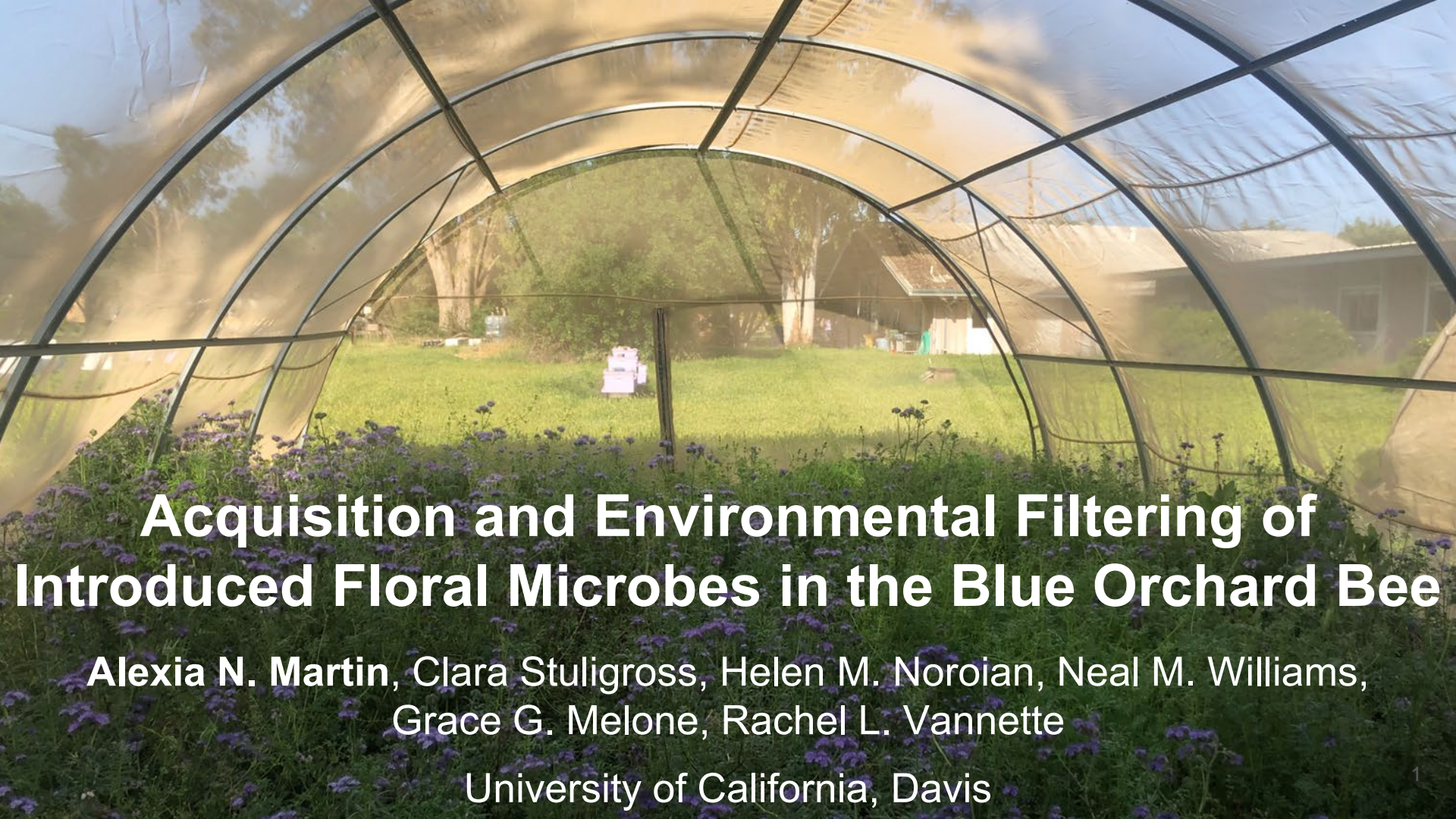


Acquisition and Environmental Filtering of Introduced Floral Microbes in the Blue Orchard Bee

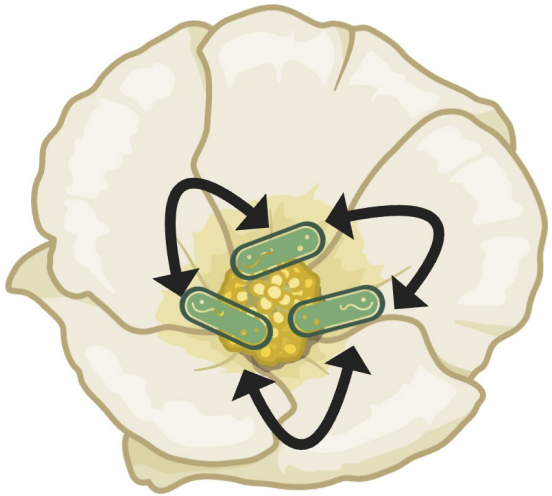
Alexia N. Martin, Clara Stuligross, Helen M. Noroian, Neal M. Williams, Grace G. Melone, Rachel L. Vannette

University of California, Davis

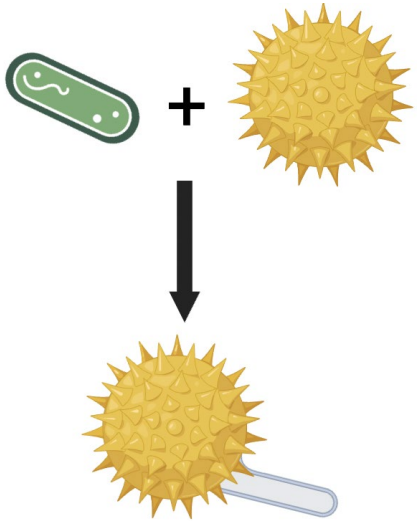
Flowers host dynamic communities of microbes within pollen and nectar.

Microbiome: group of microorganisms (e.g., bacteria and fungi) that live within a particular environment (e.g. flower, bee gut)

Floral microbes interact with each other, floral resources, and pollinators.



e.g. Vannette and Fukami, 2014



Christensen *et al*., 2021

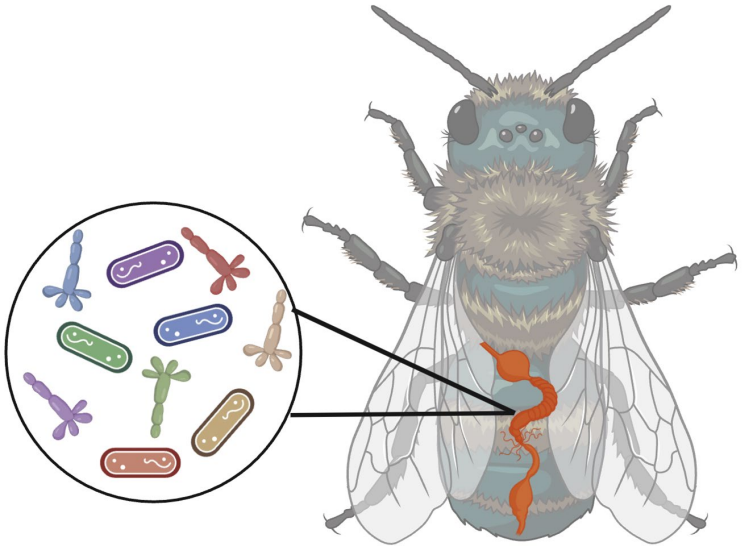
Russell *et al*., 2019

Bee guts can also be a habitat for microbes!

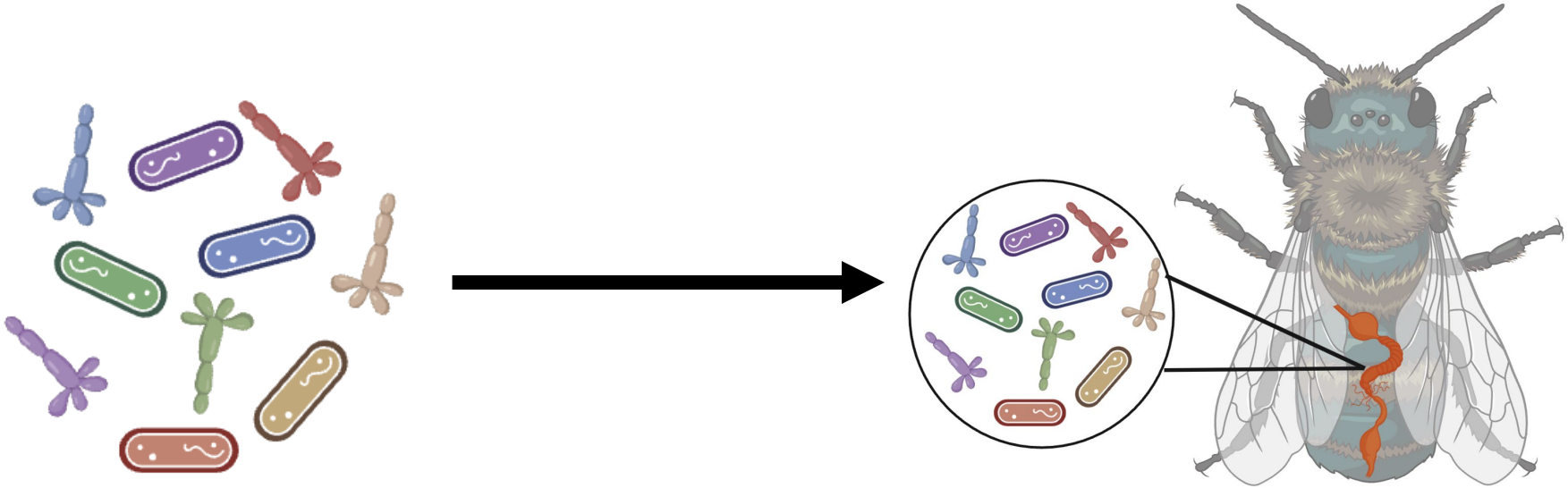
A majority of bee species studied to date, pick up microbes from their environment

Sources can include: water, nesting materials, **flowers****

What impacts the formation of a stable microbiome?



Factors of the bee gut environment can shape the presence and abundance of organisms within the microbiome.



