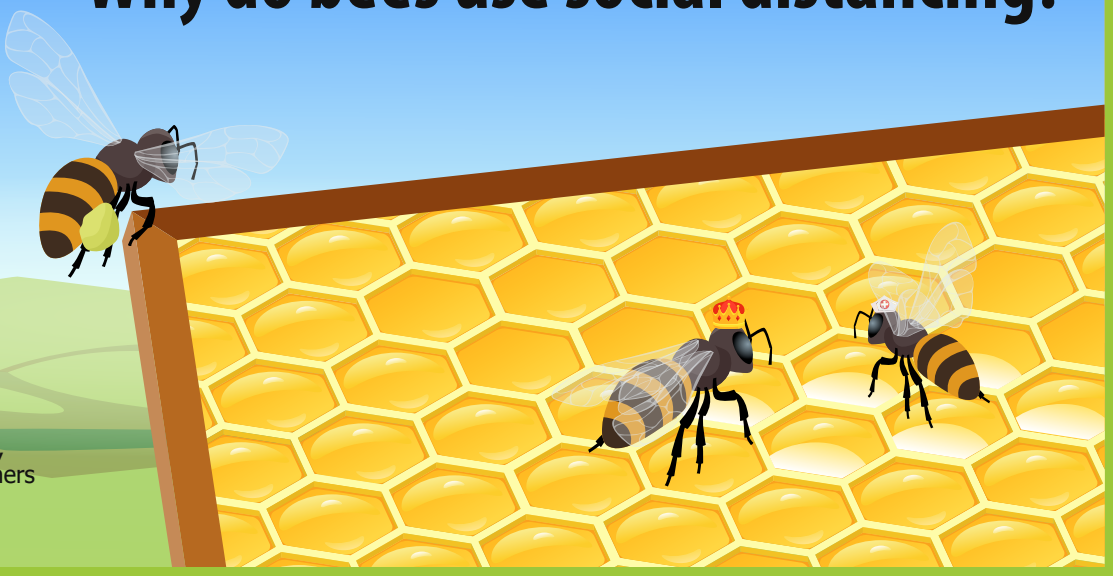
ENVIRONMENTAL SCIENCE JOURNAL FOR TEENS

MAY 2022

Why do bees use social distancing?



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Abstract

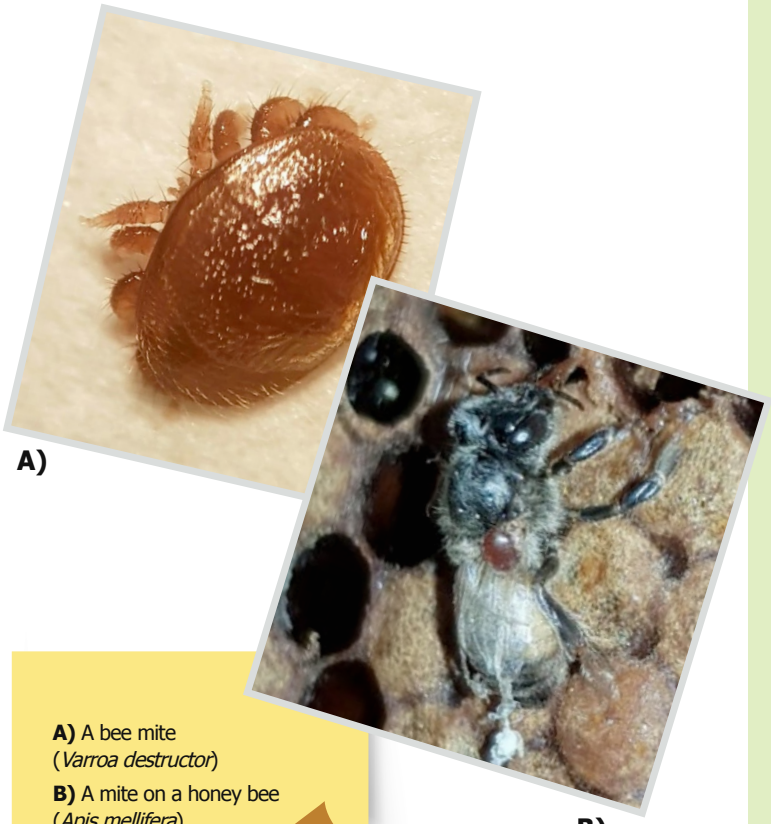
Honey bees are important insects in many of the ecosystems around us. However, they are constantly exposed to many threats. They are particularly vulnerable to disease and parasites because they live in colonies. Once a member of the colony gets infected, it is very easy for the disease to spread. This is why honey bees have some specific behaviors to help them fight infections. In this study we wanted to see how honey bee behavior changes when Varroa destructor mites come into the colony. We found that in infected colonies there was more social distancing between different types of bees. We also discovered that the infection led to higher interactions between bees of the same type. We think this helps bees fight the spread of the parasite.

