Alcohol Stops Bees Learning

Queen bees produce a pheromone that prevents young bees learning from negative experiences.

Homovanilyl alcohol (HVA) activates one of honeybees' three dopamine receptors. Dr Kyle Beggs of the University of Otago's Department of Zoology says that this may trigger a range of responses, one of which is the prevention of aversive learning, where negative experiences teach the bees to avoid similar situations. "Evolution has provided queen bees with a chemical that selectively blocks aversive learning but leaves reward learning intact," says Prof Alison Mercer, also of Otago.

Two years ago the pair demonstrated that the queen bees could prevent aversive learning in bees that feed them, but the specific pheromone involved has only been identified now. "This is an important breakthrough because it will help us understand more clearly how memories are formed and how brains tell the difference between memories that predict punishment and memories that predict reward," Mercer says. It is hoped the finding will improve insights into more complex vertebrate brains where chemicals such as dopamine are equally important.

It is not clear what purpose blocking aversive learning would serve. Other royal pheromones are unpleasant, impairing motor activity. Beggs speculates that the young bees need to forget lest they cease feeding the queen before their 2 weeks of service expires.

Why the queen produces chemicals that are unpleasant to those she depends on for food is an even more difficult question.

Queen bees use an alcohol to suppress the ability of those who serve them to learn from their mistakes.

"It may be the remnant of chemical warfare from competition within the hive for sexual reproduction," Beggs says. "You see this in bumble bees."

Bees transfer food from one to another, and in the process the queen's pheromones get distributed throughout the hive, but older bees operating outside the hive get a much lower dose, and Mercer and Beggs have not established whether they are also affected by HVA.

Beekeepers sometimes put pheromone sticks into hives that have lost their queen while they wait for a suitable replacement, rather than letting the hive find its own replacement and risk swarming. A better understanding of the role that specific chemicals play may be useful in such circumstances.

Thank Parasites for Sex

A study of water snails has supported the theory that sex became the dominant form of reproduction because it makes species less vulnerable to parasites.

Species that reproduce sexually can only do so at half the rate of those that use asexual reproduction – assuming equal numbers of males and females. It's worse for widely dispersed species that have a hard time finding mates, or those in danger of being eaten by a predator while courting a partner.

Despite this, sex has taken over the Earth, with the vast majority of animals and plants using it to reproduce. Clearly it offers some advantage, but there is debate as to what that is.

One suggestion is that sex is a way of evading parasites. Barring mutations, asexual reproduction produces identical clones of the parent. If a parasite can find a hole in an individual's defences, the same hole will apply to all offspring and they will be equally vulnerable. But by reshuffling the genetic pack, sexual reproduction gives species a chance to fight parasites off.

Mathematical models support this idea, but evidence from nature has been sparse. However, the New Zealand mud snail *Potamopyrgus antipodarum* provides a living laboratory. *P. antpodarum* is native to New Zealand, and represents kiwi revenge for the rabbits and possums that have overrun their islands. It has invaded many Northern Hemisphere waterways with disastrous results. It also has both sexual and asexual varieties.

An international team studied the snails in their native habitat and found that clones that were common at the start of the study were largely wiped out by parasites within a few years. They were replaced by initially rare clones that experienced a similar boom and bust as they became common enough to attract parasitic attention. In contrast, sexually reproducing snails maintained a relatively stable presence.

"The rise and fall of these female-only lineages was surprisingly fast and consistent with the prediction of the parasite hypothesis for sex," says Jukka Jokela of the Swiss Federal Institute of Aquatic Science and Technology. "These results suggest that sexual reproduction provides an evolutionary advantage in parasite-rich environments."