

OP-052 [Bee Biology]

The young and stressed making bad decisions: Effects of *Vairimorpha ceranae* on worker honey bee (*Apis mellifera*) foraging behaviours

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Vairimorpha ceranae is an intracellular microsporidian parasite that targets the midguts of Western honey bees (*Apis mellifera*); it replicates by consuming host-ingested nutrients, exerting energetic stress on its host. In the laboratory, *V. ceranae*-infected worker bees consume more carbohydrates and respond by extending their proboscis more to lower-quality food than non-infected workers. However, these effects on feeding behaviour have not been observed in the field. Furthermore, it is unclear how changes in worker feeding behaviours affect foraging decisions. We investigated the effects of *V. ceranae* infection and spore load on honey bee foraging behaviours in the field by inoculating and marking newly emerged worker bees with either high (25,000 spores per bee), low (400 spores per bee), or control (non-infected) spore loads. Inoculated worker bees were released into experimental colonies. Foraging age was evaluated by observing each experimental colony every day when the inoculated bees were 7-27 days old. Foraging decisions were determined by collecting marked returning foragers, and subsequent laboratory analyses to determine pollen weight and crop solute concentration. Our results demonstrate that *V. ceranae*-infected worker honey bees start foraging at a younger age than non-infected workers, and that infected foragers forage for nectar that is significantly lower in sugar concentration than do non-infected workers. Based on these results, we predict that *V. ceranae* can affect colony productivity through changes in foraging age which can negatively disrupt colony temporal polyethism, potentially causing essential roles to be under-filled in the colony. Furthermore, if infected individuals are foraging for nectar of lower sugar concentration, honey production can also be affected. Decreases in colony productivity negatively affect beekeepers; therefore, *V. ceranae* infection levels should continue to be monitored by beekeepers.

Effects of *Vairimorpha* (*Nosema*) *ceranae* on honey bee (*Apis* *mellifera*) foraging behaviours

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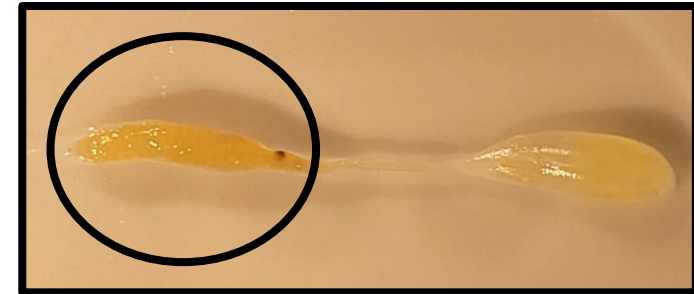
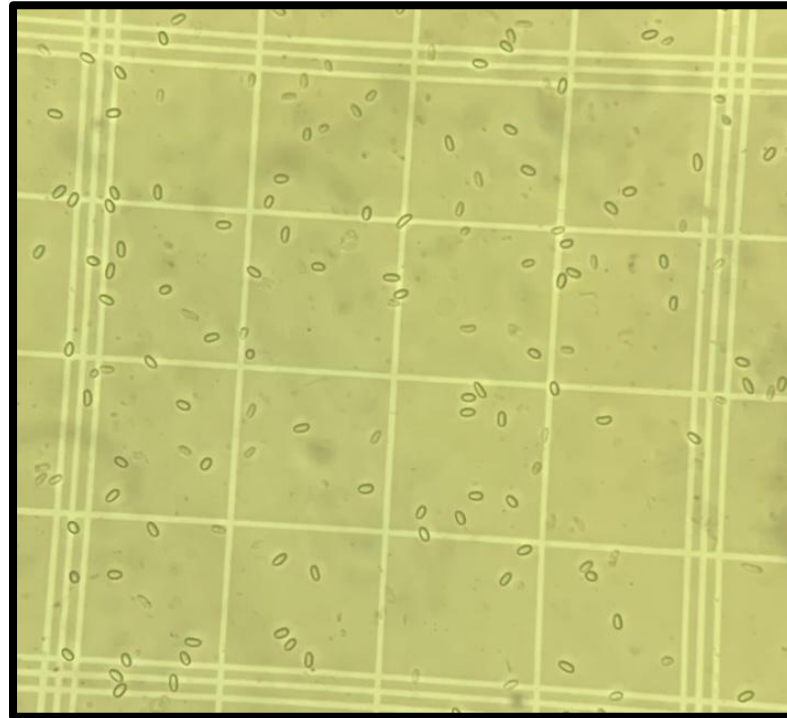
Presentation Overview

- General Background
- Objective One – Foraging Age
 - Background
 - Methods
 - Results
- Objective Two – Foraging Decisions
 - Background
 - Methods
 - Results
- Conclusion



What is *Nosema*?

- Microsporidian (obligate spore forming parasite)
- Replicates in the midgut epithelial cells
- Consumes nutrients & energy



