Notes from the Lab:

The Latest Bee Science Distilled

by Scott McArt

Bees forage more in apple orchards when they aren't in bloom compared to when they are.

In the July 2022 issue of *Notes from the Lab* [162(7):795-797] I summarized a study from Michigan showing about three quarters of pesticide risk to honey bees conducting blueberry pollination comes from pesticides that aren't registered for use on blueberries. Honey bees were simultaneously exposed to an average of 35 pesticides in pollen they collected during bloom, and the vast majority of exposures came from pesticides not used on focal farms or not used in blueberry at all.

We see this same non-intuitive pattern of pesticide exposure during New York apple pollination. For example, across 30 farms, more than two thirds of pesticide risk to honey bees conducting apple pollination comes from pesticides that aren't sprayed on those farms during bloom (McArt et al. 2017).

How can these results be explained? Well, clearly many foraging bees must be flying outside of orchards. But where exactly are they foraging during bloom of a pollination-dependent crop like apple? How far from their colony are they foraging? And what about after bloom when growers of most pollination-dependent crops start spraying insecticides? How much foraging occurs in orchards after bloom, potentially exposing bees to high-risk insecticides? These are the topics for the fifty-ninth *Notes from the Lab*, where I summarize ***"Apple orchards feed honey bees during, but even more so after, bloom,"*** written by Taylor Steele and colleagues and published in ***Ecosphere*** **[2022].**

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Photo 1 *Lead author Taylor Steele in front of the shed containing the three observation hives monitored during the study*

For their study, Steele and colleagues set up three observation hives at the Virginia Tech agricultural research and extension center (AREC), which is devoted to fruit crop research, mostly apples (see Photos 1 & 2). The landscape within a 2-km radius of the colonies was comprised of apple orchards (16%), forests (25%), and other landcover (59%), including grass/pasture, non-alfalfa hay, corn, soybean, developed/open space, and other crops (Photo 3). This is a typical landscape surrounding small- to medium-sized apple orchards in the Eastern U.S. Each colony was managed to decrease the likelihood of swarming and fed supplemental sucrose when needed.

In total, six colonies were monitored in 2018 and 2019. The authors filmed foraging bees communicating via the waggle dance on the "dance floor" (the bottom frame of each observation hive) 3-4 times per week for the entire growing season (April-October). Because the waggle dance is a classic honey bee behavior for communicating the distance and location of good forage, a brief explanation is worthwhile.

The waggle dance is comprised of two parts: the waggle run, which is

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Photo 2 *The 3-frame observation hives (covered with blankets) monitored during the study*

the information-rich portion of the dance, and the return phase. During the waggle run, a forager oscillates her abdomen at a specific angle relative to vertical for a particular duration of time, which indicates direction and distance, respectively. Then she stops, loops around to the left or right (return phase) and repeats the waggle run + return phase combination a variable number of times, with greater repetition indicative of greater resource quality.

By the end of the study, the authors had recorded 625 hours of "dance floor" videos, which were meticulously viewed, dancing foragers identified, and 3,710 individual waggle dances decoded. In other words, the authors had a very comprehensive dataset to reveal where honey bees were foraging over the course of two successive growing seasons.

So, what did they find? How far did honey bees forage from their colony throughout the season? As seen in Figure 1, some bees foraged over 11 km from their colony. But long-distance foraging was rare. The median foraging distance across both years was only 0.78 km and the upper quartile (i.e., the max foraging distance for 75% of bees) was just over 1 km. In other words, the majority of bees foraged within 1 km of their colony.

There was seasonal variation in how far from their colony workers foraged, but the only consistent pattern across years was a trend for greater foraging distance in May compared to other months. Notably, early May corresponded with peak apple bloom each year.

Did honey bees forage primarily in apple orchards during apple bloom? No. As seen in Figure 2, only 20% of foraging occurred in apple orchards during bloom (19% in 2018 and 21% in 2019). This is slightly greater than the 16% of surrounding land comprised of apple orchard (i.e., the horizontal red dashed line in Figure 2), but it certainly doesn't indicate a strong preference for foraging in apple during bloom.

Instead, a greater proportion of foraging occurred in forests during apple bloom. In 2018, 37% of foraging occurred within forests and in 2019, 33% of foraging occurred within forests. Both of these percentages are quite a bit higher than the 25% of surrounding land comprised of forest (i.e., the horizontal black dashed line in Figure 2), indicating a preference for foraging in forests during apple bloom.

Beyond apple orchards and forests, about 45% of foraging occurred in other landscape types during apple bloom, including grass/pasture, corn, soybean, developed/open space, and other crops.

What about after bloom? Where did bees forage post-bloom? Perhaps most surprisingly, more honey bees foraged in apple orchards after bloom compared to during bloom! This can be seen in Figure 2, where 29% of bees foraged in orchards after bloom compared to 20% during bloom (red points and lines) averaged across both years. Conversely, a smaller percentage of bees foraged in forests after bloom compared to during bloom (black points and lines).

