

Bees and environmental stressors—canaries in the coal mine

April 6 2017, by Mary Bates



European honeybee. Credit: John Severns, via Wikimedia Commons. Public Domain

Bee populations are declining worldwide, raising concerns of a "pollination crisis." Scientists have identified links to many human-induced environmental stressors, including pesticides, pollutants, parasites, diseases, and malnutrition.

[In a recent review](#), researchers from the University Paul Sabatier in France and Macquarie University in Australia considered why [bees](#) are so sensitive to these [environmental stressors](#), even at low levels. The team, led by ecologist Mathieu Lihoreau and graduate students Simon Klein and Amélie Cabirol, looked at how these stressors damage the bee brain and disrupt key cognitive functions needed for survival – and how these effects can snowball into catastrophic [colony collapse](#).

The Surprisingly Sophisticated Bee Brain

Bees must gather highly dispersed nectar and pollen and then return to their nests to feed their brood. For bees that can exploit hundreds of flowers spread over several kilometers at each foraging trip, this involves learning a large number of places.

Lihoreau says this foraging lifestyle is cognitively demanding.

"Foraging involves learning to recognize flowers, discriminating the most profitable flower patches, and learning how to handle flowers of different species," he says.

"Because flower meadows are extremely dynamic environments, where resources appear and disappear within hours or days, flower foraging also requires flexible learning processes for being able to keep track of environmental variability. All this in a miniature brain of about one million neurons."

To accomplish these feats, bees have evolved excellent memory and

navigation skills. In the bee brain, visual and olfactory stimuli are first processed in specialized sensory lobes, which then transmit information to multisensory integration centers dedicated to learning, memory, and spatial navigation tasks.

While the results of some human activities, like habitat loss, directly compromise bee survival, others, such as pesticides, parasites, and malnutrition, threaten colony survival by compromising bees' cognitive capacities.

The brain systems involved in learning, memory, and navigation are easily disrupted by environmental stressors. Even mild damage can seriously alter bees' ability to fly, navigate back to their nest, recognize profitable flowers, and communicate, all of which reduce their ability to collect food.

For example, neonicotinoid insecticides are neurotoxins that alter the olfactory leaning capacities of bees through their actions on two neurotransmitter pathways involved in learning and memory (the cholinergic and GABAergic pathways). Infection by the parasitic mite *Varroa destructor* also impairs the GABAergic pathway, leading to poor navigation performance.

From Problems Foraging to Colony Collapse

Across America and Europe, these environmental stressors have been linked to population declines, species extinction, and colony collapse – and the process is likely accelerating.

Stressors such as pesticides and parasites reduce brood production, alter development, induce premature foraging onset, and affect the cognition of foragers. Though these stressors usually don't kill bees outright, the stress tolerance of bees has its limits.

"Through a snowball effect, the reduced foraging efficiency has consequences at every level of the colony, potentially resulting in a dramatic colony collapse," says Lihoreau.

Due to their sensitivity to environmental stressors, bees act as canaries in the coal mine: the problems they are experiencing now indicate trouble in the environment that could have significant implications for ecosystems.

"What is particularly alarming about the decline of bees is that these insects ensure a vital ecosystem service – pollination – that is critical for the reproduction of plants," says Lihoreau. "If bees decline, plants do not reproduce and this has consequences for all the species that depend on these plants, including us humans."

Many of the environmental stressors impacting bees were identified a long time ago. Now, scientists are beginning to understand how they affect bee behavior and cognition. This is a critical step if we want to develop strategies to mitigate these effects. Through a more thorough understanding of bee ecology and neuroscience, scientists hope to identify interventions to ameliorate stress on bees.

As Lihoreau and his colleagues note in their paper, "Most of the [stressors](#) damaging [bee populations](#) are human-induced, and can be reduced or eliminated from the environment if there is sufficient will and/or economic imperative."

More information: Simon Klein et al. Why Bees Are So Vulnerable to Environmental Stressors, *Trends in Ecology & Evolution* (2017). [DOI: 10.1016/j.tree.2016.12.009](https://doi.org/10.1016/j.tree.2016.12.009)

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Citation: Bees and environmental stressors—canaries in the coal mine (2017, April 6) retrieved 20 June 2024 from

<https://phys.org/news/2017-04-bees-environmental-stressorscanaries-coal.html>

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