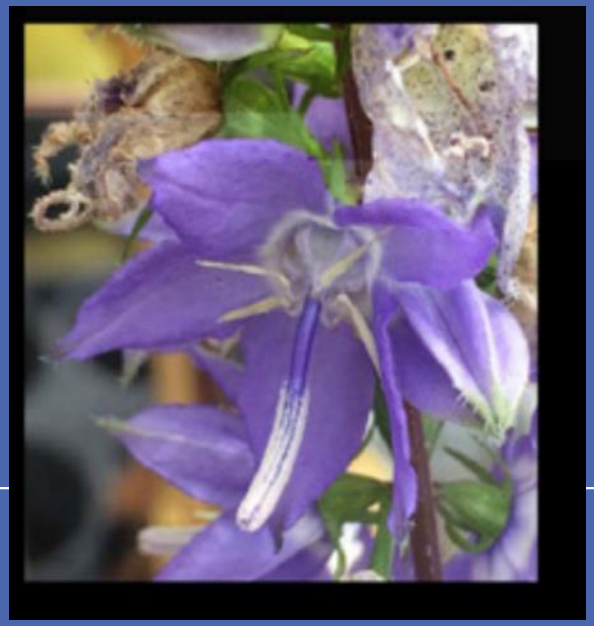
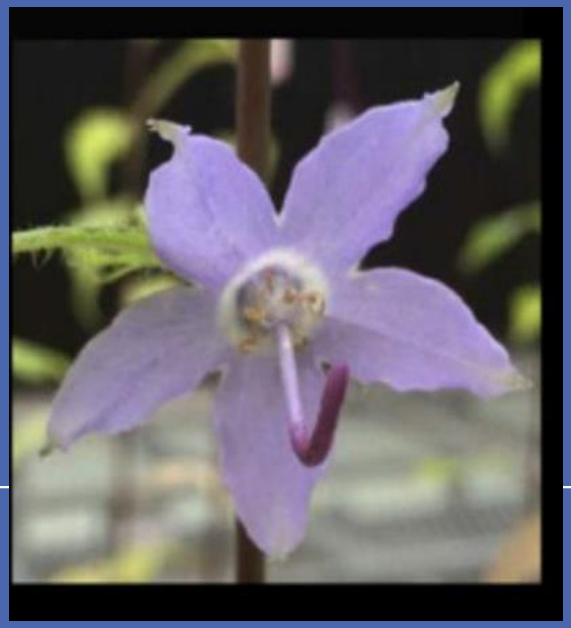
# The Role of Pollinator Preference in the Maintenance of Pollen Color Variation





## Pollinators Prefer Purple Pollen, but there is a Perplexing Prevalence of non-Purple Pollen

Jennifer L. Ison, Elizabeth Tuan, Matthew Koski, Jack Whalen, Ashley Padilla, and Laura Galloway

http://isonlab.voices-wooster.edu
jison@wooster.edu
@JenniferIsonL

# Intraspecific floral color variation

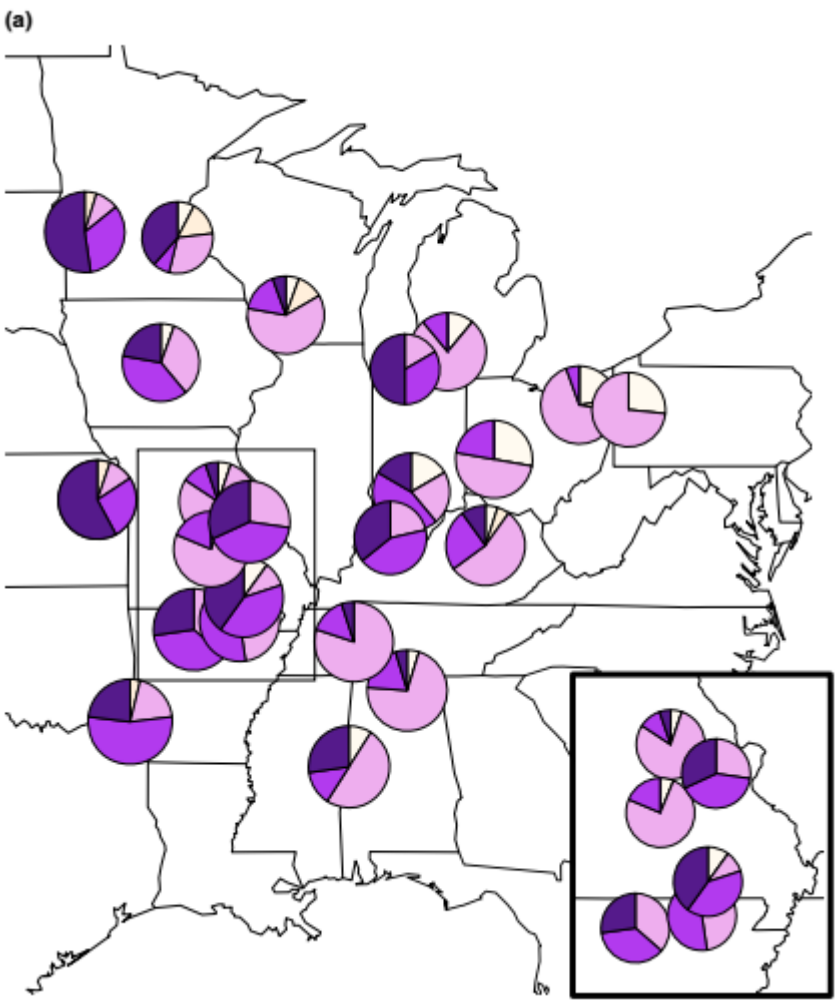
# Intraspecific floral color variation

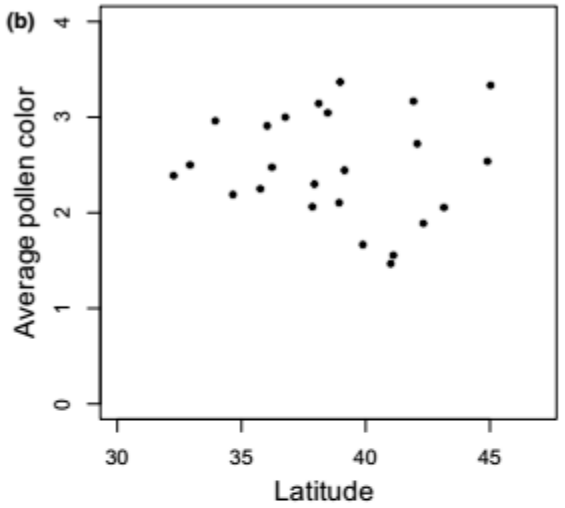
# Pollen color diversity

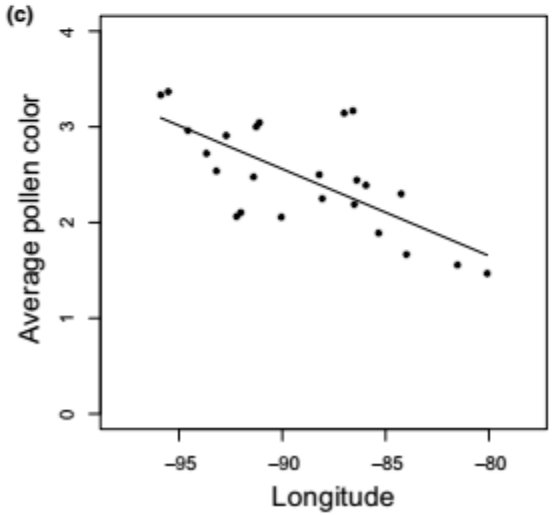
| Pollen Colors of Selected Plants | |
|---|---|
| **Plant** | **Approximate Pollen Color** |
| Apple | yellow white |
| Plum | light grey, grey |
| Pear | red yellow |
| Raspberry | white grey |
| Asparagus | bright orange |
| Siberian squill | steel blue |
| Dandelion | red-yellow, orange |
| Horse chestnut | anatolia |
| Blueberry | red-yellow, orange |
| Allium | light olive |
| Aster | reddish yellow |
| Borage | blueish grey |
| Marigold | orange |
| Joe Pye Weed | bistre green |
| White sweet clover | auburn |
| Poppy | blueish grey |
| Phacelia | navy blue |
| Goldenrod | golden |

