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BEES COULD VISIT FLOWER "PHARMACIES" WHEN THEY ARE SICK

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YOUNG REVIEWERS:


ASMI
AGE: 8


MUHAMMAD
AGE: 14


VEDANT
AGE: 10

When you are sick, you might go to the pharmacy to get some medicines. But have you ever wondered what do animals do when they are sick? Bees are tremendously important given the roles they play in the environment and human societies. Unfortunately, bees have been declining in the last decades, partly due to infection by parasites. But certain flowers may help them! Bees collect resources from various flowers and, recently, scientists have shown that some of these flower resources could help bees fight infections. Flower resources contain many essential nutrients as well as very specific medicines that could strengthen the bees or kill the parasites. Once sick, bees could prioritize the collection of resources from specific flowers to deal with their parasites and heal themselves. It is therefore important for us to plant flowers rich in essential nutrients, as well as flowers rich in medicines that help bees to thrive and fight off infections.

BEES ARE IMPORTANT FOR HUMANS

Imagine you are walking in a park and see a beautiful tree, full of white flowers. A few weeks later, you once again pass by this tree, but this time it is full of tasty cherries. Have you ever wondered what was responsible for this incredible transformation? Bees made it happen! There are more than 20,000 bee species in the world, and they come in many colors, shapes, and sizes. Bees feed on **pollen** and **nectar** found in flowers. By flying from flower to flower to feed, bees aid the reproduction of plants, which turns the flowers into seeds and fruits (Figure 1A). Seeds and fruits are not only necessary because they feed us, they also produce new plants.

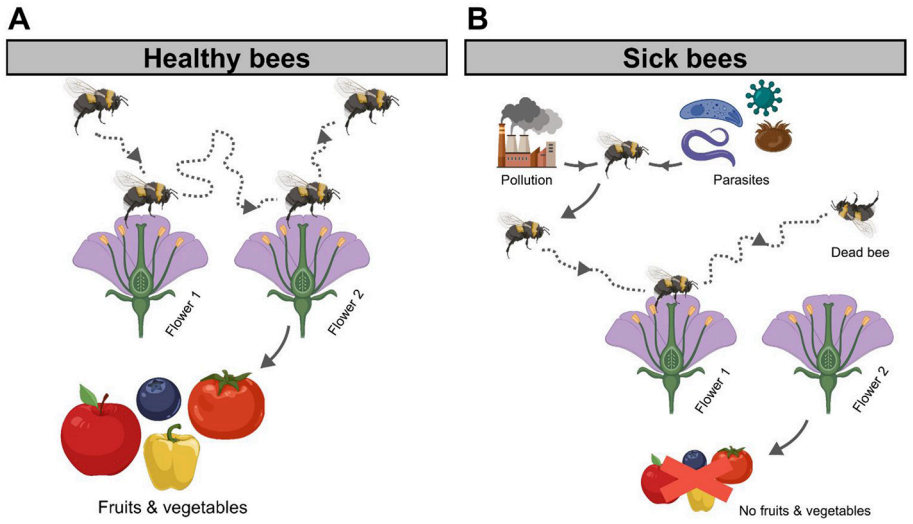

Figure 1

Thanks to the tremendous job that bees do, our gardens, parks, and crops are full of flowers and fruits. Such beautiful places bring people peace, happiness, and wellbeing [1]. Bees are also needed to produce more than half of our food, so they are necessary to feed the 8 billion people on Earth. Bees primarily assist in producing vitamin-rich foods that are crucial for human health. A world without bees would be a world without flowers and colorful parks. It would also be a world without most of our foods, in which more people would starve. Imagine how horrible such a world would "bee"!

WHAT DO BEES EAT?

For bees to be healthy, they need a huge quantity of flowers—and many kinds of flowers, too. Just like humans need a variety of foods to be healthy, bees must eat pollen and nectar from various plants to get all the nutrients they need. For instance, it is not good for bees to be in the middle of a vast, **monofloral** crop, like a field of sunflowers. There is a huge amount of food, but it is not diverse at all. Would you like to eat the same thing all the time? Bees prefer wild areas with many different

POLLEN

Fine powder made by flowers, full of essential nutrients, that is necessary for bee development. Pollen is made by the plant to produce seeds and fruits.

NECTAR

A sugary liquid made by flowers that gives bees energy to fly. It is originally produced by the plant to attract bees.