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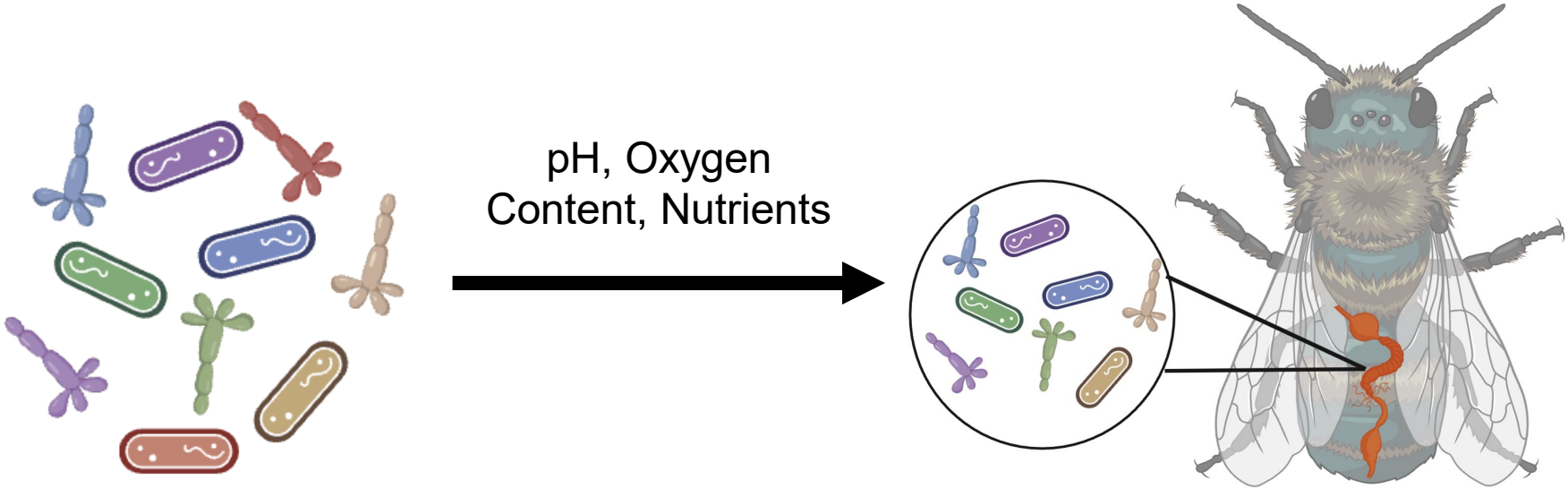
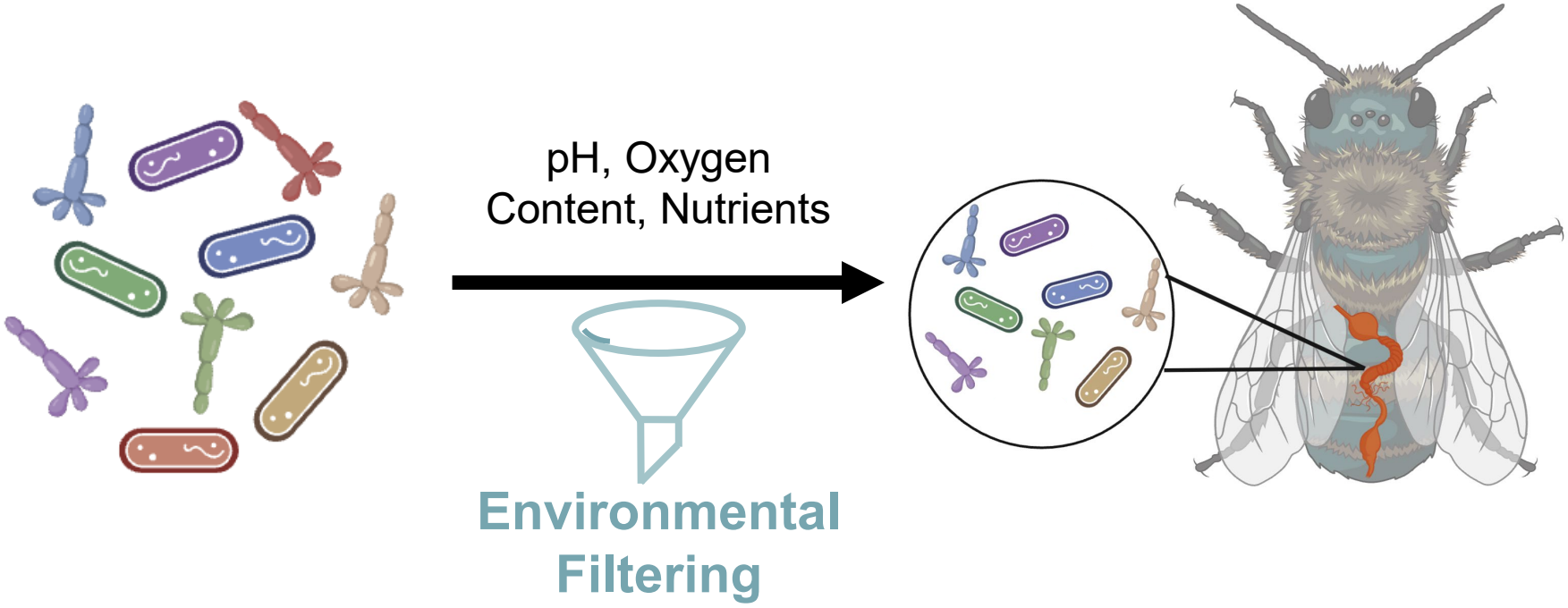
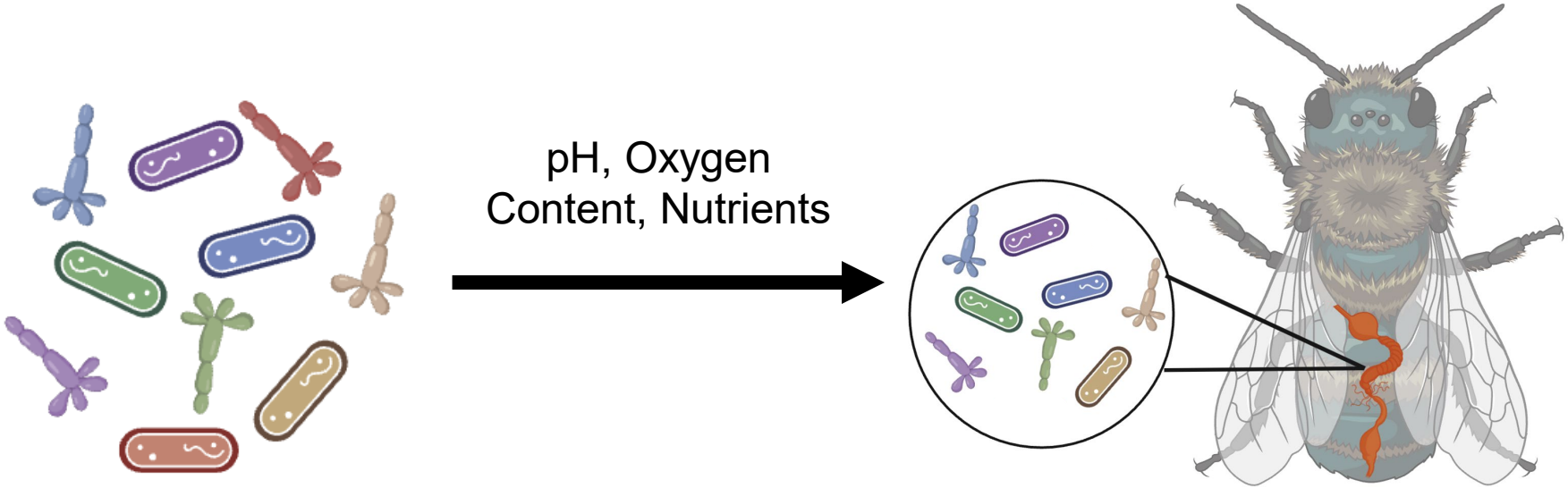


Factors of the bee gut environment can shape the presence and abundance of organisms within the microbiome.



Factors of the bee gut environment can shape the presence and abundance of organisms within the microbiome.



Though it is important to investigate the formation of the microbiome, doing so is challenging in complex systems.

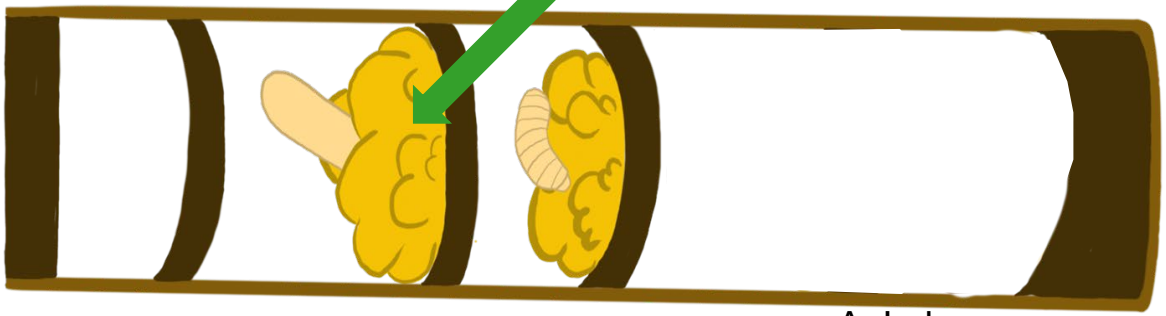
The Blue Orchard Bee (BOB, *Osmia lignaria*)

- Solitary
- Cavity nesters

A. Lehner

The Blue Orchard Bee (BOB, *Osmia lignaria*)

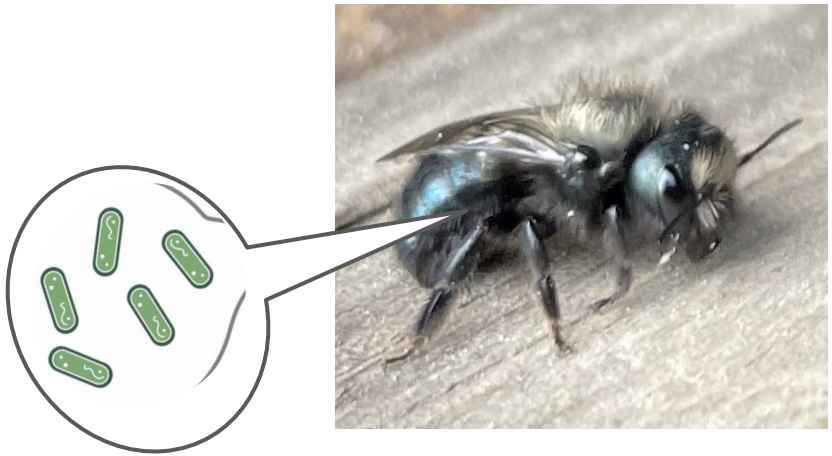
- Solitary
- Cavity nesters
- Pollen provisions = pollen + nectar collected by mom, filled with microbes

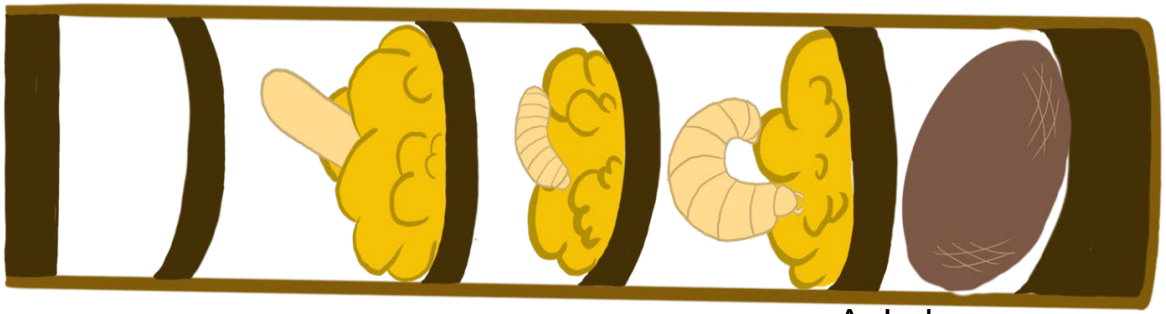


A. Lehner

The Blue Orchard Bee (BOB, *Osmia lignaria*)

- Solitary
- Cavity nesters
- Pollen provisions = pollen + nectar collected by mom, filled with microbes
- BOB adult microbiomes are environmentally derived

