K.L. CHAN

G.R. JOHNSON

Prey and predator. *Star thistle is a pest in California. One of its natural enemies—*Bangasternis orientalis*—has been imported from Europe to keep it in check.*

Bug Detectives Crack The Tough Cases

By bringing in insects that prey on pests, Department of Agriculture researchers are reducing pesticide use

A FIELD OF STAR THISTLE, WITH ITS BLUE-green leaves and dandelion-yellow flowers, makes a beautiful picture. But ranchers and farmers in the Northwest hate the sight. The needle-sharp spikes of the mature thistle keep both cows and people out of fields and rangeland. Horses that graze on the plant eventually succumb to "chewing disease" (a Parkinson's-like syndrome in which dopamine-secreting cells in the brain are destroyed) and die of starvation when their facial muscles are paralyzed. And star thistle isn't a trivial problem: There are more than 8 million acres of it in California alone, acres that could be turned into productive farm or rangeland if the thistle could be eradicated. Enter the pest hunters of the U.S. Department of Agriculture's (USDA) Agricultural Research Service (ARS), including Charles Turner of the ARS lab in Albany, California. With the help of his colleagues around the world, Turner came up with a neat solution for the star thistle case: a bug, formerly unknown on these shores, that eats nothing but star thistle.

A story in last week's *Science* described the devastation wreaked on U.S. crops and natural habitats by imported pests. ("Biological Immigrants Under Fire," by Elizabeth Culotta, 6 December, 1991, page 1446). This article describes one way the U.S. Department of Agriculture responds: by finding and releasing the natural predators and pathogens of those imported pests.

The problem with the star thistle and other species that are not native to the United States (the thistle probably came here in the late 1800s with alfalfa seeds brought from Mediterranean Europe, its native turf) is that they arrive without any of the natural pathogens, parasites, or predators that keep them in check at home. (The star thistle, for example, is not a problem for farmers anywhere in Europe). Until recently, U.S. farmers would have dealt with most pests by spraying them with insecticides or herbicides. But as the pests develop resistance, and environmental regulations restrict pesticide use, the ARS is increasingly emphasizing "biocontrol." According to Roger Fuester, the ARS's acting national program leader for biological control, the agency will spend $23,500,000 on biocontrol in 1991, a substantial fraction of that going to four overseas labs (in Montpellier, France, Seoul, Buenos Aires, and Townsville, Australia) and cooperating facilities in the United States.

Although the biocontrol program has gotten a big boost lately, the idea itself isn't new. In 1889 USDA explorer Albert Koebele returned from Australia with 128 vedalia beetles, which were released to control another insect pest—the cottonycushion scale—that was devastating California's citrus crop. The vedalia beetles rapidly reproduced and spread, reducing scale populations dramatically in a single year. Since then, the biocontrol program has initiated 11successful efforts to control specific pests, and on any given day they have about a dozen more weeds and insects on their informal "hit list."

But those cases aren't easily cracked. The search for the natural predators of the star thistle, for example, began in the late 1950s, when ARS entomologists based in Europe searched agricultural areas of Italy, Greece, and Turkey looking for star thistle and collecting any fungus that infested the plant and any insects that attacked it. The plant's natural enemies around the Mediterranean did such an effective job in keeping the plant under control that the searchers never found a field fully covered by star thistle, as they would have in California.

The most promising of the dozens of species of insects found on the thistle were taken to labs in Greece, Italy, and Albany and subjected to years of tests. The most important test was for host-specificity, a test designed to ensure that whatever insect was imported wouldn't itself become a pest—consuming valuable crops. To guard against that possibility, ARS researchers put each species in a cage with samples of important American crop plants—from safflower to cotton—and gave the bugs a choice of eating the plant or starving. Any insect that showed a sign of becoming a crop pest was rejected. The insects were similarly tested with ornamentals and native plants closely related to the target weed. The winner of this elimination competition was *Bangasternis orientalis*, which the tests and field observations proved will eat nothing but yellow star thistle and its close cousin, the purple star thistle.

The weevil was first released in California, Oregon, Washington, and Idaho in 1985. "It is now well established, and at some sites it is impossible to find a single thistle flowerhead that does not have at least one weevil egg," says Turner. Besides the weevil, he adds, "four additional insect species, two of which are now established in the United States, and a rust disease, are also under investigation to

control the star thistle."

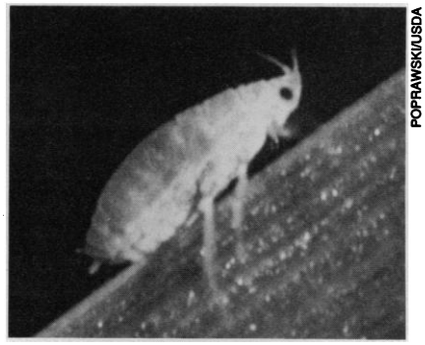
The kind of biological sleuthing that is helping to control the star thistle is also being applied to hydrilla, water lettuce, melaleuca, Eurasian water milfoil, water hyacinth, salt cedar, field bindweed, leafy spurge, and three species of knapweed. The ARS has imported candidate control species for all these pests except Melaleuca and saltcedar; candidates for those weeds have been identified but not imported yet, according to an agency spokesperson. Not all of these imports are being studied at Albany. The ARS also has quarantine facilities at Newark, Delaware, Frederick, Maryland, Stoneville, Missouri, Ithaca, New York, and College Station and Temple, Texas. Montana State University in Bozeman and the Florida Division of Plant Industry in Gainesville also have quarantine labs that ARS researchers work in, and the ARS has cooperative arrangements with more than a dozen quarantine facilities at universities and federal and state agencies.

