Using Event Logging Software to Identify and Track Bumble Bee Behaviors

Adam R. Singer, Mallory A. Hagadorn, Carson Stoker, Karen M. Kapheim

Department of Biology, Utah State University, Logan, UT, USA

UtahStateUniversity
DEPARTMENT OF BIOLOGY

Abstract

Oftentimes when conducting experiments it's important to systematically collect information on an organism's behavior. By understanding an organism's predicted behavior it allows for an efficient identification of changes in an organism's state. This is especially helpful over time when different treatments are applied to said organism. Behavioral data is often extremely important, yet it is often difficult to collect. Conducting live behavioral observations is incredibly time consuming as it often requires several sessions throughout the course of an experiment. In addition to time constraints, accurate data collection for behavioral work requires extensive training for recognizing behaviors prior to the start of an experiment. To alleviate some of the problems surrounding behavioral data collection, I worked on establishing a protocol for video recording and assessment of behavioral displays. I then evaluated this protocol in a small experiment that compared brooding and non-brooding bumble bees (Bombus impatiens). Individual bumble bee workers were recorded twice, for five minutes each, five days apart (i.e., day 1 and day 6). Afterward, I used an ethogram that we modified to score each behavioral display. I scored all behaviors using the event-logging program BORIS (Behavioral Observation Research Interactive Software). After evaluating the recording and behavioral results, we determined that this protocol was an effective way to conduct behavioral observations with increased accuracy. The protocol also facilitated quicker data analysis as behaviors were stored to the computer allowing them to be easily accessed. Future Modifications will be made to generate even more accurate results.

Introduction

- It is important to understand the behaviors of the organism you're studying
  - Allows for essay identification of change in your organism
  - Identification of important behaviors based on time allocation
- Problems of traditional observations: Various issues make collecting accurate data on live behavioral observations challenging
  - Prior knowledge and extensive training is needed to accurately score live behaviors
  - Some behaviors can be difficult to reliably identify in the moment
  - May be extremely time-consuming, a limiting factor during many experiments
- Using video recordings of behavioral observations allows for accurate, repeatable data collection that can be done at any time.

Objective

- Identify usable cameras and optimal conditions for recording specimens.
- Establish protocols for accurate and efficient scoring and tracking of behavioral observations for multiple individuals.
- Conduct a pilot experiment to test the event logging and tracking software

Organism

Bombus impatiens
(Common Eastern Bumble Bee)

- This species was chosen as it is one of the species of bees commonly used in the Kapheim Lab
- Bees exhibit predictable and easily recognizable behaviors
- Commonly researched with regards to behavioral displays

Image 1: Depicts *Bombus impatiens* investigating flower

Image 2: *Bombus impatiens* attending to brood

Methods

- Set up cameras (Wyze v3)
- Make cages that assist in video recording
- All 11 individuals were recorded twice, 5 min for each recording
- View recordings and refine an ethogram for use in testing (as shown in **Table:1**)
- chosen event logging software; BORIS v7.12
- Establish a video recording, scoring, and tracking SOP for future lab use

Behavior	Description
Larval Feeding (LF)	If a bee is manipulating wax into larval clumps and regurgitating it into a larval cell the task, Larval Feeding (LF)
Pollen Feeding (PF)	Bee is feeding on the pollen patty.
Drinking Sugar Water (SW)	Individual is on the feeder and actively drinking sugar water.
Incubation (ICB)	When a stationary bee wraps herself around a brood patch, pressing thorax and abdomen against brood patch maximizing the ventral abdominal surface in contact with the brood by elongating and flattening her abdomen. A clearly observable abdominal pumping continues throughout incubation.
Inactivity (IA)	Individuals are motionless during spot-checking.
Investigating nub/pollen patch (IPP)	Individual is actively antennating and exploring food patch and clay nub in the petri dish when no brood are present. Looks similar to inspecting, but without brood.
Inspecting (INS)	When bee walks over brood patch and antennate
Manipulating Wax (MW)	Usage of mandibles to shape or reshape a honey pot. This includes the manipulation of wax around the honey pot rim.
Antennal Movement (AM)	Bee's body is immobile and its head is moving minimally (if at all). Antennae are moving constantly in front of their face.
Abdominal pumping No brood (APNB)	A clearly observable abdominal pumping on the nub or pollen patty without the presence of eggs or larvae (brood). Looks similar to pumping in incubation, but no brood.
Investigating nub/pollen patch (IPP)	Individual is actively antennating and exploring food patch and clay nub in the petri dish when no brood are present. Looks similar to inspecting, but without brood.
Inspecting (INS)	When bee walks over brood patch and antennate brood.
Manipulating Wax (MW)	Usage of mandibles to shape or reshape a honey pot. This includes manipulation of wax around honey pot rims.
Inactivity (IA)	Individuals are motionless.
Roaming (RM)	Walking around the cage. Can be along the wall or near the brood, not while on brood.
Antennal Movement (AM)	Bee's body is immobile and its head is moving minimally (if at all). Antennae are moving constantly in front of their face.
Other (OTH)	Lumping of all other behaviors not directly relevant for this study.

