Brian Evans

Bugs for Hire

Siccing good insects on bad ones

By TINA ADLER

Farmers often have to use chemical insecticides to rid grain bins of unwanted insect visitors. Now, to solve the pest problem, scientists are adding more bugs to the bins — bugs that eat and destroy the pests.

"Look what's flying around in the grain bin, dear!" some farmers may exclaim happily this summer.

Happily?

Couldn't be. Farmers take pride in a low insect-parts-to-grain ratio.

True, but these farmers have been convinced by entomologists that the bugs that eat the pests that eat the grain deserve cultivating.

Some farmers and orchard owners have used beneficial insects to help control pests in their fields for years (SN: 10/30/93, p.277), either by adding to native populations or importing foreign species. Now, a growing number of scientists are studying helpful predators and parasites with an eye to expanding their territory.

In addition to encouraging farmers to put beneficial insects in grain bins, researchers want to convince grocers and others with a pest problem to employ these good bugs.

Grain bins seem ripe for a beneficial bug takeover, in part because these insects can seek out and destroy the eggs that pests deposit inside grain kernels, where chemical insecticides don't reach. Moreover, grain pests are developing resistance to some popular insecticides, so farmers need alternatives. The critters added to the grain don't become part of breakfast cereals or corn muffins, scientists contend: They get sifted and washed away when the grain is processed.

In North America, 132 suppliers sell 129 different beneficial organisms, mostly for controlling pests in crops and orchards, says John H. Brower of the U.S. Department of Agriculture's Agricultural Research Service (ARS) in Manhattan, Kan. The main commercial supplier of biocontrols for stored grain, BIOFAC in Mathis, Texas, sells just four insect species that control grain infestations.

Grain managers use beneficial bugs only "to a very limited extent," acknowledges Wendell E. Burkholder of the University of Wisconsin–Madison and ARS. "But it's a growing practice," adds Thomas W. Phillips of ARS in Hilo, Hawaii.

To expand the use of beneficial insects, entomologists need a better understanding of the bugs' life cycles. That way, they can advise farmers when to add insects to a grain bin and how many to use. They also need to locate — or possibly create — more pernicious predators. Rearing large insect populations to sell commercially can prove difficult, researchers say. And biological controls, unlike chemical controls, need a few months to tackle a pest problem. Getting bugs to work "is not a real simple procedure," notes Burkholder.

Noah Poritz

The Anisopteromalus calandrae *wasp laying an egg on an immature maize weevil hiding in a corn kernel.*

Brower and his colleagues recently completed a 2-year study on how well the little wasp *Anisopteromalus calandrae* controls the maize weevil beetle, the world's leading corn pest. The preliminary results, from tests with bins containing 1,500 bushels of corn, look "pretty good," says Brower. About 90 percent of the beetle population was wiped out. "There are so few [weevils] . . . they aren't doing damage to the grain," he says. Like most biological controls, *A. calandrae* doesn't destroy all its prey; otherwise, it would have nothing left to eat.

Weevils usually live inside grain kernels. *A. calandrae* preys on these pests by boring its stingerlike drill through the kernels and depositing an egg on the outside of a weevil larva, Brower explains. The young wasp then eats the larva.

How wasps track down weevils remains unclear. They may find the pests by tapping their antennae on the kernels and feeling vibrations, by smelling the weevils, or by hearing their munching sounds, says Brower.

As part of a 3-year study of beneficial bugs in grain, ARS scientists recently got full price for three 1,000-bushel bins of wheat to which they had added the wasps *Cephalonomia waterstoni* and *Choetospila elegans* to control two common varieties of beetles, reports Paul W. Flinn, also of ARS in Manhattan.

Wheat containing more than two insects per kilogram must be fumigated. The bins with the wasps had less than one beetle per kilogram; three untreated bins had three beetles per kilogram, he says.

The wheat wasps, which attack their prey much as *A. calandrae* does, worked best when the scientists added 200 to 500 wasps to each bin 20 days after storing the grain, Flinn says. Using their own computer model of the wasps and their hosts, Flinn and his coworkers calculate that they would have needed eight times as many wasps if they had waited 40 days.

The researchers have developed a computer software program that advises farmers on traditional methods of controlling stored-grain pests. Within a year, they plan to add information on how to use biocontrols, report Flinn and ARS colleague David W. Hagstrum in an upcoming issue of ENVIRONMENTAL ENTOMOLOGY.

Many insects beneficial to grain are parasites, which target only one or a very few pests. Others, like the larger pirate bug (*Lyctocoris campestris*), are predators, which show up in a variety of grains

J. Johnson

Indianmeal moth larva getting stung by the parasitic wasp Bracon hebetor.

and eat an assortment of pests, Phillips explains. He and Megha N. Parajulee recently completed a 2-year study of the behavior of *L. campestris* in stored corn.