The ARS sleuths at those facilities are not limiting their attention to plants; they are also looking for predators to control imported insects. Take *Diuraphis noxia*, the Russian wheat aphid, which, despite its name, is mainly a problem for barley growers. According to Tadeusz Poprawski, an ARS scientist in Ithaca, New York, the pest first came to the United States when aphids (originally brought from Europe) flew across the Mexican border into Texas in 1986. It has moved rapidly northward, and now infests between 50 million and 100 million acres of wheat and barley in 17 states and three Canadian provinces.

Poprawski spent 7 years—from 1983 to 1990—at the ARS lab in Behoust, France, which specialized in biological controls for introduced insects. (The Behoust lab was the predecessor of the facility in Montepellier, the newest addition to the far-flung empire of pest hunters, which opened on 1 October of this year.) Until 1988, he was working on several pests, including the gypsy moth, but since then he has concentrated all his energies on the Russian wheat aphid. Born in Poland and educated in Belgium, Poprawski is fluent in several languages, and he puts them to use tramping through grain fields in the Ukraine and Soviet Central Asia looking for plants harboring bugs. With the help of American colleagues and Soviet agricultural scientists, he has found about two dozen beetles and wasps that eat or parasitize the aphids, and three species of pathogenic fungi that infect it. Two of the most promising approaches involve several species of Aphelinus wasps and *Pandora neoaphidis*, a fungus that infects and kills the pest.

In a sense, the ARS campaign against *Diuraphis noxia* is an attempt to set nature's clock ahead: to speed up a process that might otherwise proceed on a much slower timetable. Although the ladybeetles, wasps, and fungi native to America now seem ineffective in controlling the aphid, "regions where the aphid is indigenous rarely sustain economic damage," Poprawski says, and the answer seems to be that the things that prey on the aphid seem to have caught up.

For example, the aphid was a terrible problem for Russian farmers at the turn of the century, but by 1910 its natural enemies had raced ahead and brought it under control. In 1950, it showed up in Turkey, and again caused severe losses at first; by 1965, though, it was no longer a major pest. "The same process is now under way in Ethiopia," Poprawski says. He concludes that "this history suggests that it takes 10 to 20 years for the aphid's enemies to catch up with it. By importing these enemies, mass-rearing them, and releasing them in infested fields, we hope to shorten this process dramatically."



POPRAWSKI/USDA

Illegal immigrant. *Russian wheat aphids probably entered the U.S. from Mexico.*

And indeed, whether it is shortening a process that would happen on its own but more slowly, or creating a competitive balance that is missing when a pest is imported, what the pest hunters of the ARS spend their time doing is helping level the Darwinian playing field by shipping in insects and pathogens to give the pests a run for their money. And whether the efforts now under way to find natural predators for more species are completely successful or not, advocates of the ARS's program say that it is already effective. Jack Coulson, head of the ARS Biological Control Documentation Center in Maryland, says "annual savings from our successful biocontrol programs (for both native and introduced pests), based primarily on the costs of pesticides no longer required, total over $155 million per year. That's six to seven times the total ARS budget for biocontrol." And in a social and political environment in which pesticide use is increasingly suspect, savings like those may seem more and more appealing. ■ JONATHAN D. BEARD

Jonathan D. Beard is a free-lance writer based in New York.

Hepatitis A Vaccine Shows Promise

Boston, Massachusetts—If you've ever been given a large and painful gamma-globulin shot to guard against hepatitis, you will be relieved to know that you may never have to repeat the experience. Researchers at Merck, Sharp, and Dohme in West Point, Pennsylvania, in collaboration with scientists at Johns Hopkins and Hadassah Hospital in Jerusalem, last week announced the development of an effective experimental vaccine against hepatitis A, a widespread strain of the virus—a vaccine that doesn't hurt and is much more effective than a shot of gamma-globulin.

Team member David Nalin, director for clinical research in infectious diseases at Merck, reported at the annual meeting of the American Society of Tropical Medicine and Hygiene here that a large-scale clinical trial in children has shown the vaccine to be 100% effective in stimulating protective antibodies against the virus after only a single injection. The data, says William Jordan, a consultant for the National Institutes of Health's National Vaccine Development Office, are "very exciting and convincing."

Hepatitis A is one of three major liver viruses. (Vaccines have already been developed against hepatitis B; hepatitis C is transmitted largely through blood transfusions, and screening of blood donors is reducing transmissions.) While young children are often infected with hepatitis A—most often from contact with an infected person—they are frequently asymptomatic. But, notes Nalin, they often pass the disease on to adults, who can become seriously ill for periods of up to 3 months with jaundice, fever, nausea, and abdominal discomfort. In addition, the disease is often the "nasty aftermath of a vacation to developing nations," where Western travelers may come into contact with the virus for the first time in their lives, says Nalin. Or it can be transmitted by contact with food contaminated by food handlers.

Reported cases in the United States have held steady at about 25,000 a year throughout the 1980s, according to the Centers for Disease Control (CDC) in Atlanta, but the incidence among drug users seem to be on the rise. Moreover, Eric Mast of the CDC's division of viral diseases believes the disease may be seriously underreported, with the actual incidence anywhere from 15 to 30 times higher than the statistics suggest, mostly