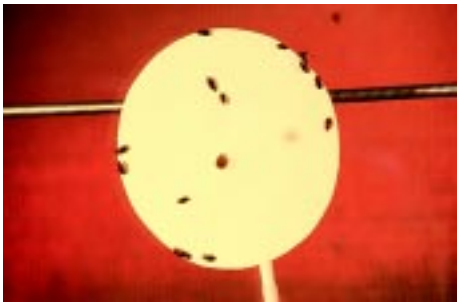
Microbes Produce Sap Beetle Attractants

Microbes—an Unlikely Source of Insect Attractants

KEITH WELLER (K8362-1)



Enticing odor from a microbial source draws sap beetles to a target.

Fooling the pineapple beetle hasn't been easy, but Agricultural Research Service scientists have finally begun to trick this pesky sap beetle—with chemical scents.

The research may lead to commercially synthesized "airborne calling cards" that will sucker sap beetles in the Nitidulidae family into field and warehouse traps. By monitoring these traps, growers and shippers will know whether they need to apply pesticides.

Besides munching on pineapple, *Carpophilus humeralis* eats dates, citrus, and sugarcane. Ordinarily, when a male nitidulid beetle gets a whiff of a favorite fermenting food, he makes his own chemical attractants to call males and females alike to join in one big feeding party.

Now, ARS entomologist Robert J. Bartelt and colleagues at the National Center for Agricultural Utilization Research (NCAUR) in Peoria, Illinois, have identified and chemically synthesized such attractants, called aggregation pheromones, for nine nitidulid species. But in research on the pineapple beetle, all three attractants they've identified so far aren't produced by the beetle but rather by microbes.

Bruce Zilkowski, an ARS technician turned support scientist, gained insights that led to these discoveries as he researched the chemical ecology of *C. humeralis* as part of his master's degree thesis.

The NCAUR researchers discovered that some organic compounds of microbial origin were unexpectedly powerful nitidulid attractants. One new chemical, called 2-5-diisopropylpyrazine, had never before been observed in nature, though it had been made in the laboratory. The microbe that produced it hasn't been identified.

The other two compounds, 2-phenylethanol and 4-ethyl-2-methoxyphenol, are common natural products of microbial and plant origin used in research.

The researchers first isolated and identified the attractive volatiles coming from decaying oranges that either male or female adult beetles had fed on. Because only male sap beetles are known to produce aggregation pheromones, the attractants clearly had to have come from a different source.

To prove that theory, the scientists switched to a different fruit—sterilized pineapple that the nitidulids had never fed on. The researchers inoculated some flasks containing the pineapple with a mixture of microbes cultured from beetle-infested oranges. After the microbes incubated a few days, large amounts of the attractants began emanating from the inoculated pineapples but not from the sterile controls.

To continue their research, the scientists purchased the two common chemicals and synthesized a stock of the pyrazine.

