Giant honeybees use Mexican waves to repel predatory wasps

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The phenomenon of "shimmering" in giant honeybees, in which hundreds—or even thousands—of individual honeybees flip their abdomens upwards within a split-second to produce a Mexican Wave-like pattern across the bee nest, has received much interest but both its precise mode of action and its purpose have long remained a mystery.

In a new study published in the journal *PLoS ONE* this week, researchers at the University of Graz, Austria, and the Royal Botanic Gardens Kew, UK, report the finding that shimmering—a remarkable capacity of rapid communication in giant honeybees—acts as a defensive mechanism, which repels predatory hornets, forcing them to hunt free-flying bees, further afield, rather than foraging bees directly from the honeybee nest.

South-East Asian giant honeybees (Apis dorsata) occur in single-comb nests in the open, preferring traditional nest sites with aggregations of hundreds of colonies on trees, rocks or human buildings, which they may revisit over years. Honeybees manage the pool of worker bees in an elaborate trade-off between foraging and defense. The bees' main defensive goal is to make the nest site a shelter zone for colony members, as well as a place of danger for potential predators. In order to set the entry fee for predators as high as possible, and to efficiently safeguard the colony's resources (keeping losses and expenses to a minimum), a plethora of defensive tactics has evolved in giant honeybees, both "aggressive" and "docile" behaviors being employed.

In the *PLoS ONE* study, Gerald Kastberger and colleagues focused on the

shimmering behavior in giant honeybees, the intriguing, docile, nest-based trait reminiscent of the Mexican waves seen in football stadiums. It was previously known that shimmering was evoked by visual stimuli of predators—particularly hovering wasps. This highly coordinated response aligns hundreds of colony members and displays a remarkable capacity of fast communication within a society, unique in the animal kingdom.

When a giant honeybee colony shimmers, it has two potential addressees: firstly, its nest mates, which coordinate themselves to participate in the shimmering, and which possibly become aroused or alarmed. The authors posit that the members of the group, which are assembled in the dense networks of a "bee curtain" on both sides of the comb, continuously produce and receive information about the state of the colony, reflecting its day-to-day business of foraging, reproduction, reorganization and defensive actions (such as shimmering). Secondly, the potential predators such as wasps and mammals are targeted—these are thought to be influenced by the dynamic visual cues of shimmering.

In their paper, Kastberger and colleagues show that shimmering is invoked as a means of anti-predatory defense. They analysed around 500 episodes of interactions between bees and hornets, frame by frame, and found that shimmering is triggered by giant honeybee colonies in response to approaching hornets, the strength and rate of the phenomenon being linked to the hornets' flight speed and proximity.

The researchers also found that hornets respond to shimmering, showing an avoidance response, which is strongly tied to the time course of shimmering. Predatory hornets are deterred by the visual cue of large-scale shimmering (in particular, when they are closer than 50 cm to the giant honeybee nest), whereas small-scale shimmering has the capacity to confuse hornets, which are extremely close to the honeybee nest. As a result, shimmering forces the hornets to alter their hunting strategy,

travelling at least 50 cm away from the honeybee nest to forage for free-flying bees.

The scientists also discuss the evolutionary principles of how shimmering benefits giant honeybees. They conclude that shimmering is a pivotal trait that allows giant honeybees to maintain their open-nesting life style which they evolved millions of years ago. The way giant honeybee colonies and bee-hawking hornets (Vespa sp.) interact during the shimmering process (showing a finely tuned interplay between the shimmering of the bee colony and the retreating of hornets) supports the hypothesis that a co-evolutionary mutual adjustment between prey and predator is at play here.

Shimmering relies on the unique principles of information transfer and is a compelling example of self organization. Further study could potentially provide insights for a range of hot topics in the biology of social systems, such as in cooperation, task partitioning, or collective decision-making, with possible implications for the study of social communication and social defense.

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