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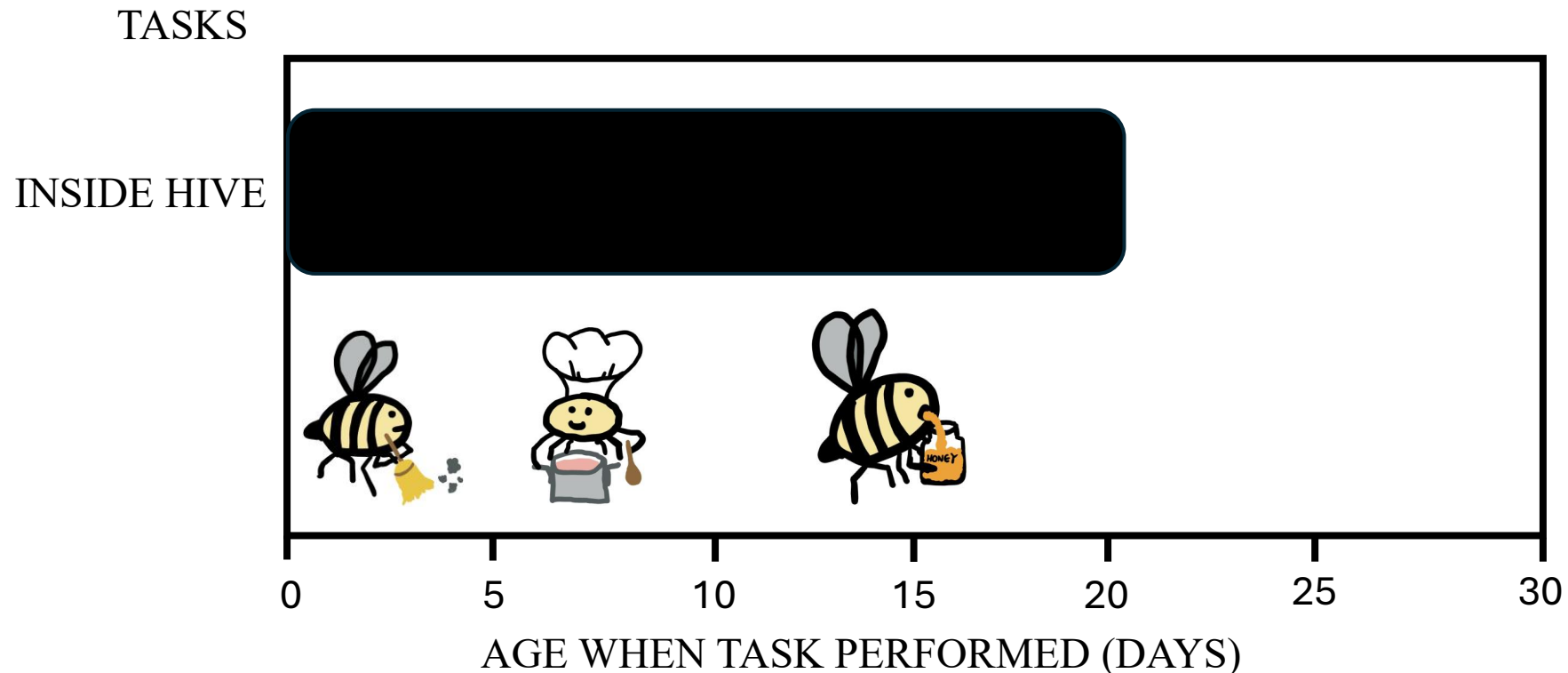
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- Colonies function as a homeostatic system by temporal polyethism (division of labour by age)



