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INSIDE JEB

Wildflower flavonoids could protect neonicotinoid-ravaged bee memories

Common eastern bumble bee (*Bombus impatiens* Cresson, 1863), Woods Hole, MA, USA, 29 September 2010. Photo credit: Donald Hobern from Copenhagen, Denmark, CC BY 2.0, via Wikimedia Commons.

Plants have been embroiled in a battle with the insects that feast upon them since time immemorial. Natural compounds such as nicotine keep insect pests at bay, inspiring the chemical industry to create materials based on these natural pesticides. Yet, these so-called neonicotinoid insecticides, which target insect nervous systems, are alarmingly indiscriminate, incapacitating obliging pollinators too. However, scientists noticed that bees that dine on a diet rich in pollen and nectar from a variety of plants fare better when drenched in insecticide than pollinators provided with a monoculture diet. Could a group of plant pigments found in pollen and nectar – known as flavonoids, which also benefit human health – provide protection from neonicotinoid insecticides for bumble bee pollinators? Andre J. Riveros from the Universidad del Rosario, Colombia, and Wulfila Gronenberg from the University of Arizona, USA, decided to find out, but first the duo needed to determine how badly the memories of American bumblebees (*Bombus impatiens*) are affected by one specific neonicotinoid insecticide: imidacloprid.

The team supplied a group of bees with a regulated diet of artificial nectar (sucrose solution) for 3 days before giving some a dose of the toxic insecticide, and then set all the bees a memory test: could they learn to stick out their tongues when they smelled a lemony scent (1-nonanol)? Sure enough, the memories of the bees that were fed artificial nectar alone were sharp, with the bees learning to recognise and then remembering the lemon scent a day later. In contrast, the bees that had been fed imidacloprid struggled to learn to recognise the scent and recall it later. However, when Riveros supplemented the bees' diet with the flavonoid rutin prior to feeding them insecticide, he found their memories were significantly better; they were almost as good at learning the scent as the insecticide-free bees and they were less hesitant. Rutin seemed to provide some protection from the damaging effects of imidacloprid on their memory. But how would the insects respond to another insecticide, fipronil, which is not a neonicotinoid and incapacitates a different aspect of the circuit that forms the insects' memories?

This time, Riveros allowed bees to saunter around an enclosure, sipping as much sucrose as they wished from a feeder laced with rutin before some were given a dose of imidacloprid, while others received fipronil. Meanwhile, other bees were fed an unlimited supply of sucrose without rutin prior to a dose of one or other insecticide. He then tested the insects' ability to learn and remember the lemon scent and, sure enough, the bees that had dined on the insecticides alone suffered problems with their memories, while those that had consumed rutin were much smarter.

However, none of these laboratory simulations recreated the true world, where the quantity of insecticide consumed by the insects is unrestricted. Riveros selected more bees, with one group dining on rutin for a few days and the other not, before being allowed to consume as much sucrose dosed with one or other insecticide as they liked. The memories of the bees that were unprotected by rutin really suffered when they consumed the insecticides; they were completely unable to learn to recognise the lemony odour. Yet, the memory of the bees on the flavonoid-supplemented diets were almost as sharp as those of bees that had not consumed insecticide.

Riveros and Gronenberg suggest that bees, and agriculture, could benefit from wildflower strips provided alongside farmers' crops, although they admit that further research is necessary to understand the true benefits of flavonoids for bee health.

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Riveros A. J. and Gronenberg, W. (2022). The flavonoid rutin protects the bumble bee *Bombus impatiens* against cognitive impairments by imidacloprid and fipronil. *J. Exp. Biol.* **225**, jeb244526. doi:10.1242/jeb.244526.

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