# Notes from the Lab:

## The Latest Bee Science Distilled

by Scott McArt

***Are virus-contaminated flowers surrounding your apiary getting wild bumble bees sick?***

As I write this, it's the beginning of fall in New York. Goldenrods and asters are filling the fields with brilliantly colorful flowers, honey bees and bumble bees are at their peak abundance, and the temperature is just right to get outside and enjoy it all. It's the most beautiful time of year in my opinion.

At the same time, more and more people want to speak with me about diseases in bees, perhaps because COVID is still on all of our minds. If you're one of those people, this article is for you. Perhaps one of the most interesting and important phenomena in bee disease ecology is happening right now, in and around our apiaries, while we all admire the flowers that are buzzing with bees.

Many species of bumble bees throughout the world are currently experiencing population declines, in part due to diseases. At the same time, it's well-known that the varroa mite is the most important risk factor for managed honey bee colonies across the globe. While varroa is host-specific and can only infest honey bees, the viruses it transmits are more cosmopolitan, especially Deformed Wing Virus (DWV). This virus has been found in hundreds of insect species and some recent studies have found that DWV can replicate in bumble bees and increase their likelihood of dying. Because of this, understanding how to limit DWV in bumble bees could help conserve them.

So, how do bumble bees get DWV? Can they get it from flowers that become contaminated from sick honey bees? Can sick bumble bees transmit DWV back to honey bees at flowers? How important is it to keep our colonies healthy, or to ensure there are abundant flowers around our apiaries, if we want to limit DWV transmission between honey bees and bumble bees? These are the topics for our forty-seventh Notes from the Lab, where we summarize ***"Flowers as dirty doorknobs: Deformed wing virus transmitted between* Apis mellifera *and* Bombus impatiens *through shared flowers,"*** written by Alex Burnham and colleagues and published in the ***Journal of Applied Ecology* [2021].**

P. Alex Burnham

**Photo 1** *Honey bees infected with Deformed Wing Virus (DWV) that are foraging on red clover flowers in small cages. This setup was used to assess whether DWV could be transmitted between honey bees and bumble bees via sequential foraging at flowers.*

For their study, Burnham and colleagues conducted a suite of simple but elegant laboratory bioassays and incorporated the data into a new epidemiological model for DWV transmission and spread. This is a common approach in disease ecology; similar models have informed our response to COVID over the past year and a half. But instead of reducing COVID transmission, the goal of the authors' model was to understand how to limit DWV in honey bee colonies and the environment, thereby limiting spillover to wild bumble bees.

To do this, the authors created small colonies of uninfected common eastern bumble bees (*Bombus impatiens*) and allowed them to forage on red clover flowers in small cages (Photo 1). Four treatments of the flowers were compared: flowers randomly collected from the field, flowers inoculated with a field-realistic dose of DWV, flowers on which DWV-infected honey bees had foraged for three days, and sterile artificial flowers that acted as a control. At the end of foraging, all bees and flowers were screened for DWV loads (Photo 2).

Next, they inoculated artificial flowers containing a small tube of sucrose "nectar" in the middle to assess the

