Neonicotinoid pesticide affects foraging and social interaction in bumblebees

January 9 2017

Neonicotinoid Pesticide Affects Foraging and Social Interaction in Bumblebees. Credit: Society for Integrative and Comparative Biology (SICB)

In a plastic, lasercut box blacked out with paint and lit with red light, worker bumblebees (Bombus impatiens) go about their daily activities:

interacting with fellow adults, extracting food from honey pots, feeding larvae, and occasionally venturing out to forage for nectar. While this nest is far from normal, the bees that live here have adapted to their new space remarkably well. Still, all is not well within the nest, and not because of its strange form. Some bees have abandoned their daily patterns and are spending more time alone, on the periphery. Others are spending less time caring for the utterly dependent larvae that will become the next generation of bumblebees.

Within the nest, the chaotic center of bumblebee life, social behavior and interactions are crucial for bee population health and the production of young. When social behavior and the care of young changes, population numbers become more susceptible to decline. James Crall, a postdoc with the Planetary Health Alliance at Harvard University, graduate student Callin Switzer and colleagues have linked these changes in social behavior with sublethal exposure to the neonicotinoid pesticide, imidacloprid.

For their study, Crall developed an 'automated behavioral tracking system' that allows a computer connected to cameras within the nest to recognize individual bees and create data points that indicate position and proximity to others. "Bumblebee nests are not the organized, beautiful geometry of the honeybee," said Crall. Instead, "they're more a hodge-podge of food and larvae in a pile in the middle of the nest space." This automated tracking system allowed Crall to see into "messy, complex, realistic, individual scenes" and could be adapted for use in natural environments.

While it might seem like the hardest part of this experiment would be development of a tracking system, Crall said the process of tagging each bee was both an art and a science, a "race against time" to glue on tags before the bees woke up, and "by far the hardest and slowest part of the experiment." Tagging a colony of bees could consume entire days, while

bee movement within nests was only recorded for a few hours. After tagging, bees were observed before and after exposure to imidacloprid. Crall then evaluated millions of data points to assess behavioral changes among treated bees. He found that bees exposed to the pesticide reduced the frequency of brood care and tended to gravitate towards the perimeter of the nest, becoming less social.

Outside the nest, this neonicotinoid also has significant effects on pollination and foraging behavior. Callin Switzer, a PhD student at Harvard University, worked to study the effects of imidacloprid on pollination behavior. Specifically, Switzer focused on buzz pollination, the ability of bumblebees to forage on and pollinate certain types of plants, using vibrations. Before exposing bees to imidacloprid, Switzer recorded the sound of bees foraging on tomato blossoms. These same bees were then exposed to the neonicotinoid and allowed to resume foraging. However, bees exposed to imidacloprid, at doses similar to those encountered in a single day, were less likely to resume foraging than unexposed bees.

Imagine it's summer, and in a field by the side of the road, rows on rows of tomato plants wait to be pollinated and produce their delicious fruit. These plants reproduce more following buzz pollination, a service eastern bumble bees are uniquely equipped to provide. However, these tomato plants are covered in imidacloprid, and when bumblebees forage here, they are exposed to sublethal levels of this pesticide. As the season progresses and exposure to imidacloprid increases, bees are still present, but they begin to forage less, don't care for their young as often, and social interactions change. Outside the nest, a decrease in foraging by affected bumblebees could contribute to lessened crop production and colony food supplies. Within the nest, altered social networks and a decrease in caring for young could lead to population declines in future generations. As the single most important native pollinator species in North America, continued use of the neonicotinoid imidacloprid could

have far-reaching effects on the survival of the common eastern bumblebee and the plants they pollinate.

More information: Callin M. Switzer et al. The neonicotinoid pesticide, imidacloprid, affects Bombus impatiens (bumblebee) sonication behavior when consumed at doses below the LD50, *Ecotoxicology* (2016). DOI: 10.1007/s10646-016-1669-z

Provided by Society for Integrative & Comparative Biology

Citation: Neonicotinoid pesticide affects foraging and social interaction in bumblebees (2017, January 9) retrieved 26 April 2024 from https://phys.org/news/2017-01-neonicotinoid-pesticide-affects-foraging-social.html

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