Pesticides impair baby bee brain development

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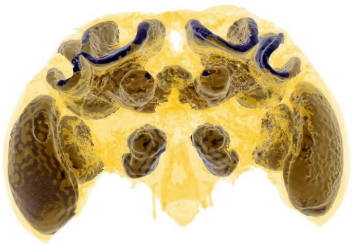

Micro-CT scan of a bumblebee brain Credit: Dylan Smith / Imperial College London

Imperial College London researchers used micro-CT scanning technology to reveal how specific parts of bumblebee brains grew abnormally when exposed to pesticides during their larval phase.

Most previous studies have tested the effects of pesticide exposure on adult bees because these individuals directly collect pesticide-contaminated nectar and pollen. However, this study shows that baby bees can also feel the effects of the contaminated food brought back to the colony, making them poorer at performing tasks later in life.

Lead researcher Dr. Richard Gill, from the Department of Life Sciences at Imperial, said: "Bee colonies act as superorganisms, so when any toxins enter the colony, these have the potential to cause problems with the development of the baby bees within it.

"Worryingly in this case, when young bees are fed on pesticide-contaminated food, this caused parts of the brain to grow less, leading to older adult bees possessing smaller and functionally impaired brains; an effect that appeared to be permanent and irreversible.

"These findings reveal how colonies can be impacted by pesticides weeks after exposure, as their young grow into adults that may not be able to forage for food properly. Our work highlights the need for guidelines on pesticide usage to consider this route of exposure."

The team, who published their results today in *Proceedings of the Royal Society B*, used detailed micro-CT scans to gain unprecedented insights into the development of bee brains under the effects of pesticide exposure.

The colony was provided with a nectar substitute spiked with a class of pesticides called neonicotinoids, some of which are restricted within the EU but used widely across the globe. Once the young emerged as adults from their pupae, their learning ability was tested after three days and after 12 days, and some went on to have their brains imaged using micro-CT technology at the Natural History Museum.

Bumblebee foraging on a flower. Credit: Tara Cox / Imperial College London

These results were compared with young from colonies that were fed no pesticides, and those that were fed pesticides only once they had emerged as an adult.

Bees that were fed pesticides when they were developing as larvae showed significantly impaired learning ability compared to those that were not. The researchers tested this by seeing if the bees could learn to associate a smell with a food reward, scoring how many times out of ten each successfully performed the task.

The researchers scanned the brains of close to 100 bees from the different colonies and found that those who had been exposed to pesticides also had a smaller volume of an important part of the insect brain, known as the mushroom body.

The mushroom body is known to be involved in learning ability in insects, and poor performance on the learning task correlated with smaller mushroom body volume. This supports the suggestion that smaller mushroom body volume associated with pesticide exposure is the cause of the bees' poor performance.

Bees that were exposed to pesticides during larval development but not as adults showed similar learning impairment and mushroom body volume reduction when tested at both three and 12 days as an adult. This suggests that at least within the unexposed nine days they were adults, the effects of larval exposure could not be overcome, pointing to a potentially permanent effect.

Lead author of the study Dr. Dylan Smith, from the Department of Life Sciences at Imperial, said: "There has been growing evidence that pesticides can build up inside bee colonies. Our study reveals the risks to individuals being reared in such an environment, and that a colony's future workforce can be affected weeks after they are first exposed.

"Bees' direct exposure to pesticides through residues on flowers should not be the only consideration when determining potential harm to the colony. The amount of pesticide residue present inside colonies following exposure appears to be an important measure for assessing the impact on a colony's health in the future."

The team previously pioneered the use of micro-CT to scan bee brains, and with this study have shown how the technology can be used to test ecologically applied questions that require measuring tiny but important differences in size and shape.

More information: DOI: 10.1098/rspb.2019.2442
Insecticide exposure during brood or early-adult development reduces brain growth and impairs adult learning in bumblebees, *Proceedings of the Royal Society B*, rspb.royalsocietypublishing.or … .1098/rspb.2019.2442

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