

## **Multitrophic Interactions between Insects, Fungi and Plants: Using Naturally Produced Chemicals to Solve an Invasive Species Problem.**

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The beekeeping industry is critical to many agricultural crops. In fact pollination by domesticated European honeybees is the only way in which some crops, like almonds, are pollinated. Recently, an invasive pest of honeybees, the Small Hive Beetle was introduced into North America. Beetles invade hives and feed on pollen, bee brood, and ruin honey with their feces. As such, the beetle invasion has had a dramatic effect on the \$14 billion/year apiculture and pollination industries in the United States, already are at risk from Varroa mites, other bee pests and diseases. We have discovered that the beetles are attracted to honeybee alarm pheromones. We also isolated a yeast vectored by the beetles which, when grown on bee collected pollen from plants produces the bee alarm pheromones. European bees are less responsive to alarm pheromones and less aggressive in repelling intruders than the original host of the beetle, African honeybees, and fail to recognize the beetle invasion until it is too late to avoid colony collapse. Using this knowledge we have developed effective monitoring and control programs for the beetle using both in hive traps and traps external to hives baited with the yeast which produces the attractants. This provides the first demonstration of the use of multitrophic level semiochemical communication in insects and its application to control of invasive species.