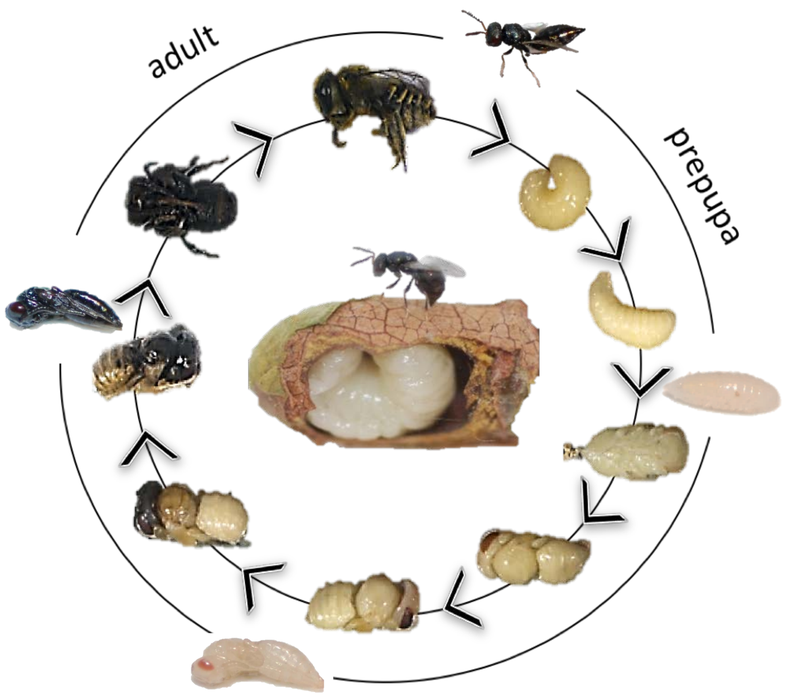
Pollinators and their parasites: an examination of cold tolerance between the leafcutting bee and chalcid wasps

Korie DeBardlabon[1], Meg Bennett[1], Joseph Rinehart[2], George Yocum[2], Kendra Greenlee[1]

North Dakota State University[1], USDA-Agricultural Research Service[2] Fargo, North Dakota

Introduction

- The alfalfa leafcutting bee, *Megachile rotundata* is used extensively in commercial pollination of alfalfa seed[1].
- Chalcid wasps, *Pteromalus venustus,* parasitize developing leafcutting bees and are a major problem in commercial pollination.
- Characterizing the cold tolerance of the parasite and bee could help improve bee survival using cold exposures.
- Fluctuating thermal regimes during development result in fewer sublethal effects in adult bees versus static thermal regimes[2].
- Previous studies have shown that in some insects prior exposure to cold increases their cold tolerance[3].



*wasp photos: www.gov.mb.ca

Hypotheses & Predictions

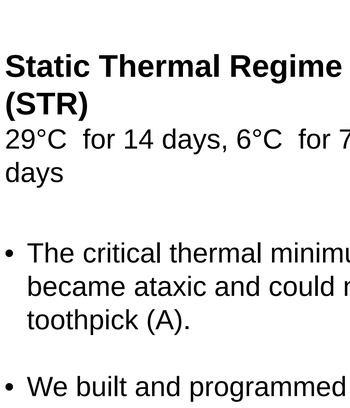
1. **Cold tolerance varies across metamorphosis for both species.**
   - Earlier stages are more cold tolerant in both species.
2. **Cold tolerance varies between parasitic wasps and bees.**
   - The parasite is more cold tolerant than the bees.
3. **Low temperature exposure during development improves adult cold tolerance .**
   - Developing bees exposed to fluctuating thermal regimes will have an increased chance of surviving a cold shock as adults.

Methods

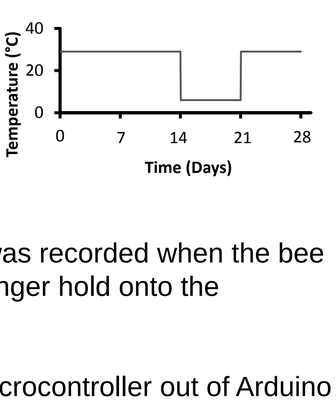
Assessing supercooling point (SCP)

- I-buttons were used to asses supercooling points of the leafcutting bees (A).
- Differential scanning calorimetry (DSC) was used to asses the SCP of the parasitic wasps (B).

A



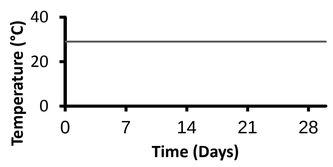
B



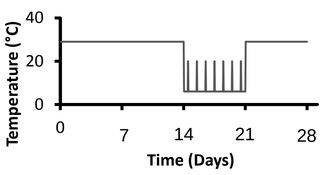
Assessing critical thermal minimum (CTmin)

- Bees were maintained at the USDA-ARS in environmental chambers at 6°C until placed into one of the following treatments.