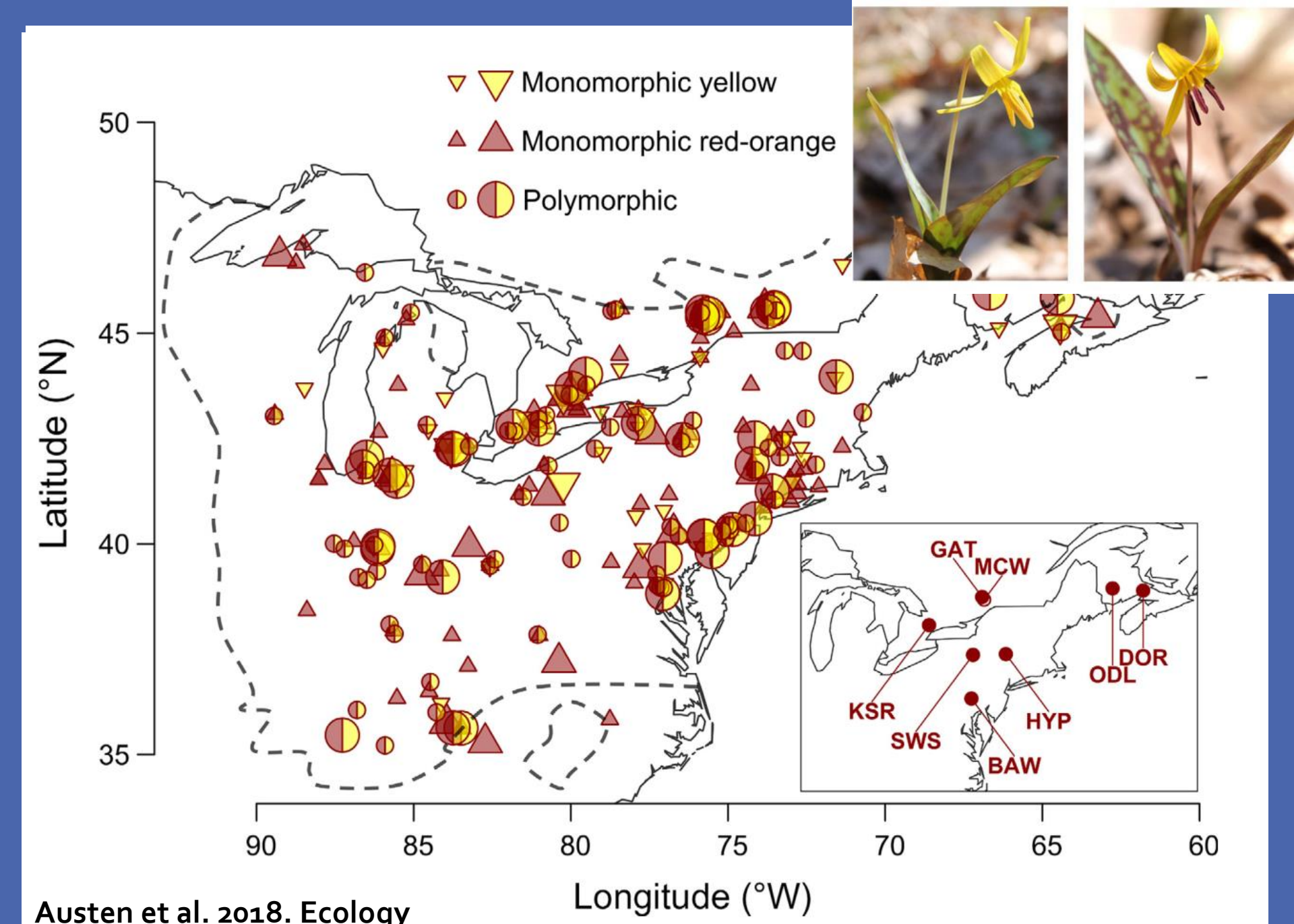
# Pollen color variation in American Bellflower (*Campanula americana*)