MONOFLORAL

Used to describe an area that contains only one type of flower. For instance, a sunflower crop is a monofloral crop. A meadow that contains many types of flowers is not monofloral.

flowers. However, not all bees like the same kinds of food. Some bees collect pollen and nectar from lots of different flowers, while others collect pollen and nectar from very specific flowers. We could say that some bees are easy-going and some are picky.

Bees can detect what is in their food, and they know what is good for them. While flying, bees inspect their environments using their senses of vision and smell. They recognize which flowers are around and choose which ones to land on. Then, once they are on the flower, they taste the pollen and nectar with their tongues and antennae. In this way, bees can sense the amounts of protein, fat, sugar, and other chemical ingredients in their food. Proteins and fats are essential for bee development as **larvae**, while sugar is an important energy source, especially for flying. Bees collect these resources, eat them, and provide some to their larvae.

LARVAE

Baby animals that look very different from their parents. Larvae eventually grow and change into adults. For instance, the caterpillar is the larva of the butterfly.

BEES CAN GET SICK

Unfortunately, bees are not doing so well recently. Researchers calculated that one-quarter of bees have disappeared in the last 50 years [2]. But why? First, humans destroy natural environments full of flowers to build more cities and roads, and to plant monofloral crops. This can result in bees not getting enough good-quality food. Imagine if all our supermarkets were replaced by apartment buildings! Second, humans build factories and technologies that release dangerous chemicals into the air, soil, and water. These chemicals end up in pollen and nectar and are then eaten by bees, which can make the bees sick. This is kind of like poisoning seen in children who accidentally drink cleaning products. Finally, humans travel across countries and continents. During these trips, bees can accidentally be moved thousands of kilometers, hidden in cars, boats, and planes. Some of these bees may be infected by tiny **parasites**. When this happens, a bee in America can get infected by a parasite coming from Europe that American bees have never encountered before. Remember COVID-19? It went terribly wrong for humans, partly because humans had never seen the COVID-19 virus before. When many bees get sick, the amounts of fruits and vegetables produced can decrease (Figure 1B).

PARASITE

A relatively small organism that needs another organism, called the host, to survive. This relationship is harmful for the infected host.

Bees can be infected by many kinds of parasites. Most of these parasites live in the bee gut, but some are found in other parts of their bodies. Some parasites are worm-like and visible with the naked eye, while others are rice-like and so tiny that we need microscopes to see them. Bee parasites also differ in how dangerous they are. It is the same as for humans: people can get sick with either a mild cold with very few symptoms or a bad flu with terrible headaches and vomiting. Similarly, a mild parasite does not prevent the bee from collecting pollen and nectar, and the bee actually feels OK. In contrast, a dangerous parasite

disorients the bee, impedes its flying abilities, and prevents it from getting food. These bees are very likely to die.

SELF-MEDICATION

Behavior in which an animal uses a specific chemical to heal itself when sick. Humans should not self-medicate, only medical doctors or pharmacists can prescribe medicines for a person to get better.

MEDICINES FOR BEES?

What do you do when you are sick? You might go to the hospital or pharmacy, and doctors or pharmacists prescribe you some medicine. What do bees do when they are sick? Bees, like many other animals, have a behavior called "**self-medication**". For a long time, researchers thought that animals could not heal themselves when they got sick. However, in the last decade, experiments have shown that animals can self-medicate, and bees are no exception [3]. In the pollen and nectar from certain flowers, bees can find very specific chemicals—special ingredients that can help sick bees. There are two ways such chemicals can help sick bees (Figure 2A). First, they can increase the ability of bees to tolerate infection. These chemicals generally strengthen bees' organs but do not affect the parasites directly. Second, some chemicals can help bees to resist infection. These chemicals usually affect parasite development or even kill parasites [4].

