Everett Foreman—

Listening to Insects

What does a fruit fly maggot sound like as it feeds on grapefruit pulp?

Everett Foreman considers the question. "It sounds like Rice Krispies popping in milk—you hear little pops and clicks, which are the sounds of the larvae tearing at the pulp and chewing it," he says.

Foreman remembers this as one of the first insect sounds he heard when he started working for USDA's Agricultural Research Service in the summer of 1984, before his senior year in high school. At an agency lab in Gainesville, Florida, he assisted engineer J.C. Webb on a project to detect larvae inside citrus without having to cut open the fruit. To accomplish this, Webb, now retired, devised a stethoscopelike microphone system that he attached to an intact citrus fruit so he could hear the sounds of larvae chewing.

KEITH WELLER

After ARS entomologist Richard Mankin (left) inserts a sensitive microphone into the grain sample container, engineering technician Everett Foreman will place them both in a sound-insulated cylinder that allows the chewing sounds of insects to be detected and amplified. (K7361-1)

In 1985, after graduating from Gainesville High School as co-valedictorian of his class, Foreman entered Northwestern University, where he studied electrical engineering. While at college, he returned to Gainesville each summer to work at the agency's Insect Attractants Laboratory, which specializes in finding environmentally friendly ways to control insects. He joined the lab full time after graduating in 1989. Today, it has been merged with a neighboring lab to form the ARS Center for Medical, Agricultural, and Veterinary Entomology.

Foreman now works at the center as an engineering technician and helps students there get a sense of what the world of laboratory research is all about. "I often take the role of mentor, and I really enjoy it," he says.

In one project, he's working with Cornelius Dunmore, a sophomore at Florida A&M University, on the feeding patterns of insects that commonly infest stored products during their life cycles—and how sudden increases in temperature affect insect feeding. Foreman's work with Dunmore is part of an ongoing agency program to give students a first-hand look at science.

And who better to do that than a former student who hasn't lost that initial fascination with those grapefruit-munching fruit flies? Today, Foreman is still listening to the flies, only now he's measuring their mating calls. But he spends most of his time listening to weevils munching on stored grain.

In late April, Foreman accompanied Gainesville lab scientists Richard Mankin, Dennis Shuman, and David Weaver on a trip to a USDA Federal Grain Inspection Service office at a commercial grain elevator in New Orleans, Louisiana.

There, they conducted successful field tests on a system called ALFID (Acoustic Location Fingerprinting Insect Detector), which will make it possible to detect hidden insect infestations in grain samples. One of Foreman's main tasks on the trip was to record and compare background levels outside and inside the acoustic shielding device that protects ALFID from external noise.

"Everett spends a lot of his time setting up complex insect-listening devices, recording sounds, and working with computer programs to analyze the sounds," says Mankin, who is Foreman's supervisor. "He'd be really hard to replace, because I can turn these tasks over to him and know they'll be done right."

Several years ago, for example, Mankin, Foreman, and cooperators wound up on Brush Key, an island off the Florida Gulf Coast near Naples, where they set up microphones, recorders, and computers to detect and analyze the sounds of salt marsh mosquito swarms.

"You could hear this low, widespread insect buzz—like a mosquito flying in your ear, except a lot louder," he says. There could be 5 to 10 million mosquitoes emerging in a typical swarm—enough to make you itch just thinking about it.

"The idea was to determine when and where swarms would occur, so we could help mosquito control agencies know where to apply pesticides or use other control procedures," he says. "We've also

Inside a sound room, or anechoic chamber, Everett Foreman and Florida A&M University student Cornelius Dunmore insert an insect detection device into another kind of portable, sound-insulated enclosure. Photo by Keith Weller. (K7358-1)

looked into using the sounds to attract mosquitoes to traps."

Trapping is also part of the idea behind listening to fruit fly mating calls. "We're trying to determine what it is in a male fruit fly song that is most attractive to a female fly," Foreman says.

If you can determine the ideal male mating call, you might be able to use it to help attract females to pheromone traps. Pheromones are chemical scents that the males emit to attract females over long distances. The calling song, or buzz, attracts females once the scent has drawn them close.

How loud is a male fruit fly's mating call? "About 50 decibels at 2 centimeters," says Foreman.

How about a swarm of male mosquitoes at 10 yards? "About 35 decibels," he says.

And how about a weevil in a grain kernel? "Very quiet—about 15 decibels. To give you a frame of reference, a person whispering at 4 feet is about 20 decibels, tree leaves rustling in a breeze is about 10 decibels, and heavy traffic noise is about 90 decibels."

The fruit fly mating calls vary, Foreman says, depending on how long the males buzz their wings to create the sounds.

"They might buzz for three-tenths of a second, delay for that long, then continue. These buzz-stop, buzz-stop patterns are the calling songs, and some are more effective than others at attracting mates."

Foreman says recent cooperative work with the Florida Division of Plant Industry has centered on sorting males into good and bad mating groups, based on their mating calls.

So far, Mankin says, research shows that "the best at mating seem to have better control over their wingbeat frequencies, and their mating calls tend to be a little bit lower in pitch. Bigger insects have bigger wings, so they don't have to beat them as fast."

Foreman never thought he'd wind up in this line of work. It wasn't part of a grand plan. Some people know from a young age what they want to be when they grow up, but he wasn't among them. He always excelled in math and science, and he remembers how much he enjoyed getting hold of his first computer in the seventh grade. But he also did well in the liberal arts. His mother is a school teacher, and his father is a university English professor.

"I don't think my parents still fully understand what I do," he says with a laugh. Eventually, he picked engineering over liberal arts. "It wasn't as clear to me what you could do with an English or history degree as it was with an engineering degree," he says.

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Foreman first heard about the lab's summer program for students from a high school guidance counselor. At the lab, electrical engineer Carl Litzkow, who worked with Webb, encouraged Foreman to consider engineering. "He gave me a lot of help," Foreman says of Litzkow. "He showed a lot of interest in my future."

Scientists at ARS are urging Foreman to go even further with his career. Last year, he was invited to ARS headquarters in Beltsville by national program leader Ken Vick, for whom Foreman once worked at Gainesville. Vick says he wanted to give Foreman a chance to explore other engineering job opportunities in ARS. Foreman appreciated the chance, and is now considering whether to return to school for his doctorate—a must for anyone pursuing a research career.

"I've really come to enjoy the research end of my job," he says. "It's possible I can combine engineering acoustics with entomology. The science of acoustics is being used more and more to learn about insect behavior."

He says he'll soon decide whether to return to graduate school in the fall of 1997.

How helpful was the student program to Foreman?

"It's been very important," he says. "The lab atmosphere is very good for high-quality research. The level of cooperation and interaction between scientists and support staff has been a big help to me. I've been fortunate to have the chance to work with good people at ARS."—By **Sean Adams,** ARS. ◆