# Bellflower's pollen color cline



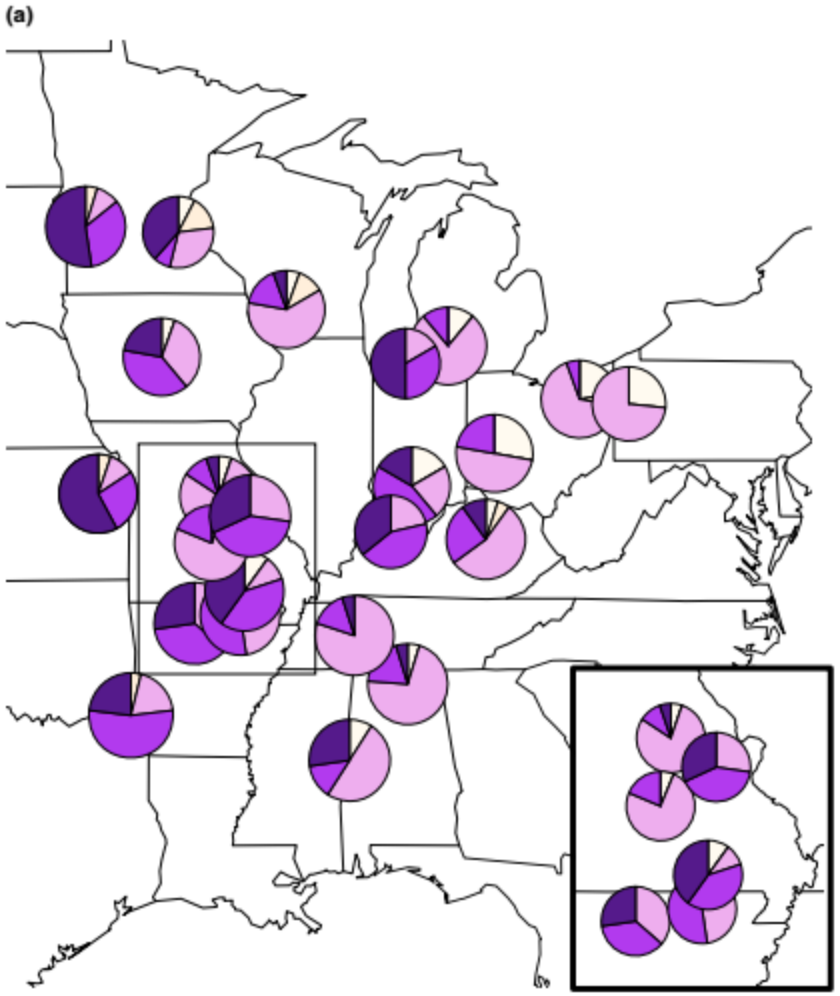





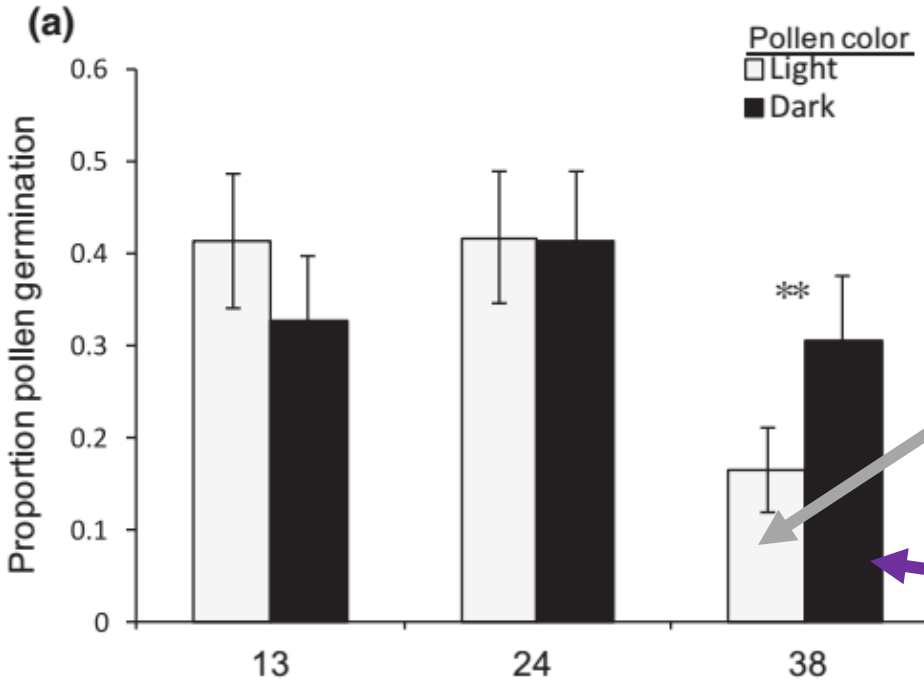

Austen et al. 2018. Ecology

# Mechanisms for Bellflower's pollen color cline

- Pollinator-mediated selection
- Abiotic selection
- Neutral



# Purple pollen is more resistant to temperate stress




New Phytologist

Research

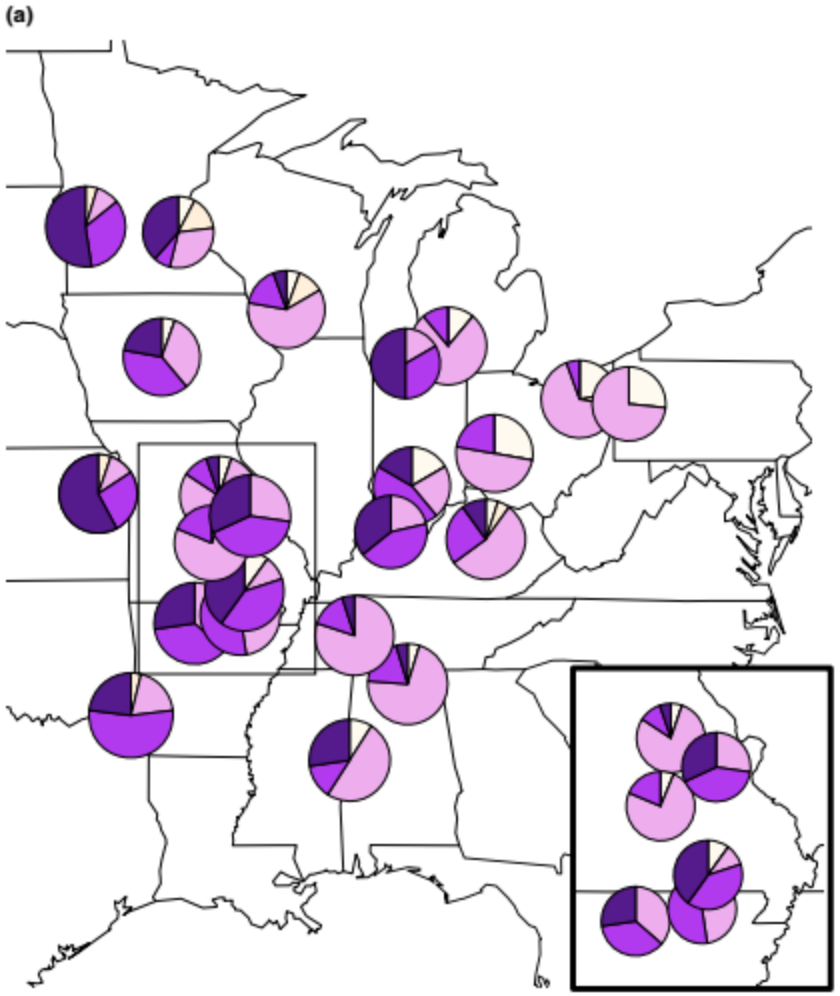
## Geographic variation in pollen color is associated with temperature stress

**Matthew H. Koski and Laura F. Galloway**

Department of Biology, University of Virginia, Charlottesville, VA 22904, USA

# Mechanisms for Bellflower's pollen color cline

- **Pollinator-mediated selection**
- **Abiotic selection**
- **Neutral**



# Team Bellflower


THE COLLEGE OF WOOSTER

UNIVERSITY of VIRGINIA

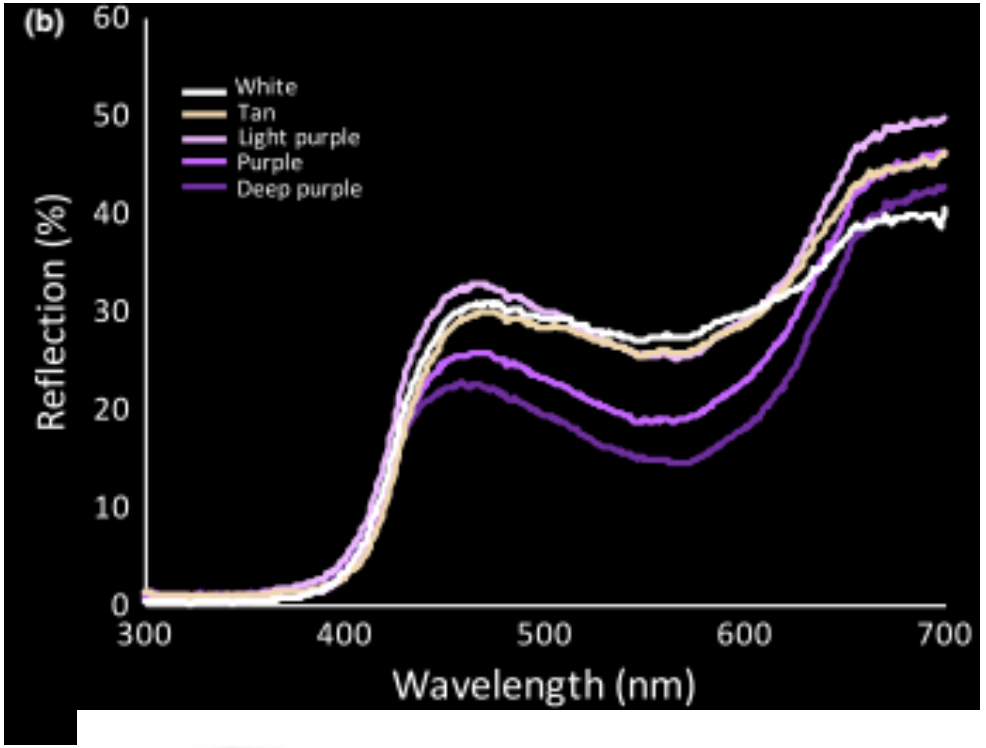
# Research questions

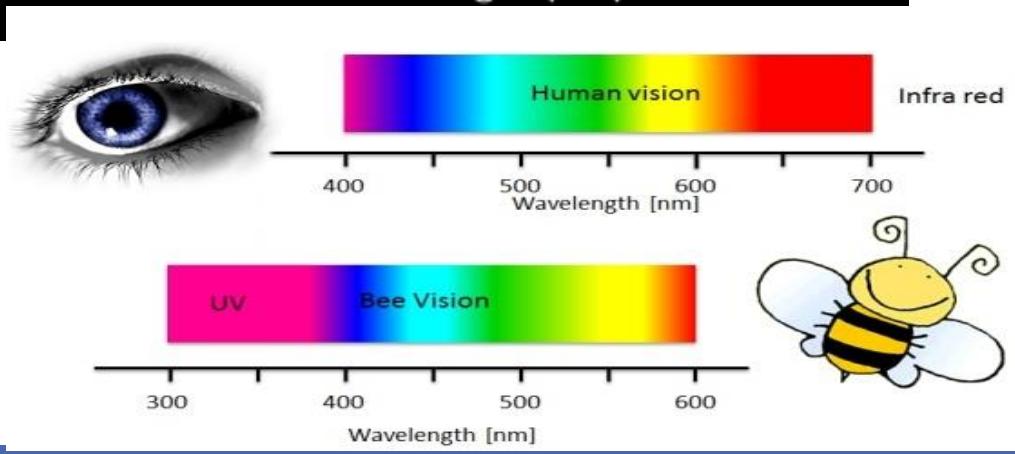
- Is this even variation that the pollinators could select for?

- Do the pollinators differ in their per visit pollination efficiency?

- In field conditions, do the pollinators have a pollen color preference?

