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Experience vs. Age in the Bumblebee, Bombus huntii

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INTRODUCTION

Background

I will be studying the bumblebee, *Bombus* huntii. Hives average 50-250 individuals, with a queen who lays the eggs, callows which are the newly emerged adults, nurses who tend the hive and are confined to the nest, and foragers who venture out and collect pollen and nectar.

Bumblebees, and other such insects can be used as model organisms to indirectly study learning and memory formation. In insects, the part of the brain that controls this is called the mushroom bodies. It is made up of the Kenyon Cell Bodies (densely packed interneurons) and Neuropils (dendrites – collect information and axons – send out information). [2]

Previous Results

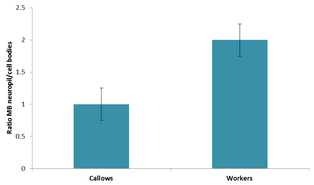
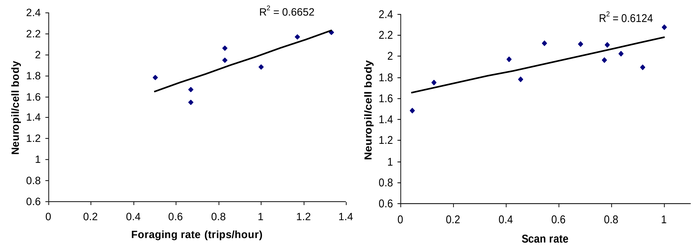


Figure 1. The ratio of the mushroom body's neuropils to cell bodies. Callows have a much smaller ratio that both the in-hive nurses and the foragers.



a. b.

Figure 2. The neuropil to cell body ratio compared to the activity rate for foragers (a) and nurses (b). The growth in the brain was greater for the bees that exhibited greater levels of activity, whether it is scanning for the nurses, or collecting food for the foragers.

Research Question

By examining the Mushroom Bodies of bumblebees of known age and behavior, I hope to determine whether age or experience plays a bigger role in the development of brain connections, which in general should provide insight into the continuation of brain plasticity of an individual.

BEE HUSBANDRY

Figure 3. The in-lab bumblebee hives. The queen bees captured in the wild were housed in mock hive boxes to lay eggs and begin colonies. The bees foraged for sugar water from tubes until the hives grew large enough in size to set up for outdoor foraging.

Daily Bee Care

- Sugar water solution was refilled in each tube.
- Pollen was ground up and compressed into pellets for the bees.
- New bees were counted, recorded, and marked with the colored paint dot of the week.

Figure 4. Nina and Jackie preparing to visit the honeybee hives. We spent the first portion of the summer, while we waited for the bumblebee hives to grow, practicing lab techniques on honeybees captured from our local hive.

Figure 5. A bumblebee being marked for identification. Once the hive reached a size of at least 50 workers, the bees were removed, anesthetized with cold, and tagged with a small plastic number glued to their backs.

Observations

- Two sets of observations took place for the hive
- Each set consisted of two days, with morning and afternoon observations
- 90 minutes of audio of who was leaving and entering the hive was recorded and 60 minutes of video of the in-hive interactions was taken.

Lab Techniques & Analysis

- The workers were pulled from the hive and anesthetized.
- The brains were removed from the bees, fixed, and sliced with a cryostat.
- The wings of each bee was removed and mounted after death and the thorax width was measured to gain an idea of size.
- These were mounted, stained, and photographed at 100X magnification.
- The key areas of the brain were measured using an imaging tool.

FUTURE RESEARCH

This semester, I plan to finish up the data collection and analysis. This includes dissecting out the remaining brains and slicing them as well as measuring the mushroom bodies using an image processing software. The behavioral analysis from observations will also be finalized at this time.

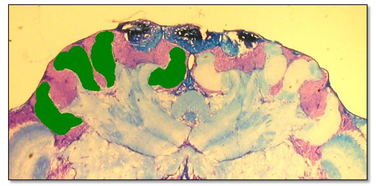
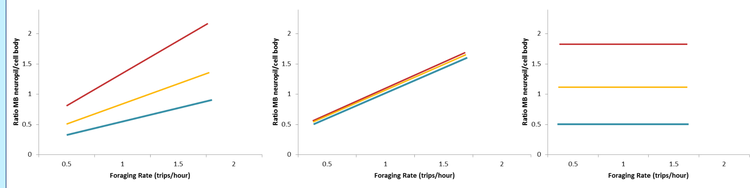


Figure 6. The sliced and stained brain of a bumblebee. The cell bodies appear purple and are surrounded by the neuropils, which are highlighted green.



a. b. c.

Figure 7. Possible results for the data. There may be correlation which shows an increase of the synapse to cell body ratio with age and amount of foraging (a), then it would support the idea that each contributes to growth in the brain. If there is no increase in the % mushroom bodies with the rate of foraging but there is with age (b), then growth may only dependent on age and not experience. The foraging rate may cause an increase in brain growth, but age may not playing a significant role (c), showing the opposite effect.

LITERATURE CITED

Some figures borrowed from Sue Hannaford.

1. Hammer, M., & Menzel, R. (1995). Learning and memory in the honeybee. *Journal of Neuroscience, 15*(3), 1617-1630.
2. Fahrbach, S. E., Farris, S. M., Sullivan, J. P., & Robinson, G. E. (2003). Limits on volume changes in the mushroom bodies of the honey bee brain. *Journal of Neurobiology, 57*(2), 141-151.
3. Farris, S. M., Robinson, G. E., & Fahrbach, S. E. (2001). Experience- and age-related outgrowth of intrinsic neurons in the mushroom bodies of the adult worker honeybee. *The Journal of Neuroscience, 21*(16), 6395-6404.

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