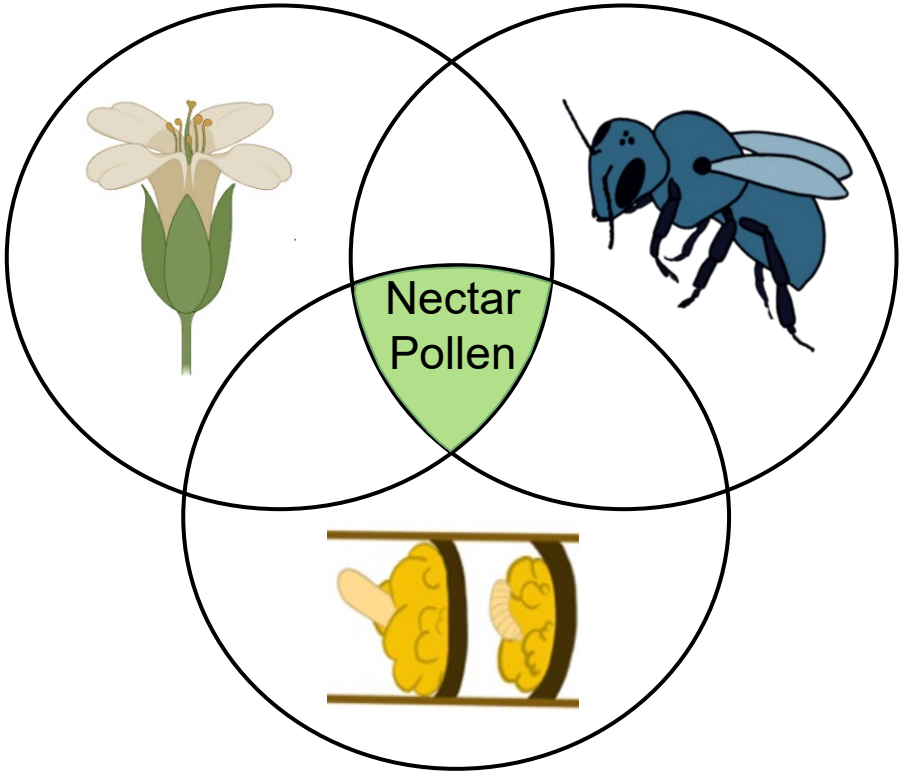




A. Lehner

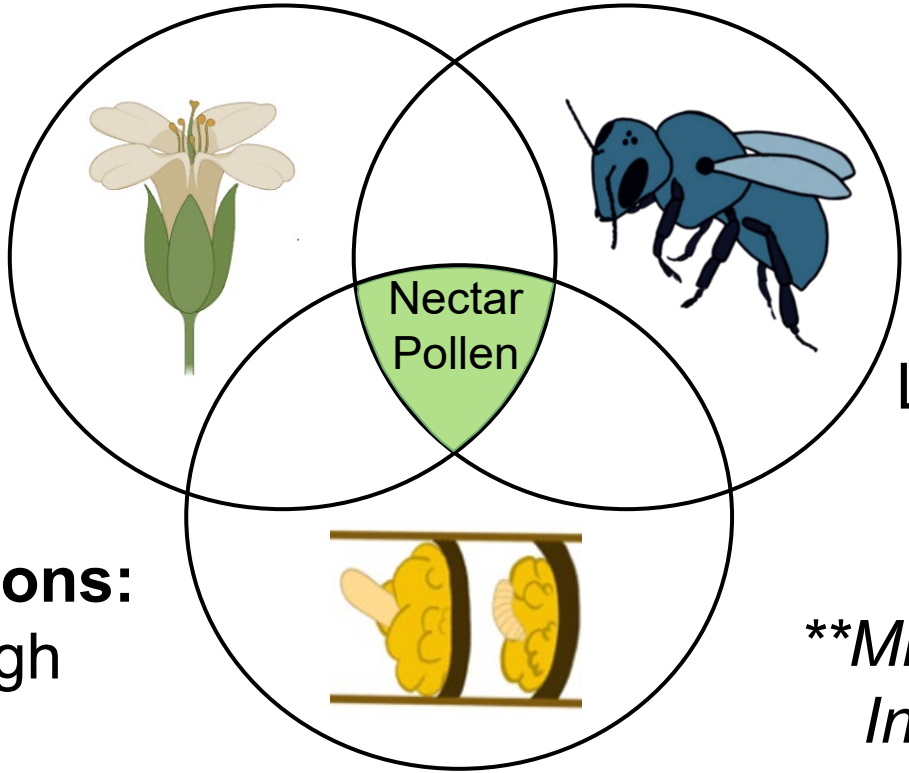
Cohen et al., 2020

Flowers, Bee Guts, and Provisions contain the same nutrients



Flowers, Bee Guts, and Provisions contain the same nutrients - BUT may exert unique pressures on microbial communities.

Flowers:
High Sugar
Low Nitrogen
UV

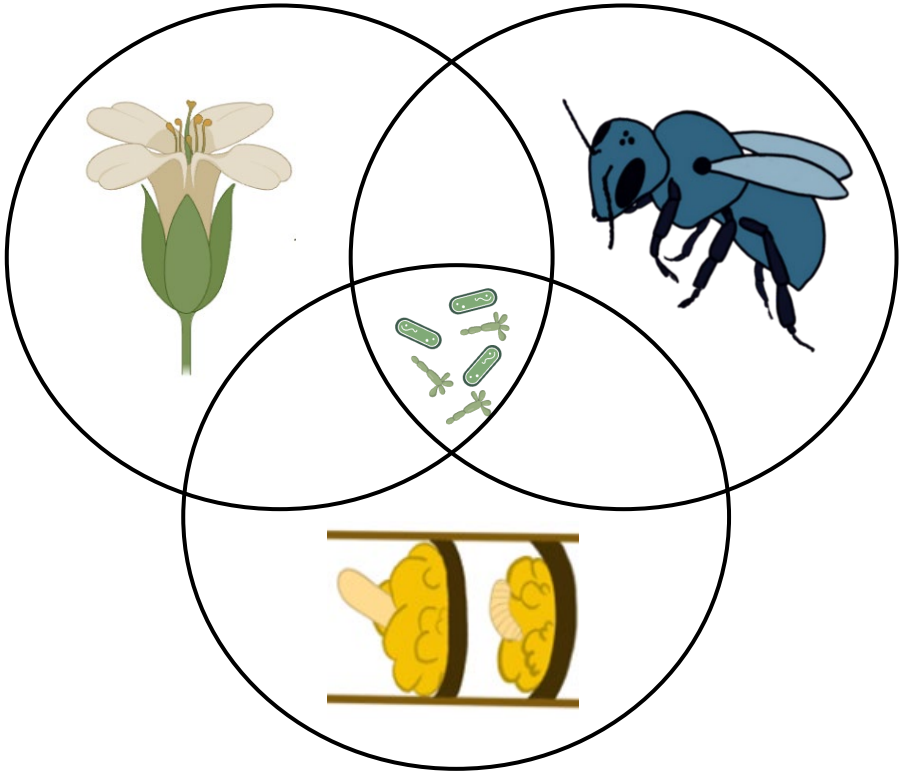


Bee Guts:
Host Defenses
Low O_2
Limited nutrients

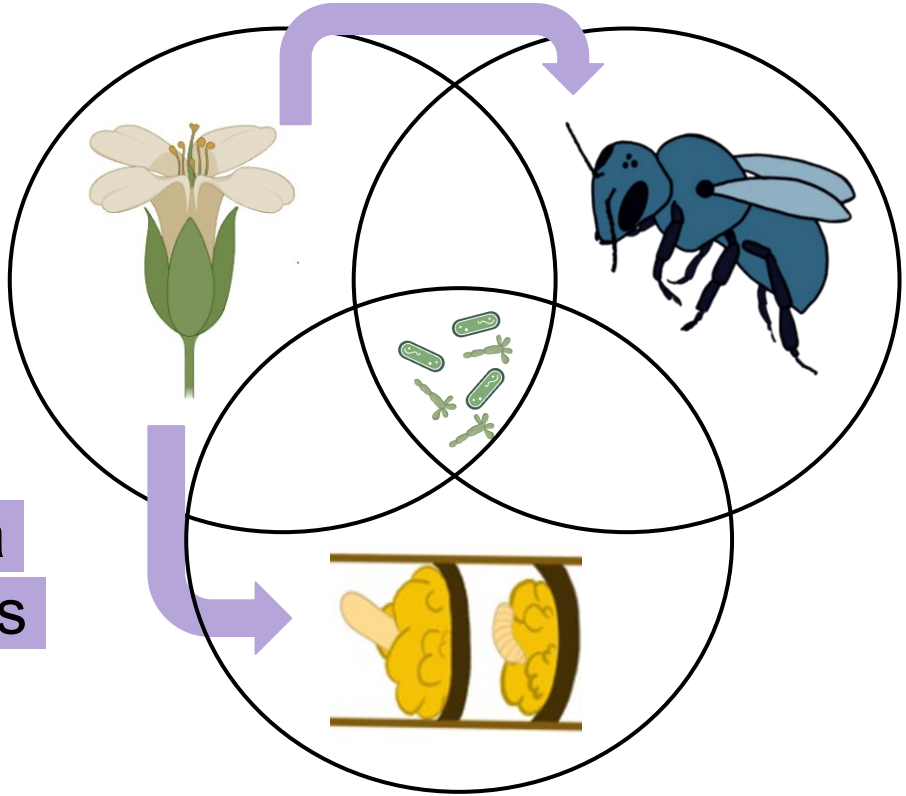
Pollen Provisions:
Pollen = tough

Microbe-Microbe Interactions!

Studies surveying microbial communities in flowers, adult bee guts, and provisions find overlap.

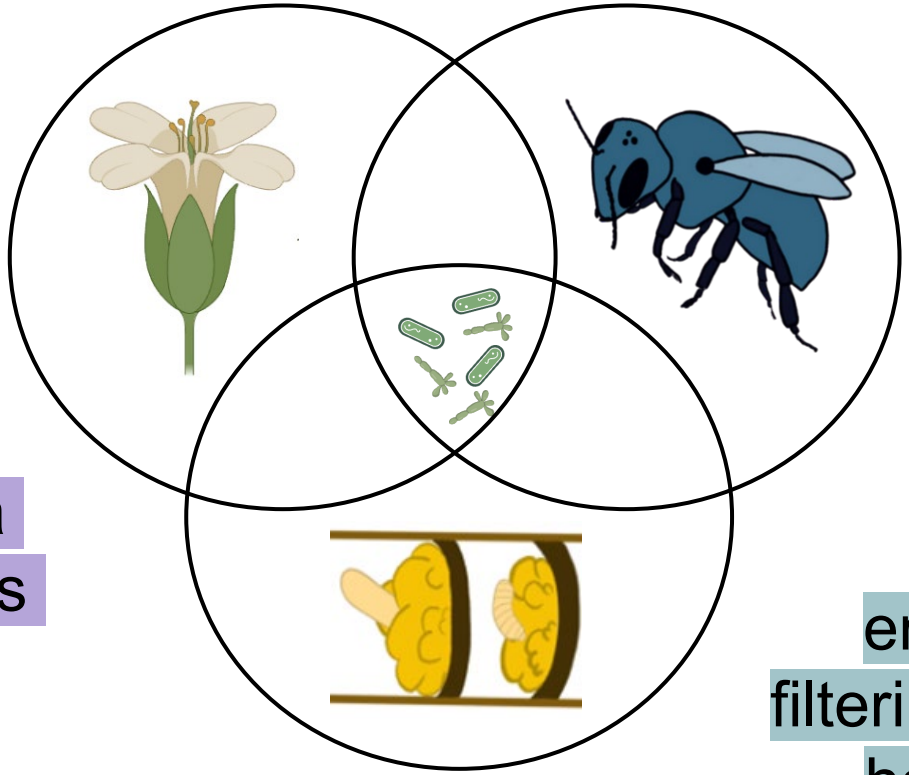


Studies surveying microbial communities in flowers, adult bee guts, and provisions find overlap.



Q1: Are flowers a source of microbes for adult *Osmia lignaria* females and provisions?

Studies surveying microbial communities in flowers, adult bee guts, and provisions find overlap.



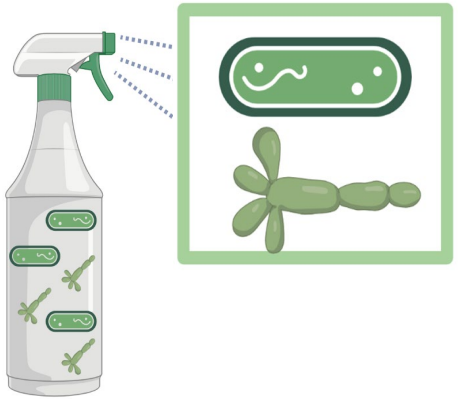
Q1: Are flowers a source of microbes for adult *Osmia lignaria* females and provisions?

Q2: Does environmental filtering occur across habitat types?

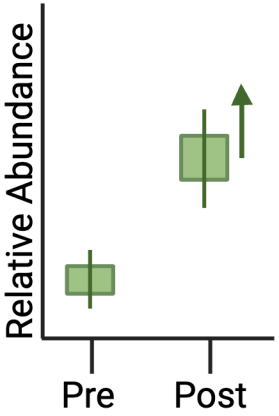
To test this, we inoculated flowers in a hoophouse system with a known microbial community and surveyed microbial communities before + after.