Introduction

Did you know that honey bees, also known as *Apis mellifera*, are social insects? This means that they live in groups or colonies. Colony members live really close together in small, enclosed spaces: their **hives**. Because of this, they are very vulnerable to disease and **parasites**. If a parasite gets into the colony, it can spread very fast. To fight this, their colonies are very organized.

There are two main types of bees in a beehive: younger **nurse bees** and older **foragers**. Foragers are in charge of supplying food. They fly from flower to flower collecting pollen. This means that they can sometimes run into parasites, like mites, and bring them back to the hive without knowing. To protect the young bees and the queen, foragers live near the entrance of the hive. That means the center of the hive, where nurse bees and the queen live, can remain a safe space. These techniques used to keep the colony healthy are known as **social immunity**. An example of a social immunity technique is social distancing.

In this study, we wanted to see how bee behavior changes when the parasitic mite *Varroa destructor* infects a colony.



A) A bee mite (*Varroa destructor*)

B) A mite on a honey bee (*Apis mellifera*)

We looked at four different types of behaviors:

1. **Forager dances**: usually take place between the center of the hive and the entrance. They are how bees communicate the source of the food they bring.
2. **Allogrooming**: when a bee removes and kills parasites from another bee, the same way your parents comb your hair if you have lice. This is a behavior that's more normal among nurse bees.
3. **Antennation**: the way bees recognize their nestmates by rubbing their antennas with each other.
4. **Trophallaxis**: a feeding technique during which a bee gives liquid food to other bees.

Methods

To start, we focused on whole colonies of bees. Artificial beehives are made of wooden frames placed one next to the other. Each frame contains a **honeycomb** made of many cells. The cells closer to the edges of the hive are usually used to store food. Cells in the center are mostly used as nests for the **larvae (brood cells)**.

We studied the colonies by looking at different frames and checking how bees moved around the honeycombs. That meant we could see if they changed how they used their space. We filmed each colony using high-resolution cameras (Fig 1.). Then, we used the videos to look at where the foraging dances and allogrooming were happening. We compared hives that had naturally become infected with *Varroa destructor* to non-infected hives.

We then studied small groups of caged young bees so that we could focus on detailed social behaviors. This time, we infected some of the bees experimentally in the laboratory. First, we focused on individual bee behavior, looking at allogrooming, antennation, and trophallaxis. Next, we looked at the social network: how bees interact with one another. We compared the behavior of the infected bees to the non-infected ones.

Figure 1:
Our experimental set-up. We used cameras to film the beehives so we could analyze the bee behavior later.

Results

Our experiments confirmed that bees change their behavior when bees in their colony have mites. Overall, bees increase social distancing between foragers and nurse bees.

Our results from observing whole hives showed that in infected colonies:

- Foragers tend to dance closer to the outer edge of the hive (Fig. 2) and they stay closer to the entrance of the hive. They also dance closer to food cells, instead of using all the space in the honeycomb.
- Nurse bees stay closer to the center of the hive. This means that allogrooming does, too. It shifts towards central areas of the honeycomb and closer to brood cells, helping to kill new mites.

Our results from observing smaller groups of young bees showed that there is more allogrooming when some of the bees are infected with mites. To our surprise, there was also more trophallaxis and antennation. Because of this, nurse bees become more central and interact more with each other.

Please see Figure 2 on Page 3

What happens to the forager dances when there are mites in the colony?

