How water collector bees know when to quench hot hive's thirst

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Credit: Lilla Frerichs/public domain

Thirst is a sensation that we can all relate to; however, dealing with this basic physiological impulse takes on a whole new dimension when an entire bee colony craves water.

"We are interested in the social physiology of honey bee colonies, that is, how they work as physiological units", says Thomas Seeley, from Cornell University, USA, who was curious how the elderly bees that are tasked with gathering water know when the colony's collective thirst is running high. "Water collectors do not spend much, if any, time in the broodnest, and yet somehow they know when to start collecting water to control its temperature", explains Seeley. Intrigued, the scientist and his colleagues Madeleine Ostwald and Michael Smith turned up the heat to make a bee colony thirsty. They discovered that water collector bees begin searching for water when the colony is thirsty in response to insistent begging by nest mates; and when water is available and the colony is hot, water bottle bees store water for later use. The team publishes their findings in *Journal of Experimental Biology*.

Bees use three mechanisms to cool an overheated hive - nest evacuation, fanning with their wings and water evaporation - so Seeley and his colleagues raised the temperature in a glass-walled hive by positioning a lamp close to the broodnest to find out how the hive responded. However, the water collectors did not spring into action immediately. It was only when the workers began desperately begging for water - by walking up to the face of another bee, contacting the bee's antennae with her own and then extending her tongue between the mouthparts of the other bee - that the water collectors increased their water-bearing activity. By begging more, the thirsty nurse bees in the broodnest had prompted water collectors to embark on water-collection flights and the hive managed to stabilise its temperature at around 40°C.

The team then removed the nearby water supply for 2.5h to find out how the hive coped, and this time the temperature soared dangerously to almost 44°C. "The water collectors continued visiting the empty water source, which they probed feverishly but unsuccessfully", recalls Seeley. Ostwald and Smith also gauged the colony's thirst by pipetting a 0.2 ml puddle of water onto the floor of the hive, which the bees gulped down in just 46s - in contrast to the well-hydrated cool bees from earlier in the day, which took almost 5min to drain the puddle. Despite increasing the air flow through the hive by recruiting more fanning bees and evacuating workers, the thirsty bees were unable to use evaporation to keep the hive cool. However, when the team returned the hive's water supply 2.5h later, the water collectors' delivery rate skyrocketed, from 3.2g/30min (when the hive was cool) to 22.8g/30min as the colony satisfied its thirst; which is impressive when each bee can only carry 50mg of water per excursion. Some even performed waggle dances to recruit additional water collectors.

Finally, the team set the bees another challenge when they warmed the hive briefly while providing unrestricted access to water before gathering bees

later the same day to analyse their crop contents and the contents of brood cells. "We had to open the hive in the evening and then pluck bees, one-by-one, off the combs, and squeeze their abdomens so that they would regurgitate their crop contents to get data", recalls Seeley, who narrowly avoided being stung in the eye by the disturbed insects. However, the team's courage was rewarded when they discovered that the hive was stock-piling water in the brood comb. In addition, many of the bees had bulging abdomens full of water. "We called them the "water bottle bees"", chuckles Seeley, who is now keen to find out whether water collector bees are also motivated by their own personal thirst.

More information: Ostwald, M. M., Smith, M. L. and Seeley, T. D. (2016). The behavioral regulation of thirst, water collection and water storage in honey bee colonies. J. Exp. Biol. 219, 2156-2165. DOI: 10.1242/jeb.139824

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