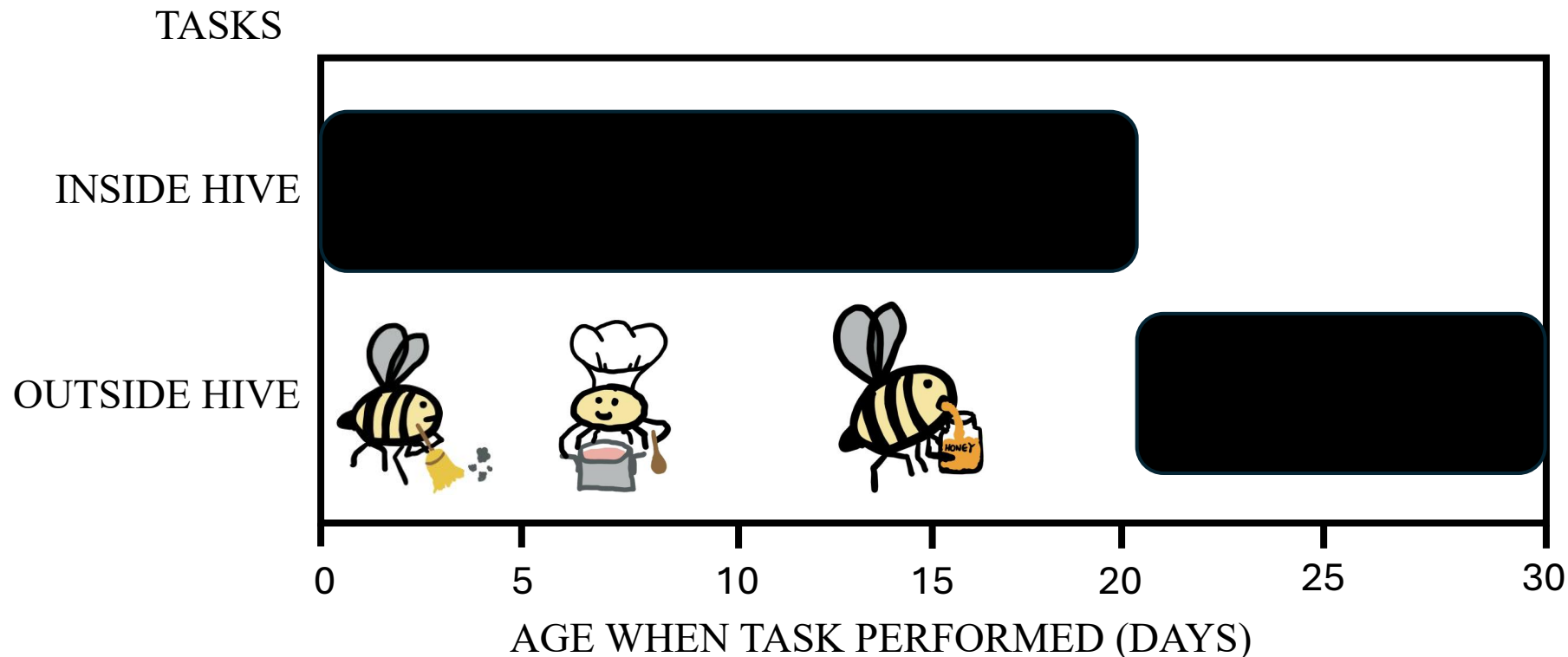
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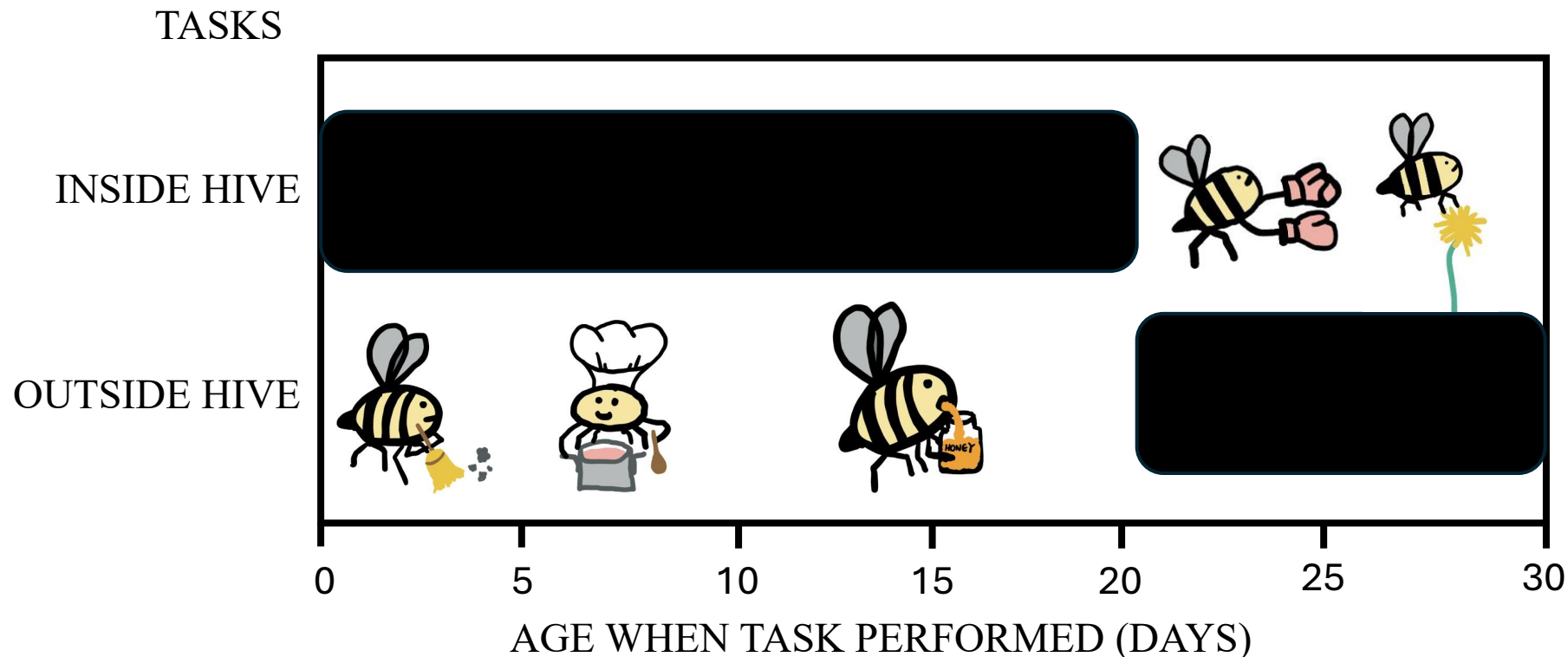
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