# More about *Campanula americana*, American Bellflower



# We know that pollen color is heritable

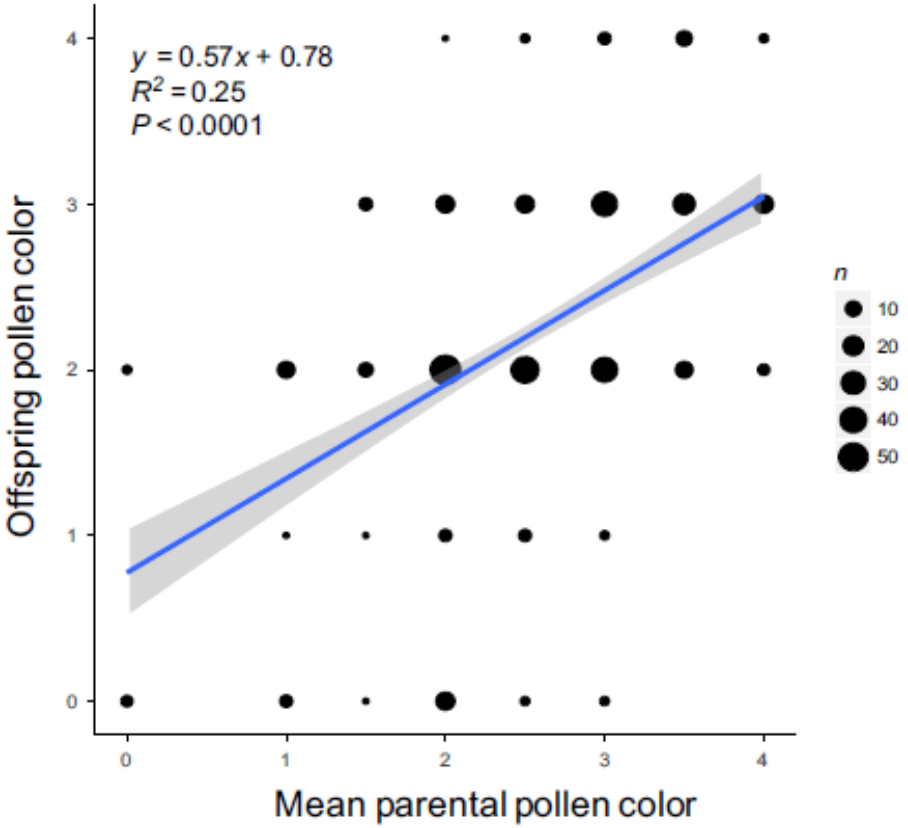



**Fig. 3** Pollen-color score of offspring as a function of average parental pollen-color score for *Campanula americana*. The size of each data point (*n*) corresponds to the number of offspring. The regression line represents the best-fit linear function and standard error.

**Koski and Galloway. 2017. New Phytologist**

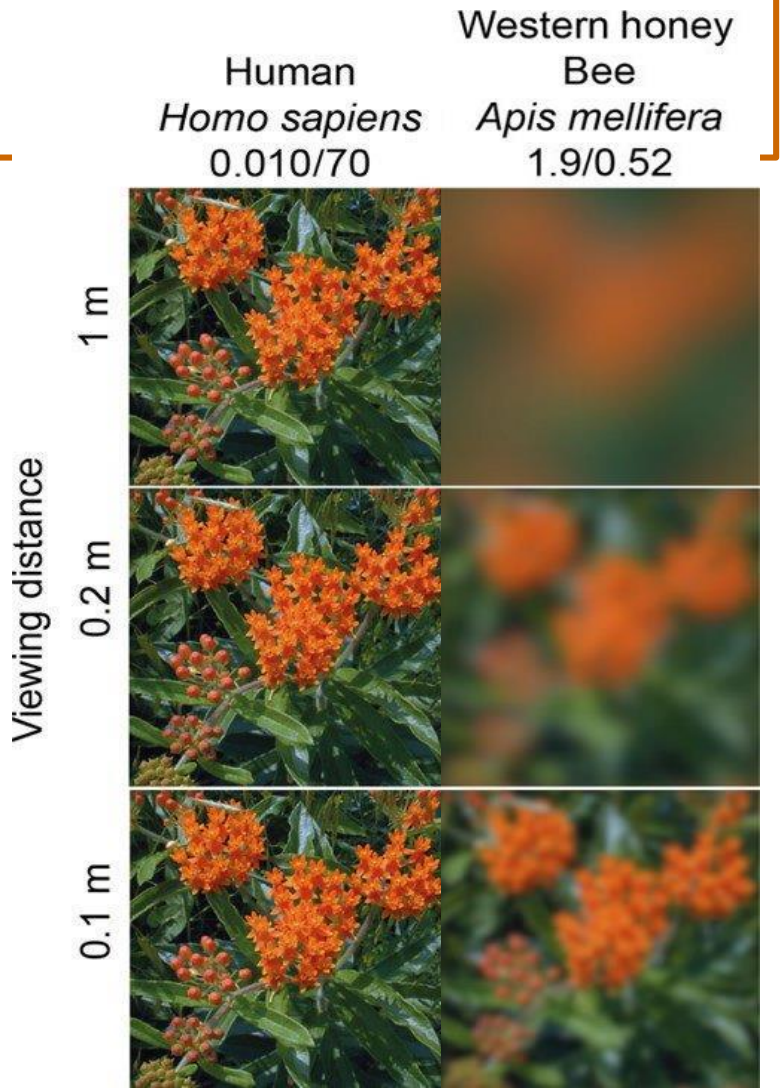
# Three main pollinator taxa

- Native bumblebee species

- *Megachile campanulae*
  - A specialist solitary bee

- Small sweat bees

- Is this even variation that the pollinators could select for?
  - i.e. Can they perceive it?




Caves and Johnsen. 2017. Methods in E&E

- Is this even variation that the pollinators could select for?
  - i.e. Can they perceive it?


Jack Whalen '18

# Pollinator perception methods

White pollen plants—
Non-rewarding (water only)

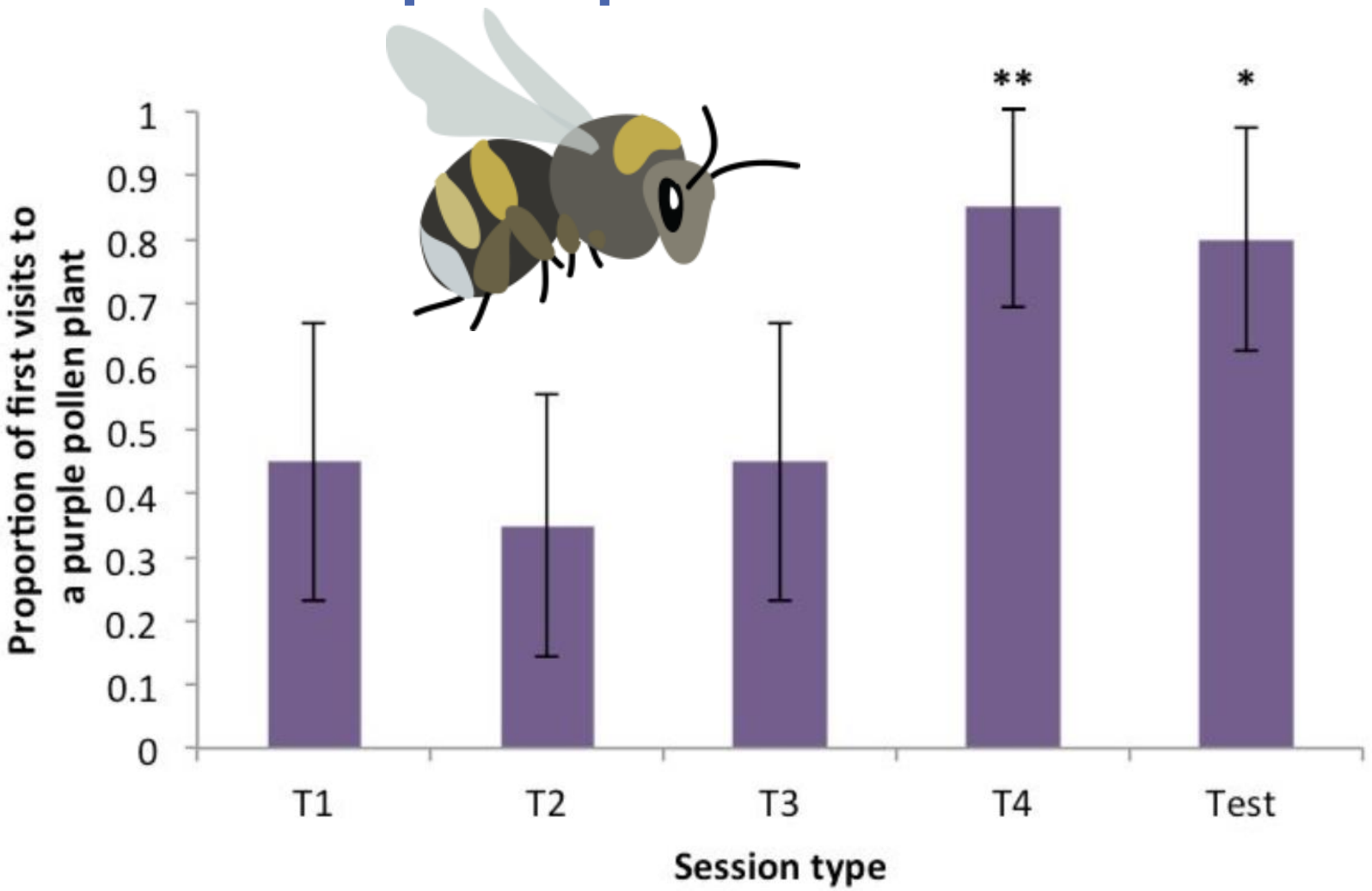
Purple pollen plants—
Rewarding (sugar water)

# Pollinator perception methods

White pollen plants—
Non-rewarding (water only)

Purple pollen plants—
Non-rewarding (water only)

# Pollinator perception results



# Research questions

- Is this even variation that the pollinators could select for? **YES!**
  - i.e. Can they perceive it?

