MOTHS, BEETLES AND COCKROACHES MAKE ROOM FOR APPLE MAGGOTS

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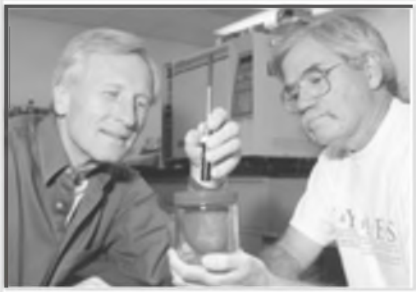

Suggested caption: Under a $1.6 million grant from the NSF, Cornell University entomologists Wendell Roelofs (left) and Charlie Linn (right) use solid phase micro extraction to absorb fruit chemicals from an apple and determine what volatiles trigger apple maggot responses. CREDIT: R.Way/NYSAES/Cornell

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GENEVA, NY: For the last 20 years, European corn borers, scarab beetles, and German cockroaches had the run of the insectary, the electroantennogram, and the wind tunnel at the New York State Agricultural Experiment Station in Geneva. But a $1.6 million grant from the National Science Foundation (NSF) is making room for maggot flies.

Charles E. Linn and Wendell L. Roelofs received the grant to study how populations of the pesky apple maggot, *Rhagoletis pomonella*, shifted from one host plant to another to become a separate species. The Cornell University entomologists will collaborate with Stuart Berlocher of the University of Illinois and Jeffrey Feder of Notre Dame on the five-year, interdisciplinary project.

"The grant is one of the first to be funded by the NSF under a new initiative that seeks to stimulate collaborative research in environmental biology," says Roelofs, who is the Liberty Hyde Bailey Professor of Biochemistry. "Over the last two decades, our lab has developed key technologies that make it possible for us to apply this kind of research to other species of insects, and we are excited to do so."

The NSF Initiative

The NSF initiative is designed to meet a growing need for larger integrated research projects that address major issues across the fields of ecology and evolution. Environmental biology includes the fields of systemic biology, population biology, ecology, ecosystem studies, ecological and evolutionary physiology, and animal behavior.

"Aspects of our project fall into all the fields the NSF is interested in with this new initiative," says Linn, the senior research associate on the project whom Roelofs credits for tapping into the five-year "Mother Lode" from the NSF. "The biology of the *R. pomonella* fly makes them ideal for research on the ecology of speciation, We hope to use them to help answer questions in ecology, behavior and genetics," says Linn.

The NSF recognizes that insects are model systems for higher orders of animals, including humans. Solving questions of insect behavior helps shed light on the larger questions of evolution that plague biologists.

The research has applied implications as well. *R. pomonella* is a major pest of apples, and related species attack cherries, blueberries, walnuts, green peppers, tomatoes, and several other crops. By deploying the tools of molecular genetics, the researchers hope to understand exactly how flies of one species spread to different host plants and why domesticated plants are attacked–research that could have important consequences for designing effective pest management schemes for these related maggot species.

Technology is Key

"Dr. Stuart Berlocher and Jeffrey Feder have been working on the *Rhagoletis* flies for many years trying to determine the genetics of host plant shifts, but have been stymied because they could not assess hybrid flies for their behavioral responses to host odors," says Roelofs. "When we developed the techniques to identify key volatiles and to study the attraction of flies to the various volatiles, the whole project became possible. The NSF has recognized that we need all of our research labs working together to go to the next level on this research."

Roelofs and his associates have devoted 30 years to unraveling the secrets of insect communication. It is this track record that helped them secure the prestigious NSF grant. They have documented that sex mating behavior between males and females is chemically linked to odors known as sex pheromones, and determined how male insect s receive the blend. In current research involving antennal lobe transplantation in European corn borers, they are studying how insect behavior is mediated in the central nervous system and how the behavior is genetically and hormonally controlled.

Several technologies developed and refined at the Geneva Station will be used to achieve the goals of the NSF grant. Several techniques for identifying host odors or volatiles were combined and applied to insects by Aijun Zhang and Roelofs using Solid Phase Micro Extraction (SPME), Gas Chromatography (GC), and Electroantennogram Detection (EAD). In the SPME phase, a tiny needle is used to absorb volatiles from the fruit, and inject them directly into the gas chromatograph, without contamination by solvents at the concentration the flies encounter in the field. Using an antenna from the insect itself as a detection device (EAD), the researchers determine which fruit chemicals or volatiles trigger the insect's response. Using a flight tunnel he developed, Linn then tests the adult insect response to the volatiles of the various host plants. Throughout the entire process, larvae and adults are gathered in the field. Subsequent generations are reared in growth chambers called insectaries, where diet and environment are very closely controlled by Harvey Reissig's

research group. The Barton Lab insectary at Geneva is the insect equivalent of the Bronx zoo.

Under the NSF grant, further work will involve hybridization studies to cross flies and test the behavior of subsequent generations. The populations with a given set of mating behaviors will be sent to Illinois and Notre Dame where researchers will use advanced molecular mapping techniques called quantitative trait loci (QTL) to determine which genes control host plant specificity and where those genes are located in the chromosome.

Roelofs is one of the principal figures in the field of insect biochemistry. His identification and synthesis of a series of sex pheromones from the Oriental fruit moth, the redbanded leafroller, and the European corn borer, together with the novel approach of using electroantennogram (EAG) bioassays, led to the development of the biocontrol of insects as an alternative to pesticides. For this work, he received the prestigious Wolf Prize for Agriculture in 1982.

But Roelofs is as humble as he is competitive on a tennis court and team-oriented in the lab. "I am like the ‘coach’ of our research team. The real players are the academicians and technicians who are doing the work in the laboratory."