ScienceWatch - A Pharmacy in the Woods

"In much the same way that we recognize the power of these (antibiotic-producing) microorganisms, I think other organisms, in an evolutionary sense, have also recognized their power" — J. Scott

In nature a vast array of associations between species can be found. These relationships are fascinating because they show us the myriad ways organisms interact, and they provide insights into how these intricate relationships continue to evolve. Symbiosis, the living together of two species, can be viewed as a sliding scale of relationships. At one extreme is mutualism, where both species benefit. At the other extreme is parasitism, where one benefits and the other is harmed or even killed. In between these extremes exists a spectrum of associations.

For example, at one end we see lichens, an association of an alga and a fungus. The fungus provides support and shelter; the alga provides food from photosynthesis. Sliding along the spectrum, many orchids live as epiphytes in tree branches where they benefit by gaining sunlight without harming the host tree, which gains nothing. At the other extreme are strangler figs, which also start out as epiphytes, but eventually overwhelm and strangle the host tree.

Insects provide many interesting examples of symbioses. For example, leaf-cutting ants live in a close mutualistic association with a fungus, farming it for food- see- *ScienceWatch - Leaf-Cutting Ants: The Original Organic Farmers* (November/December 1999). Bark beetles, insect pests responsible for killing millions of acres of pine forest in the U.S., are another example. The mountain pine beetle (*Dendroctunus ponderosae*) infests its preferred host, lodgepole pines in the west, while the southern pine beetle (*Dendroctunus frontalis*) attacks many pine tree species in the south. Lack of hard, cold winters in recent decades has aided the beetles in their destructive march.

In the case of the southern pine bark beetle, the attack begins when the tiny brownish-black female selects a tree, usually one that is stressed, drills through the bark, digs galleries in the wood and lays her eggs. Like the leaf-cutting ants, the female lives in a mutualistic relationship with a fungus (*Entomocorticium sp.* A), which she carries with her in a specialized structure (mycangia) beneath her throat. The fungus grows in the galleries, living off the tree's vascular tissue (phloem), and eventually killing the tree. As the fungus grows it nourishes the hatching larvae, while the adults live off the inner bark layer, the cambium. Soon after the initial attack the female releases an attractant pheromone (frontalin), which brings many more beetles. In response to the drilling, the tree secretes sticky, white resin into the holes, which sometimes entombs the beetles. But the *Entomocorticium* fungus also aids the beetle in its battle by blocking the flow of resin. The beetle–fungus relationship is a fine example of mutualism; the fungus is spread by the beetle and in return provides it with food and protection.

Now new research shows that another microbe, a bacterium, is involved in this drama, forming a complex tripartite association. Writing in the October 3, 2008 issue of *Science*, a team led by Jarrod Scott and Cameron Currie, Department of Bacteriology, University of Wisconsin, Madison, WI, reports that the pine beetle harnesses a previously unknown bacterium to protect its fungal food source from a competing fungus brought in by mites that live on the beetle. The competitor (*Ophiostoma minus*) also grows on pine phloem, but provides no nutrition for beetle larvae. Consequently, beetles reproduce poorly in trees with luxuriant growth of *O. minus*.

Using a scanning electron microscope, Scott *et al*. could see bacteria growing profusely in the beetle galleries as well as in the beetle mycangia. DNA analysis of isolated bacterial cells put it in a group famous for its ability to produce streptomycin and a host of other antibiotics. This *Streptomycete* bacterium also produces an antibiotic, which the team isolated, and the new antibiotic proved to inhibit the growth of the competing *O. minus* fungus, but not the *Entomocorticium* food fungus. A similar situation exits for the leaf-cutting ants also studied by Currie and Scott.

These findings are exciting because, according to Currie, “If we actually start to look, we may find these associations to be very common.” He says the new antibiotic could have broad spectrum activity against human pathogenic fungi and that many anti-fungal agents also act as anti-cancer drugs.

Nature’s pharmacy has always been there, we just have to look for it when we walk in the woods.

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