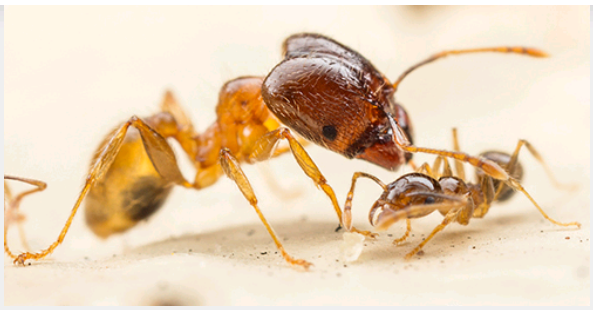
Study: Big-headed ants grow bigger when faced with fierce competitors



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Big-headed ants get their name from the soldier ants, left, which are larger than other workers and have disproportionately sized heads. The ants pictured here are from Australia.

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10/2/2014 | Diana Yates, Life Sciences Editor | 217-333-5802; diya@illinois.edu

CHAMPAIGN, Ill. — The big-headed ant (*Pheidole megacephala)* is considered one of the world's worst invasive ant species. As the name implies, its colonies include soldier ants with disproportionately large heads. Their giant, muscle-bound noggins power their biting parts, the mandibles, which they use to attack other ants and cut up prey. In a new study, researchers report that big-headed ant colonies produce larger soldiers when they encounter other ants that know how to fight back.

University of Illinois entomology professor Andrew Suarez (left) and postdoctoral researcher Bill Wills discovered that big-headed worker ants grow larger in the presence of other competitive ants. | Photo by L. Brian Stauffer

The new findings appear in the Biological Journal of the Linnean Society.

Big-headed ants are world travelers, hitching rides with humans to get around. Scientists have found them in more than 1,600 sites across the globe (see map). Their arrival at a sufficiently warm destination (they cannot tolerate cold weather) spells almost certain doom for native ants, spiders, beetles and other invertebrates that are unaccustomed to their brand of warfare.

"If you think about the worst invasive species, ants frequently show up on those lists, and big-headed ants are among the most problematic," said University of Illinois entomology professor and animal biology

The big-headed ant is a world traveler found in more than 1,600 sites around the globe. | Graphic by: Julie McMahon, after James K. Wetterer

department head Andrew Suarez, who led the new study with postdoctoral researcher Bill Wills. “They are very aggressive. And unlike a lot of native ants, they produce large numbers of queens, so they have incredibly high potential for reproduction.”

Big-headed ants spread out, assembling multiple nests that cooperate on defense, reproduction, territorial expansion and food procurement, the researchers said.

Soldiers and non-soldiers in a *Pheidole megacephala* colony are sisters, so genetic changes do not account for their differing morphology. Changes in nutrition during development are primarily responsible for their different shapes and sizes, Suarez said.

“We know that you can feed larvae differentially and that will change hormone levels that will cause a completely different developmental pathway to turn on, so you get this giant head, you become a big-headed ant rather than a small worker,” he said.

The team wanted to know if environmental cues, such as the presence of other aggressive ants, would cause the big-headed ant colonies to produce more, or bigger, soldiers. To study this, they looked at the ants in five locales: Australia, Florida, Hawaii, Mauritius (an island off the southeast coast of Africa) and South Africa.

“Hawaii is interesting because there are no native ants there, so a lot of the local insect and arthropod fauna are not necessarily adapted to dealing with social insects,” Wills said. “But the native ant fauna in Australia is very dominant and diverse.”

The study sites in Florida, Mauritius and South Africa represent a kind of intermediate condition, where the big-headed ants encounter competitors that are not as fierce or diverse as the ants of Australia, he said.

The team found that big-headed soldiers and non-soldiers grew largest in Australia and smallest in Hawaii. On average, the Australian big-headed ant soldiers were three times more massive than their equivalents in Hawaii, Wills said. The ants at the other study sites were intermediate in size.

Genetic analysis showed that the ants from all the study sites were closely related, Suarez said, ruling out the possibility that size variation was the result of long-term evolutionary change.

“This shows that they were able to adapt to a new environment relatively quickly,” Suarez said. “It’s kind of exciting and scary that it can happen so quickly.”

(In a separate study, Wills found that fire ants can begin to morph their body size within 60 days in a new environment.)

The big-headed ants produced bigger workers in response to external cues, but they did not generate a larger share of soldiers in any of the sites, Suarez said.

“We found that the ratios of soldiers to non-soldiers were relatively constant across our populations,” he said

The researchers hypothesize that the ants use chemical signals called pheromones to determine when the nest has the right proportion of soldiers to other workers. If this turns out to be the case, scientists may be able to control the ants with chemical signals without disrupting the surrounding ecology, Suarez said.

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The paper, “Body size variation and caste ratios in geographically distinct populations of the invasive big-headed ant, *Pheidole megacephala* (Hymenoptera: Formicidae),” is available online or from the U. of I. News Bureau.