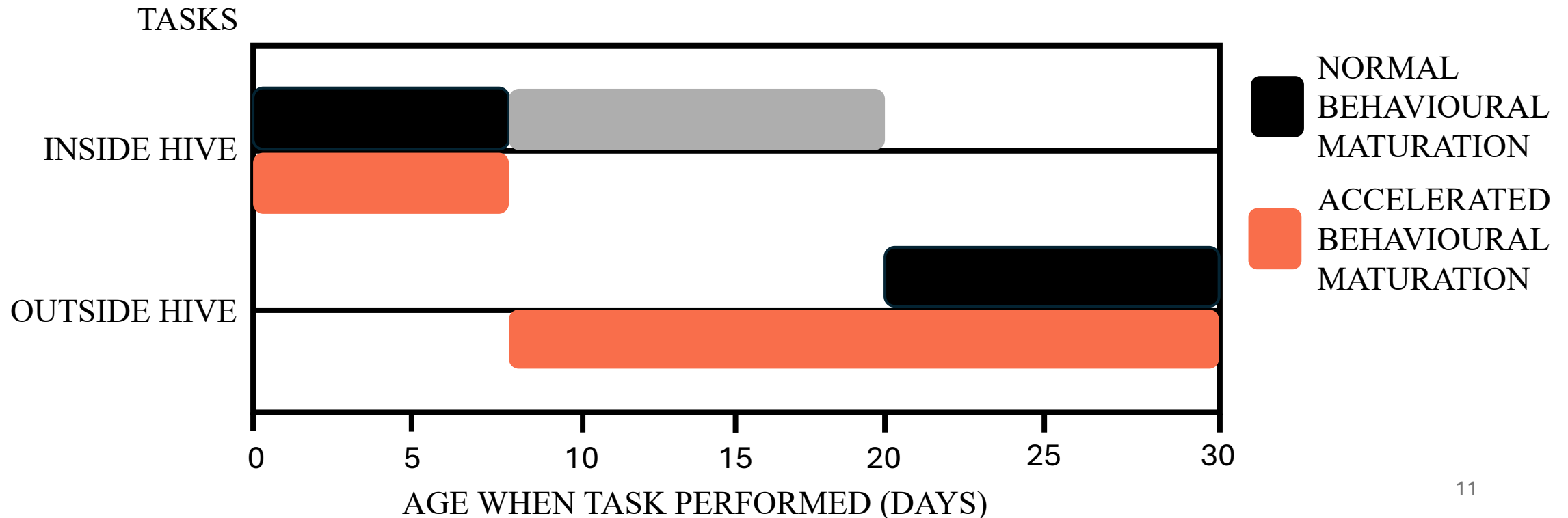
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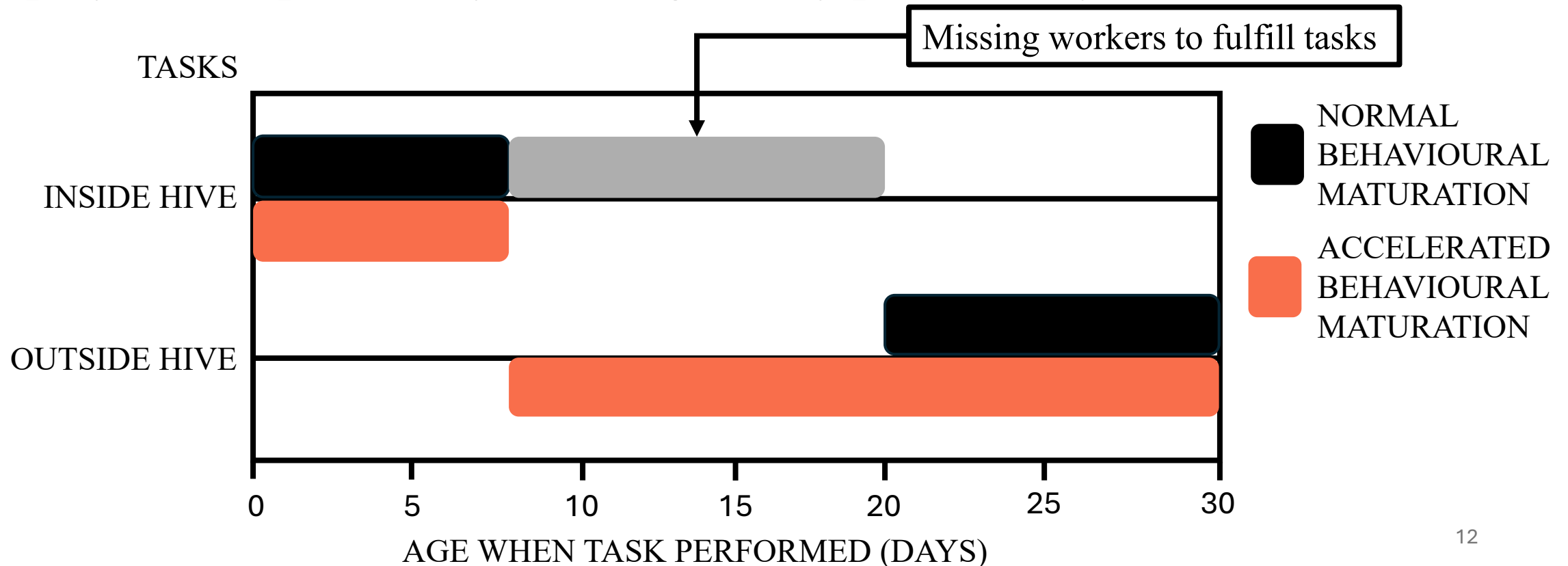
Objective One: Background

