New research provides clues about honey bee decline

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Heather Mattila working with honey bees and one of her undergraduate researchers, student Anita Yau '17 at Wellesley College. Credit: Wellesley College/Ping Ji

A new study by Heather Mattila, a leading honey bee ecologist and Assistant Professor of Biological Sciences at Wellesley College, published this April in *PLOS ONE*, reveals that inadequate access to pollen during larval development has lifelong consequences for honey bees, leading not only to smaller workers and shorter lifespans, but also to impaired performance and productivity later in life. For the first time,

this study demonstrates a crucial link between poor nutrition at a young age, and foraging and waggle dancing, the two most important activities that honey bees perform as providers for their colonies and as pollinators of human crops. The study was co-authored by Hailey Scofield, Wellesley Class of 2013, a former undergraduate research assistant who will begin a Ph. D program (in Neurobiology and Behavior) at Cornell University in Fall 2015.

The need to study nutritional stress in honey bees has grown pressing in recent years. In 2013, the U.S. Department of Agriculture and the Environmental Protection Agency named nutritional stress one of the top research priorities for understanding unexplained losses of honey bee colonies, a phenomenon known in the U.S. as Colony Collapse Disorder (CCD). With bee pollination accounting for over $15 billion in food crops and $150 million in honey annually in the United States alone, bee losses have enormous ecological and economic consequences. If bees vanish, many plants, including vital food crops like apples, almonds, berries and cucumbers, may also be at risk. Researchers believe there may be several interrelated factors contributing to bee decline, including nutritional stress, loss of foraging habitat, pesticides, pathogens, and parasites. These concerns prompted President Obama to form a Pollinator Health Task Force in 2014, an unprecedented action that named studies of the effect of poor nutrition on bees as one of its primary goals.

While a number of sophisticated nutrition studies have been undertaken recently, the Wellesley study is the first to show that nutritional deficits early in life can have far-reaching consequences for adult honey bees, including effects on complex behaviors like foraging and waggle dancing. "Nutritional stress has long been known to shorten bees' lifespan," stated Mattila, "but we've never had such a clear understanding of its impact on the tasks they perform, or known that its effects persist until their last days, even when bees have plentiful food as adults."

The study is also one of the few to be conducted entirely in a natural hive environment, which allowed larvae and adults to function in normal colonies, rather than in the incubators and cages that are more typical of nutrition studies. This unique methodology allowed Mattila, Scofield, and their undergraduate research assistants to observe the bees foraging and dancing in a natural context, activities they would not be able to perform in artificial lab conditions.

Foraging and waggle dancing are especially important to the health of a honey bee colony because they are the key means by which honey bees acquire food supplies like nectar and pollen, and communicate with other bees about the location of food sources and nest sites. When honey bee larvae were raised with a limited pollen supply, as might happen during periods of bad weather or as a consequence of habitat loss or commercial management practices, there were multiple negative consequences. The pollen-stressed bees were lighter and died younger, and fewer bees foraged. Those that did foraged earlier, for fewer days, and were more likely to die after just one day of foraging. Pollen-stressed workers were also less likely to waggle dance than workers that had been well-fed as larvae, and if they danced, the information they conveyed about the location of food sources was less precise. "Their dances were often visibly inconsistent and almost disoriented in the worst instances," said Scofield.

Importantly, nutritional stress interacts with a number of other stress factors, like pesticides and pathogens, which are already known to decrease longevity and impair foraging ability, creating a vicious cycle of poor health and population decline. Nutritional stress is also tied in part to a loss of foraging habitat, which can compound stresses from pesticide use and other commercial practices. Poor foraging and waggle dancing, in turn, could escalate bee decline if long-term pollen limitation if it prevents stressed foragers from providing sufficiently for developing workers. "If poor foraging habitats impose nutritional stress

in colonies, then our study shows that the average stressed bee cannot compensate for reduced foraging opportunities by working harder to find food. This likely exacerbates nutritional stress and further limits the colony's ability to overcome food-finding challenges in areas that are no longer suitable for bees," explained Mattila.

The study also suggests that poor nutrition has the potential to undermine colony health and promote collapse. Conversely, ensuring that honey bees have access to diverse and plentiful forage throughout the year could mitigate the potential for collapse. "This means keeping bees in areas that are bee friendly, green, and full of flowering plants within the normal foraging radius of a colony, regularly checking colonies' food supplies, and providing supplements when natural forage is not available or colony stores are low," said Mattila. "Failure to provide these necessities may impose a legacy of dysfunction on colonies."

More information: "Honey Bee Workers That Are Pollen Stressed as Larvae Become Poor Foragers and Waggle Dancers as Adults." *PLoS ONE* 10(4): e0121731. DOI: 10.1371/journal.pone.0121731

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