+

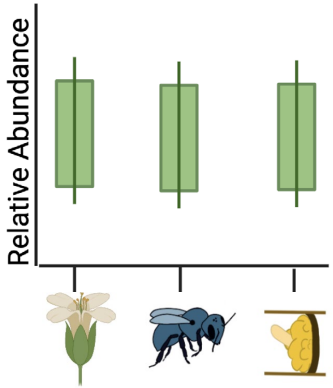
+



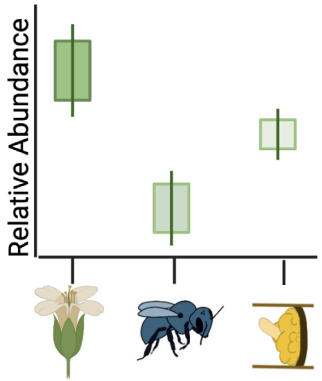
H1:



H2:



or

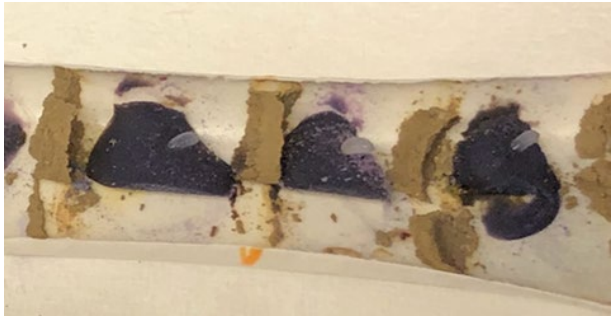


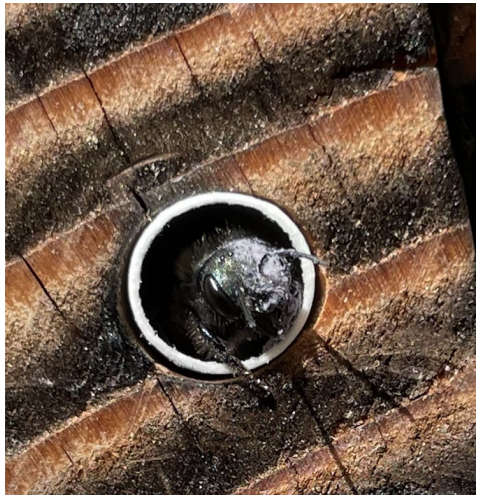
No Filtering

Filtering

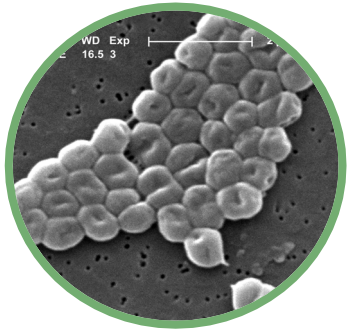
Lacy Phacelia (*Phacelia tanacetifolia,* Benth.) was used as a food source for bees.

- Annual, Native in CA
- Provide high quality nectar and pollen for bees, including BOBs (Boyle et al., 2020; Williams 2003)
- Pollen is purple!

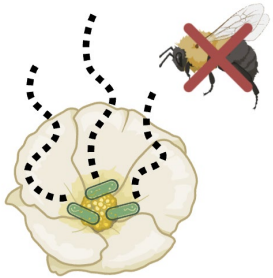




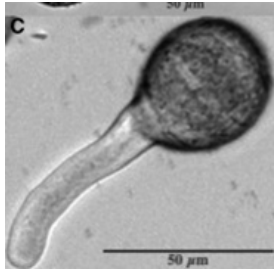
Microbes chosen for the inoculum have known associations with bees and flowers.



Acinetobacter pollinis



Schaeffer et al., 2019



Christensen et al., 2021

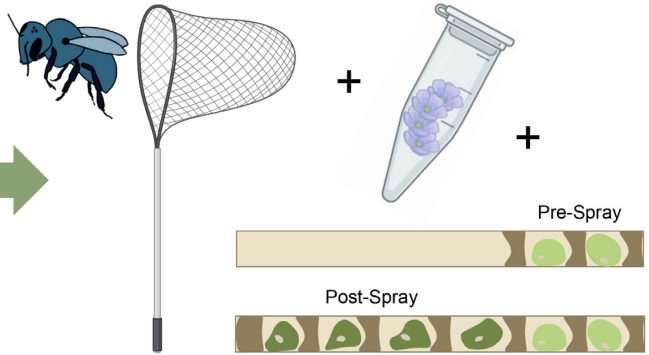
Metschnikowia reukaufii,
Starmerella bombicola,
Debaryomyces hanseii,
Aureobasidium pullulans

Apilactobacillus micheneri

McFrederick et al., 2017; Vuong and McFrederick, 2019

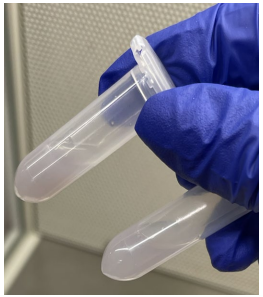
** These microbes were also not found in previous hoop house studies **

Methods



2 Rounds

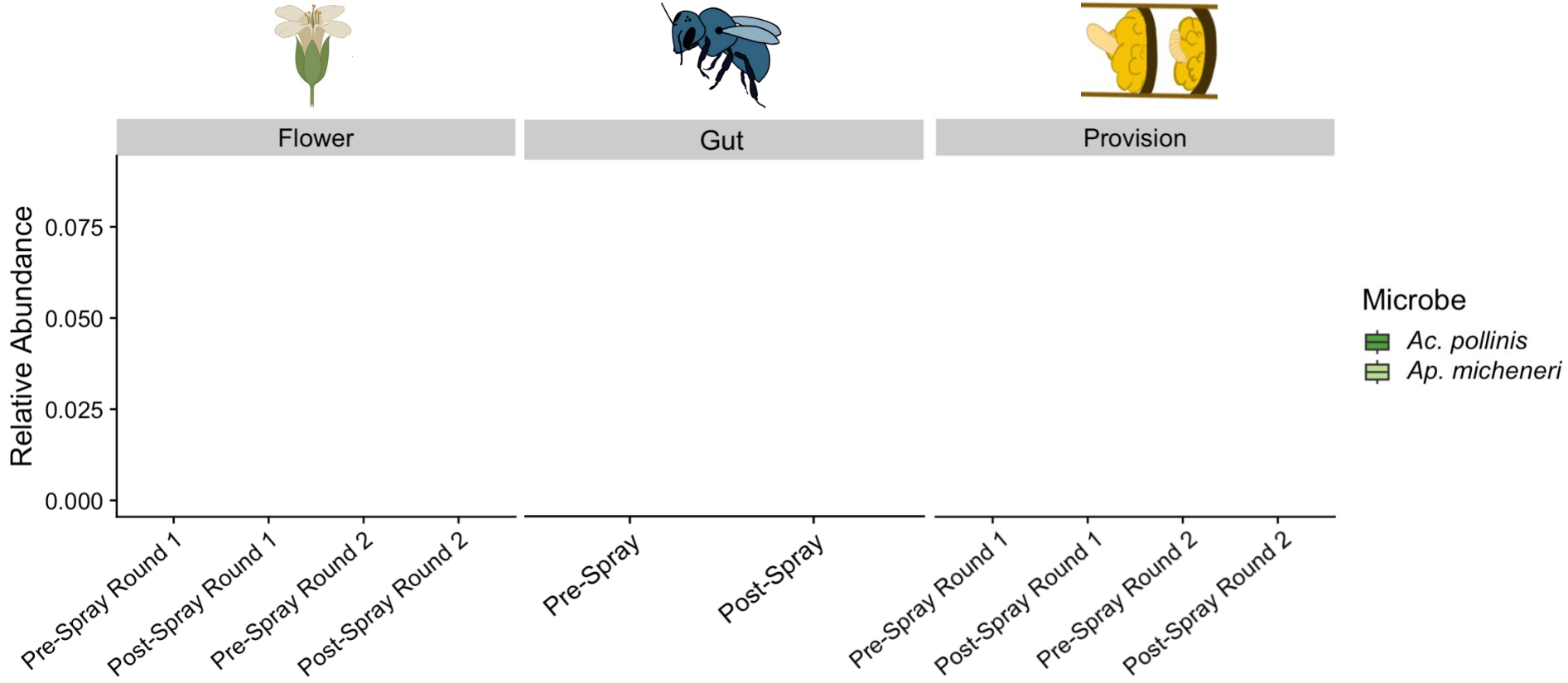
Acinetobacter pollinis,
Apilactobacillus micheneri,
Yeasts



DNA Extractions + Sequencing

Determine relative abundance in flowers, adult bee guts, provisions + compare across habitat types

Q1: Are flowers a source of microbes for adult BOB females + provisions?



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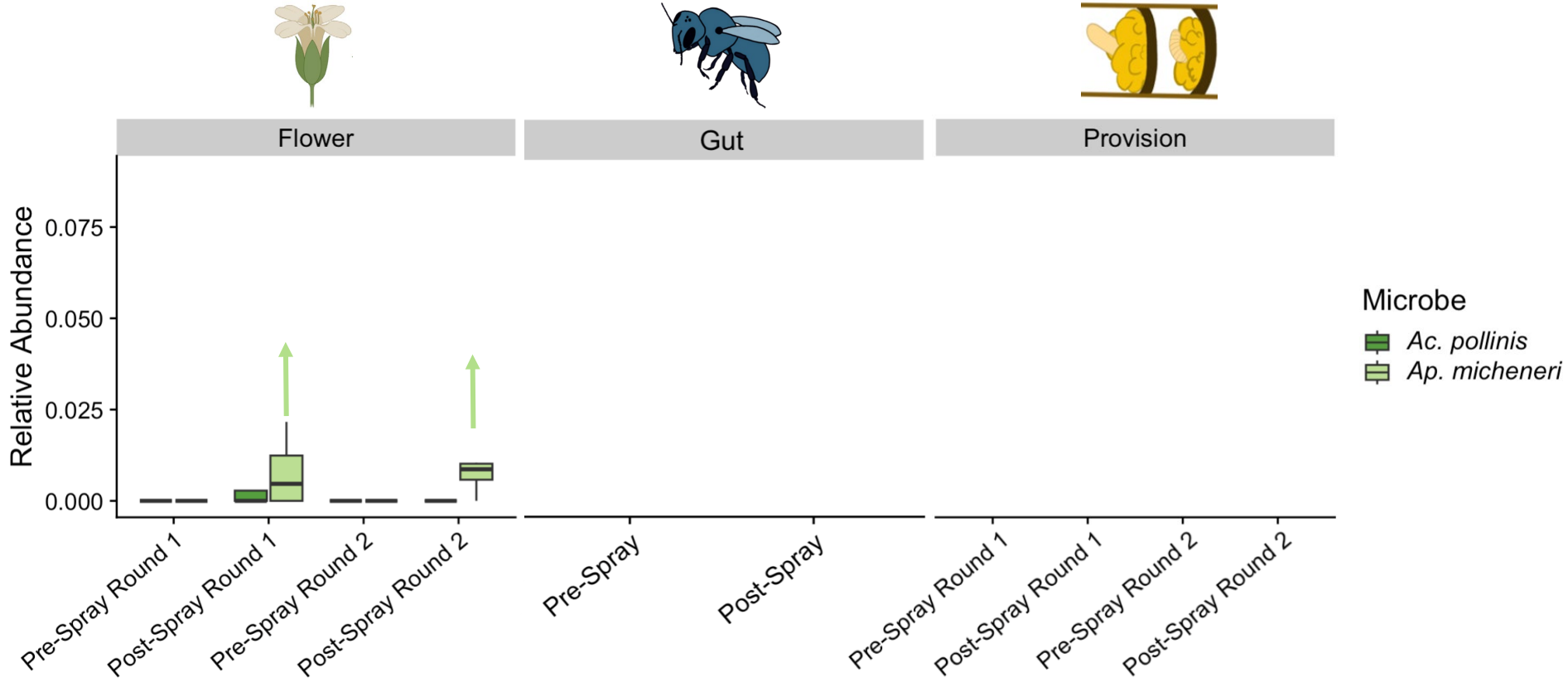