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- *Nosema* infected young bees have shown to experience accelerated behavioural maturation (Goblirsch et al., 2013; Dussaubat et al., 2013)
- Accelerated behavioural maturation can disrupt colony temporal polyethism, potentially affecting colony productivity (Vance et al., 2009; Perry et al., 2015)



Objective One: Background

- Conflicting results if *Nosema* induces accelerated behavioural maturation (Lach et al., 2015; Mattila and Otis, 2006; Goblirsch; et al., 2013; Dussaubat et al., 2013)
- Inconsistent spore loads used across experiments
- Suggesting *Nosema* spore load influences accelerated behavioural maturation differently

Objective One:
Investigate effects of *Nosema* Dosage on
Behavioural Maturation

Objective One: Methods

- Inoculated newly emerged bees in groups of 180 with one of three treatments
 - High spore load = ~25 000 spores per bee
 - Low spore load = ~400 spores per bee
 - Control = 0 spores per bee
- Marked inoculated bees to indicate treatment received



We marked over
6480 bees in 2
days!



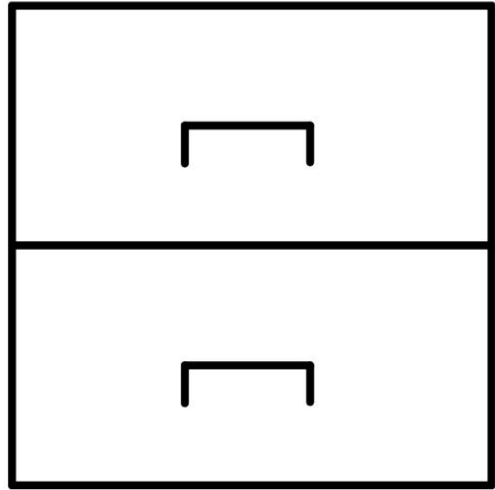
Objective One: Methods

- Released marked bees into experimental colonies

540 control
bees

540 low
spore load
bees

540 high
spore load
bees



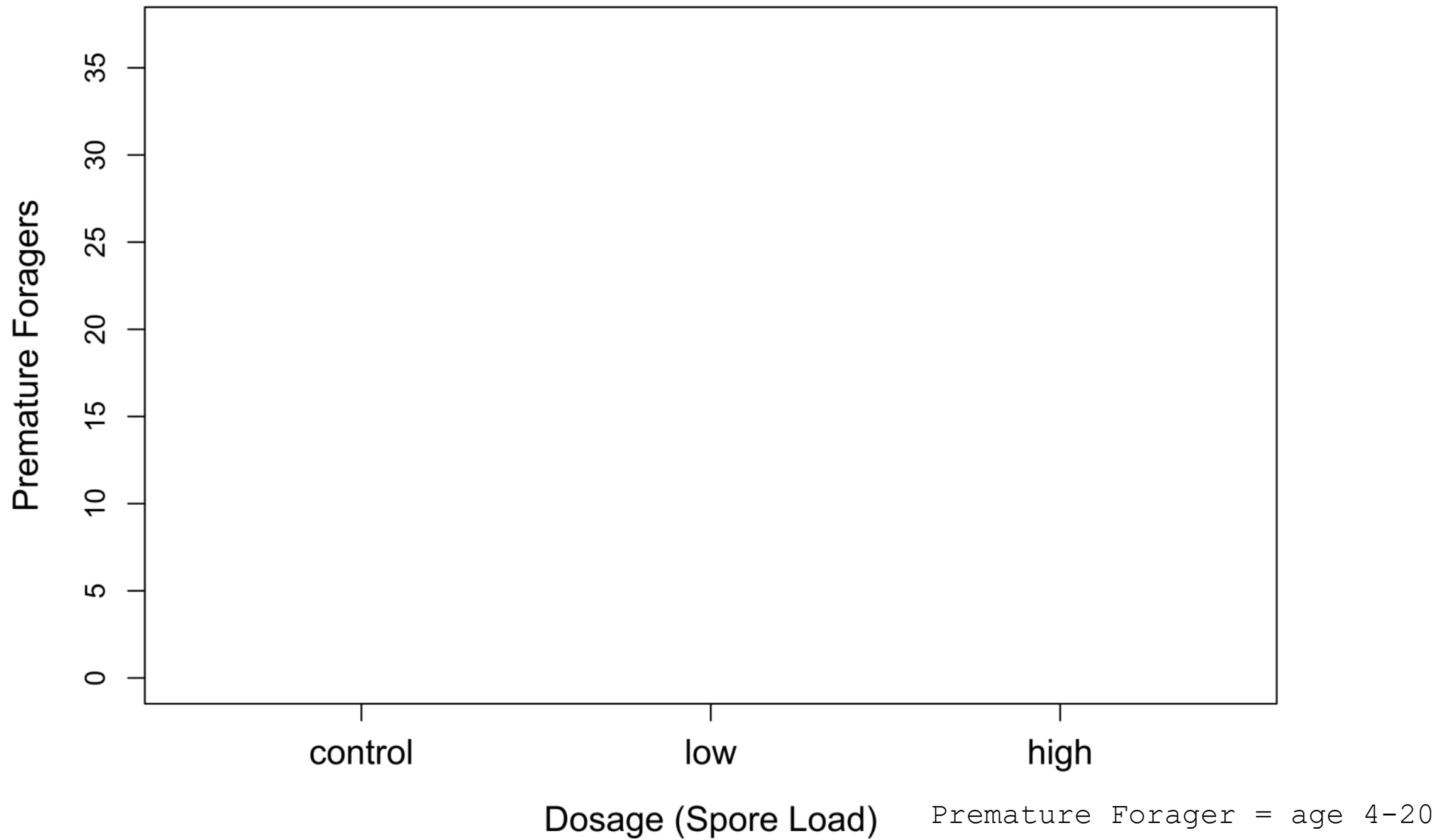
x5

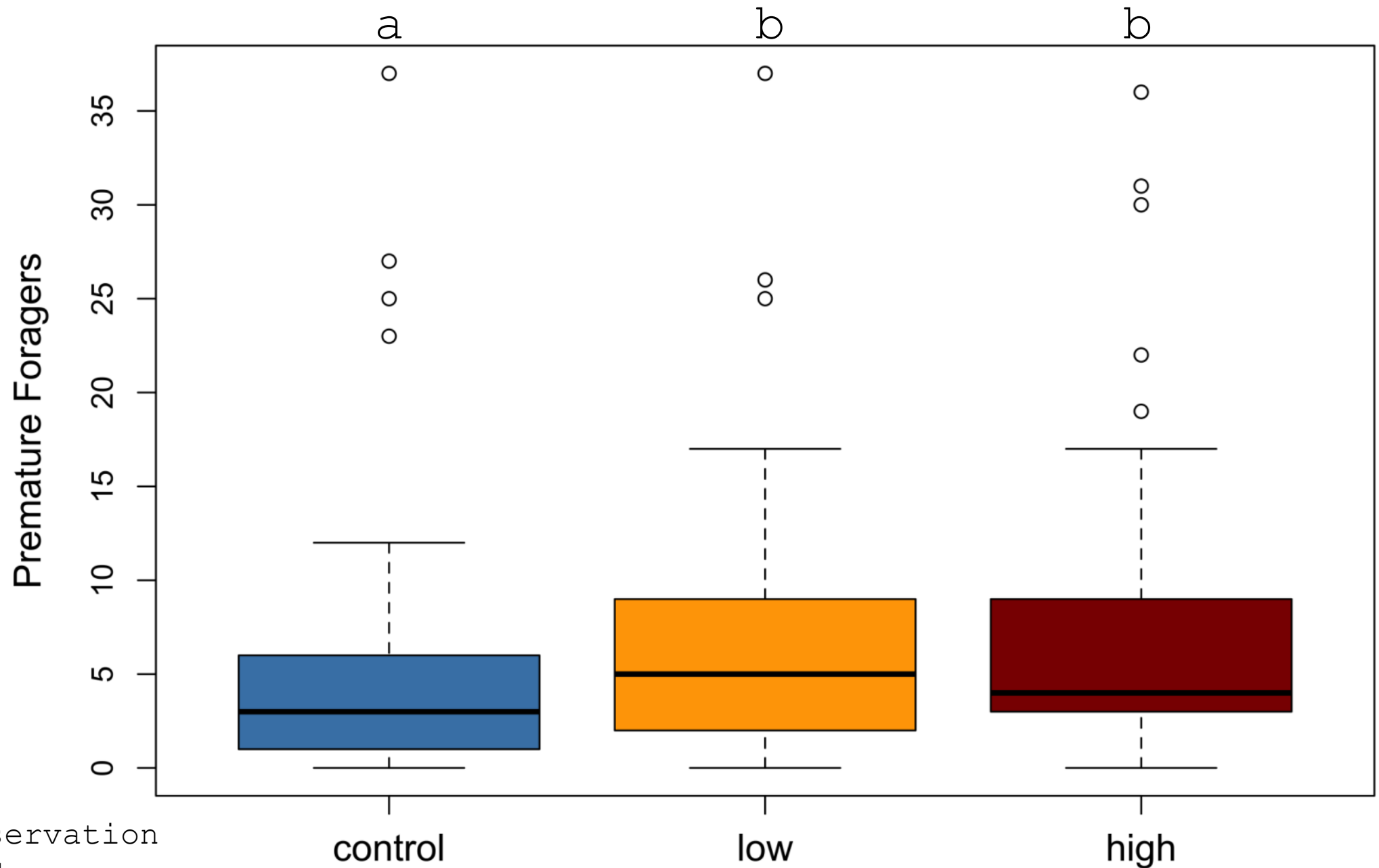


Objective One: Methods

- Performed daily 30-minute observation periods to collect and count premature and mature foraging bees







81 observation
periods per
treatment

N = 5

Dosage (Spore Load)