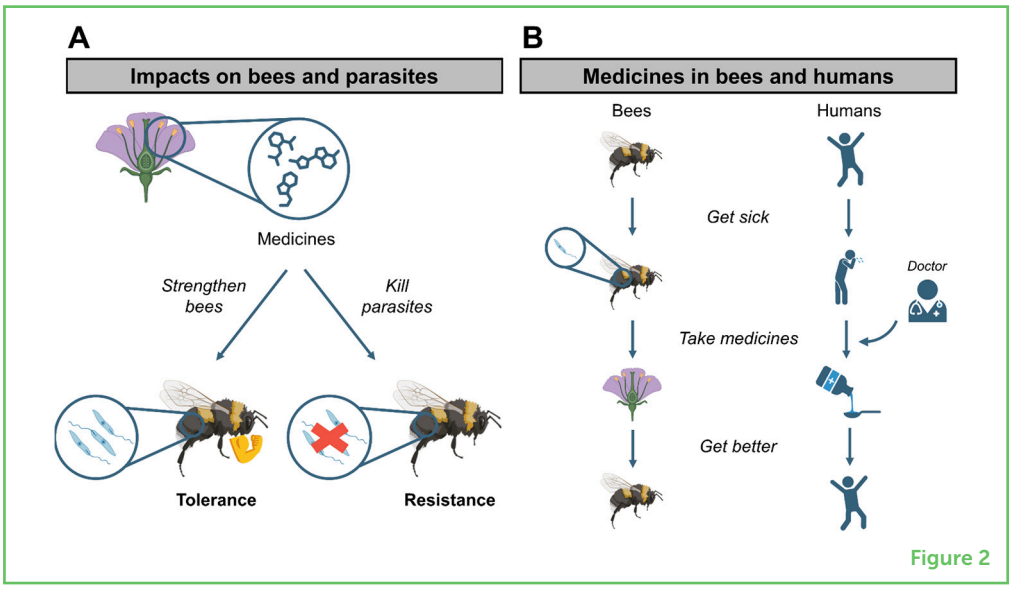

Figure 2

Self-medication in bees. **(A)** Chemicals from certain flowers can help bees in two ways, either by making them stronger and increasing their ability to tolerate infection or increasing their resistance to infection by killing the parasites. **(B)** Taking medicines in bees and humans shows a similar pattern.

Demonstrating that bees can self-medicate is not an easy task for scientists (Figure 2B). To demonstrate that a bee can self-medicate, a list of six criteria must be met.

- The bee must be able find the chemical in its environment—otherwise, how could the bee ingest it? To demonstrate this, scientists study the chemicals found in flowers to see which ones are available to bees.
- The plant that contains the chemical must be known by the bee—otherwise, how would the bee know to visit this plant for "medicines"? So, scientists observe which flowers bees go to.

- The bee must be able to detect these chemicals with its tongue or antennae. In laboratories, scientists touch the bee's tongue and antennae with such chemicals and observe the bee's reaction.
- It must be more advantageous for the bee to ingest these chemicals than to deal with the infection using its own defense mechanisms. This is really hard to study because scientists do not really know how to measure the bee's defenses.
- Ingesting these chemicals in high quantity in the absence of parasites could be harmful for the bee, otherwise bees would eat these chemicals all the time. To demonstrate this, scientists give these chemicals in high quantity to healthy bees to see what happens.
- Ingesting these chemicals when parasites are present must be helpful for the bee, otherwise why would the bee do it? To demonstrate this, scientists give sick bees these chemicals to see what happens.

All these criteria make for a lot of work for scientists! That is why studies demonstrating self-medication in bees are scarce [5].

PLANTING MORE PHARMACIES

Helping bees is urgent since they are vital for the environment and human societies. There are various laws all over the world to keep people from destroying areas with many flowers and to reduce the use of dangerous chemicals that harm bees. Recently, there has also been more attention paid to the ways we could help bees face their parasites. First, scientists must find which plants and which medicines boost bees' health and resistance to infection. Second, such plants should be favored in gardens, hedgerows, parks, and other public places, so that sick bees are more likely to find the necessary plants and chemicals to self-medicate. The hope is that, ultimately, planting more "bee pharmacies" will reduce bee decline.

Once researchers find the plants and chemicals that help bees to self-medicate, should we plant *only* these plants? That would be risky because, as we noted above, these chemicals in high quantity are harmful to healthy, uninfected bees. Also, these plants often lack essential nutrients, and no bee can survive feeding on "medicines" alone. This means that if bees have no other choice but feeding on "pharmacy" plants, it will harm them. Bees need nutritious plants all the time, even when they are sick. Your doctor would not tell you to take medicines if you were *not* sick—and when you *are* sick, the doctor would not tell you to stop eating your usual food.

