Tracing Brain Structures of Alkali Bees to Investigate Endocrine and Social Effects on Neural Plasticity

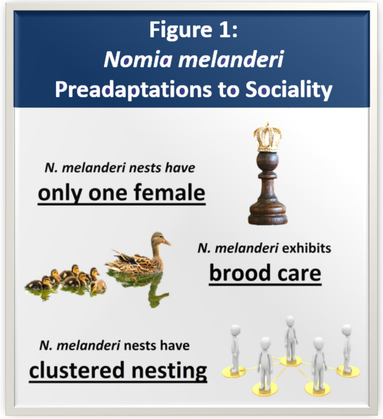
Justin Tirrell, Mallory A. Hagadorn, Makenna M. Johnson,
Karen M. Kapheim, Department of Biology, Utah State University.

Abstract

For highly social bee species, juvenile hormone (JH) and social cues are linked to increased expression of class-based social features. However, little data has been collected on the relationship between these variables and homologous features in non-social bees. To fill this gap in data, we studied the neuroanatomical response of *Nomia melanderi*, a non-social bee species, to endocrine and social treatments. Since *N. melanderi* is a non-social bee with pre-adaptations to sociality, such as brood care and aggregative nesting habits, its responses to hormone treatment and social cues can be used to model how neural plasticity in non-social ancestors of highly social bee species may have played a role in social evolution. Specifically, we measured volumetric difference in mushroom body structures, which are known to function in social cognition in social bees, in response to our treatments. Brains from the six treatment groups were dissected and imaged using confocal microscopy techniques. By scaling the actual distance in an image to its pixel density, reliable measurements of volume are produced from evenly spaced cross-sections of *N. melanderi* brain. Since data collection for the current phase of the project is still underway, it's premature to make any conclusion about how JH and social cues influence neural plasticity in *N. melanderi*. However, the results of our experiment are likely to provide unique insights into the evolution of sociality in bee species generally.[1]

Introduction

Nomia melanderi, a solitary bee species, has traits which lean towards sociality. These traits make it a candidate to represent the ancestor of a highly social bee. Figure 1 illustrates these traits.



By testing the response of *N. melanderi* to a juvenile hormone treatment, we can infer the role that juvenile hormone plays in the *evolution of sociality in bees.*

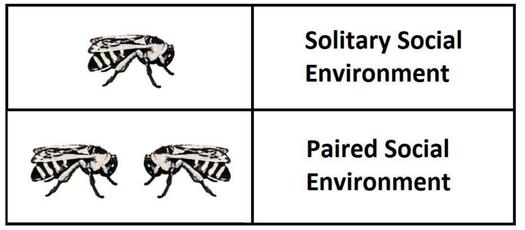
Brain volume, ovary size, dufour's gland size, and oocyte maturation have been considered as potential measures for sociality.

In our research, we focused on how our treatment groups affected the volume of *Mushroom Bodies* in *N. melanderi* brains.

Table 1- *N. melanderi* Treatment Groups

Six treatment groups tested for the effect of JH, DHF solvent, and social cues *on N. melanderi.*

JH treatment	Solvent Control	Sham control
Paired S.E.	Paired S.E.	Paired S.E.
Solitary S.E.	Solitary S.E.	Solitary S.E.



Objectives

1. Acquire the skills necessary to recognize and determine the extent of brain structures in *Nomia melanderi*
2. Use the acquired volumetric data to make conclusions about the mechanics of social evolution in bees that are ancestral to social bee species.

Methods

Images of bee brains were produced using confocal microscopy. These images are now being traced in Reconstruct, a software which uses pixel density to create measurements of brain volume. Since *brain volume of Mushroom Bodies* has been linked to sociality in bees[2,3], we use it as a measure of sociality.

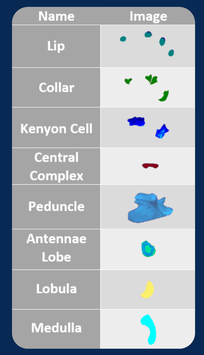
The treatments groups included were :

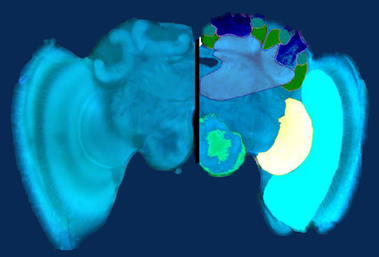
- A control for the effect of the bee-pipette interaction,
- A control for the solvent used to dissolve juvenile hormone
- A treatment of juvenile hormone

These treatments groups were subdivided into:

- *N. melanderi* paired with actively reproductive females
- *N. melander* kept in isolation

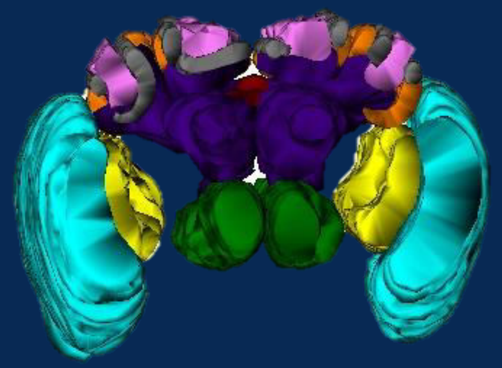
Figure 2 – *Nomia melanderi* Brain Tracing





Left: Brain Tracing in the lab. Right: an example of a cross-section of N. melanderi's brain that has been traced in Reconstruct Software. Center: The key identifies the structures traced.

Figure 3 – Whole-Brain Modeled from Tracings



A 3D model created from tracing cross-sections of Nomia Melanderi

Results

- I've developed the necessary familiarity and skill to take reliable measurements of *N. melanderi's* brain structures (see Figure 2).
- As more data is collected, we look forward to making conclusions about the roles that the endocrine system played in the social evolution of bees.

References

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Justin Tirrell
Utah State University
Biology
tirrelljustin95@gmail.com