- Do the pollinators differ in their per visit pollination efficiency?
  - Implications for potential strength of selection

- In field conditions, do the pollinators have a pollen color preference?
  - Is the preference frequency dependent?

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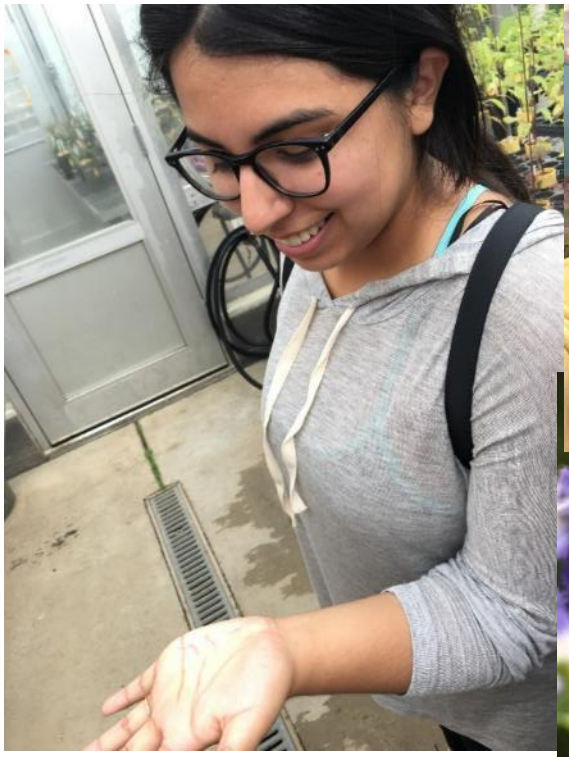
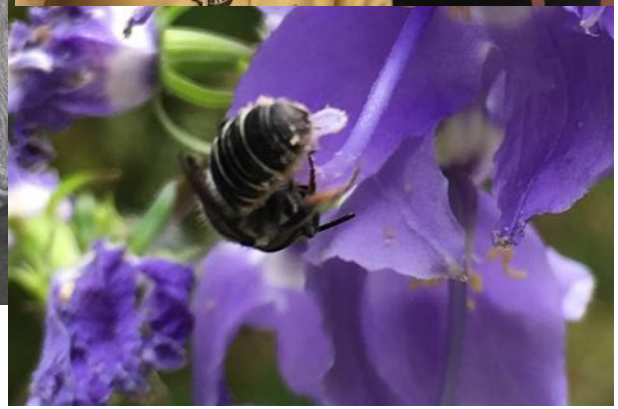


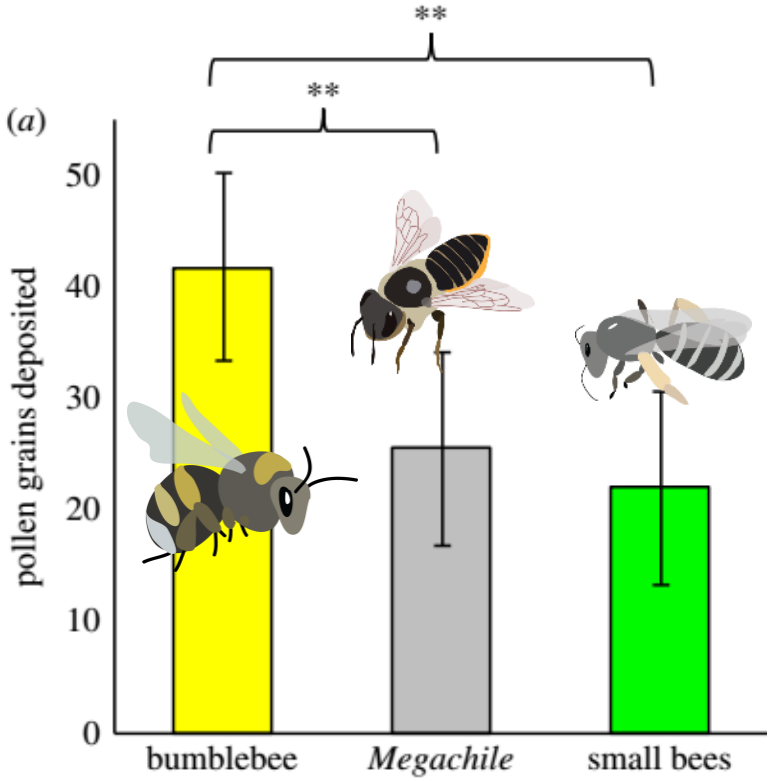
Ashley Padilla '18

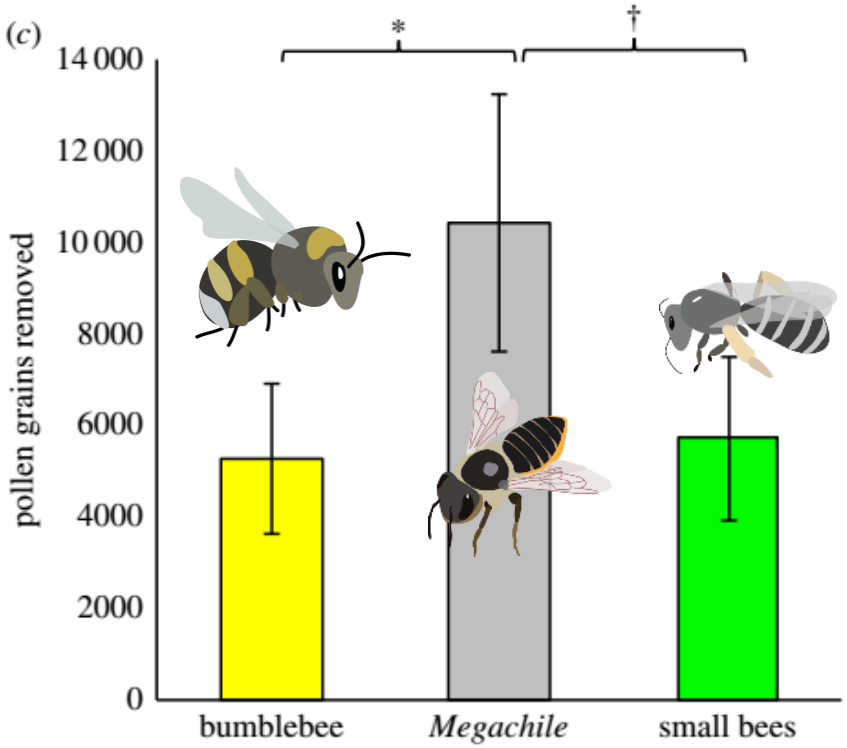
# Pollinator efficiency: methods

- **Measures:**
  - **Female function**
    - **Fruit set**
    - **Seed set**
  - **Male function**
    - **How much pollen a pollinator removes compared to how much it deposits**