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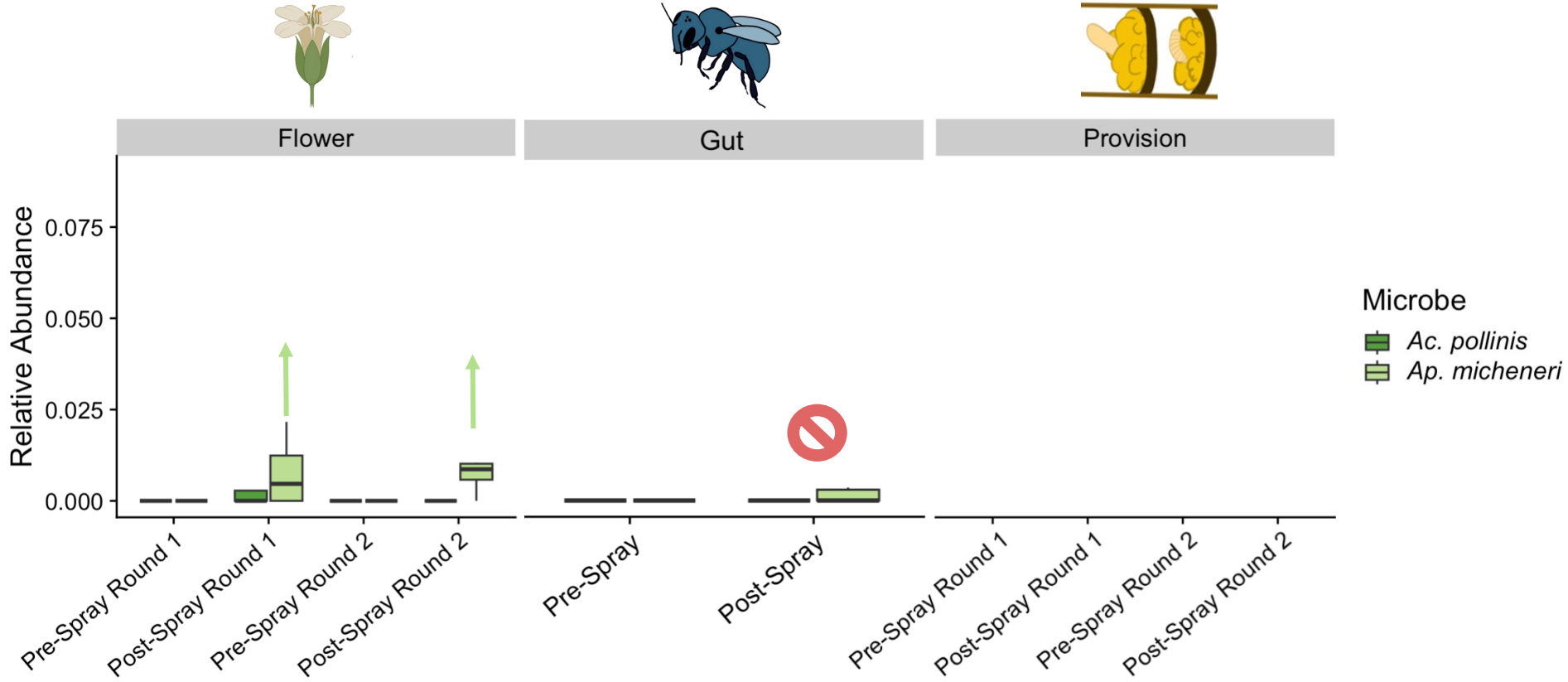

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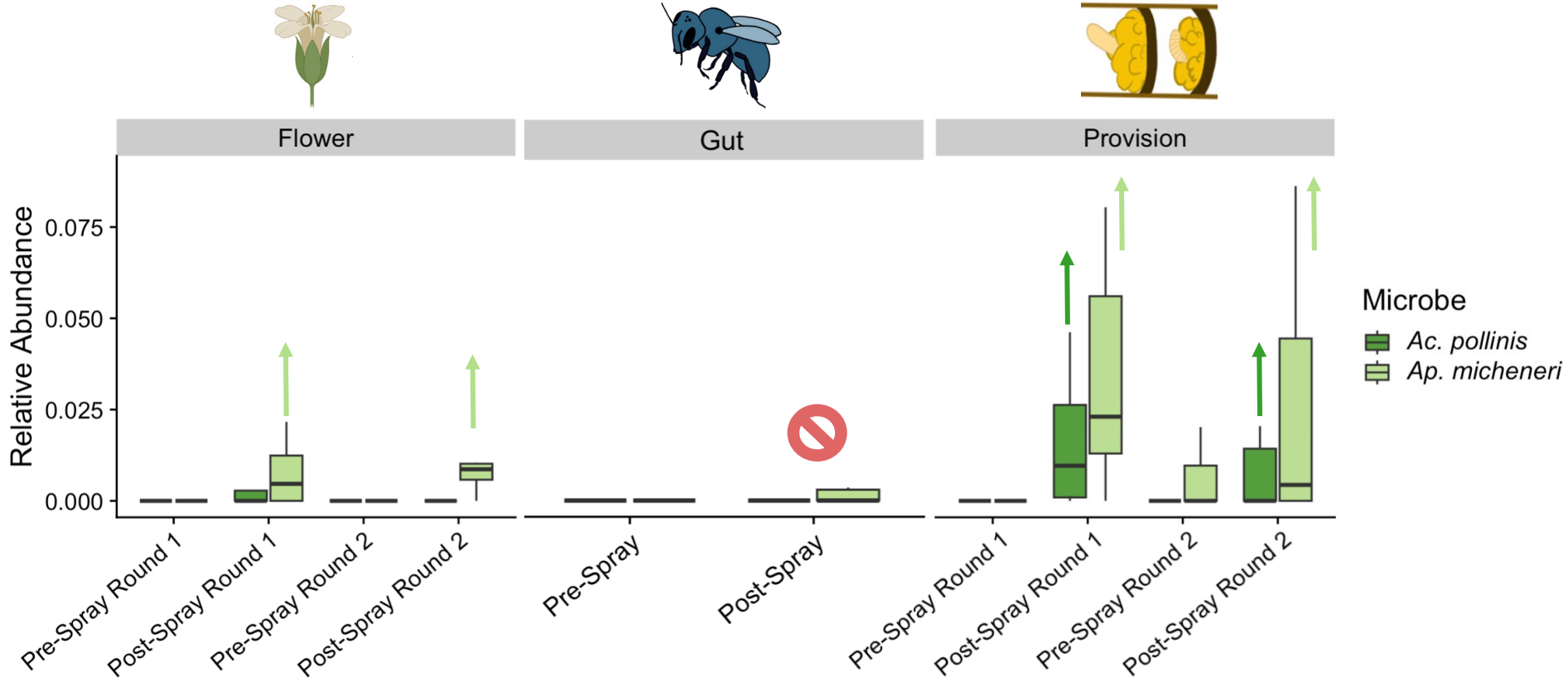

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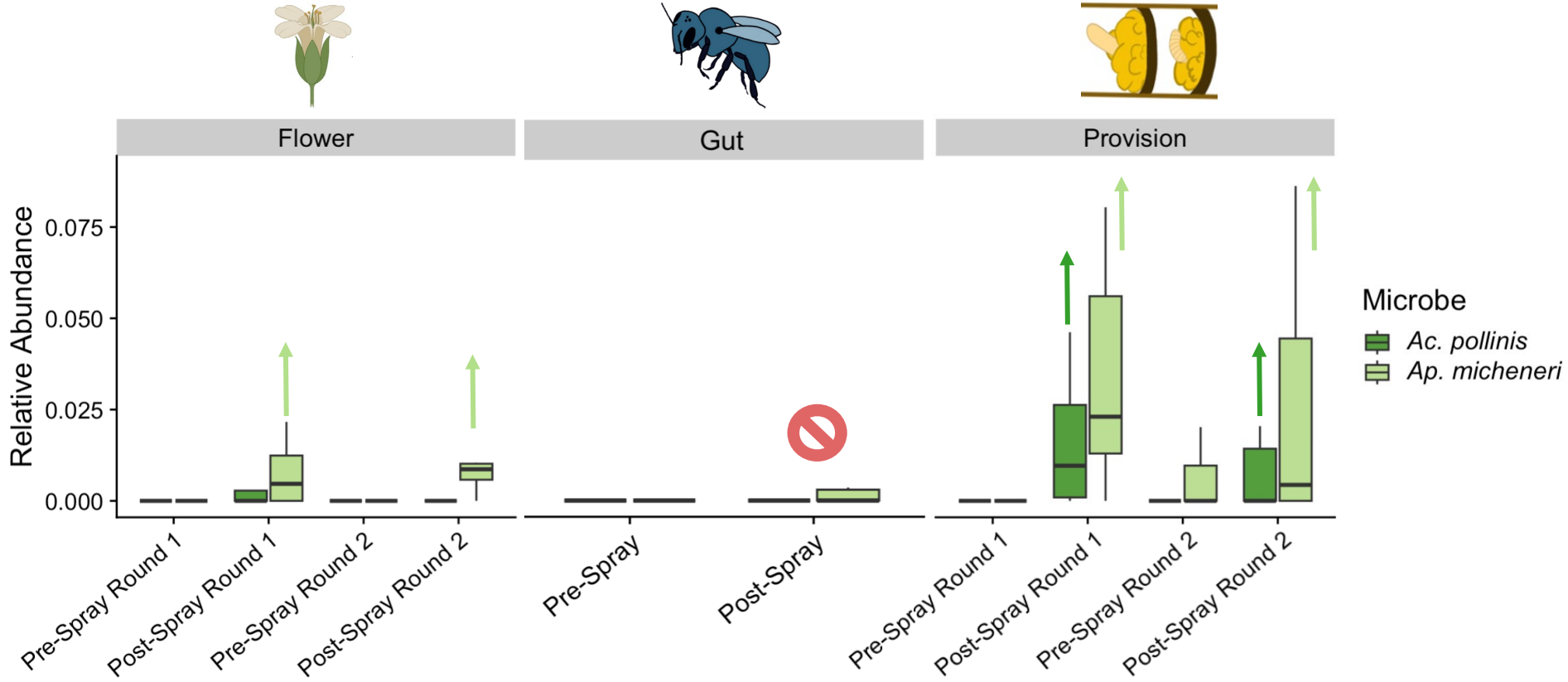
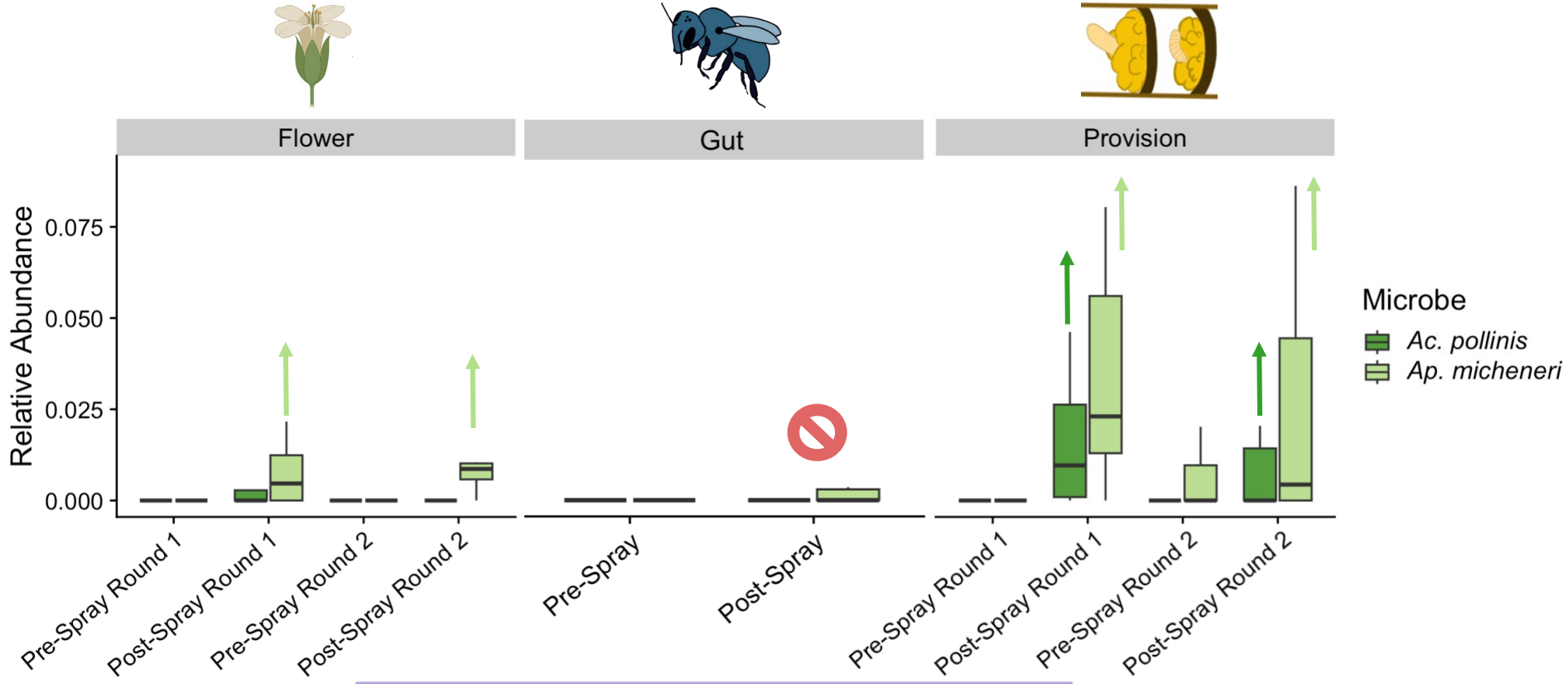