Premature Forager = age 4-20

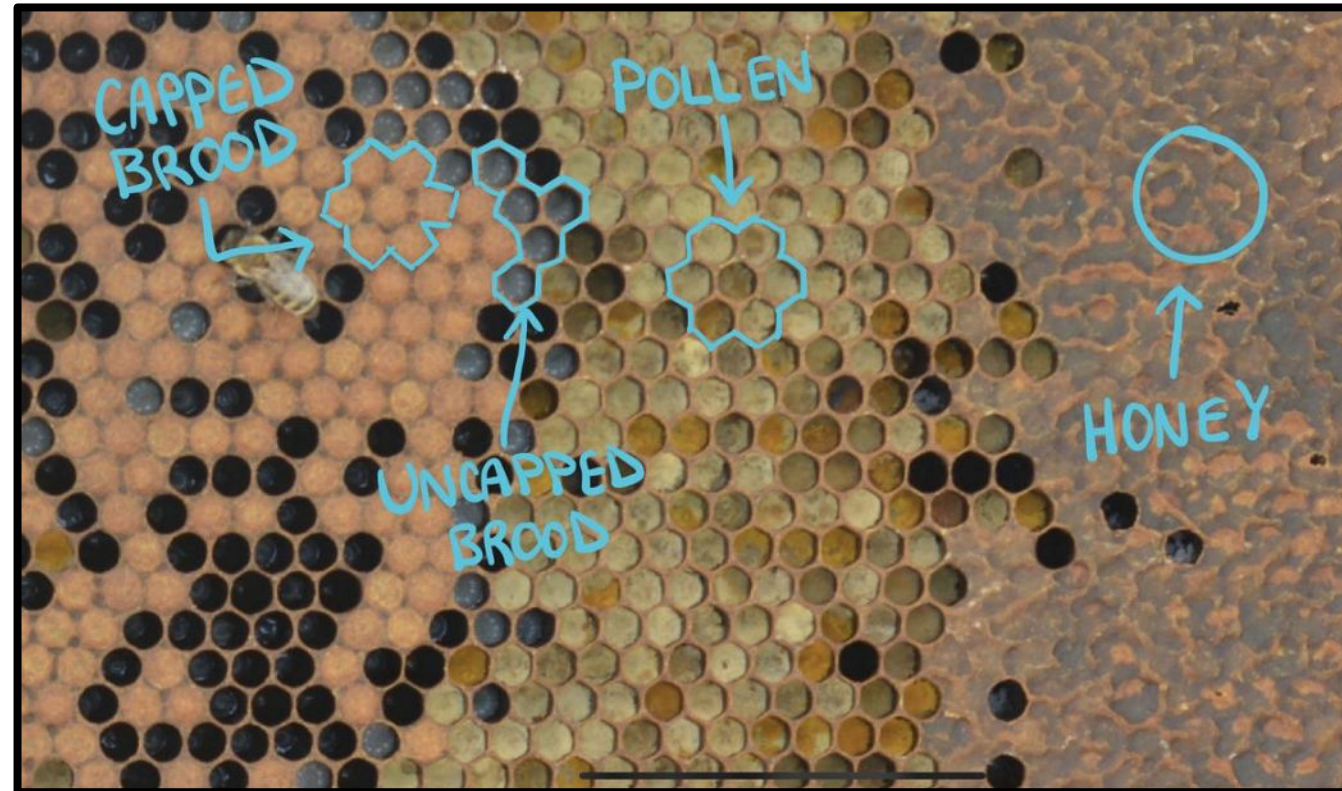
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Objective Two: Background

- Forager choice for pollen, nectar, and/or water
 - Pollen
 - Only source of protein
 - Essential for larvae diet
 - Nectar/honey
 - Important source of carbohydrates
 - Water
 - Used to regulate colony temperature



Objective Two: Background

- Lab studies showed changes in *Nosema* infected bees feeding behaviours
 - More reactive to lower sugar concentrations and consumed more sucrose than non-infected bees (MacInnis et al., 2023; Naug & Gibbs, 2009; Martín-Hernández et al., 2011)

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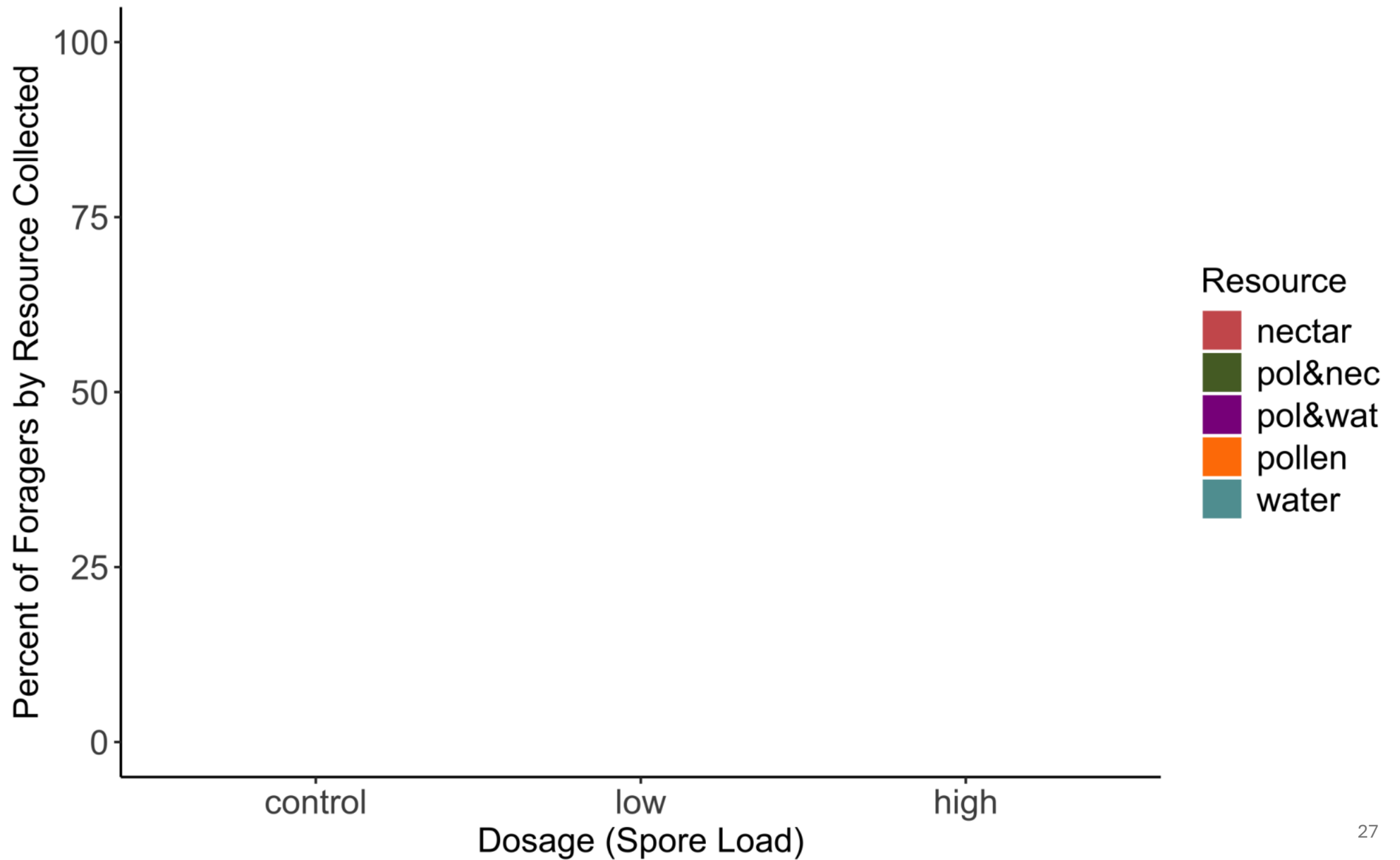
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- Suggesting potentially infected bees are foraging preferentially for nectar to compensate for the energetic stress *Nosema* imposes

