



Look Who's Dancing

Check out the steps—and the songs—of honeybees' overlooked cousins

By SUSAN MILIUS

*The inner life of stingless-bee nests is coming to light now that James Nieh has developed a special observation hive that suits the tropical species *Melipona panamica*.*

Photos: Nieh

What do you envision when you think about dancing bees? Honeybees, yes, as they loop around in celebration of a food find. But what about the bigger, fatter, more bumbling bumblebees?

At first, the notion seems out there with elephants in tutus and Volkswagens in flight. Yet certain bee researchers are taking the question seriously. Likewise, analysts of the huge tribe of stingless bees are monitoring pirouettes as well as frenzies of bee beeping in search of communication that compares with honeybees'.

The past year saw reports of both bumblebees and stingless bees doing something like dancing. Some of these discoveries, like the song-and-dance routines of the stingless *Melipona* bees, rival honeybee sophistication. Other aspects are to honeybee choreography what the mosh pit is to the minuet, but never mind. They provide hints about the origins of bee communication.

After a long period of investigating whether honeybee dances really convey information, research on bee communication today often starts with the premise that honeybee movements encode specific information. The newer explorations have arisen from such questions as, How have abstract communication systems evolved? and, If they're so great, why don't more creatures have them? Before answering these ques-

tions, biologists need to determine just which insects are communicating what.

The basis for this work—the idea that a honeybee buzzing home from a great flower patch dances out the location for her sisters—faced a dramatic challenge during the past 3 decades.

The fundamentals of one side in the debate remained true to the groundbreaking Austro-German zoologist Karl von Frisch. After trying to decode honeybee dances for some 25 years and bungling the explanation the first few times, von Frisch hit upon a simple system.

When returning triumphant from a distant food supply, a forager jogs in a figure eight across one of the combs inside the hive. Her angle of orientation indicates the direction to the food. The dance's duration, in particular the number of shimmies, or waggles, indicates the distance. This discovery was greeted as the first clear-cut example of a system besides human language that offers an abstract representation of the real world.

During the late 1960s and early 1970s, Adrian M. Wenner, now an emeritus of the University of California, Santa Barbara, began an ongoing challenge to that idea. Although he and his colleagues acknowledged that honeybee wiggings might very well correlate with locations, the re-

searchers proposed that foragers weren't actually using that information but were just sniffing their way to the food.

The challenge "resuscitated a field that had almost fallen asleep," recalls James L. Gould of Princeton University. New generations of experiments applied tighter controls and reached heroic proportions without resolving the issue. Gould himself, as an undergraduate, worked on one project that required chilling 4,000 bees, one at a time, to slow them down so he and his colleagues could glue form-fitting, numbered plaques to their bodies.

The experiment that did sway opinion toward the honeybee dance as communication was reported from Gould's lab in 1975. His research team took advantage of the observation that bees orient their dance differently in light than in the dark.

To detect dim light, the bees use three eyelike organs called ocelli, which nestle among the hairs atop their head. When researchers painted over the ocelli on some bees, those insects couldn't detect an artificial light placed near their special glass-sided hive. Unpainted bees, however, acted as if they were in pale daylight.

Thus, when a painted forager returned and shared her news of finding a feeder, she oriented as if she were dancing in the dark, defining angles by gravity alone. Her unpainted audience, however, assessed the angles in relation to the light. The dancer, thus, unwittingly gave the wrong



Melipona bees (above) can feed high in the tropical canopy or on the jungle floor, so researchers have not been surprised that the insects can communicate the height of a food find. Honeybees, mostly temperate foragers, don't bother with height.

directions to her audience.

Even though scent could have drawn them to the feeder she visited, most of the bees went to an identical feeder in a different spot. When researchers shifted the light to another position, the bees shifted, too, going to still another—also wrong—feeder.

"Though locale odors may be important under some circumstances, it is clear that the language really does communicate direction and distance," Gould concludes.

The honeybee's dance, "to many scientists, including me, remains the single most fascinating discovery in animal communication," says Lars Chittka of the Bavarian Julius Maximilians University of Würzburg in Germany. The origins of such a dance especially intrigue him.

To reconstruct ancient behaviors, modern observers can look at family trees, he explains. If the same trait shows up in two close relatives, their common ancestor probably had it, too. Otherwise, the trait would have had to evolve independently twice, a less tidy explanation.

Chittka and other researchers have begun to look for dance communication in other bees, including bumblebees. "The general opinion, for several decades, was that bumblebees do not have any communication system whatsoever," he says. "It was assumed that they do not dance. Everyone believed it, and so no one tested it."

Bumblebees, like honeybees, harvest nectar and pollen and will crowd around feeders that researchers stock with sweet treats. Bumblebees returning from a feeder tear around in their nest for several minutes. They zigzag over the combs, occasionally bumping nest mates, before flying off again.

In the nest, "other bees seemed not at all impressed by such excited foragers," Chittka notes. The next foragers to set off, who might have picked up tips from the earlier forager, weren't more likely to visit the place she had discovered than other spots.

The original forager's apparently useless frenzy puzzled Chittka. "If colony fitness depends on food intake, why would foragers waste precious time that could be spent collecting food?" he asked.

Looking more closely at three species, Chittka and Anna

Dornhaus found that the bees in a nest check out a returning forager's deposits to the communal honey pots within the nest. Among *Bombus impatiens*, *Bombus occidentalis*, and *Bombus terrestris*, all the other foragers took off to search for food when a bee brought home several loads from a good site.

To see if the nest mates were just reacting to a sudden surge in their nectar deposits, the researchers inserted what they call a ghost forager. With a syringe, they injected small bonuses into the honey pots. The ghost did motivate nest mates to go out and get busy, but not in the same numbers as a real bee did.

