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Do bees get the flu?

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Abstract

Do bees scare you? Instead of fearing them, you should appreciate their role in our ecosystem. In addition to providing us honey, they are responsible for pollinating much of the food we eat. Unfortunately, wild bees and honey bees (*Apis mellifera*) are dying. Many honey bees die because of viruses and conservationists worry that these viruses may transfer to wild bees.

We tested 169 wild bees for five common honey bee viruses. We found them in over 80% of the wild bees, yet the *viral load* (virus concentration in the bee's body) was low. We infected two wild bee species with high doses of viruses, and they didn't get sick immediately. This hopeful finding suggests that honey bees and wild bees can co-exist even if some are infected with viruses. To be sure, though, we need to test if other viruses infect the many wild bee species that co-occur with honey bees.

Introduction

We often hear that bees are really important to us and to our planet (Fig. 1). According to some estimates, bees are responsible for one of every three bites of food we eat (Fig. 2). Bees spend most of their lives collecting pollen and nectar from a variety of flowering plants to feed their offspring. Bees transfer pollen from one plant to the next which helps plants make seeds and reproduce. This process is called *pollination* and honey bees and wild bees are significant pollinators of crops. So these insects supply us with a great deal of the fruits, vegetables, nuts, and oils we eat.

In recent years, many wild and honey bee populations have been dying. There are many different possible reasons for these deaths – loss of habitat, exposure to pesticides and infection with different diseases, including viruses. Honey bees are hosts for many viruses (often deadly to them) and sometimes they may transfer those viruses to other bee species.

We wanted to answer the following questions:

1. Are there many honey bee viruses in wild bees and how often does this transfer happen? If so - what are the virus levels (also known as *viral load*)? How do these levels compare to viral loads in managed honey bees?

2. What is the effect of those viruses on wild bee species?

Figure 1:
A beekeeper holding a baby bee (Source: http://earthjustice.org)

For Figure 2, please check page 2

Methods

We collected and identified 284 wild bees from four prairies and one agricultural site in Iowa, USA. We collected honey bees from a nearby apiary for comparison.

To answer our first set of questions, we extracted genetic material from each bee, using a chemical process. The genetic material was RNA. (Many viruses use RNA instead of DNA as their genetic material!) If the bee was infected, the extracted RNA would include both the bee's RNA and viral RNA.

Then we had to determine if our sample actually contained viral RNA. To do this we used qRT-PCR (*quantitative reverse transcriptase polymerase chain reaction*). It sounds very complicated but this simple process identifies and measures the amount of RNA found in a sample. It allowed us count how many copies of the viral RNA were present in a bee (if any).

To answer our second question, we designed an experiment. We chose two common wild bee species and *inoculated* them (infected them on purpose). We basically gave them food contaminated with several common honey bee viruses (aka *inoculum*). As *experimental control*, we also used this inoculum on honey bees. This way we made sure the inoculum could actually make honey bees sick or even kill them.

Figure 2:
Can you imagine a picnic without bees?
Bees and other pollinators supply us with 1/3 of our food
(Source: http://earthjustice.org)

Results

The bees we collected belonged to five different families. Most of them were wild species and some were honey bees found flying in the wild (Fig. 3).

Most of the wild bees (80.4%) had at least one honey bee virus. Also, almost every virus we looked for was present in all wild bees. However, the viral load was actually very low – a lot lower than the viral load in healthy honey bee colonies.

Even though the wild bees we captured appeared healthy, this doesn't mean that they can't get sick. So the results of the inoculation experiment were also important: only a few of the wild bees we infected with high doses of the viral inoculum died. By contrast, most of the honey bees fed with the same inoculum died. We found that the same mixture of viruses that was deadly to honey bees didn't make the wild bees really sick.