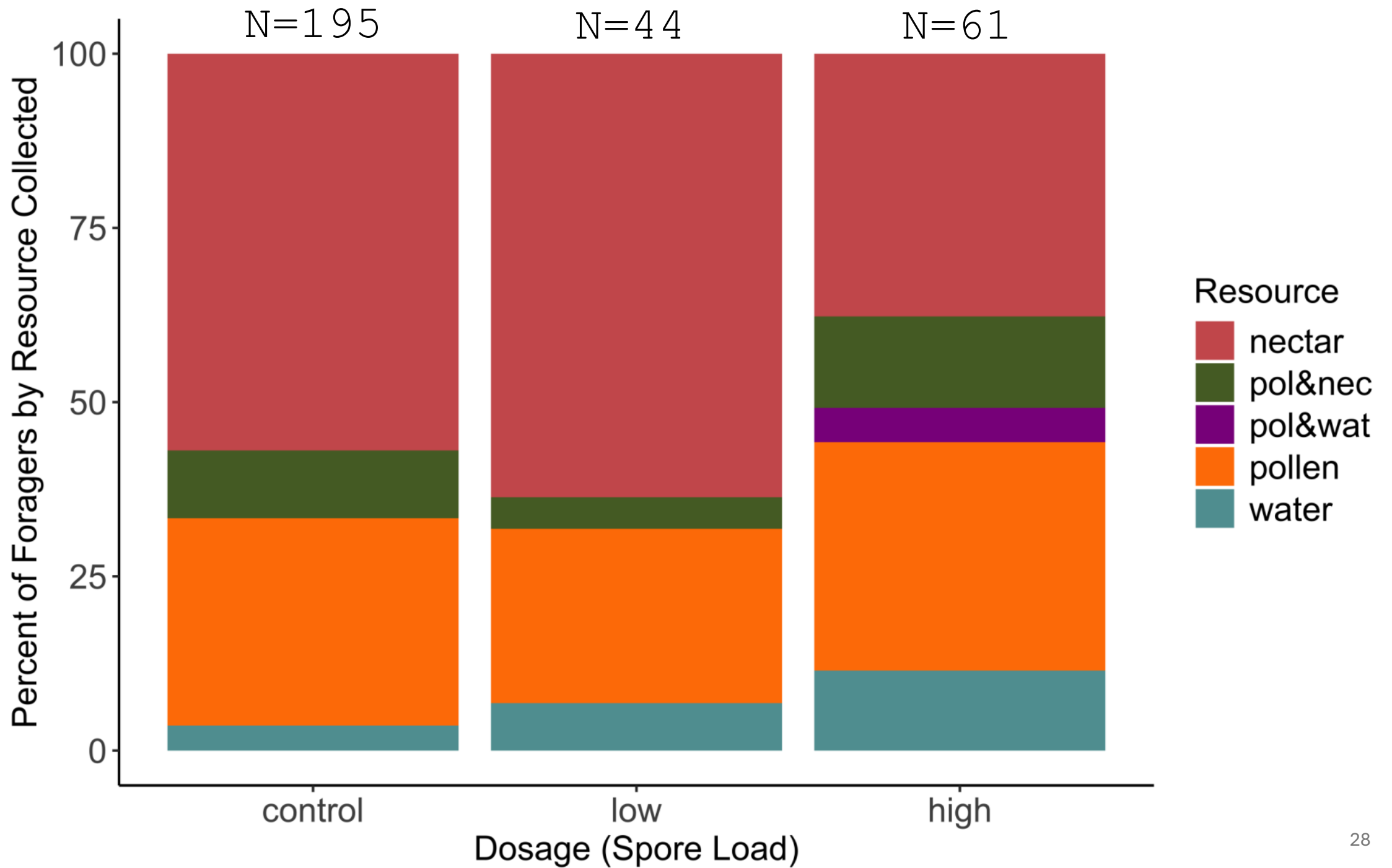
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Investigate Effects of *Nosema* Dosage on Foraging
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Objective Two: Methods