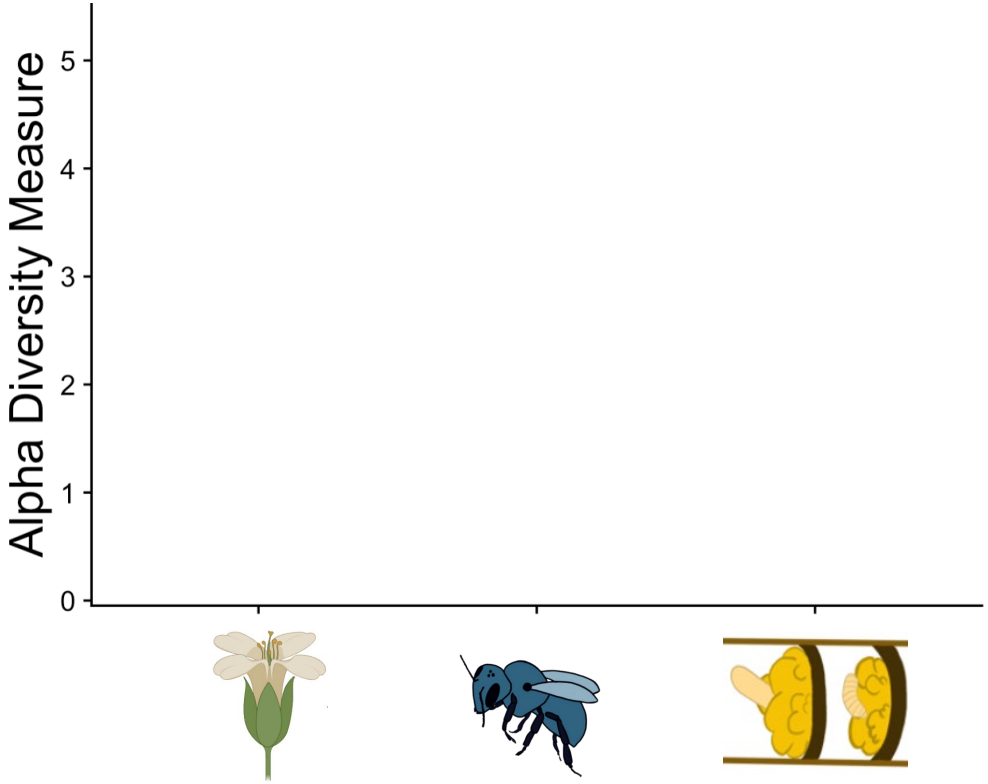
Yes, for provisions! Though they show up in guts, it is not as common.

Q2: Does environmental filtering occur across habitat types?



Yes!

Q2: Does environmental filtering occur across habitat types? (More Broadly)



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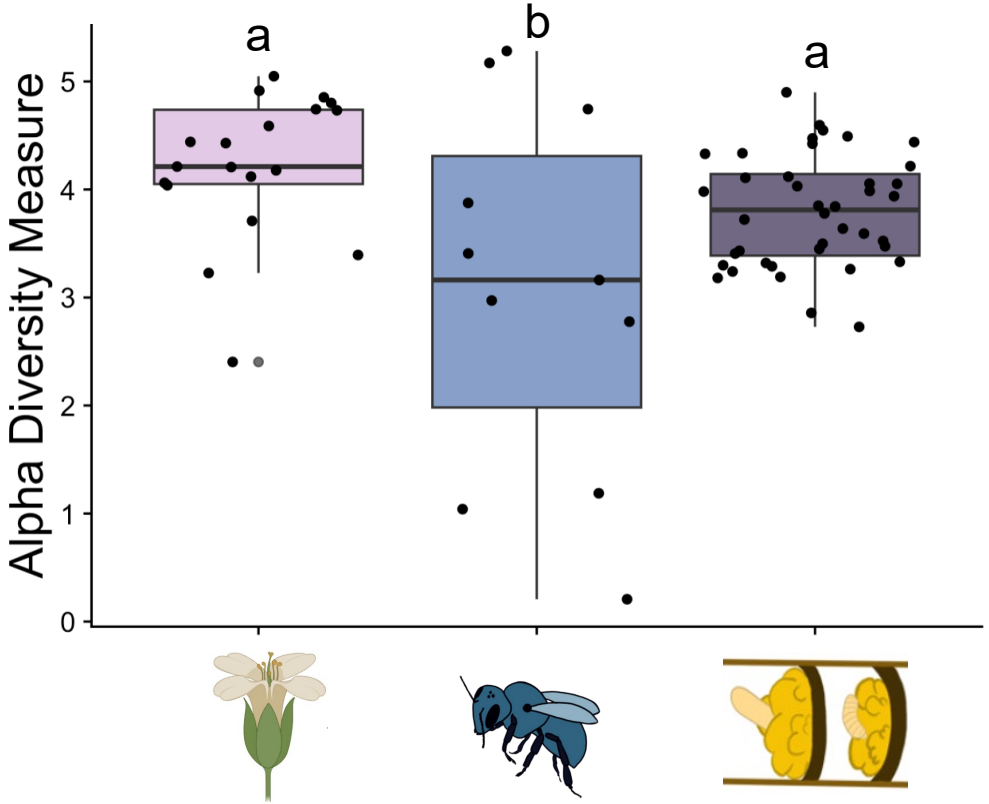
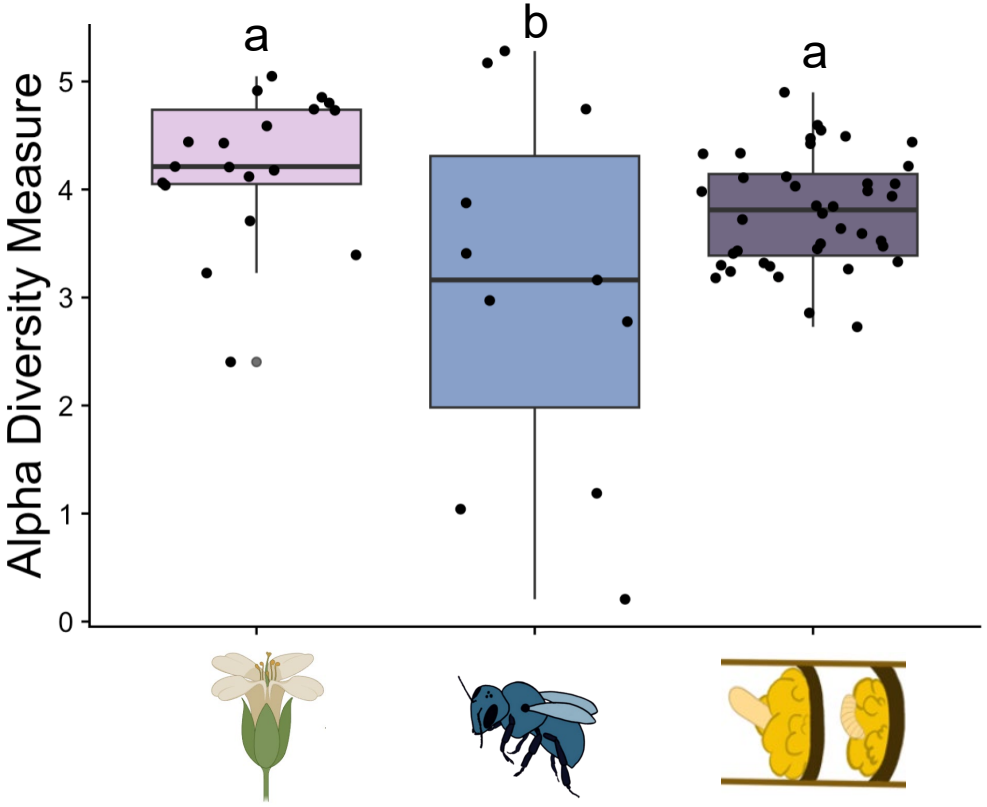
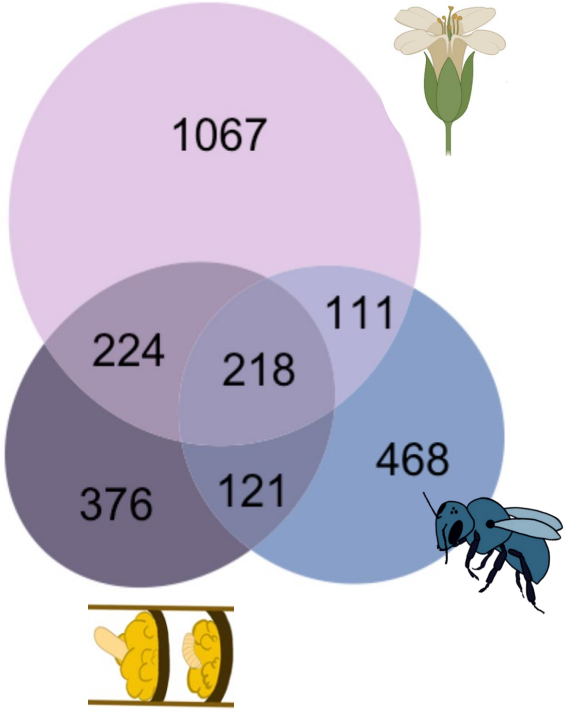


Yes! Even more broadly, we see filtering across the habitats.

Q2: Does environmental filtering occur across habitat types? (More Broadly)

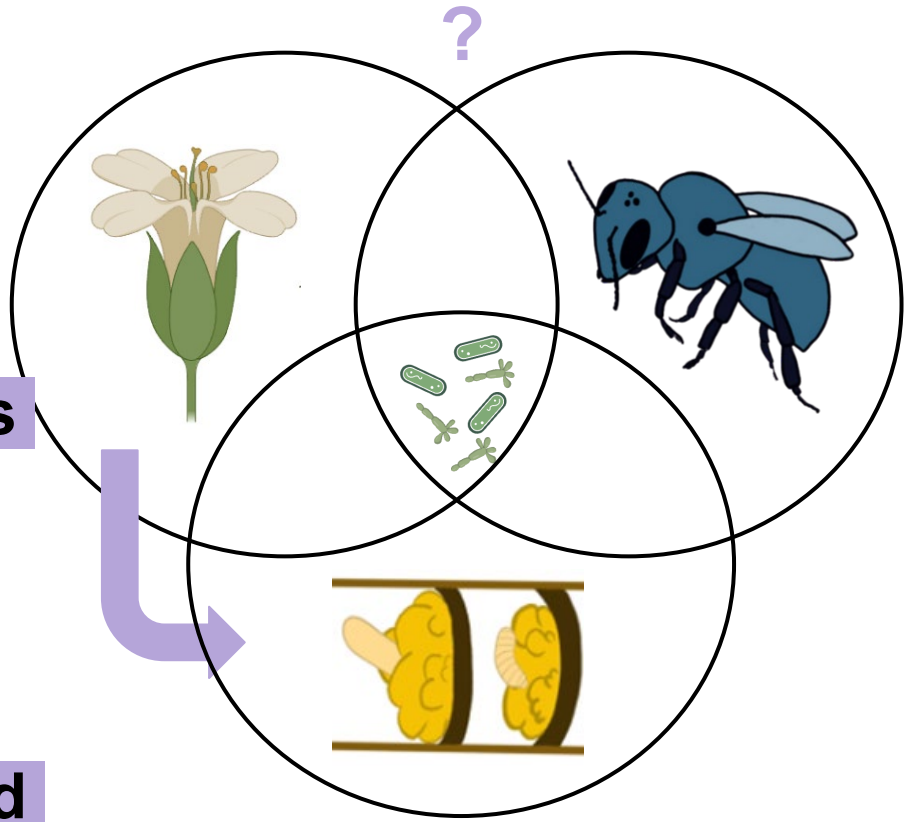




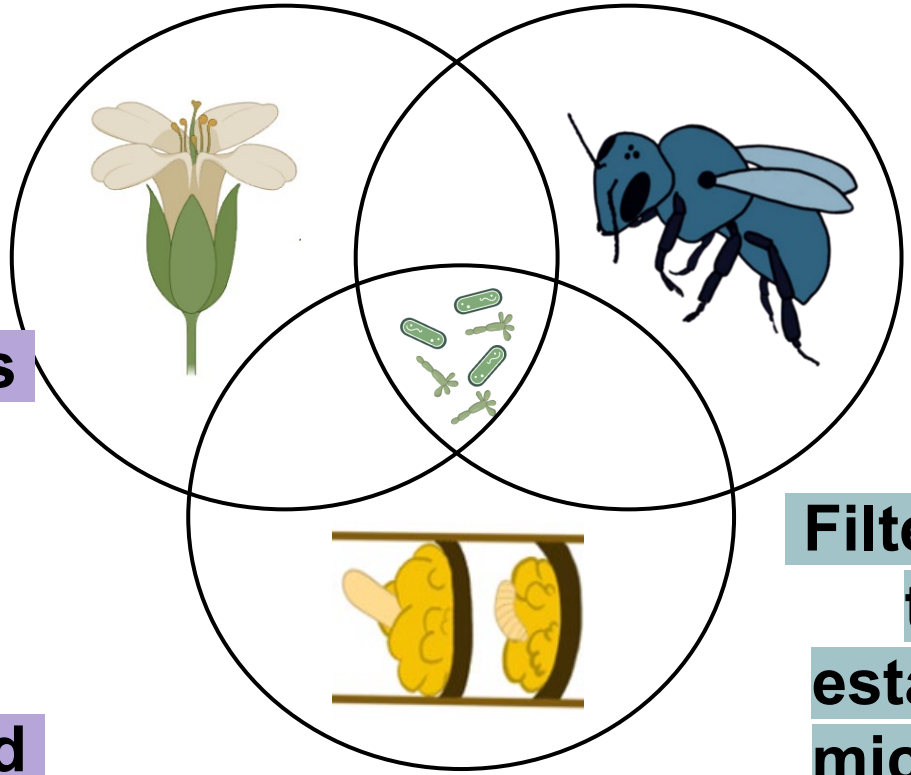
Yes! Even more broadly, we see filtering across the habitats.

