Honeybee jobs: Like father, like daughter

Job specialization among worker honeybees – long believed to be a function of environmental cues – is strongly influenced by inherited predispositions for specific occupations, new research indicates.

Two studies, performed independently and published in the May 25 NATURE, demonstrate for the first time a genetic component to behavioral differences among related honeybees. The research hints at a resolution to one of the most vexing problems in evolutionary biology: How can worker bees – which are sterile females and thus have no means of directly passing their genetic makeup to offspring – survive, specialize and evolve in the dog-eat-dog world of natural selection?

"This research answers some very fundamental questions about organization in social insects," says Roger Morse, chairman of the department of entomology at Cornell University in Ithaca, N.Y.

Both studies examined occupational trends in worker honeybees whose pedigrees were traced by different marker systems. Peter C. Frumhoff and Jayne Baker, working at the University of California at Davis, glued tiny, numbered and color-coded tags to the backs of more than 7,000 bees born to a queen artificially inseminated by two different males. Queen bees typically mate with and store sperm from as many as 17 males – a behavior known as polyandry – before settling down to a year or two of continuous egg-laying. By inseminating the queen with sperm from only two, genetically distinct males with different colored bodies, the researchers could keep track of which offspring shared the same father and the sorts of specialized jobs each offspring performed. Focusing particular attention on the occupational specialty of grooming, in which a few bees repeatedly groom nestmates over time, they found "striking patrilineal differences in the propensity of workers to groom nestmates."

In an elegant departure from the body-color method for tracking honeybee genealogy, Gene E. Robinson and Pobert E. Page Jr. of Ohio State University in Columbus inseminated queens with sperm from males identical in appearance but who differed slightly in the chemical makeup of one enzyme, called an allozyme. Thus "blinded" to unintended bias based on body color, the researchers kept track of individual offspring that became "guard bees" and "undertaker bees," two occupational specialties found in honeybee hives. Later, they killed bees in each profession and analyzed their enzyme profiles to determine paternity. Statistical analysis showed that in both cases, genetic relatedness accounted for more than 80 percent of the likelihood of a bee "choosing" a particular job.

Specialized diets during the first days of life and varying social milieus in different parts of the hive are among the environmental factors usually cited as determining a bee's future occupation. But the new research, says Robinson, "highlights the fact that the genetic structure of an insect society has a very important role in the social structure. That was a link that was never made before." Such a link between genetic variation and colony behavior is critical to Darwinian theory, he says, because "then you have the raw material upon which natural selection can act" to change worker behavior and colony organization through the course of evolution.

The researchers caution that queen-bee polyandry did not necessarily evolve just to satisfy the hive's need for genetic variation and job specialization. However, says Frumhoff, "No one expected that differences among lineages, if they existed, would be as strong as they are. And the greater the difference, the more likely you'd want to think that it has some functional significance."

Frumhoff's worker honeybees marked with colored, numbered tags.

Scientists now may have to explain how social cooperation among honeybees has been maintained in the face of such high degrees of genetic variation within hives, since variation usually leads to conflicts of interest. One controversial theory is that honeybees continue to practice cooperative behavior patterns not because they are altruistic, as some scientists have argued, but because they are *oppressed* by the "fittest" bee of all – a ruthless queen. *– R. Weiss*

Large lava field discovered in Pacific

At the ocean bottom, along the mountain chain known as the East Pacific Rise, scientists have discovered an immense field of fresh lava they think may be as young as 25 years old. Aside from garnering size records, such as "the largest lava field created within recent times," this discovery is forcing geologists to reconsider theories about the creation of the ocean's floor.

Ken Macdonald of the University of California at Santa Barbara and his colleagues detected the lava field about 1,200 kilometers southwest of the Galápagos Islands while using side-scan sonar to map the East Pacific Rise – part of a worldwide network of seafloor spreading centers where molten basalt from the mantle rises to form oceanic crust. What the researchers actually found is a 53,000-acre bright spot on the sonar images, which they say corresponds to fresh lava, still free of the sediment cover that dulls the floor's reflectivity.

"We have continuous coverage of 3,500 kilometers, which is most of the East Pacific Rise from Baja California to Easter Island, and this is the only area that was so bright in terms of reflectivity, and this was the largest area of high reflectivity," says Macdonald, who presented the finding at the spring meeting of the American Geophysical Union in Baltimore.

The eruption appears to have started near the central axis of the spreading center. It then flowed downslope, over cliffs and valleys, for 20 kilometers. By estimating the height of the cliffs the lava covered, the researchers calculated the volume of erupted material to be 15 cubic km. While some prehistoric basalt flows were thousands of times larger, this flow – if confirmed – would capture the title for largest during historic times, says Macdonald. In comparison, the current record-holder, the 1783 eruption of the Icelandic volcano Laki, netted only 12 cubic km. According to Macdonald, the volume of the new field is also "enough to pave the entire U.S. interstate system to a depth of 10 meters."

"What's really startling," he says, "is that the way in which new oceanic crust is formed may be much more episodic than we had thought. People have been thinking about [seafloor spreading] as a wound that never heals – a slow oozing of magma." Conversely, this flow or series of flows seems to represent a period of prodigious, punctuated ridge activity. Geoscientists have only recently started to consider this kind of activity possible, in the wake of discoveries of large "megaplumes" of heated water near spreading centers (SN: 10/10/87, p.238). Such plumes could be produced only by short periods of intense volcanic activity.

The researchers suspect the field may be related to earthquake swarms recorded in that area of the Pacific in 1964, 1965 and 1969. Moreover, in 1972 oceanographers found to the southwest of the lava field a 2,000-km-long plume of helium-3, which serves as a tracer for undersea volcanic eruptions. One of the original discoverers of the helium plume, Santa Barbara's John Lupton, calculated that if the eruptions at the newly discovered field had occurred during the mid-1960s, known ocean currents could account for the plume's 1972 position. *– R. Monastersky*