Checking for some signal produced by foragers, Chittka and Dornhaus placed two nests near each other but separated them by wire mesh. When foragers from one colony returned after a successful run and rushed through their nest, bees from both colonies took off. Yet the neighbors stopped responding when researchers separated the two colonies with clear plastic wrap.

Perhaps the excited racing spreads some kind of pheromone message through the colony, Chittka muses. "Admittedly, this scenario is speculative, but at present there is no better explanation."

The forager does seem to be communicating something, albeit in a primitive mode, Chittka insists. He goes so far as to call bumblebees' performance a dance, though he qualifies the term. "While honeybees perform a pretty ballet," he says, "bum-

blebees perform something more like a slam dance."

Stingless bees can get much more sophisticated, reported James C. Nieh of Harvard University in a series of papers last year. The more than 300 species of these bees in some 50 genera strike him as holding rich possibilities for comparative studies of what communication systems evolve under which circumstances. Whereas honeybee species resemble each other strongly, stingless bees offer a little of almost everything.

The group sweeps around the globe but does not reach into the United States. They may be stingless, but they're hardly defenseless, Nieh points out with considerable feeling. Many bite, and some can produce a chemical weapon. "They spit at you, and it sort of melts away your skin," he says.

Stingless bees include vulture bees, which forage for dead flesh. They drool on their treasures, partially dissolving them so they can bring home the protein. Another stingless bee lives only in termite nests. Others descend in a cloud on well-provisioned nests of another species, emitting lemony fumes that send the rightful owners packing without much resistance. Most stingless bees, however, gather nectar and pollen or other sweets the same way that honeybees and bumblebees do.

Work by one of von Frisch's students, Martin Lindauer, in the 1950s and by Harald E. Esch of the University of Notre Dame (Ind.) in the 1960s found considerable diversity in the way stingless bees invite their friends to join them at the buffet. Some species lay scent trails to the food. Others guide the pack of foragers back.

Describing the first communication system that may be representational in stingless bees, Esch reported that two Brazilian species of *Melipona* broadcast sound pulses whose durations correlate



Marking stingless bees with tiny numbers and offering them feeders stocked with sugar solution has allowed researchers to show that nest mates of a forager flew to the food she had just discovered even if it was 95 meters farther from the nest than an identical feeder.

with the distance to the food that they've just found.

Another species, *Melipona panamica*, combines sound, motion, and scent for surprisingly informative communication, report Nieh and David W. Roubik of the Smithsonian Tropical Research Institute in Panama City, Panama. They recently noted that most nest mates of a recent forager flew to the feeding station she had just visited, even when it was 100 meters away and an identical station lay just 5 m from the nest.

When researchers arranged the food so that foragers had to find their way over water, the bees still visited the target feeder. So, the foragers are not laying scent trails, Nieh and Roubik conclude.

Scent does seem to play a role though, they report. They let bees visit a feeder and then traded it with one nearby. When the next wave of foragers arrived, they went to the station that had just been visited, even though it now stood in the wrong place (although a similar distance from hive). The scent doesn't seem to carry more than 2 to 4 m from the target, however.

The communication system that the researchers have pieced together for this stingless bee bears only a passing resemblance to the honeybees'. When one of the stingless bees comes home after a good trip, she unloads her booty and beeps in loud pulses. "You can hear them, standing outside," he reports. His

kinder, gentler rendition sounds a little like a dump truck backing up but with a lower pitch.

The sounds come from intense, high-speed contractions of muscles that make the wings vibrate and possibly the nest too. "It's very frantic," he reports. The bees, having no eardrums, gather around the returning forager to pick up the vibrations, sometimes bending their antennae near. This message conveys the height of the food source, Nieh explains. Faster beeps mean food higher in the forest canopy.

Next, the forager makes semicircular turns, beeping the whole time. Nieh and Roubik tried to wring information out of some aspect of the motion, like the angle of orientation and pattern of clockwise versus counterclockwise turns. However, the motion may signal only a change of topic. Beeps during the turning correlate with distance, certain pulses growing longer as distance increases.

The bees seem to communicate direc-



Inside the hive, a stingless bee forager communicates the height of a food source by the length of her buzzes, and then with a second burst of buzzing while turning, she reports the distance to the source.

tion, but Nieh thinks that happens outside the nest. The researchers nabbed the discoverer of a feeding station as she emerged from the nest. Without her, the others must try to find the food relying only on messages they'd gotten inside. The new foragers blundered to feeders at the right distance and height but showed no preference for direction.

With all the elements in place, however, these bees seem able to communicate a location in three dimensions, Nieh points out. In contrast, honeybees don't seem to indicate height. The difference may reflect their habitats. Stingless bees forage in tropical forests where they may dine on flowers blooming high in the canopy or fruit that has fallen to the floor. Most honeybees live in temperate regions instead and gather nectar and pollen relatively near the ground.

Both the honeybee and stingless-bee systems, Nieh notes, mix presumably simple methods, like scents, with fancier ones, like specialized motion. "There are many ways information can get garbled," he says. "It's good to be redundant."

The amount of information that honeybees, bumblebees, and stingless bees exchange inside the nest has inspired Nieh to speculate on the advantage of elaborate communications. The supposedly simpler methods, trailing scent droplets like bread crumbs, for example, could tip off competitors as well as the crew from the home nest. What happens inside a nest, however, becomes much harder for foreigners to observe.

Advantageous as that shift inside might be, it does require some way to abstractly represent the larger world. Such a system might develop under pressures of intense competition from other hives, Nieh speculates. Or, to put it another way, representational language could be just one way of countering espionage. □

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