P. Alex Burnham

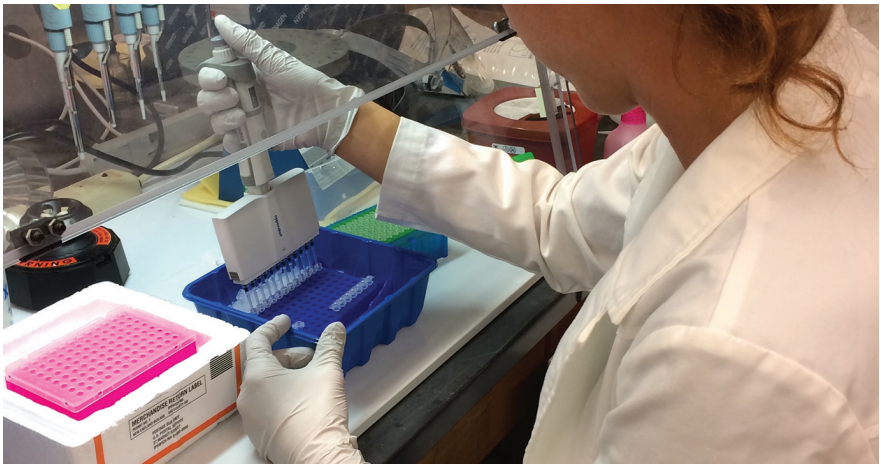


**Photo 2** *Author Samantha Alger screens samples for DWV in the lab.*

number of viral particles that were acquired by bumble bees over progressively longer foraging bouts (Photo 3). These data were compared to a dose-response curve that assessed the amount of virus inoculum required to retain high levels of virus in bumble bees after pickup. In addition, inoculated bumble bees were allowed to forage on clean artificial flowers to see if they could contaminate flowers (i.e., if transmission could potentially work in both directions between honey bees and bumble bees).

Last, a model was created to study theoretical transmission dynamics within a honey bee population and spillover to bumble bees through shared foraging at flowers. The model was parameterized with results of the authors' study, previous observational datasets, and other data from the literature.

**So, what did they find? Can DWV transmission occur between honey bees and bumble bees at flowers?** Yes. As seen in Figure 1, ~30% of bumble bees foraging at flowers that were hand-inoculated with DWV (Hand Inoc.) or exposed to honey bees infected with DWV (HB Inoc.) tested positive for DWV three days after foraging. The loads of DWV in these bees were fairly high; average viral loads of ~$10^5$ and $10^4$ genome copies, respectively (gray bars).

Interestingly, foraging at contaminated flowers for only a few seconds resulted in bees acquiring fairly high loads of DWV. As seen in Figure 2, the longer that bees foraged at flowers, the more DWV they acquired. But the important point from this figure is that even bees that foraged for only a couple seconds sometimes acquired in excess of $10^5$ genome copies. That's very quick transmission at flowers!

P. Alex Burnham

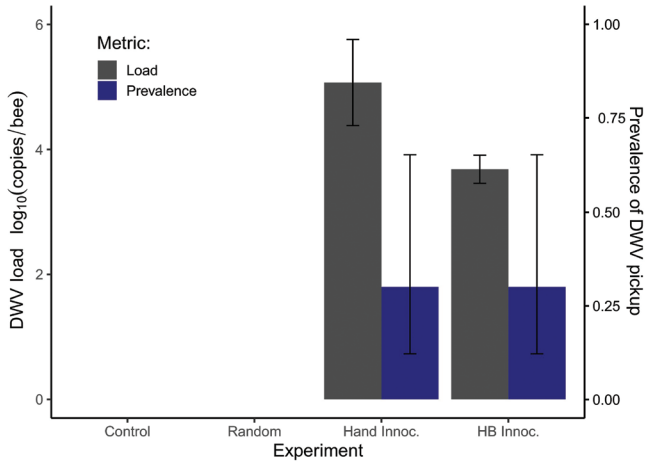
*Artificial flowers contaminated with DWV were offered to bees for varying amounts of time to assess the duration of foraging necessary for successful transmission.*