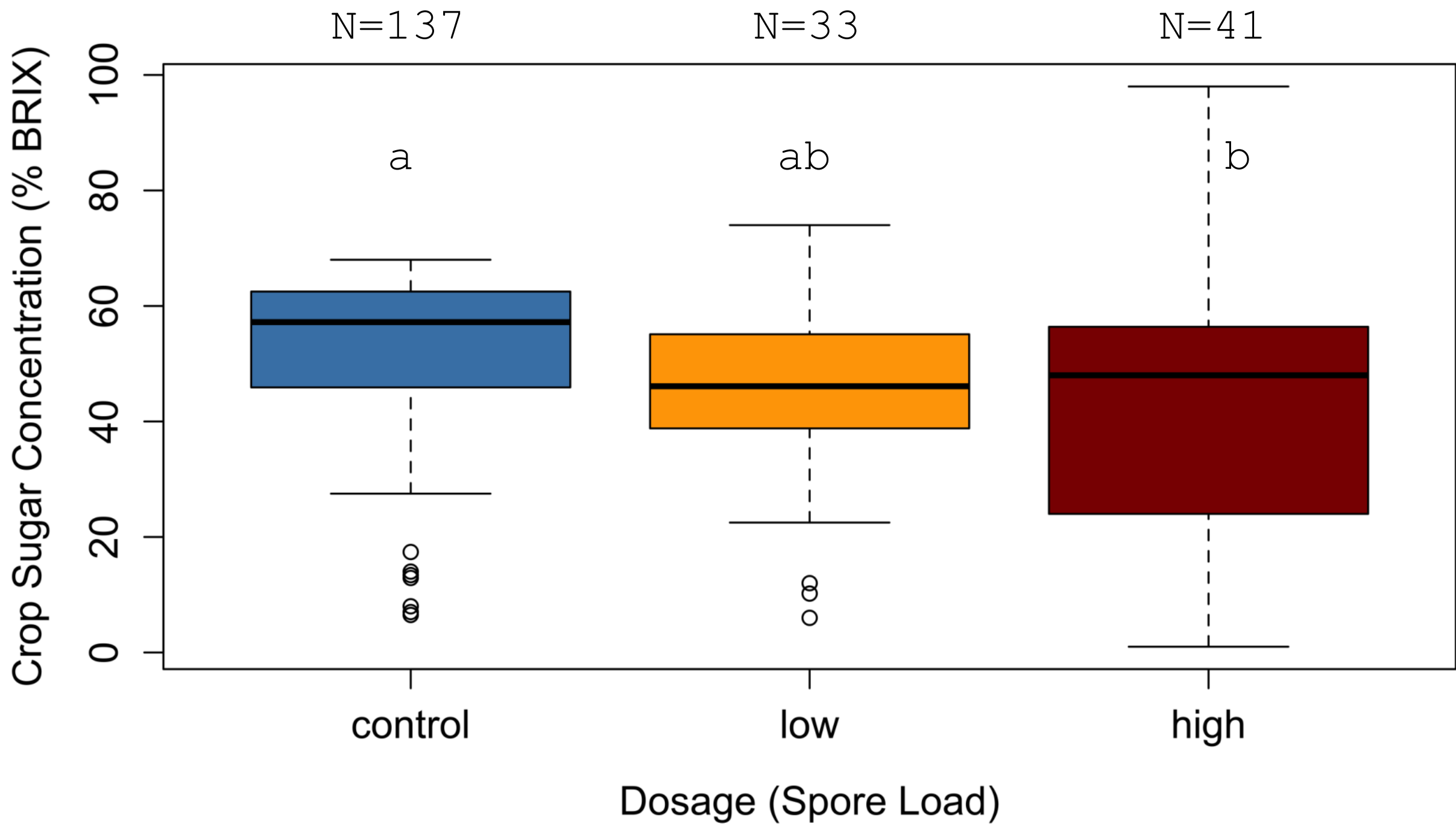
- Lab dissections of each collected forager
 - Spore count
 - Pollen weight
 - Crop content sugar concentration











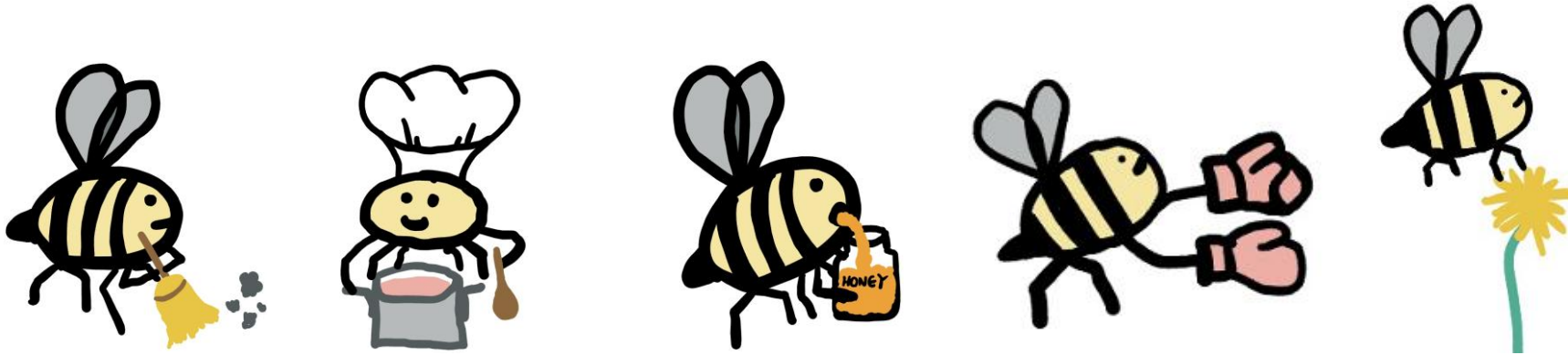
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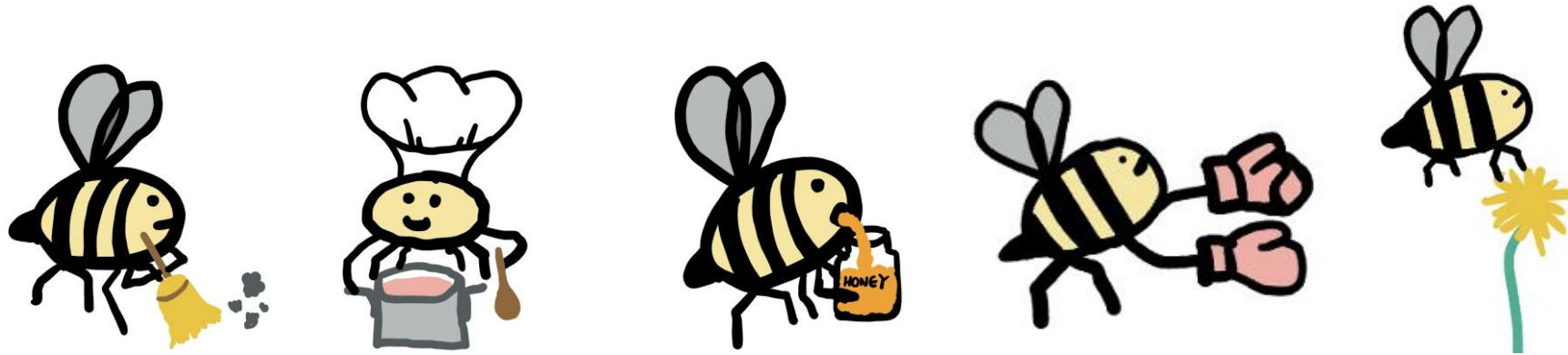
Conclusion

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 - Disrupts temporal polyethism



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- Infected workers foraged for lower sugar concentrated resource
 - Potentially affect honey production

Thank you!

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