees in falcon tubes into storage bin and seal with masking tape
- Attach hose to the bin
- Turn on pure CO₂ stream for 1 minute
- Remove and seal hose hole
- Allow CO₂ to decrease over 30 minutes while stored in incubator
- After 30 minutes, remove from the storage bin and place individual bees into respective cages with brood patches.