Leaf-cutter ants

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Leaf-cutter ants, which cultivate fungus for food, have many remarkable qualities. Now there's a new one to add to the list: these ant farmers, like their human counterparts, depend on nitrogen-fixing bacteria to make their gardens grow. Credit: University of Wisconsin

Leaf-cutter ants put on quite a show. In established colonies, millions of "workers" cut and carry sections of leaves larger than their own bodies as part of a well choreographed, highly functioning society.

"Anyone who has ever come across a trail of ants cutting leaves and watched that trail run through the forest can recognize how charismatic, and what kind of large impact they have on the tropical ecosystems in which they occur," says bacteriologist Cameron Currie.

With support from the National Science Foundation (NSF), Currie and his team study ants and their complex, productive societies to help address some of human society's most pressing challenges, such as better drugs and cleaner energy.

But for Currie, the research is more than just finding solutions to problems. "My doctoral work on leaf-cutting ants was not from an 'Oh, we can discover enzymes for bio-energy,' or 'Oh, we can discover antibiotics for medicinal use.' It was from a fascination with understanding the interaction of organisms in the natural world," says Currie from his lab at the University of Wisconsin-Madison.

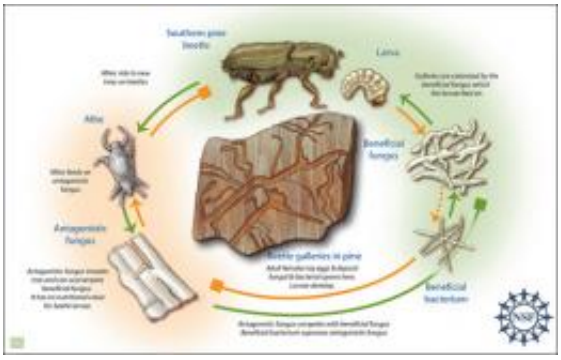
For example, these ants may have been the planet's first farmers. The insects chew up the leaves they cut and integrate them into a fungus garden, which then becomes both their food and their living space. This "mutualism" between the ants and the fungus was discovered in the late 1800s.

In the wild, primarily in Central and South America, large colonies may have as many as five to 10 million workers, with up to seven different castes, or job categories. Different-sized animals do different tasks. The queen, far larger than the others, may lay 50 million eggs over a lifetime. Soldiers protect the nest; workers gather leaf material. "Minima" or smaller workers are specialized for moving around in the small spaces of the fungus garden.

"This includes elaborate behaviors for tending their food crop. So, they actually groom it, and clean it, and prune it," explains Currie.

There is also a specialized group of ants that are the trash workers, who carry the old garden material and put it in specialized refuse dumps.

A third "player" is also crucial in this symbiotic city.



Many microbes, plants and animals benefit from 'friendly' associations. Researchers describe the complex relationship between a beetle, two types of tree fungus and a bacterium that aids in their struggle to survive and thrive. Adult beetles have a specialized compartment in their bodies used to store two other organisms: a slow-growing beneficial fungus that serves as a food source and a bacterium that produces a recenly discovered antibiotic. Interestingly, the antibiotic inhibits the growth of a fast-growing competitor fungus but does not affect the slow-growing beneficial fungus. Credit: Zina Deretsky, National Science Foundation

Bacteria found on the bodies of the ants produce antibiotics that help maintain the health of the fungus garden. "Our current evidence indicates that the ants have been dealing with diseases in their fungus gardens for millions of years," says Currie.

Over the years, these bacteria appear to have evolved new antibiotics to keep the gardens healthy. This co-evolution could help researchers create new antibiotics for humans.

Energy experts

Leaf-cutter ants are also adept teachers in energy research. The Currie Lab works with a wide range of experts at the Great Lakes Bioenergy

Research Center (GLBRC), a multi-institutional partnership at the University of Wisconsin-Madison working to create fuel from the non-edible parts of plants, known as cellulosic ethanol.

"Our understanding of the process of breaking down that plant material to produce digestible nutrients for the ants is very limited," says Currie.

Figuring out how the ants do it could lead to cleaner replacements for petroleum.

"We hope to both reduce society's dependence on fossil fuels and generate those fuels from a feedstock that isn't part of the food chain," explains Tim Donohue, professor of bacteriology and director of GLBRC. "We think biofuels have a clear position in replacing the fossil fuels that go into the automotive and aviation sector, and we hope that we'll be able to generate fuels that are efficient, cost effective, [and] equally important, sustainable, from an economic and environmental perspective."

GLBRC is supported by the office of science in the U.S. Department of Energy. Donohue says the success of this renewable energy work could also provide farmers and foresters with a second revenue stream from their agricultural products; essentially another income from what is now a waste product.

Still fun to watch!

The nonstop work of these social insects can be mesmerizing to just about anyone who observes them. There's a display of a live leaf-cutter community in the lobby of the Microbial Sciences Building on the Madison campus, and an Ant Cam.

"The display is really a great thing for education," says Joseph Moeller, a

lab technician in the Currie Lab. "We have lots of people of all ages, always interested in the types of things these leaf-cutter ants can do, and interested in how we travel down to Panama and Costa Rica to collect these ants to come back and study them."

For Currie, who has had his share of bites from angry "soldiers" over the years, the discoveries never get old.

"Working on leaf-cutter ants, doing field work is a major passion," he says. "The connection of seeing your study organism in the field, what it is doing, watching the ants carry leaves, it's captivating, and very exciting seeing the ants in their ecosystem, and their role and their function."

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