Well that's interesting. Why would honey bees forage so much in apple orchards after bloom? Clearly, attractive food resources became available in orchards after apple bloom. At the same time, previously attractive food

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Photo 3 *The Virginia Tech agricultural research and extension center (AREC;* **https://www.arec.vaes.vt.edu/arec/alson-h-smith.html***) in Frederick County, Virginia, where observation hives were placed and monitored from April-October in 2018 and 2019*

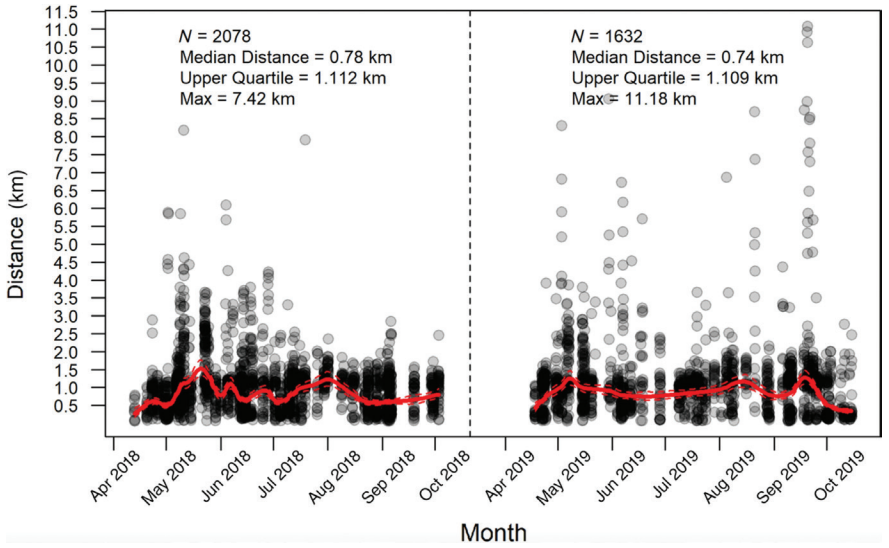

Fig. 1 *Foraging distance as communicated by dancing honey bees across the foraging season in both 2018 and 2019. Predicted foraging distances are shown for n = 3,710 waggle dances across the two years. Moving average (median) foraging distance through time is shown via the red line.*

resources in places such as forests potentially became less available. To look into this, the authors surveyed the orchards after bloom, finding 40 species of plants that bloomed through the remainder of the season. Especially abundant were white and red clover (*Trifolium*) and plantain (*Plantago*), each of which bloomed after apple. As we all know, honey bees love clover, which probably drew them in.

So what does all of this mean? Well, everyone knows bees strongly prefer to forage in apple orchards during bloom and then forage elsewhere after bloom, right? *Wrong*. From a fundamental perspective, the paper from Steele and colleagues shows honey bees forage in very non-intuitive places.

From an applied perspective, this study reveals a lot about where honey bees could be exposed to pesticides during and after bloom of a pollination-dependent crop. Simply put, the answer is that pesticide exposure can potentially occur nearly anywhere, anytime, since bees are constantly foraging throughout agricultural and non-agricultural landscapes. That realization certainly helps explain why many high-risk pesticide exposures during Michigan blueberry pollination and New York apple pollination aren't coming from blueberry plantings or apple orchards.

The study from Steele and colleagues also sets up the possibility that researchers could track exactly when and where foraging bees are exposed to pesticides in mixed agricultural landscapes, ultimately identifying sources of non-intuitive high-risk exposures, then working to reduce those exposures. If you realize the importance of this possibility as much as me, stay tuned for another paper that's currently in the works from this excellent team of researchers.

Until next time, bee well and do good work.

Scott McArt

References:

McArt, S. H., A. A. Fersch, N. J. Milano, L. L. Truitt & K. Böröczky. 2017. High pesticide risk to honey bees despite low focal crop pollen collection during pollination of a mass blooming crop. *Scientific Reports* 7:46554. **https://www.nature.com/articles/srep46554**

Steele, T. N., R. Schürch, B. D. Ohlinger & M. J. Couvillon. 2022. Apple orchards feed honey bees during, but even more so after, bloom. *Ecosphere* 13:e4228. **https://doi.org/10.1002/ecs2.4228**

Taylor Steele earned her M.S. degree in the Couvillon Lab at Virginia Tech, which investigates how honey bees collect their food in the landscape. For questions or comments related to this study, please contact Dr. Maggie Couvillon, Assistant Professor of Pollinator Biology and Ecology in the Department of Entomology at Virginia Tech.

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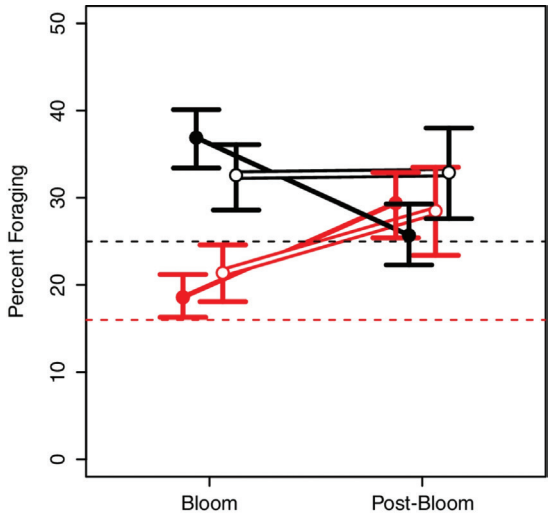

Fig. 2 *Percent foraging in apple orchards and forests as a function of apple bloom, calculated during and after apple bloom. Foraging to apple orchards (red) increased from bloom to post-bloom for both 2018 (18%-21%, connected by a solid red line, medians symbolized with red points) and 2019 (21%-28%, connected by a red line with white fill, medians symbolized with white points), with the apple orchards representing 16% of the landscape (dashed horizontal red line). By contrast, percent foraging to forests (black) decreased from bloom to post-bloom for 2018 (36.9%-25.7%, connected by solid black line, medians symbolized by black points) but remained consistent for 2019 (32.6%-32.9%, connected by black line with white fill, medians symbolized by white points), with forests representing 25% of the landscape (dashed horizontal black line). Data represent all the decoded dances during that time period, mapped on the landscape, and calculated as being within an area of interest (apple orchard or forest) or not.*