# Pollinator efficiency results

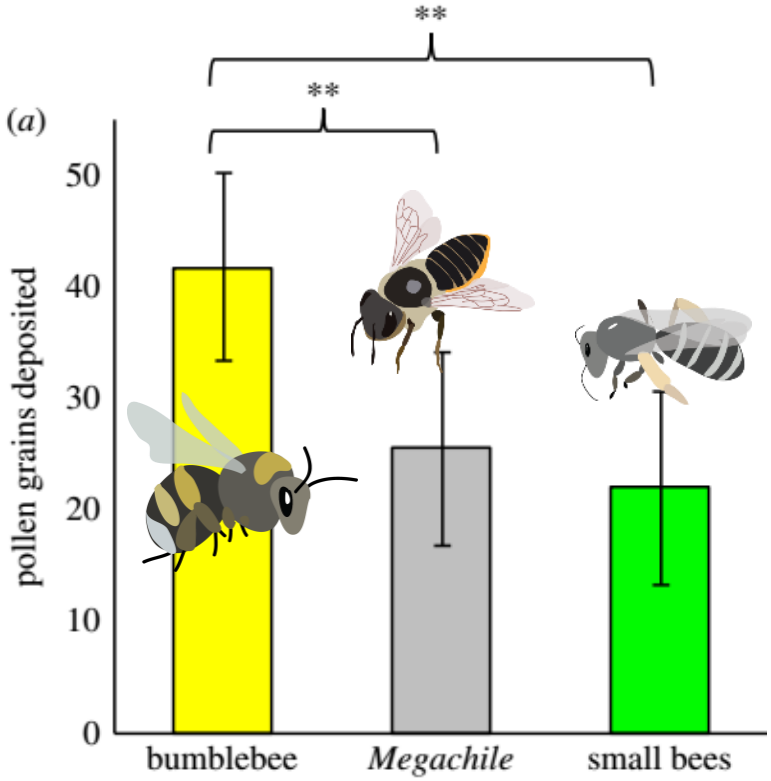


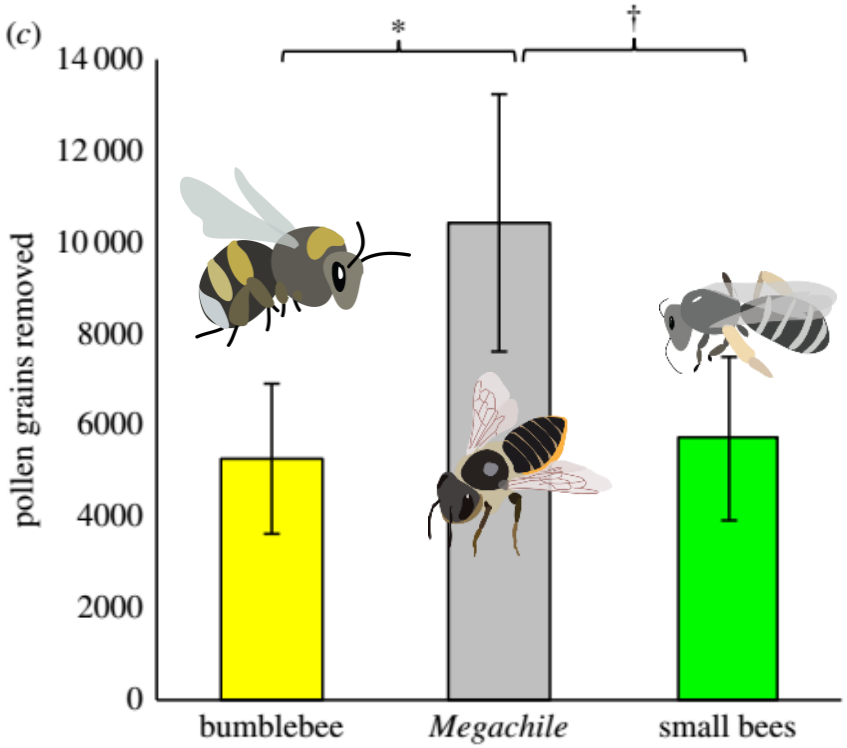

- Bumblebees deposited significantly more pollen grains.




- *Megachile* removed twice as much pollen than the other bees.

# Pollinator efficiency results




- **Notice the pollen loss!**
  **5,000-10,000 removed and only 25-40 grains deposited!**

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Research

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**Cite this article:** Koski MH, Ison JL, Padilla A, Pham AQ, Galloway LF. 2018 Linking pollinator efficiency to patterns of pollen limitation: small bees exploit the plant–pollinator mutualism. *Proc. R. Soc. B* **285**: 20180635. http://dx.doi.org/10.1098/rspb.2018.0635

## Linking pollinator efficiency to patterns of pollen limitation: small bees exploit the plant–pollinator mutualism

Matthew H. Koski[1], Jennifer L. Ison[2], Ashley Padilla[2], Angela Q. Pham[1] and Laura F. Galloway[1]

[1]Department of Biology, University of Virginia, Charlottesville, VA 22904, USA
[2]Department of Biology, The College of Wooster, Wooster, OH 44691, USA

MHK, 0000-0002-0274-3145

Seemingly mutualistic relationships can be exploited, in some cases reducing fitness of the exploited species. In plants, the insufficient receipt of pollen limits reproduction. While infrequent pollination commonly underlies

# Research questions

- Is this even variation that the pollinators could select for? **YES!**
  - i.e. Can they perceive it?

- Do the pollinators differ in their per visit pollination efficiency? **YES!**
  - Implications for potential strength of selection

- In field conditions, do the pollinators have a pollen color preference?
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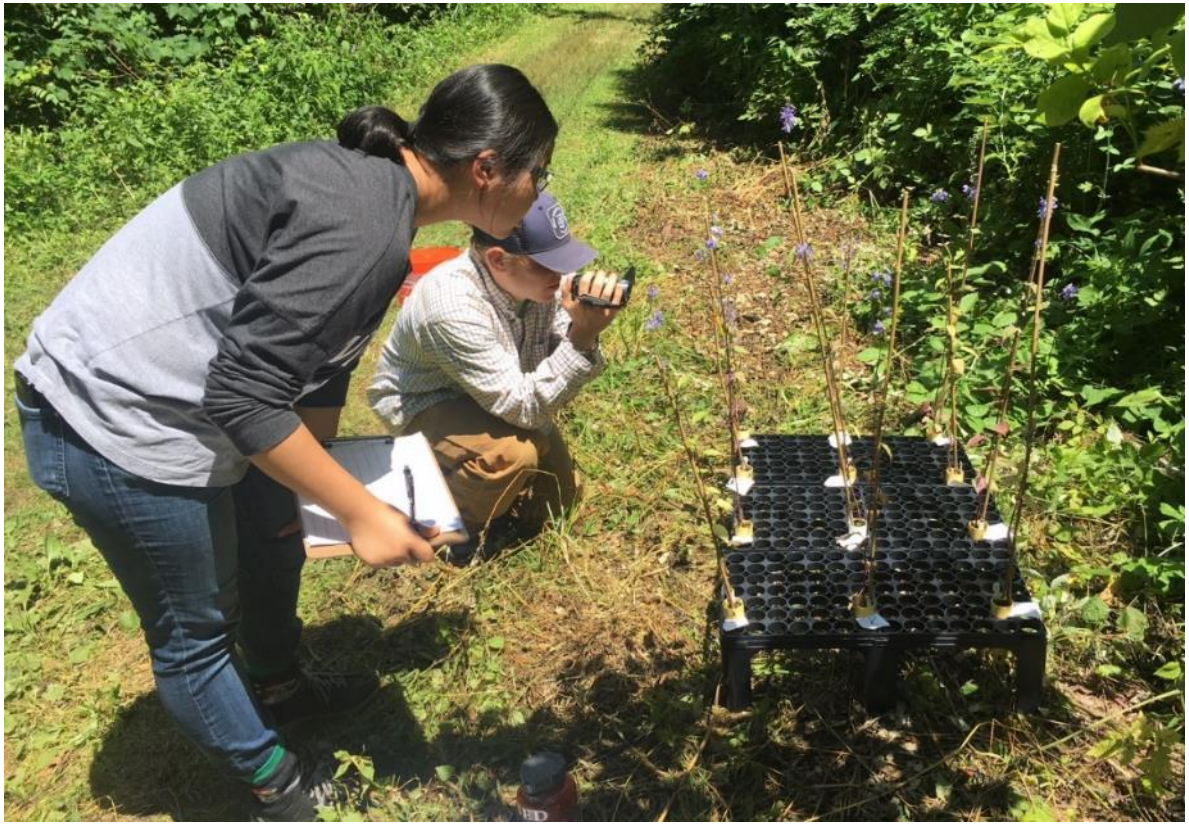
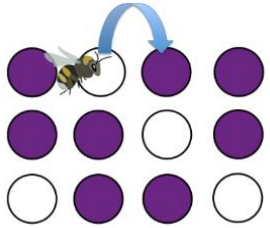
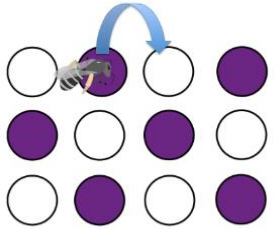


