

STEPHEN DUTTON/INRA



Everyone gets a say

House-hunting bees behave like a brain

ROWAN HOOPER

WHEN 20,000 bees need to find a new nest site, how do they scout out potential locations and decide where to set up home? The queen's role is crucial to the life of the hive, but she's no house hunter.

Instead, democratic decisions are made through a process using thousands of worker bees. The swarm is a superorganism, says Kevin Passino of Ohio State University, Columbus. It uses "group memory" to make collective decisions in a way that parallels how neurons communicate in a vertebrate brain. "The swarm knows more than the sum of what every bee knows," says Passino.

In springtime, half of a healthy bee colony will form a swarm cluster (pictured) in preparation for finding a new home. Several hundred scout bees set off to search potential sites, such as holes in trees. Each scout will spend about 30 minutes assessing relevant factors such as the size of the cavity, the presence of ants and the aspect of the sun.

The scouts then fly back to the cluster and use a combination of waggle dances and runs across the body of the cluster to transmit information about the site to the other bees. The more runs across the cluster a scout makes – on average 150 – the higher the scout rates the site.

The scout then revisits the potential home, taking one or two "recruits" with it to make their own assessment. If a recruit likes the site too, it will return to the cluster and give positive feedback in the form of a similar waggle-and-run combination, which generates yet more recruits, and so on. If enough recruits agree on a particular site, a "quorum threshold" is reached and the swarm lifts off to the

new location. This ongoing recruitment process means that the swarm can simultaneously assess, compare and "remember" different sites during selection.

However, if recruits disagree with a scout's positive assessment of a potential site, then support for it will fade away. That's because every time a bee returns to the swarm from a potential site, it makes about 15 fewer runs across the cluster than after its previous trip. Without a good number of returning recruits joining in to advocate the site with their own runs, the number of bees in favour of that site diminishes until support for it drops to zero.

Passino and colleagues built a computer model to simulate the process. It showed that starting with 150 runs, and reducing by

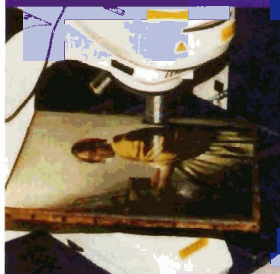
"The swarm uses 'group memory' to make collective decisions in a way that parallels how neurons relate in a vertebrate brain"

15 each time, ensures that a swift yet accurate decision is reached, and the choices of error-prone bees are filtered out (*Behavioral Ecology and Sociobiology*, DOI: 10.1007/s00265-007-0468-1).

The decision-making process is a race to see which option accumulates sufficient evidence in its support, says co-author Thomas Seeley of Cornell University in Ithaca, New York. Brains make decisions in a similar way: a neuron's level of activation is akin to the number of runs a bee makes, and high activation helps "recruit" more neurons to its cause.

The study "beautifully demonstrates 'quorum sensing' as a mechanism for collective decision making," says Bert Hölldobler, of Arizona State University in Tempe. ●

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