Table 1: Includes all the behaviors and their descriptions that were observed in the *Bombus impatiens*

A)

Image 2: The Wyze camera that was used to record behaviors

B)

Image 3: Includes two different angles of the cages that were made and used to store the individual being studied.
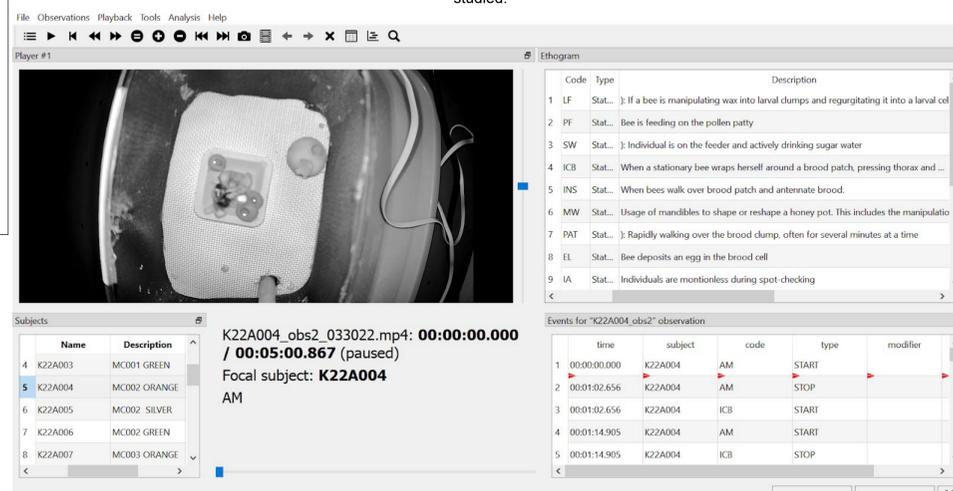
C)

Image 4: This is a screenshot from the BORIS software showing what the screen looks like when a video is being scored. (includes ethogram, list of individuals along with timestamps of scored events)

Testing Application

- Tested the effectiveness of video observations by observing the behavioral display of *Bombus impatiens* in both Brood and non-Brood caring roles
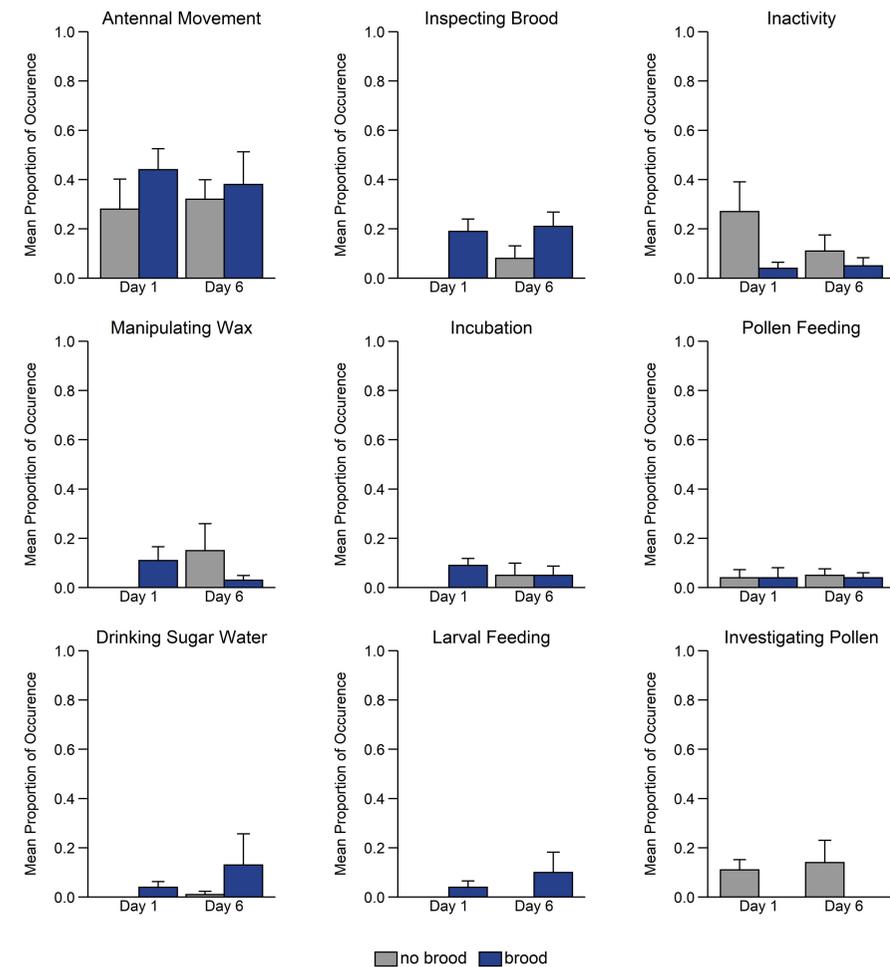

no brood ■ brood

Figure 1: This figure depicts the total amount of time in seconds that behavior was expressed in a given day. These are the total times from all the individuals on either Day 1 or Day 6. Certain behaviors were excluded if they only showed up in one treatment group or had a very low frequency of occurring.

Conclusion

- Was able to produce a protocol to effectively utilize cameras as a source of behavioral observations
- Protocol /Methods need more fine-tuning such as better cameras to enhance observed observations
- The protocol will be written up in a formal "how to" document for future use
- Developing an effective lab protocol is difficult
- When conducting research one needs to be able to adjust when problems arise

Acknowledgments

Citation

Ethograms modified from (Cameron 1989; Gamboa et al 1987; Claverie et al 2021)