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Worker Ants: You Could Have Been Queens

Whether an ant becomes a worker or colony royalty may depend on insulin metabolism.

By Karen Weintraub
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The critical factor for determining which ants become queens or workers may be as simple as some extra insulin.

In a study published Thursday in the journal Science, researchers showed that the genes behind insulin signaling appear to play a key role in distinguishing the ants' assignments.

In some ant species, a queen can be substantially larger and live 20 times longer than a worker, even though they are genetically identical. A number of insect species, including ants, wasps and bees, have queens that are responsible for reproduction, while a far larger number of often-sterile workers forage for food.

"We were interested in where these differences come from, how they're regulated and how they evolved," said Daniel Kronauer, the paper's senior author and an evolutionary biologist at Rockefeller University in New York.

By looking at which genes are activated in the brains of queens and workers of different ant species, Dr. Kronauer and his colleagues determined that a hormone called insulin-peptide 2, or ILP2, played the most important role. But other insulin-signaling and unrelated genes were also differently activated, Dr. Kronauer said.

“Insulin signaling — and this ILP2 version of insulin — seems to be at the core of these queen-worker differences,” Dr. Kronauer said.

Clonal raider ants tending to their larvae.

Vikram Chandra & Ingrid Fetter Pruneda

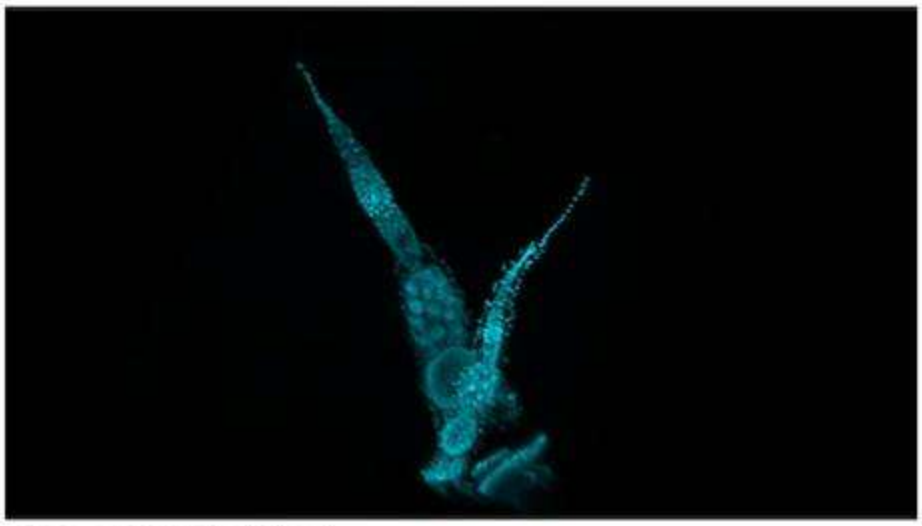
In one species, the clonal raider ant, Ooceraea biroi, the team added this hormone to worker ants and activated their ovaries. This suggests that an extra dose of insulin may make the difference between foraging for food like a worker or laying eggs like a queen.

During development, the larvae that are destined to become queens eat more than the ones destined to become workers, which at least partially explains their higher levels of insulin-like peptides, Dr. Kronauer said.

The team also found that insulin levels drop in worker ants when they’re exposed to ant larvae. A bit like people getting hungry when their insulin levels fall, these worker ants are driven to seek food when they are exposed to larvae — which they then feed to their hungry young.

“From an evolutionary perspective, that’s a pretty clever way to make an organism social,” Dr. Kronauer said.

Ant ancestors developed the queen-worker social structure because it provided an evolutionary advantage. The new study suggests that insulin signaling could have driven that evolution.



Ovary suppression in a clonal raider ant.

Vikram Chandra & Ingrid Fetter Pruneda

There are 14,000 species of ants, all of which are believed to share the same mechanism of differentiation between queens and workers.

Wasps, bees and other insects are thought to have evolved along another pathway, so insulin signaling is unlikely to be the defining distinction for them, said Roberto Bonasio, a molecular biologist at the University of Pennsylvania's Perelman School of Medicine, who was not involved in the research.

"I think the question is, how does something so difficult seem to happen repeatedly in different branches of life?" said Dr. Bonasio, whose lab studies how genes change in the brain as ants change behavior.

With this experiment, the researchers lend support to the theory that changes in insulin signaling is one of the ways this can come about, he said.

In people, when we eat, insulin is released into the bloodstream, enabling cells to take in sugar and use it for energy. Problems with this insulin system lead to diabetes. In ants, these insulin-like peptides regulate a lot of activities including metabolism, longevity and reproduction, Dr. Bonasio said.

There is more work to be done to confirm these findings and to figure out what other types of genes are at work, he said. Such genetic analysis is tricky, he added, and more than half of key genes identified in the study were involved in activities other than insulin signaling.