In earlier studies, the scientists found that the larger pirate bug can tackle caterpillars 10 to 15 times its size. It likes to dine on the Indianmeal moth, one of the most common moths found in homes and food warehouses, but it will also eat beetles and other kinds of moths. The pirate bug shows up in grain bins, manure, tree bark, bird nests, and elsewhere, and it prefers moldy and moist environments to dry ones.

Pirate bugs kill by biting the pests and, possibly, injecting a paralyzing venom. They then suck out blood and other juices, Phillips says.

Able to live through periods of freezing temperatures and to go 2 to 3 weeks without food or water, pirate bugs are survivors. When their numbers got too high in a laboratory setting, the young insects ate each other, Phillips and Parajulee report in the January JOURNAL OF ENTOMOLOGICAL SCIENCE. This cannibalism could actually help group survival, the authors assert. When the population of normal hosts declines, pirate bugs can always turn to their colleagues for a bite.

In many grain bins, beneficial bugs get doused with pesticides along with their hosts, so both groups die. Indeed, parasites generally tolerate pesticides less well than their prey. But not always.

James E. Baker of ARS in Manhattan and David K. Weaver of ARS in Gainesville, Fla., reported in 1993 that the *A. calandrae* wasp can withstand much more malathion than one of its hosts, the rice weevil. The wasp also tolerates small doses of other organophosphate insecticides used on grain.

The scientists have since found that *A. calandrae* can withstand up to 200 times more malathion than rice weevils can. Moreover, the poison fails to alter the wasp's interaction with its prey, Baker and his colleagues report in an upcoming issue of the JOURNAL OF ECONOMIC ENTOMOLOGY.

Researchers have found two other beneficial species in stored grain that tolerate pesticides well, Weaver notes, including a strain of the pirate bug.

Scientists are tinkering with insects to make them more resistant to chemicals, says Marjorie A. Hoy of the University of Florida in Gainesville. She and her colleagues raise pesticide-resistant insects.

They also plan to genetically engineer beneficial insects to make them better able to withstand pesticides. Eventually, they'd like to alter such insects' genes to confer other useful characteristics, such as tolerance to cold, she adds. However, the group has inserted only nonfunctional marker genes so far.

Beneficial bugs show up in more unusual places than grain bins. Shopping mall gardens, for example — or better yet, cattle dung. Cattle can be so tortured by blood-sucking flies, the horn fly in particular, that they eat poorly and their milk production and weight suffer, explains G. Truman Fincher of ARS in College Station, Texas.

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The Choetospila elegans *wasp.*

Since 1986, Fincher and his colleagues have been in search of certain species of beetles that are the flies' natural predators. They scour manure where horn flies lay their eggs, and they have imported beetles from overseas. In Europe and elsewhere, insect predators keep horn flies from becoming a problem, says Fincher.

The predator beetles dine on a variety of fly species, but they don't bother beneficial insects or any that live outside dung or rotted organic matter, Fincher notes. The beetles eat both fly eggs and newly hatched flies.

In recent laboratory tests, the scientists found that the imported beetles do only as well as the locals at controlling flies, but the researchers plan to import better beetles, Fincher reports. They released three imported varieties in Texas last year and will check annually to determine whether the beetles have established themselves, which other species have failed to do.

To find more job opportunities for beneficial bugs in the real world of grain bins, manure, shopping malls, and family kitchens, researchers must overcome more than the technical problems of growing large colonies or perfecting the timing of their release. They also must answer the question, Do good bugs go bad?

No evidence has indicated that beneficial insects harm other desirable insects in grain bins, although such attacks do occur in fields, Phillips asserts. Some scientists argue that entomologists just haven't looked closely enough at the effect of imported insects on nontarget pests or plants, he adds.

There's another hurdle: discrimination.

People have a difficult time with the idea of inviting additional insects — even good ones — into their workplace or residence, grain bin or warehouse. Food industry representatives have expressed an interest in the research on beneficial insects, Phillips notes. But for now, their sanitation standards require bugfree environments, he says.

Homeowners "are kind of funny — they don't like any insects in their homes," says Brower. "We're not at the point yet where most consumers would release more insects in their home," agrees Phillips. □

Bringing beneficial bugs home

Homeowners frustrated by all-too-hardy cockroaches may someday employ a small, nonstinging wasp to silence the scurrying scourge. The wasp would only occasionally fly through the house.

Aprostocetus hagenowii drills a hole in the cockroach's egg case and deposits its own eggs there, explains Lynn M. LeBeck of the University of Hawaii in Honolulu. Then the offspring of the wasp devour their birthing center. Each roach egg case carries 10 to 40 potential roaches, "so it's a nice little packet of nutrients," says LeBeck. The toughness of the case prevents all but a few species of parasitic wasps from drilling through it, she notes.

A. hagenowii tackles only the American roach, however. Although quite common throughout the world, American roaches have German cousins that frequent U.S. homes and manage to outsmart parasites, says LeBeck. The German roaches hold on to their egg cases, and so far, scientists have found nothing that will parasitize them, she laments. — *T. Adler*