Please see page 3, Figure 3

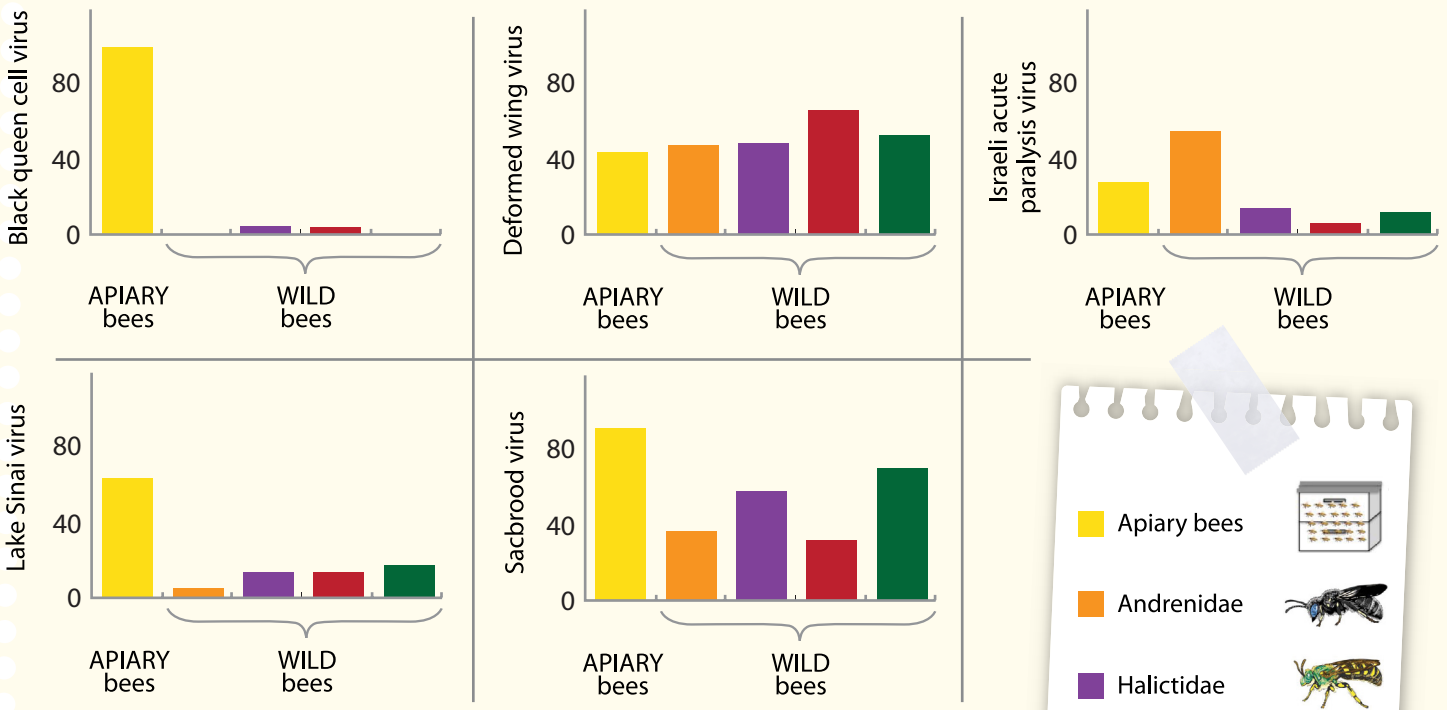

Figure 3:
Viruses in different bee families. (Percentage of tested bees which had each virus)
Honey bees living in the wild are not shown. (Bee images: Amy Geffre)

Discussion

Most viruses infect only one species. So it was a bit alarming, when we found honey bee viruses in most of the wild bees.

But the viral loads we detected in the wild bees were very low. This means that even though honey bees can transfer viruses to wild bees, these viruses are not found at levels which we think make wild bees sick.

Continuing this research is important, because we don't actually know what viral load will make each of the bee species sick.

The second part of our experiment confirmed this conclusion - viruses lethal for honey bees did not kill the wild bees. It is possible, though, that these viruses have other effects - a virus can make an animal sick without killing it quickly. The infection may cause it to behave differently or die from other stress (like starvation or pesticide exposure). For a fuller picture, we would need to track the wild bees for their entire lifespan.

Keep in mind that we've examined only a few of the wild bee species for only five different viruses. There are many more viruses and a lot more bee species. Unfortunately, RNA viruses can evolve really quickly, so even if they don't make wild bees sick now they may evolve to be more lethal.

Conclusion

Bees are useful even if we don't always realize it. That's why wanted to understand why so many are dying. Only then can we try to stop this process. As a matter of fact, every one of us can help them. We can plant bee-friendly flowers that provide both nectar and pollen throughout the summer.

Although there is more to learn about the many viruses that may harm bees, our data suggests that both honey bees and wild bees can share these flowers without immediately putting wild bees at risk for honey bee viruses.

Glossary of Key Terms

Apiary – a honey bee farm.

Pollination – the process where insects, birds, bats and the wind move pollen from one flowering plant to another in order to make seeds and reproduce.

Habitat – natural home of an animal, plant or other organisms. Chimpanzees, for example, live among trees, where they can climb and swing and search for food.

Pathogen – a virus, bacterium or other microorganism that can cause disease in another organism. For example HIV, which causes AIDS; or *Vibrio cholerae*, that causes cholera.

Viral load – it tells us how many viruses are in a certain volume, like a milliliter of blood for example. Generally if it's high – it means that the virus is happy and the infection is worse.

Inoculation and inoculum – scientists give a pathogen (or sometimes just parts of it) to a living organism. This is done to observe the effects of an infection or for vaccination. When we receive a dead virus (inoculum) in our body we develop immunity against it.

RT-qPCR – quantitative reverse transcriptase polymerase chain reaction (PCR) - this is a type of PCR that uses RNA as a template. And PCR is a method for creating multiple copies of a specific part of the genetic material. By making a lot of copies, we can visualize them and eventually identify them.

Experimental control – when we test if the application of a treatment (like a virus) can harm an organism (like a bee) we want to compare the results with 1) something we are sure has the virus, that's called positive control; 2) something we are sure has no virus, which is called negative control. By comparing the survival of bees that get either a positive or negative control, we can more reliably confirm that the treatment is harmful.

Check your understanding

1. What is the problem with bees dying?
2. What are some possible causes of bee deaths?
3. You know what a pathogen is. Can you think of any pathogens, other than viruses?
4. Are weeds good or bad for bees?
5. Our virus mixture didn't kill wild bees outright, but could have other effects. What kinds of experiments could we do to figure that out?

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