ScienceWatch - Leaf-Cutting Ants: The Original Organic Farmers

Ants are fascinating creatures. Their behavior as social insects parallels ours in many ways. They make war, keep livestock and even enslave other ants. About 50 million years ago some ants also invented farming. These leaf-cutting ants (Attini) are well known (some of you may remember the colony on display at the Reptile House in the Bronx Zoo). They are widespread in the South American tropical forest (the "Attine" genera contain about 210 species), where they form a major component of the ecosystem. Estimates are that they consume as much as 15% of the leaf production of the forest. A single colony may contain 8 million individuals, with the biomass of a cow, and like a cow they cut vegetation from the forest and chew it to a pulp.

The similarity to a cow ends there because the ants do not consume the pulp. Instead, they use it as a substrate in their underground gardens to propagate a mushroom-like fungus (*Lepiotacea*, spp.), which they eat. So important is the fungus to the ant that each founding queen carries with her a fungal pellet from her old nest as a "starter" for her new garden. This association between ant and fungus is a textbook example of a mutualistic symbiosis. The fungus benefits by being spread among ant colonies and the ants benefit by having a staple crop. Extensive studies of the ant-fungus association have shown that pests rarely attack the ant fungus farms. Scientists have long believed that the ants keep them out by being scrupulously clean.

More recent studies present a story that is much more fascinating. In one study, yet to be published, Cameron Currie and colleagues show that a parasitic fungus in the genus *Escovopsis* is capable of infesting the ant fungal gardens. The fungus is an extremely potent pathogen that grows only in the garden. Apparently, foraging ants bring hitchhiking spores into the nest where, like many well-adapted parasites, they can remain for some time, waiting for the moment when the health of the garden is compromised. Once this occurs *Escovopsis* overgrows and destroys the fungal crop, forcing the ants to abandon their garden.

What prevents most ant fungus gardens from succumbing to this virulent pathogen? Currie *et al*. have made a stunning discovery, published in the April 22nd issue of *Nature*; the ants protect their fungal farms with an antibiotic they administer to their food crop. The ant colony does this by constituting what amounts to a pharmaceutical laboratory. The outer covering (cuticle) of leaf-cutting ants has special areas coated with what to the naked eye appears to be a whitish-gray crust. Earlier investigators thought this was a waxy coating produced by the cuticle. Closer examination by Currie and his colleagues, using a scanning electron microscope, revealed that the "wax" was actually the filamentous growth typically exhibited by bacteria of the genus *Streptomyces*. This group produces over half the antibiotics used by humans (Streptomycin was the first one discovered in 1944 at Rutgers University.). The bacteria were found on queens and

workers, but not males, of all 22 species of attine ants studied. The males play no role in nest founding or gardening.

When the scientists studied the antifungal ability of the bacteria, they found potent inhibition against the garden parasite (*Escovopsis*), but not other fungi. Amazingly, not only do the antibiotic-producing cells inhibit the parasite, they also promote the growth of the garden fungus. Thus, they form the perfect complement to the ant-fungus association.

Understanding the use of antibiotics by ants could have great benefit for our own survival. During the 60 years we have been using (and over using) antibiotics, the evolution of disease-causing microbes that are antibiotic resistant has outpaced our ability to develop new drugs. "Hospital staph" and "drug-resistant TB" are just two examples of potentially lethal pathogens that evolved during our brief "age of antibiotics". How have the ants been able to use an antibiotic for tens of millions of years without also producing a resistant pathogen? What goes wrong when the parasite destroys the garden?

The answers lie in gaining an understanding of the evolutionary "arms race" occurring over the last 50 million years, during which parasite, bacteria, ants and the fungal crop have all evolved as a group. Hopefully, we can conserve the rapidly disappearing rain forest so we have the chance to learn from the ant.

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