Therefore, we should grow two types of plants to reduce bee decline: plants that do not harm healthy bees and provide them with essential nutrients, alongside plants that produce medicines that help bees

when they are sick. The ideal environment for bees should consist of many plants full of essential nutrients and a few plants that produce medicines (Figure 3).

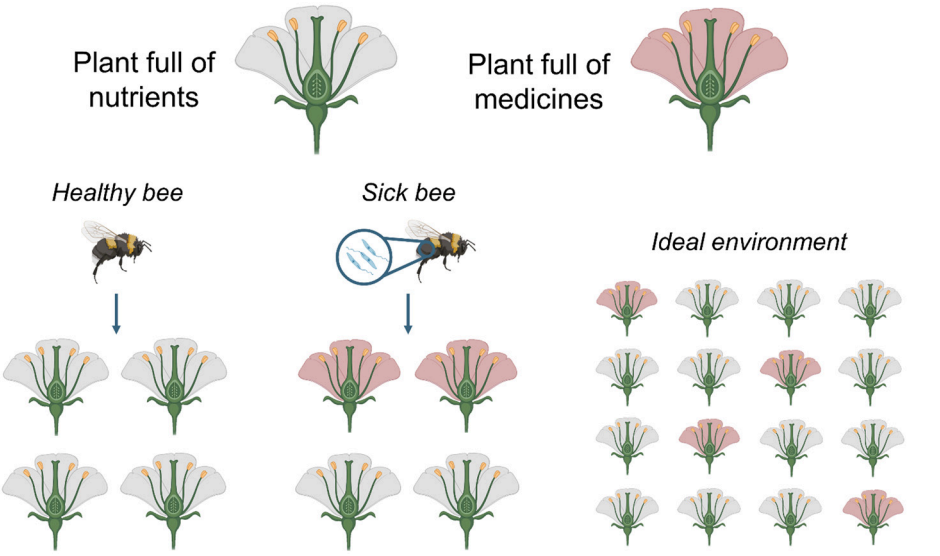

Figure 3

Planting pharmacies for bees. In their environments, bees need a mix of plants—some that provide essential nutrients and some that provide medicines to help bees deal with parasites.

By flying from flower to flower to collect pollen and nectar, bees aid the reproduction of new plants and provide humans with fruits and vegetables. Regrettably, bees are disappearing, partly because of human activities that expose them to new parasites. Bees get sick, cannot visit flowers, and eventually die, thereby reducing the production of food for humans. The great news is that scientists suggested that bees could self-medicate by eating chemicals found in specific flowers. Yet, demonstrating that bees can heal themselves is difficult as a list of criteria must be met. To reduce bee decline and to help them face parasites, scientists invited governments and people to plant flowers that provide bees with essentials nutrients and flowers that provide bees with medicines.

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWERS

ASMI, AGE: 8
I love animals. I enjoy doing art, playing dress up, and I am learning classical Indian dance since 2 years.

MUHAMMAD, AGE: 14
The turning point in my curiosity came when I secured first place in my grade 3 science project. It was about photosynthesis, which I chose after knowing the fact that plants are universal food makers. The science textbook of every grade always familiarized me about the magical wonders behind my daily life's surroundings.

VEDANT, AGE: 10

I love playing Minecraft and I enjoy creating different worlds in it. I am very curious. I am also a chatterbox and I love asking questions.

AUTHORS

ANTOINE GEKIÈRE

Hi, I am Antoine. I am a Ph.D. student working at the University of Mons in Belgium. I study the impacts of pollutants (namely trace elements and pesticides) and parasites on bees and their intestinal flora. I am fascinated by the tremendous importance of the microbes that live on and inside animals. I am particularly interested in the roles humans play in their environment, and what we could do to reduce human impacts. Life on Earth is amazing, and, at my scale, I try to do my best to understand and preserve it. *antoine.gekiere@umons.ac.be

MARYSE VANDERPLANCK

Hi, I am Maryse. I am a researcher at the CEFE, a French research Center in Ecology and Evolutionary Ecology. I study the role of pollen chemicals in the functioning of bee-plant interactions, to deepen our understanding, and to discover the threats that contribute to bee decline. I hope to learn about the capacity of bees to cope with a changing world by understanding how pollen chemicals contribute to bees' wellbeing and by demonstrating whether wild bees can self-medicate to face environmental stressors.