

Companies Seek Out These Tiny Assassins To Fight Crop Pests

A Biopesticide Maker Prowls Wilderness Areas to Find Fungi, Parasites and Spores

By JOEL MILLMAN

DAVIS, Calif.—The autopsy began. “See?” Pamela Marrone said, nudging another scientist closer to the blackened corpse. “The white thing—it’s growing out of the right side of his head.”

Wrinkling her nose at the aroma of decay, cadaver specialist Sherry Heins leaned in. “But how do we know it’s the cause of death?” she asked.

The two women stuffed the victim—all two centimeters of a recently deceased corn-ear worm—into a glass chamber filled with cornstarch and molasses. If the bacteria that killed the worm were still alive, they would gorge on the sweet sludge and swell up into something big enough for Dr. Marrone and her team to study.

Corn-ear worms destroy corn crops. Dr. Marrone’s biotech company, AgraQuest Inc., hunts for worm-killing germs. It also seeks fungi, parasites, spores and anything else that kills crop-eaters in the wild.

The Davis, Calif., company is one of a new generation of “biopesticide” makers that search for innovative ways to kill crop pests without using synthetic chemicals. Though the science of biopesticides is decades old, it’s rather new in commercial enterprises, with a slew of products just coming to market. Some of the companies breed insects and other bugs to eat the pests. Others develop carriers of deadly microbes to poison the pests. Still others search for the specific germs that kill pests and mass produce the microscopic assassins. Most of these companies are small start-ups, few of whom have yet to show a profit. Their business plans read like part science fiction, part “CSI: Fruit Orchard.”

Take Pasteria Biosciences LLC, a Gainesville, Fla., start-up that is raising capital to kill nematodes, worms that attack plant roots. Pasteria uses a fermentation process to reproduce a killer microbe called *Pasteria penetrans*, which burrows into nematodes and prevents them from producing eggs. Soybean plantations and golf courses, both veritable salad bowls for nematodes, could be huge markets, says Tom

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Pamela Marrone

Wall Street Journal

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Hewlett, a nematologist who launched Pasteria in 2003.

Then there’s *Trichoderma harzianum*, a microbe discovered at Cornell University, which is now marketed by BioWorks Inc. of Fairport, N.Y. *Trichoderma* grows a shield around a plant’s roots, and secretes an enzyme that destroys invading fungi. Another firm, Certis USA, a unit of Japan’s Mitsui & Co., produces a bug killer, called Azadirachtin, from the sap of Asia’s neem tree, which poisons aphids and whiteflies.

Overall, biopesticide sales are expected to reach \$340 million this year, up 20% from 2004, according to the Biopesticide Industry Alliance. That’s small change compared with some \$30 billion in chemical pesticide sales, but that market is barely growing. Thus far, biopesticide companies’ products are sold mainly in the U.S., usually to greenhouses and horticulture farmers.

Biopesticide customers include not only organic farmers, but conventional farmers who worry that heavy reliance on chemical pesticides will poison their fields and water sources, especially in the tropics where a lush climate produces a host of crop-eating pests.

In Costa Rica, which last year imported about \$100 million in chemical pesticides, biopesticide vendors are making inroads, in part, because the government wants to market the country as an ecological haven. Ball Horticultural Co. of West Chicago, Ill., is busily replacing toxic pesticides with bio-killers at its Costa Rican nurseries. AgraQuest sells Ball a fungicide, called Serenade, which kills molds by eating their cell walls.

Dr. Marrone, AgraQuest’s 49-year-old founder, grew up in a family of organic gardeners in New England. After getting a Ph.D. at North Carolina State University, she worked at Monsanto Co., where synthetic chemical pesticides were the norm and she was encouraged to seek biological substitutes. But when Monsanto shifted its focus to genetically engineering crops, Dr. Marrone decided to search for venture capital instead. Today privately owned AgraQuest has 72 employees and expects sales of \$10 million this year.

While many biopesticide makers tinker with microbes discovered on university campuses, AgraQuest is unusual because it searches fields and jungles for new compounds, often finding them in dead bugs. It’s painstaking work. Of the billions of bugs that inhabit the planet at any given moment, fewer than 1% die of infection.

Over the past decade, Dr. Marrone estimates she’s screened some 23,000 suspects. Tanks and storage boxes filled with rotting vermin line the hallways at

AgraQuest’s headquarters. Besides bugs, there are growing collections of ocean sponges and bird feathers. Sponges harbor microbes yet to be exposed to garden pests, Dr. Marrone explains. Feather shafts are breeding grounds for microbes that kill lice, and perhaps crop-devouring bugs, too.

Putah Creek, a nature reserve near Davis, is one of Dr. Marrone’s favorite hunting spots. A former walnut grove, the area swarms with fruit-eating bugs, especially after spring floods. This summer, on ground still slick with runoff, she walked along a brackish stream, examining rotting walnuts, tree bark and spider webs for specimens. “Oh, my God,” she exclaimed, chancing on a cache of aphid husks on a blade of wild millet. Within hours they were bagged and tagged in her laboratory’s microbe morgue.

Other times, Dr. Marrone relies on professional microbe hunters, mainly academics who prowl wilderness areas. In Honduras, Gary Strobel, a Montana State University researcher found a fungus called *Muscodor albus* nestled in the bark of a mutant cinnamon tree. When dropped into water, it releases a mixture of gases that asphyxiate insects. Dr. Strobel licensed the microbe for around \$100,000, plus royalties, to AgraQuest. The company hopes to turn it into a replacement for methyl bromide, a chemical pesticide that is being phased out by the Environmental Protection Agency because of its hazard to the ozone layer.

In the lab, Dr. Marrone isolates microbes from the plant pests they kill and tries to figure out which specific microbe did the deed. “You can squash the guts on a glass slide and look under a microscope for spores or something that might have caused an infection,” she says with a knowing grin. “Or you can put the corpse into a Clorox solution, put it on a petri plate and see what crawls out.”

Eventually, proven killers are released for further testing in bug colonies, usually fruit flies or mosquitoes. Next, AgraQuest determines how well a killer can survive storage. The hardiest germs are reproduced by fermentation in a plant outside Tlaxcala, Mexico, and then dehydrated for shipment. Farmers add water to the microbes and then spray them on crops with hand pumps or crop-dusting aircraft.

Most of AgraQuest’s sales are from its best-selling product, Serenade, derived from *Bacillus subtilis*, a microbe Dr. Marrone found in a Fresno, Calif., peach orchard. During her recent trip to Culiacán, Mexico, a local tomato farmer, Juan José Ley, told her he’s such a Serenade fan he used it in his greenhouses even before the Mexican government gave it regulatory approval. “We imported from the states, illegally,” he said.

Back at home, Dr. Marrone said she’s trying to clear her kitchen of specimens, especially the ones she keeps among the ice-cube trays. “My husband has been bugging me to get these things out of the freezer,” she said with a smile, reaching for an open jug of Clorox.