Beetles in a wind tunnel were most

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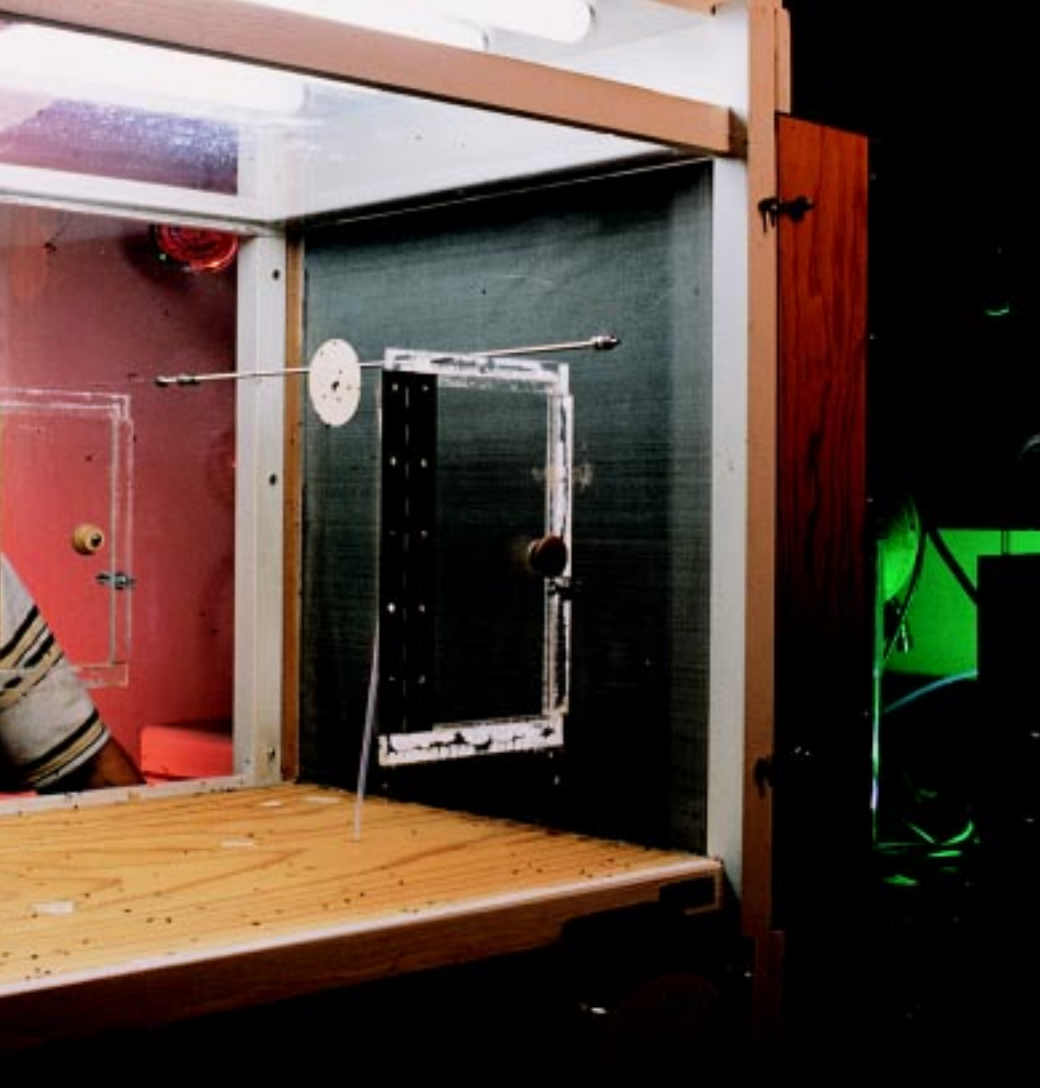
Entomologist Bruce Zilkowski observes sap beetles flying upwind in a wind tunnel, drawn to attractive volatiles emanating from a tube.



attracted to minute quantities of the compounds when they were all mixed together with common food fermentation chemicals such as propyl acetate, which by itself is only mildly attractive. "We weren't surprised by this synergism," Bartelt says, "because mixtures of compounds always seem to attract nitidulids better than single compounds."

Until the scientists identified the pineapple beetle attractants, they had focused most of their attention on pheromones and small volatiles from fermentations. "Now we know some of the larger microbial compounds can also play an important role in attracting nitidulids," says Bartelt.

NCAUR scientists have been collaborating with researchers around the world in both laboratory and field research involving at least a dozen *Carpophilus* species, most of which are pests of crops and stored commodities in tropical and subtropical regions.

In Illinois, a model insect for their field research is the dusky sap beetle, which often causes unsightly damage to local sweet corn. Besides infesting corn, the dusky sap beetle—like many of its nitidulid cousins—is a generalist, feeding on a wide variety of ripening fruits and vegetables.

One particularly powerful combination of pheromone and fermentation scents that the researchers synthesized attracts a species called the confused sap beetle. In a date garden in California, individual traps baited with the pheromone-scent formulations have captured as many as 100,000 of these beetles in a single day.

So What's the Holdup?

Despite successes in synthesizing reliable and powerful pheromones, Bartelt says there are impediments to commercializing the technology. Chemical synthesis often involves numerous costly steps.

Because various beetles mostly inflict the greatest damage on less extensively grown crops, market development for pheromone traps tailored for these low-acreage niche crops is economically problematic.

Further, serious infestations in the niche crops are intermittent, depending somewhat on weather conditions. Nonetheless, in some recent years, nitidulids have caused about $2.5 million in damages to the California fig crop alone.

Timely control would be more important than only minimizing direct feeding damage to commodities. Damaged goods often invite toxin-producing microbes into the picture. Although nitidulid damage to field corn is usually negligible, the insects can infect kernels with the fungus *Aspergillus flavus*, which often produces the metabolic byproduct known as aflatoxin.

Nitidulid control may take on increased importance as "greener" methods are developed to deal with other insects. For example, corn genetically engineered to produce *Bacillus thuringiensis* (Bt) toxin controls caterpillars. But when spraying the crop for caterpillars becomes unnecessary, nitidulids may thrive. That's because the nitidulids that might have been controlled by the spray would not be affected by Bt. And should a type of peach be developed that can be picked and shipped riper, the beetles might be more attracted to them.—By **Ben Hardin,** ARS.

This research is part of Crop Protection and Quarantine, an ARS National Program described on the World Wide Web at http://www.nps.ars.usda.gov/programs/cppvs.htm.

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