And - Though there is overlap, each habitat has a high proportion of unique ASVs.

Flowers serve as an acquisition source of microbes in provisions, though guts need to be further examined



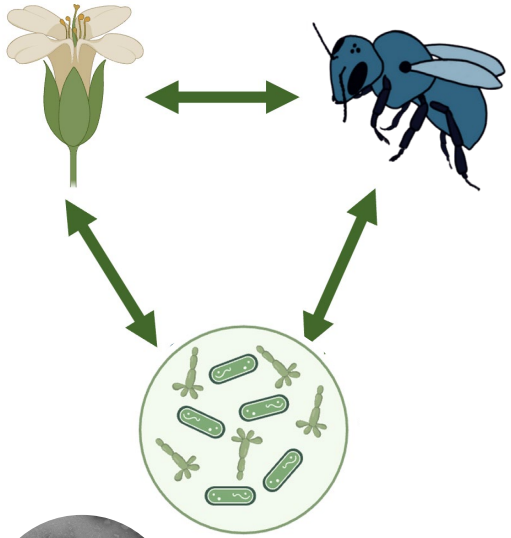
Flowers serve as an acquisition source of microbes in provisions, though guts need to be further examined



Filtering may lead to unequal establishment of microbes across habitat types

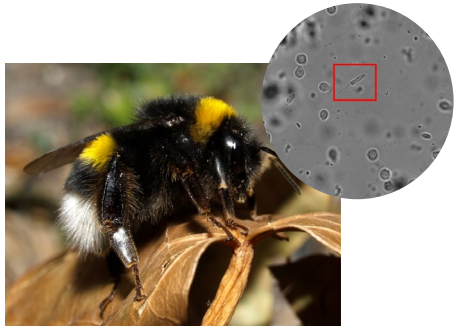
How does this relate to broader bee and plant health?

Flowers = Dirty Door Knobs



Crithidia bombi and *Bombus* spp.

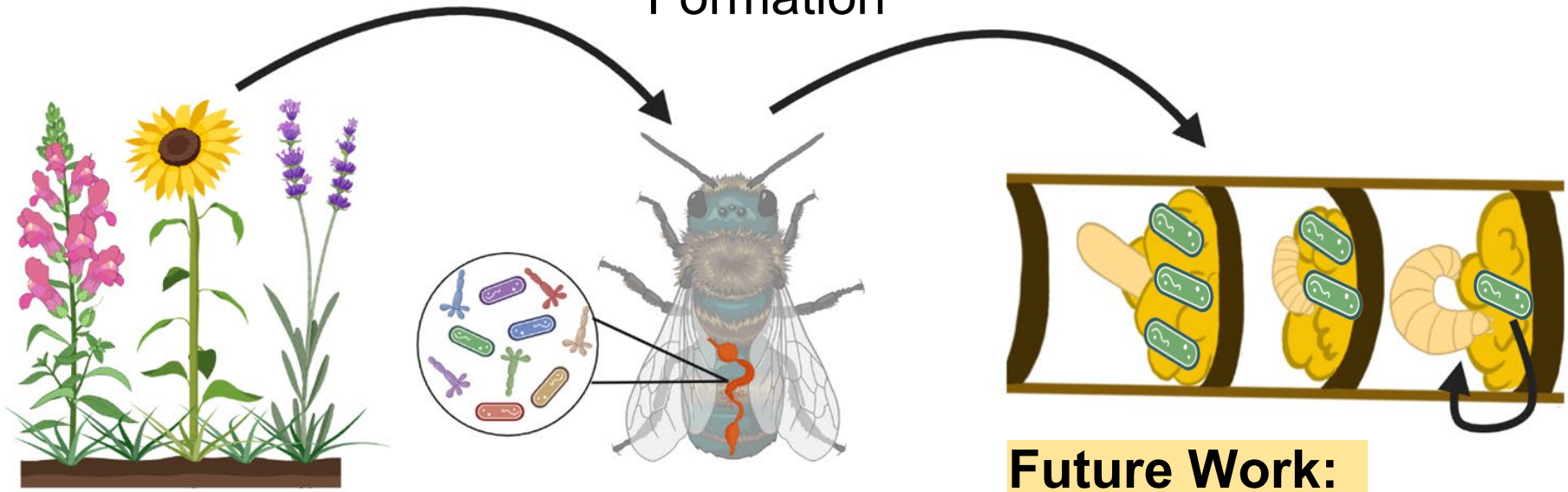
Durrer and Schmid-Hempel, 1994



Fireblight and *Bombus* spp.

Mukhtar *et al*., 2024

Current Study:
Formation



Future Work:
Function

Can floral microbes protect bee larvae from pathogens?

Acknowledgements

Vannette Lab Members: Dr. Rachel Vannette, Dr. Jacob Francis, Dr. Jacob Cecala, Danielle Rutkowski, Shawn Christensen, Dino Sbardellati, Gillian Bergmann, Leta Landucci

Neal Williams & Lab Members

Funding: George H. Vansell Award, NSF GRFP

Bees: Foothill Bee Ranch

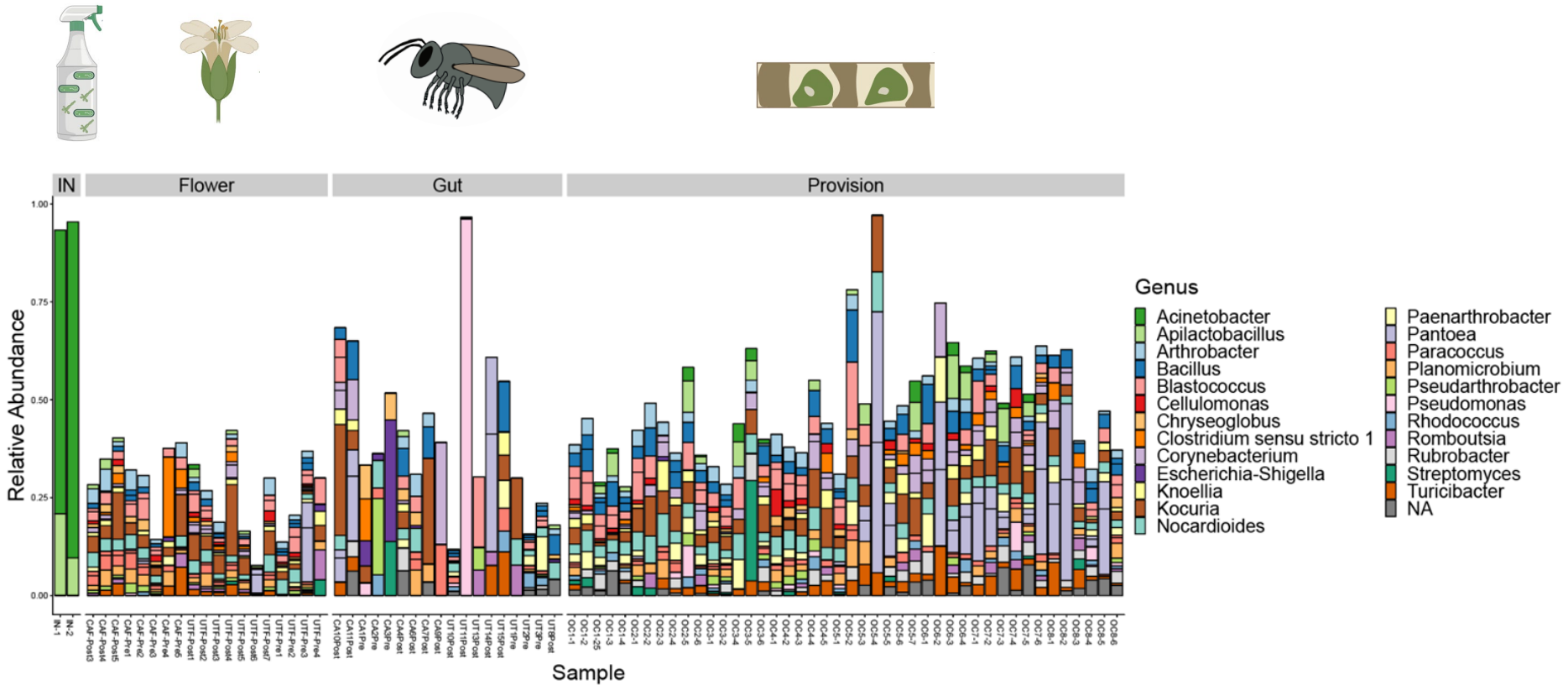
Questions?

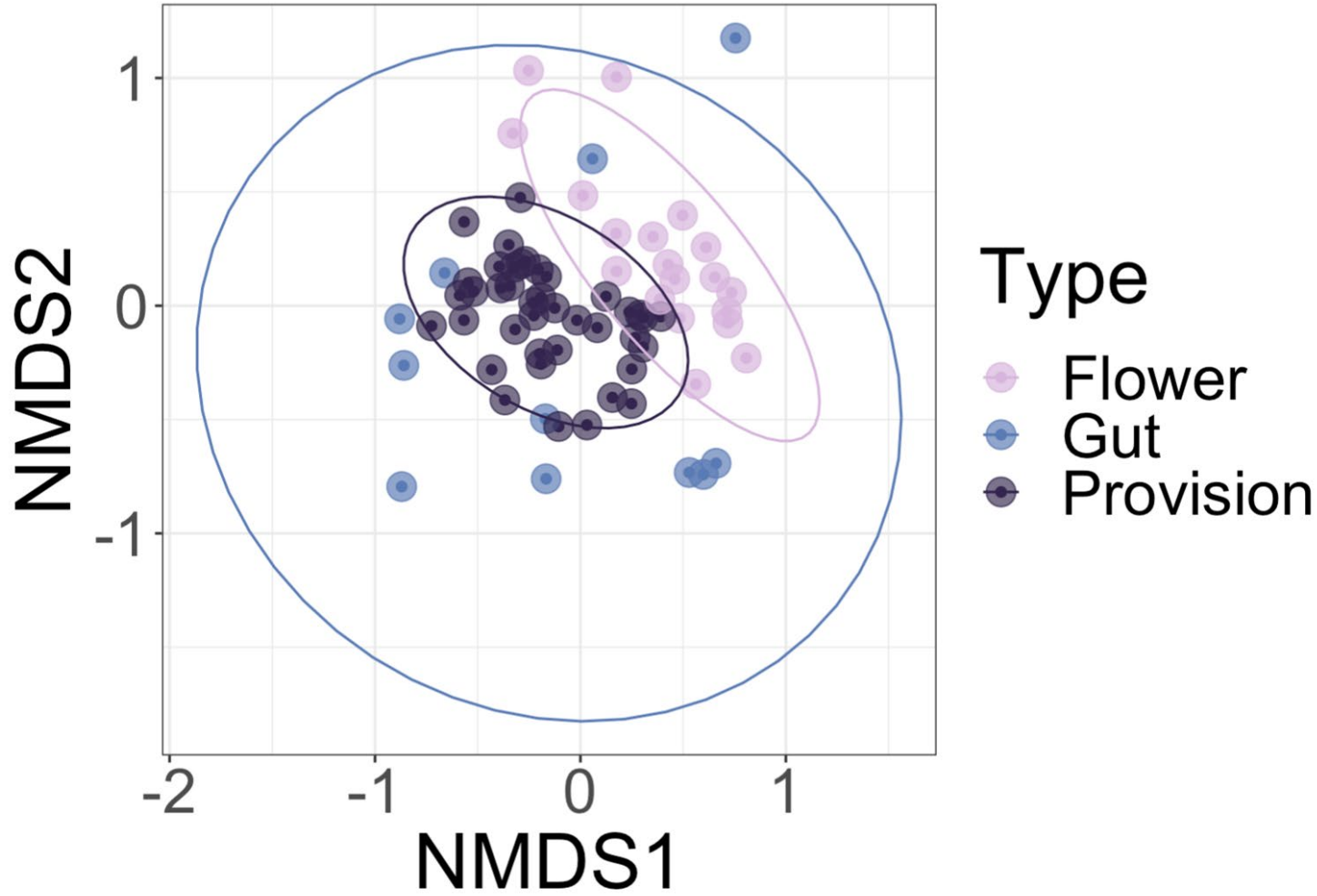
Contact Me!

