FORAGING LINES

Peering through a window into the spirit of the hive: the adventure, utility, and difficulty of observation hive studies.

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Note: Brad Ohlinger is a Ph.D. student with Dr. Maggie Couvillon. His research looks at honey bee foraging in Virginia, USA. In particular, he will examine the effect of landscape on forage availability by decoding waggle dances, which he does in three representative landscapes across Virginia which have different land use characteristics at each site.

Brad Ohlinger and observation hive.

THE honey bee colony is a true civilization. It consists of thousands of cooperating individuals, each equipped with behaviors that allow the colony to function and succeed as a group (Seeley 1995). Such apiarian societies have captured the intellectual curiosity of scientists and beekeepers alike and have made the honey bee one of the most well studied organisms on the planet. The famous playwright and beekeeper Maurice Maeterlinck was so mystified by the complexity and harmony of his honey bee colonies that he evoked a supernatural force, which he dubbed, "the spirit of the hive", to explain the group-level functioning of his colonies (Maeterlinck 1901). In his book published in 1901, "The Life of the Bee", he famously asked the questions, "What is the spirit of the hive?" and "Where does it reside?" (Maeterlinck 1901). To answer these questions, scientists need to be able to peer into the undisturbed world of the honey bee. The opaque walls of traditional hives require that beekeepers and scientists open the hive, pull out individual frames, and inspect them one by one. This temporary dismantling of the hive disturbs the colony and alters the behavior of its inhabitants. Therefore, to get a clear view of the honey bee colony, scientists use glass-walled hives that provide the observer with a window into the world of the honey bee through which they can observe the colony and unlock its mysteries.

Over the last 100 years, scientists have used these observation hives and have carefully designed experiments to reveal the mechanisms that regulate honey bee behavior and comprise the metaphorical "spirit of the hive"(Von Frisch 1967, Seeley 1995). Most notably, Karl von Frisch used the observation hive to determine the function of the waggle dance (Von Frisch 1967). He demonstrated that successful honey bee foragers use the waggle dance to communicate the distance and direction of rewarding sources of food in the landscape to their nestmates (Von Frisch 1967).

For our research at Virginia Tech, we are following in the great tradition of observation hive studies. However, instead of using observation hives to answer basic research questions related to honey bee societies, we use them as a tool to answer applied research questions about how, where, and when honey bees forage in different landscapes. More specifically, we use the waggle dance communication to monitor honey bee foraging in an orchard crop system, a row crop system and a mixed landscape. The idea is very simple: we let the bees tell us -- with their waggle dances -- where they are going in the landscape to get food (Couvillon and Ratnieks 2015). To do this, we use a protocol that allows us to extract the information from the dance (Couvillon, Pearce et al. 2012) and then plot the locations advertised by the dances on a map (Schürch, Couvillon et al. 2013, Couvillon, Schürch et al. 2014, Schürch, Zwirner et al. 2019). Because honey bees only dance for the best sources of food in their environment, we can use the waggle dances to identify the locations of the most rewarding patches of forage in the landscape. This allows us to answer a variety of important questions related to pollinator ecology: what types of foraging habitat do honey bees prefer? what times of year do honey bees struggle to get food? and how do landscapes differ in their ability to feed pollinators? All these questions would be much more difficult to answer without the waggle dance communication and the observation hive, which allows us to view and to interpret the dances.

For our study, we use three-frame glass-walled observation hives. Each of our observation hives are placed into sheds at one of our three field sites and the bees are allowed to enter/exit through a PVC pipe that extends from the entrance of the hive, through the wall of the shed, to the outside. Our observation hives consist of a large structural wooden frame with slots to insert

three full depth Langstroth frames, each placed vertically, one on top of another.

Each year we set up the observation colonies at our local field site, a mixed landscape in Blacksburg, VA (southwest Virginia), and three at each of our two remote sites: an orchard crop system in Winchester, Virginia (northern Virginia), and a row crop system in Suffolk, Virginia (southeast Virginia). With our field sites separated by hundreds of miles, we nervously install each of our observation hives knowing that any mistake will require a long, frustrating drive across the large state of Virginia to resolve. Observation hives are clunky to transport and difficult to work with. The glass walls are fragile and the frames fit tightly, often glued to the observation hive with propolis. The snug fit makes it extremely difficult to insert/remove frames gently without knocking large numbers of workers off the frame and out of the observation hive, leaving behind an angry vortex of bees. After a clumsy first field season, we decided to widen the slots of the observation hives and settled on a gentler method of inserting/removing frames. We carefully use the curved edge of our hive tools to slowly pull each side of the frame out one slot at a time. Little methodological advances like this have helped us to address many of the pitfalls of observation hive management, but it seems like there are always unforeseen dangers lurking.

It always feels good to be done with the maddening process of installing observation hives. There is a feeling of relief that comes with having all of our observation hives installed, queen-right and ready to dance. Unfortunately, any sense of security is short lived. The design of the observation hive is a trade-off between honey bee biology and scientific utility, providing an acceptable, but not ideal, home for our honey bees and a useful, yet cumbersome, tool for scientists. The first issue arises in the early spring immediately after installation, when weather fluctuates between relatively warm weather that elicits honey bee foraging and cold weather that requires colony thermoregulation. The high surface area to volume ratio of our tall and narrow observation hives is ideal for viewing the colony, but makes it difficult for the colony to regulate its internal temperature. A cold day can freeze our colonies, which can create a gap in our data collection and stress our apiary. With a close eye on the weather, we mostly prevent these issues by insulating the colonies with thick blankets on cold days and by collecting data on warm days.

The spring build-up phase of the colony cycle and the midsummer fluctuation of forage availability create additional challenges for us as we manage our colonies. The hives are relatively small and do not provide much room for colony growth and food storage. This awkward size means that our colonies are in a perpetual state of uncertainty, walking a fine line between starvation and explosion. We are left with the difficult task of deciding when to feed and when not to feed, knowing that overfeeding or underfeeding can rapidly change the status of the colony. After several unsuccessful attempts to prevent swarms by replacing frames of brood, we decided that given the difficulty of working with observation hives and the cost of travel to our field sites, it is best to just let our colonies swarm.

Our hands-off approach underscores the importance of observation hives to honey bee research. We do everything we can NOT to work with them, and yet, they are an integral part of our research. After a frustrating and sometimes embarrassing two field seasons working with observation hives, we have a more profound appreciation of the beauty and complexity of the honey bee colony. What else – other than the allure of the "spirit of the hive" - would make us sign up for the stress of observation hive management?

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