Elizabeth Tuan '18

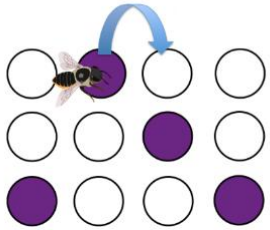
# Pollinator preference methods



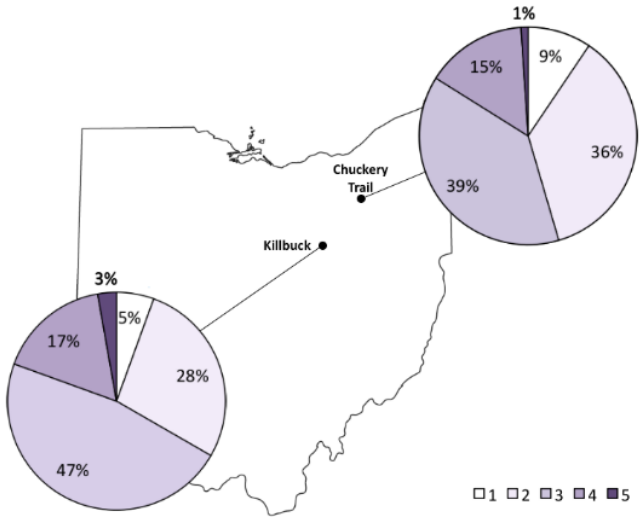
Purple array
$2_p:1_w$



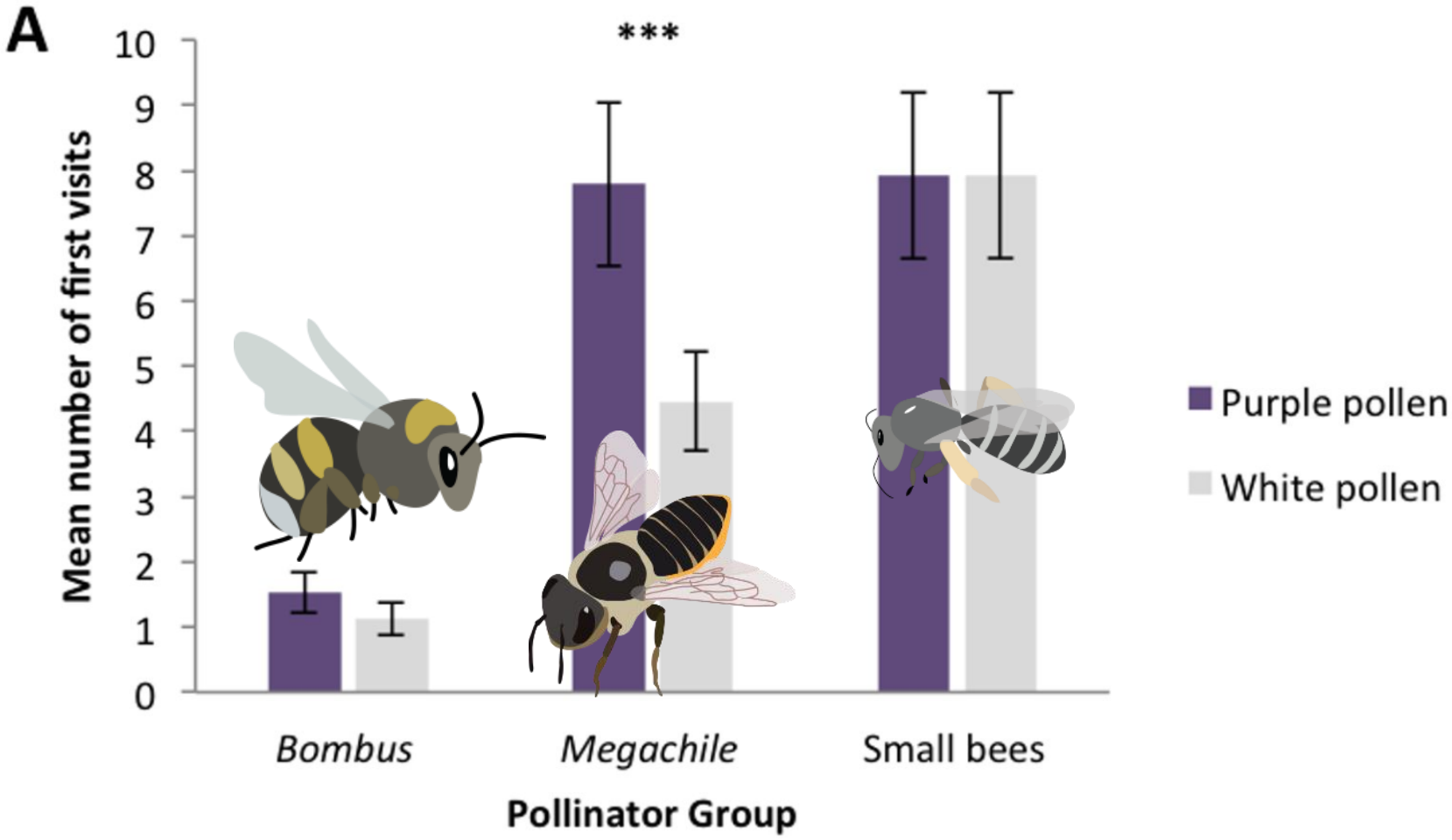
Mixed array
$1_p:1_w$



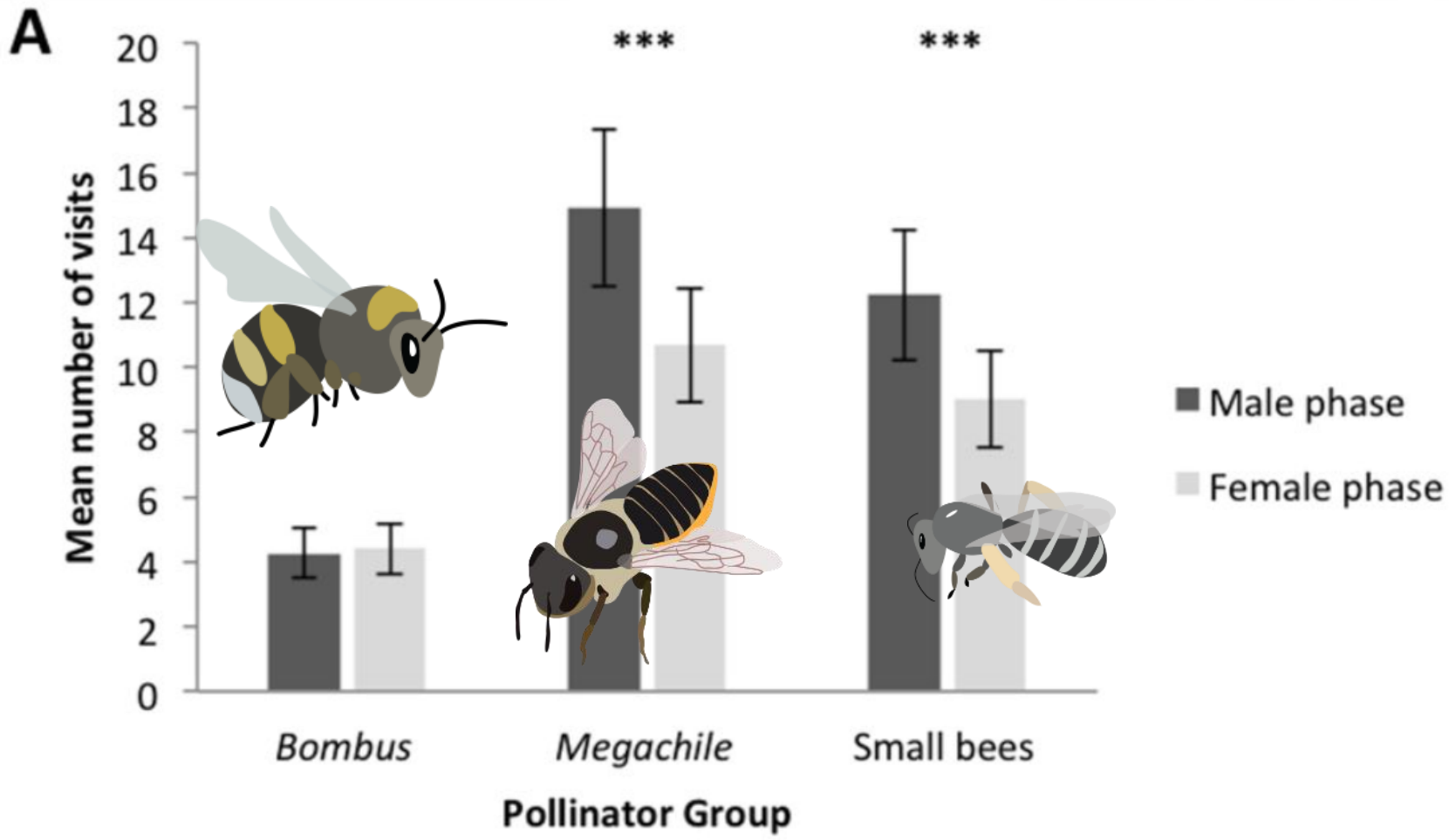
White array
$2_w:1_p$



# Pollinator pollen color preference



# Pollinator floral sex phase preference

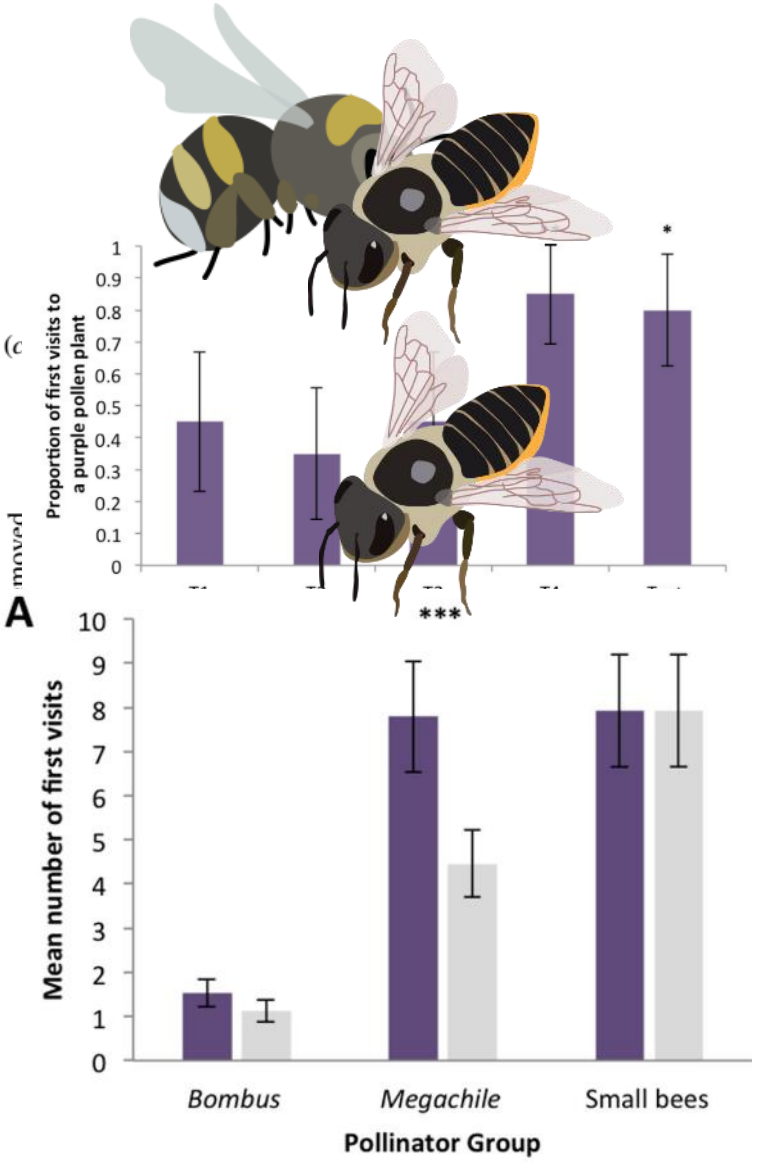


# Research questions

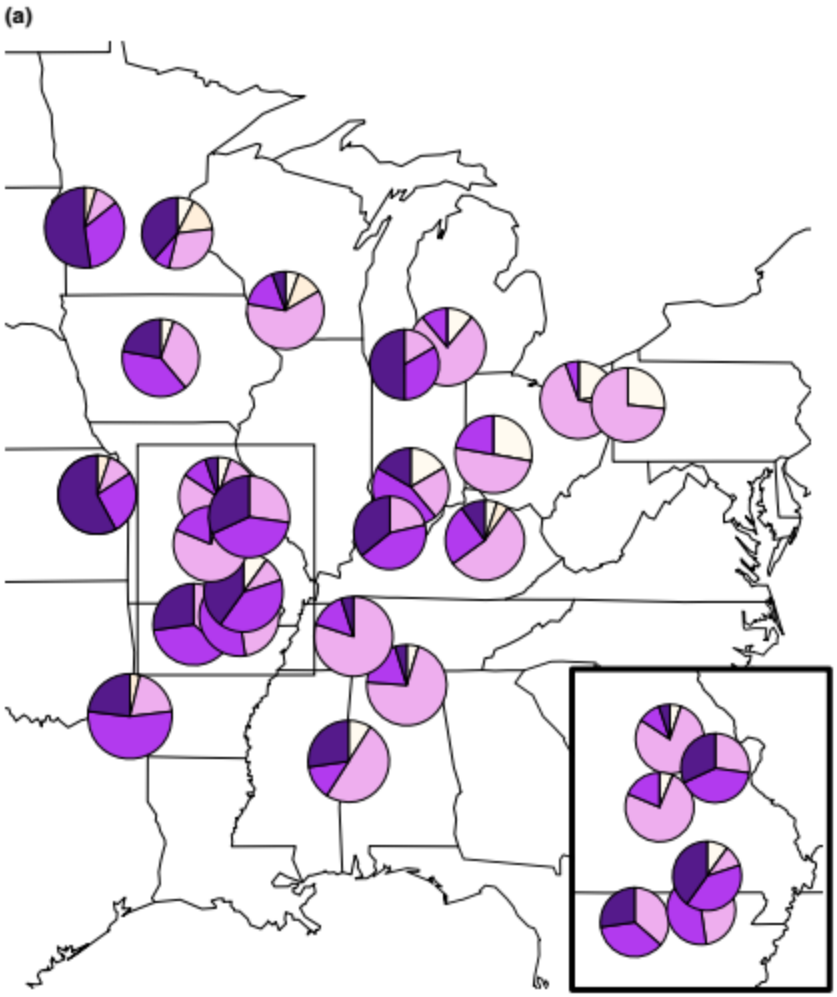
- Is this even variation that the pollinators could select for? **YES!**
  - i.e. Can they perceive it?
- Do the pollinators differ in their per visit pollination efficiency? **YES!**
  - Implications for potential strength of selection
- In field conditions, do the pollinators have a pollen color preference? **YES!**
  - Is the preference frequency dependent? **NO!**