Control
29°C until adult emergence



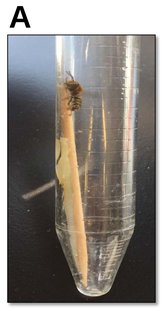
Fluctuating Thermal Regime (FTR)
29°C for 14 days, 6°C with a spike to 20°C for an hour each day for 7 days



Static Thermal Regime (STR)
29°C for 14 days, 6°C for 7 days

- The critical thermal minimum was recorded when the bee became ataxic and could no longer hold onto the toothpick (A).
- We built and programmed a microcontroller out of Arduino hardware to measure the temperature ramping of the environmental chamber (B).

A



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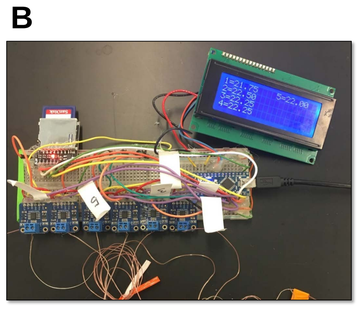
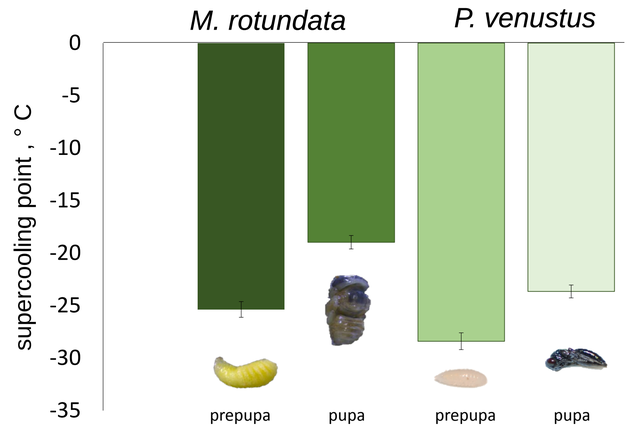


Results

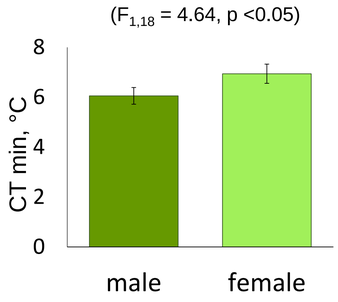
SCP was lower in the parasitic wasps at different developmental stages compared to the bees.

($F_{1,56}$ = 28.55, p <0.001, $F_{1,56}$ = 59.72, p <0.001)

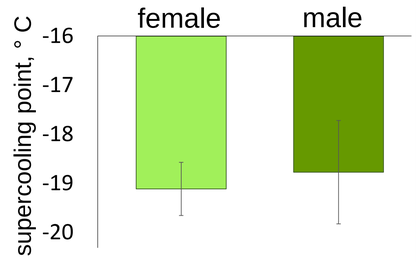


Female bees were less cold tolerant than males.

($F_{1,18}$ = 4.64, p <0.05)

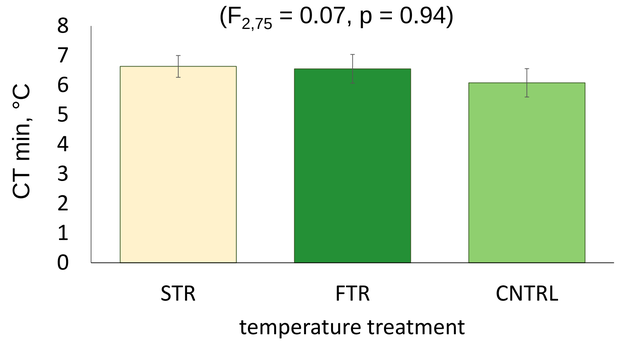


Male and female bees had the same SCP.



Adult CTmin was unaffected by cold exposure during development.

($F_{2,75}$ = 0.07, p = 0.94)



Conclusions

- Our first two hypotheses were supported because we saw that pupa were less cold tolerant than the prepupa, and the wasps were more cold tolerant than the bees.
- Having differences in thermal tolerance could affect their species range.
- Exposure to FTR and STR does not change the bee's thermal physiology, with respect to low temperatures.

Future Directions

- We will analyze mortality curves of the parasitic wasps and bees at -5°C, -10°C and -15°C.
- Adult SCP of parasitic wasps and bees will be examined after emergence.

References

1. Pitts-Singer T., and J. Cane, Annual Review of Entomology. 2011. 56:221-37
2. Bennett M. M., Cook M. K., Rinehart P. J., Yocum D. G., Kemp P. W., Greenlee J. K., Physiological and Biochemical Zoology. 2015. 88(5):508-520
3. Le Bourg, É. Biogerontology 2007. 8:431.

Acknowledgments

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