

Facing external threats, bees may get help from internal organisms

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Microorganisms in the bee gut offer the prospect of improved health. Image credit:. Credit: CC0 via Unsplash

Awareness is growing worldwide of the crucial role that bees and other pollinators play in preserving natural habitats and securing food supplies.

In the run-up to World Bee Day on 20 May, *Horizon Magazine* takes a closer look at how microorganisms in a bee gut are key to ensuring the insects'—and the planet's—future.

With [three-quarters of global food crops](#) depending on pollinators to some extent, ensuring the well-being of these resourceful insects as they confront [habitat loss](#), pollution and pesticides will be central to improving food provisions in years to come.

Easy honeybee

For [bees](#) as well as humans, a healthy digestive tract could go a long way towards enhancing longevity. That's why researchers are studying the mysterious inner microbiome in bees' guts to learn more about their resistance to diseases and how best to protect against sickness.

"The [gut microbiota](#) is important for protecting bees against pathogens," said Dr. Amélie Cabirol, a postdoctoral researcher in honeybee health at the University of Lausanne in Switzerland. "We need to understand all the determinants of the bee's physiology to be able to say 'This is the ID card of a healthy bee.'"

In the world of honeybees, [average lifespans](#) can range from eight weeks to five years depending on the type of bee. Worker bees die within months while queen bees can live for years.

A honeybee's gut is relatively straightforward to study because it is dominated by specialized communities of only around nine [bacterial species](#). That means they could serve as a good basis for learning more about microbiome in other species too, including humans.

Some pesticides and herbicides affect the gut microbiota of bees. Pesticides called neonicotinoids have often been implicated in pollinator

declines. While their use outdoors was banned in the EU in 2018, exemptions have been granted before [recent attempts to end the practice](#).

Changes to what's in a bee's gut aren't always lethal but can still hamper the ability to pollinate.

Bacteria-memory link

"There is growing evidence that having a disturbed gut microbiota will impact on bees' learning and memory performance," said Cabirol. "Such cognitive abilities are important for bees to associate odors with nectar they get from flowers and therefore remember the best food sources in their environment."

The [HarmHoney](#) project that she worked on investigated bee gut health using genetic sequencing and the study of small molecules involved in metabolism within cells. The initiative ran from May 2020 until October 2022.

Cabirol's team found that honeybees [learned and memorized information](#) better when their gut contained five types of core bacteria than when they contained just one or none.

That suggests performance is improved by interactions between microbe types. The next step will be to test various combinations to pinpoint what's happening.

"Now, we can only say that each microbial member on its own is not sufficient to promote these cognitive abilities, but we cannot yet say if every member is necessary for this," said Cabirol.

Although [recent research](#) suggests honeybees have been on the rise over the past decades, she said that individual colonies can still suffer severe

losses and hopes that HarmHoney's findings can be applied to other threatened bee species.

For example, [studies](#) carried out by her colleagues at the University of Lausanne have started to unravel more about the diversity in the gut microbiomes of so-called stingless bees.

The relative ease of studying honeybees as a result of factors like their widespread global presence makes them good test cases, according to Cabirol.

"Honeybee colony losses raise the alarm that other non-managed bee populations may be suffering from similar stressors," she said.

"Understanding the causes of colony collapse is critical for identifying stressors that may affect all pollinators, and should help improve agriculture and beekeeping practices."

Parasite problem

Among the stressors facing honeybees are gut parasites such as *Nosema ceranae*, which has become [widespread globally](#).

Infection of adult bees at a young age can cause them to have difficulty digesting food for the rest of their lives. Follow-on implications include a shorter lifespan and reduced colony health, population and performance, which can ultimately result in the colony dying.

The antibiotic fumagillin has historically been deployed against *Nosema* species, but its use has been restricted in Europe as a result of bans on antibiotics in beekeeping and [some studies](#) have questioned how well it actually works in *Nosema ceranae*. That calls for new methods of prevention.

"We have to find natural solutions that do not create problems for bees and the environment," said Professor Diana Di Gioia, an agricultural microbiologist at the University of Bologna in Italy. "The concept is that, if the host has an increased composition of beneficial bacteria, it can react better to parasites."

She has led the [NO PROBLEMS](#) project looking into potential new eco-friendly gut treatments for strengthening bees' resilience to disease. The initiative, which began in 2018, has been extended beyond a March 2023 end date.

During the project, the team has conducted DNA-based studies involving both bacterial solutions and plant-derived products in the lab and in the field in Ireland, Italy, Malta and Argentina to study their effectiveness under varying climates and levels of infection.

Secret formula

The researchers have found that a formula containing a mixture of two types of beneficial microorganisms seemed to lead to a [reduction](#) in *Nosema ceranae*.

The team has now developed a prototype formulation based on probiotic microorganisms and plant-derived molecules. The idea is that this formulation, for which a patent is being sought, can be fed to bees in their food and help improve their balance of microbiota.

The hope is to run a follow-up project in which the formulation can be tested under different conditions and doses to hone it and pinpoint the best application methods.

Apart from the benefits to bees, research into them may be very useful for examining the gut microbiome and its evolution more widely.

"With honeybees, we have this powerful tool," Di Gioia said. "It looks as though the bee was made to be a model for examining the gut microbiota."

More information:

- [HarmHoney](#)
- [NO PROBLEMS](#)

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