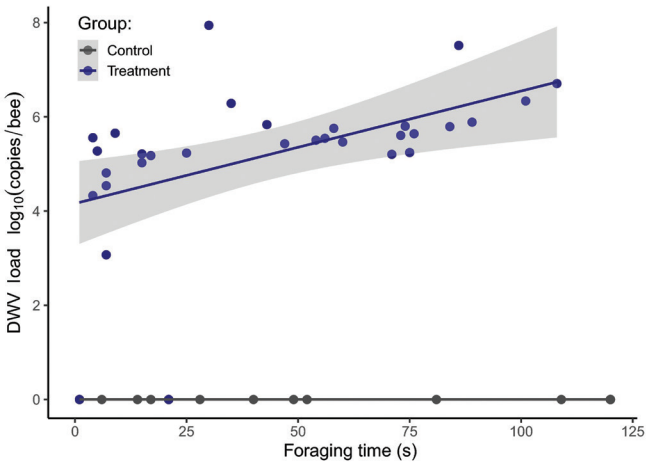
**Are bumble bees likely to get sick from the DWV they acquire at flowers?** Good question. The authors inoculated bumble bees with varying DWV doses (between $10^6$ to $10^7$ genome copies) and assessed loads in bees three days post-inoculation. These doses are a bit higher than typically found on flowers, but previous studies have observed that some flowers do have levels of DWV in this range. Between 50-75% of the bumble bees still had $10^4$ to $10^7$ genome copies three days post-inoculation. This result suggests that at least some bumble bees may become infected after acquiring DWV from flowers in the field.

**What does the model suggest we should do to reduce the number of DWV-infected bees?** There are two major conclusions from the model. First, controlling DWV in honey bees greatly reduces the number of bumble bees that become infected. Perhaps this is intuitive, but the application of this knowledge is no less important. Because we know varroa infestations greatly increase DWV in honey bees, controlling varroa is therefore important for reducing DWV spillover to wild bumble bees.

The second major result is slightly less intuitive, but bear with me and I think you'll find it's easy to understand. The authors' model shows that increasing the number of flowers in the landscape (i.e., flowers surrounding our apiaries where both honey bees and bumble bees forage) will reduce the number of bumble bees that become infected. This is because bumble bees are less likely to encounter a contaminated flower when there are a lot more flowers than infected honey bees in a given landscape. I particularly like this result since more flowers also means more food for bees. In other words, more flowers is a win-win for pollinator health!

After reading this article, you may look at the flowers surrounding your apiary a bit differently. Perhaps you'll see them less as beautiful bouquets and more as "dirty doorknobs" where bees transmit disease. But we can all maximize the chances that the flowers are beautiful bouquets instead of "dirty doorknobs"! If we all do our part to promote as many flowers as possible and keep varroa levels low, I




**(L) Fig. 1** *The viral load (gray bars, left y-axis) and prevalence (blue bars, right y-axis) for bumble bees that have been exposed to DWV on flowers. Control bees foraged on sterile sucrose solution on artificial flowers, "Random" bees foraged on red clover haphazardly selected from the field, "Hand innoc." bees foraged on red clover that had been hand inoculated with a field-realistic dose of DWV, and "HB innoc." bees foraged on red clover that had been exposed to infected honey bees. Error bars for prevalence represent the 95% confidence interval. Error bars for load represent standard errors.* **(R) Fig. 2** *The amount of virus acquired by a foraging bee as a function of foraging time. Blue dots represent individuals that foraged on inoculated artificial flowers while gray dots are control bees that foraged on sterile artificial flowers. Lines represent the line of best fit with shaded standard error. No bees that foraged on the control flowers were infected (gray dots).*

think it's safe to say the 49 species of bumble bees in North America (and maybe more of our ~4,000 other species of wild bees) will be healthier.

Until next time, bee well and do good work.

Scott McArt





**Reference:**

**Burnham, P. A., S. A. Alger, B. Case, H. Boncristiani, L. Hébert-Dufresne & A. K. Brody. 2021.** Flowers as dirty doorknobs: Deformed wing virus transmitted between *Apis mellifera* and *Bombus impatiens* through shared flowers. *Journal of Applied Ecology*, 00, 1– 10. **https://doi.org/10.1111/1365-2664.13962**

**Scott McArt,** an Assistant Professor of Pollinator Health, helps run the Dyce Lab for Honey Bee Studies at Cornell University in Ithaca, New York. He is particularly interested in scientific research that can inform management decisions by beekeepers, growers and the public.

Email: **shm33@cornell.edu**
Lab website: **blogs.cornell.edu/mcartlab**
Pollinator Network: **pollinator.cals.cornell.edu**
Facebook: **facebook.com/dycelab**
Twitter: **@McArtLab**