lexmartin@ucdavis.edu

https://entomolexie.wordpress.com

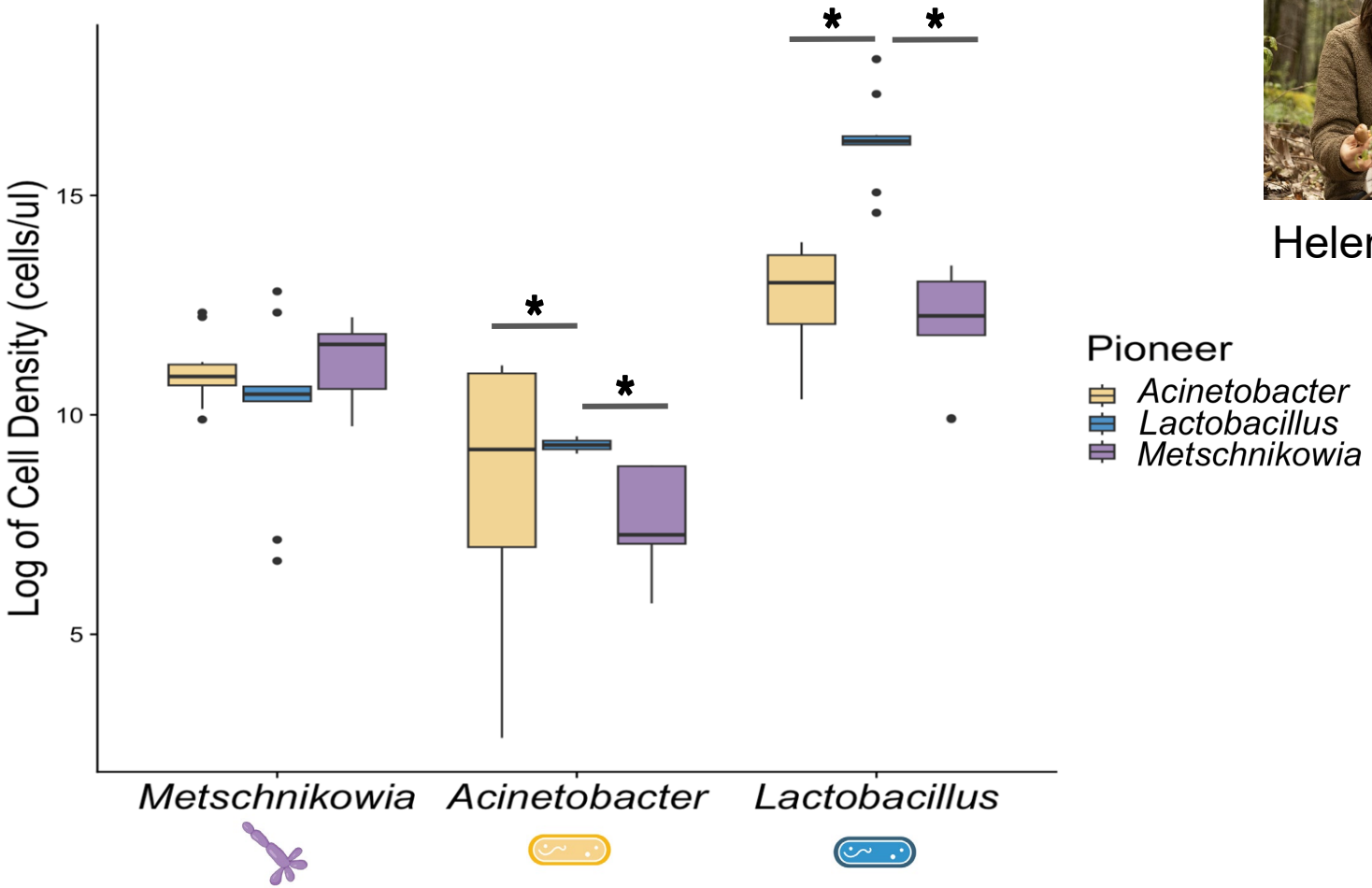
Top 30 Most Relatively Abundant Taxa



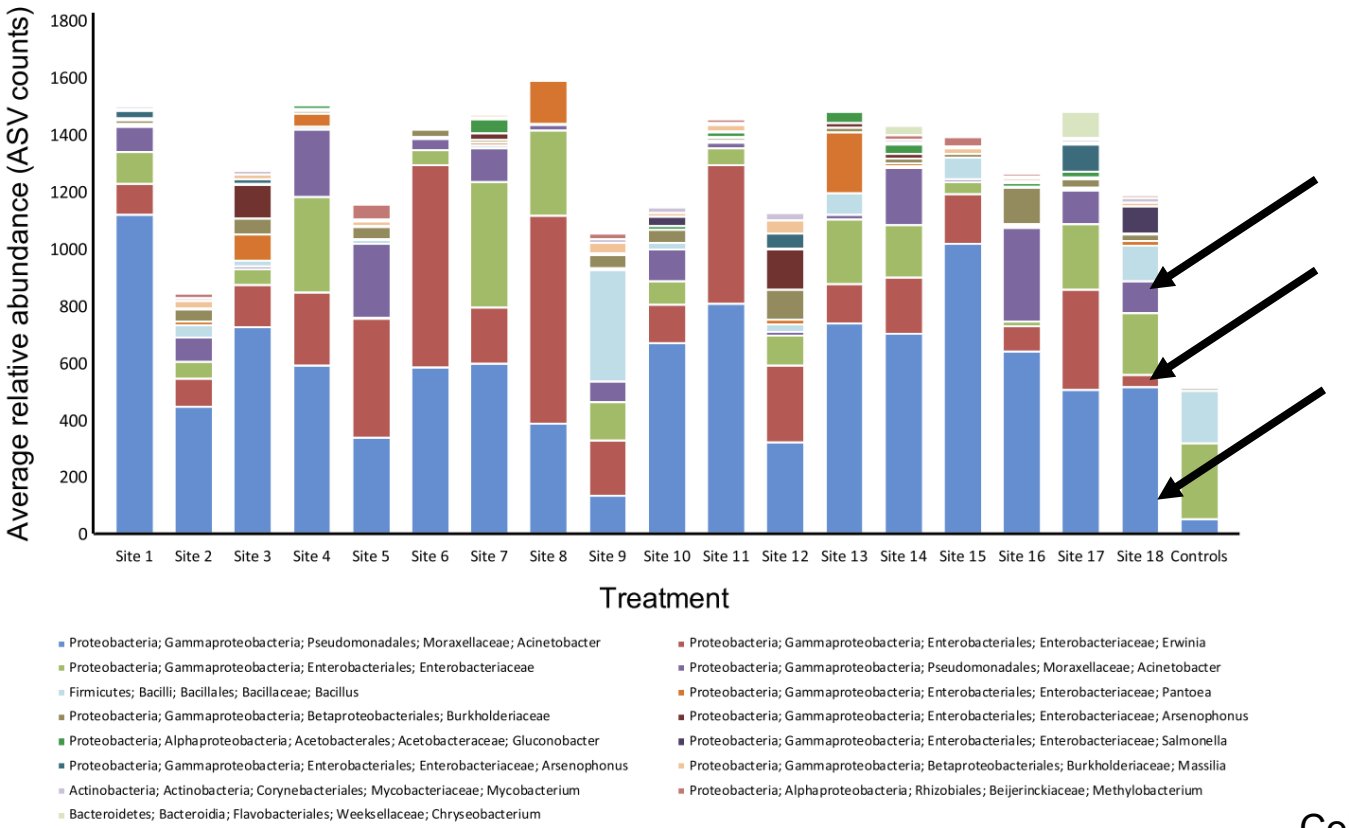

NMDS2
1
0
-1
-2
-1
0
1
NMDS1
Type
Flower
Gut
Provision

Priority Effects in Artificial Flowers

Helen Noroian

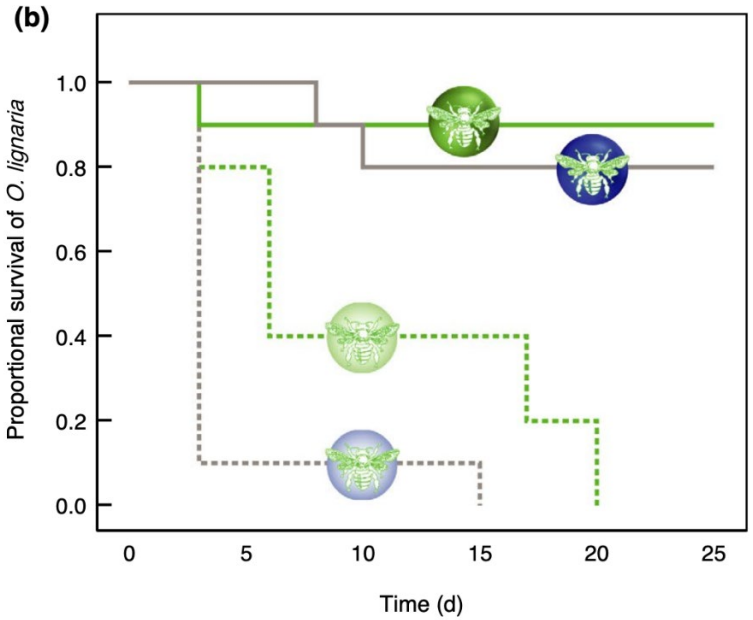


Floral microbes dominate the gut of *Osmia lignaria*.



Cohen *et al.*, 2020

Floral microbes in provisions are important for survival of *Osmia lignaria* larvae.



Dharampal *et al*., 2020

Analyses

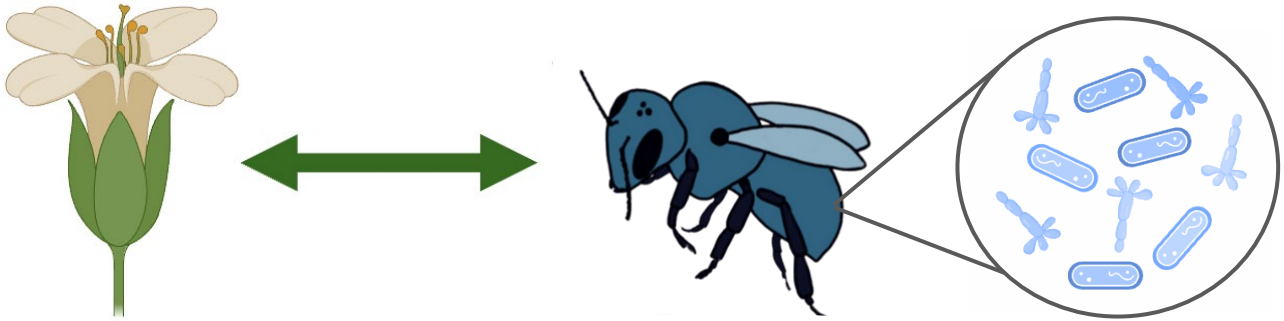
<u>To analyze inoculated bacterial establishment within each sample type:</u>

1) PresAbsMicrobe ~ Treatment * SprayRound + HoopHouse, test= Chi-Sq
2) RelAbMicrobe ~ Treatment * SprayRound + HoopHouse, test = F

   *** For Guts, Spray Round not included

<u>To analyze difference in bacterial establishment across sample types:</u>

1) PresAbsMicrobe ~ SampleType, test= Chi-Sq
2) RelAbMicrobe ~ SampleType, test = F



How does a stable microbiome form?