# Overall conclusions

- **Pollinators can use pollen as a visual cue**
- **Pollinators vary in their effectiveness**
  - ***Megachile*** **may deplete pollen from populations.**
- ***Megachile*** **have a strong and consistent purple pollen color preference.**



# So what are the mechanisms that maintains the pollen color variation in Bellflower?

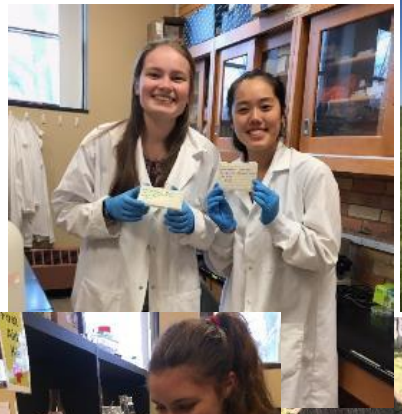


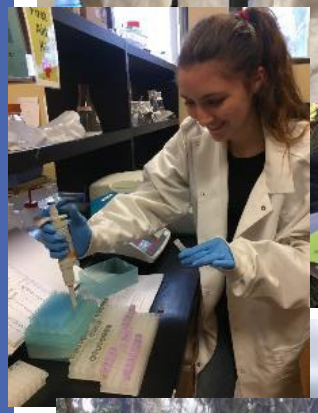

- **Abiotic**
  - Purple pollen is more heat stress tolerant.
- **Pollinator-mediated**
  - In predominately light colored populations, purple pollen is likely depleted by *Megachile*.
- **Neutral?**

http://isonlab.voices.wooster.edu
jison@wooster.edu
@JenniferIsonL











**Funding from:**
NSF-ROA supplement
The College of Wooster's
Copeland and Wilson Awards
Pollinator drawings by KJB