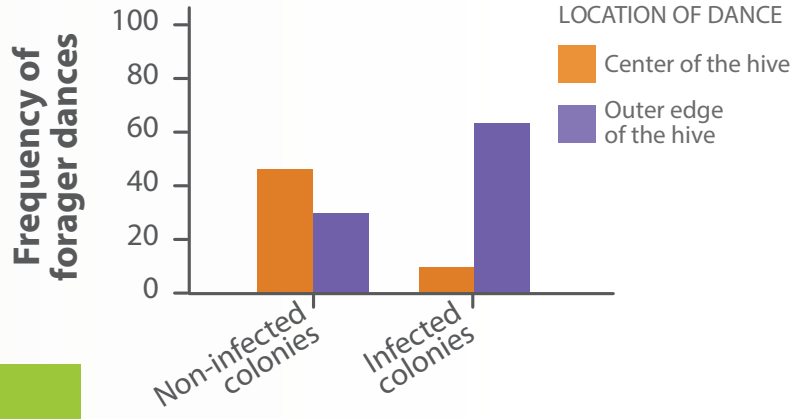


Figure 2:
When *Varroa destructor* mites infect a colony, this changes where the forager bees prefer to perform their dances.

Discussion

When looking at whole colonies, our results showed more social immunity in infected hives. But in the smaller groups of just young bees, social distancing didn't seem to be happening. This was surprising! We expected antennation and trophallaxis to decrease. This would reduce the contact between bees and could help stop the spread of the parasite. We think that social interaction does not decrease between bees of the same age because this would be too costly for the colony. Also, increasing trophallaxis and antennation could increase the overall level of care between bees. This could, in a way, help fight the mite.

We concluded that while social immunity measures, like social distancing, help bees fight parasites, they might also be harmful. For example, when foragers perform their dances further away from brood cells in the comb, they may get fewer foraging mates to come help them gather food. That makes it more work to feed the colony. This is probably why bees only apply social distancing to a certain extent.

Conclusion

Social distancing is a useful response to disease, but it can be very costly. As the COVID-19 pandemic has shown us, it means giving up many things. However, social immunity measures are widely used in the animal kingdom. This suggests that the benefits outweigh the costs.

Bees are very important in our ecosystem: they help plants reproduce and help produce a lot of our food! Since bees eat pollen and drink nectar from flowering plants, you can help bees by planting these kinds of plants in your garden – or ask your school to do so! You could also build a bee hotel, a home for wild bees who live alone rather than in hives.

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Acknowledgment: This article's adaptation was supported by the Goggio Family Foundation.

Glossary of Key Terms

Allogrooming – When an animal removes dirt and parasites from another animal of the same species.

Antennation – Rubbing of antennas between bees to recognize their nestmates.

Brood cell – Cell of a honeycomb that stores eggs or developing larvae.

Forager bee – Bee in charge of collecting food.

Forager dances – How forager bees communicate where they found the food they are bringing in.

Hive – A bee's honeycomb-celled nest. Farmers who farm bees to produce honey usually build artificial hives that give them easier access to the inside of the hive. Typically these hives are wooden boxes with many wooden frames placed one next to the other.

Honeycomb – A structure of hexagonal cells of wax, made by bees to store honey and eggs.

Larvae – An insect at its very young stage. Larvae (larva in singular) look and behave differently from the adult version of the insect. When larvae reach maturity, they transition to their adult form. We call this process metamorphosis.

Nurse bee – Young bee that lives closer to the queen and takes care of the larvae.

Parasite – An organism that lives inside or on another organism of a different species (called a host). The parasite benefits from the host, but the host is harmed by the parasite.

Social immunity – Behaviors in social groups, such as insect colonies, that help prevent the spread of diseases or parasites.

Trophallaxis – Feeding technique during which a bee distributes liquid food to other bees.

Check your understanding

1. Why are honey bees particularly vulnerable to disease and parasites?

2. What does it look like when bees practice social distancing?

3. How is that similar to and different from how you practiced social distancing during the COVID-19 pandemic?

4. What other behaviors did the bees change when their colony had mites? How did they act differently?

5. Why isn't social distancing a perfect solution for bees to fight parasites?