

Foreign Agents

Imported for Weed Control

You enter through a thick, metal door. When it closes, only a small window provides light in the room. Next, you go through another door into a room with another small window. The goal: to lure potential escape artists toward a trap in the window rather than allow them to sneak outside.

Through a third door, you enter a network of laboratories

KEITH WELLER (K8797-4)



In quarantine tests, potential biological control agents are confined in small cages with a test plant (Scotch thistle, in this case) to confirm whether they will feed and reproduce on that plant.



and greenhouses that hold beneficial insects from foreign lands. These insects, scientists and landowners hope, may help control some of the United States' worst weed invaders—like leafy spurge, saltcedar, and melaleuca.

“Invasive species, including weeds, cost U.S. consumers and producers billions of dollars each year,” says Ernest S. Delfosse, the Agricultural Research Service's national program leader for weed sciences in Beltsville, Maryland. “Natural enemies from the weeds' homelands may be our most effective and economical tools for long-term control.”

When beneficial insects arrive from overseas, they are carefully sorted, screened for parasites, and reared in quarantine facilities like the one just described, which is located at ARS' Western Regional Research Center in Albany, California.

Though the specifications may differ, about two dozen U.S. quarantine facilities serve as strictly regulated gateways for importing biological control agents. Researchers at some locations focus on beneficial insects like wasps to control insect pests such as alfalfa weevils or gypsy moths. Those at other locations look at diseases and other microscopic agents for both weed and insect control.

This story highlights ARS research on using beneficial insects for biological control of weeds. ARS operates laboratories with quarantine facilities in Albany; Stoneville, Mississippi; and Temple, Texas. New quarantine operations will open in Fort Lauderdale, Florida, and Sidney, Montana, within the next few years.

ARS also collaborates with universities and other state and federal agencies that run additional quarantines,

including a long-term program at Gainesville, Florida. Each uses a variety of traps, doors, entryways, and sanitizing procedures to keep the insects inside until they are intentionally released on approved weed targets.

Biological control aims to restore some of a weed's natural complement of enemies, making it less damaging here. This approach has been used successfully and safely for many years. Since 1945, more than 110 insect species have been released in the continental United States



(K2602-4)
***Aphthona flava* flea beetle feeding on leafy spurge.**

and Hawaii against some 57 weeds. Some of the worst pests no longer cause significant damage.

“Of course, we have to ensure that we protect our natural resources at the same time,” Delfosse says. “The quarantine facilities are just one of the steps we take to keep biological control safe.”

In tandem with the domestic laboratories, ARS operates or collaborates in the operation of several overseas laboratories

for hands-on discovery and collection of the weeds' natural enemies (see story on ARS' foreign biological control laboratories, page 7). These labs are in Montpellier, France; Hurlingham, Argentina; Beijing, China; and Indooroopilly, Australia.

Often working with local landowners and biologists, ARS researchers look for the insects that will likely do the most damage to the weed and the least damage to anything else. Scientists at the foreign labs study the basic biology of the insect agents. They verify that the insects significantly damage the weed and begin testing to make sure the insects don't eat or reproduce on U.S. native or crop plants.

Together with hundreds of cooperators here and overseas, ARS quarantine and foreign research laboratories serve as an invaluable pipeline for identifying, testing, importing, and releasing biological control agents against some of our most troublesome weeds. USDA's Animal and Plant Health Inspection Service (APHIS) plays a key role in regulating the importation of all beneficial organisms, as well as overseeing quarantine facilities. Several examples highlight this unique research conduit.

A Key Strategy for TEAM Leafy Spurge

First identified in the United States in 1827, leafy spurge (*Euphorbia esula*) now infests at least 5 million acres in 35 states and Canadian provinces. The weed degrades grazing lands for livestock and wildlife and reduces land values.

ARS began research on biological control of leafy spurge in the 1970s at laboratories in California, Montana, and Italy. Since then, ARS, APHIS, and foreign cooperators have discovered, imported, and released 12 natural enemies.

The stars so far have been a group of four related flea beetles from Eurasia that belong to the genus *Aphthona*. The beetles have rapidly expanded from some areas. At one site in North Dakota, where

Technician Eve Lednický examines beneficial insects being evaluated within the containment portion of the ARS quarantine facility in Albany, California.

77 beetles were released, about 2 million were harvested in 1999 for distribution to other spurge-infested areas.

The young beetles burrow into the weed's roots. Adults feed on the leaves. In addition to harming the plant directly, this feeding allows invasion by disease-causing fungi or bacteria and impairs its reproduction.

"There is no question that biological control will be a key to long-term control of leafy spurge," says Neal R. Spencer, an entomologist who leads research at ARS' Northern Plains Agricultural Research Station in Sidney, Montana.

To demonstrate biological control and other integrated pest management (IPM) techniques for leafy spurge, ARS formed The Ecological, Areawide Management (TEAM) Leafy Spurge project in 1997. ARS and APHIS coordinate the project, with participation by dozens of other federal, state, and local organizations and ranchers.

TEAM Leafy Spurge is the third in a series of ARS-funded, 5-year IPM projects but the first to target a weed. Researchers examine biological, cultural, and chemical methods individually and in combination to manage the weed. The goal is to find the best tools, from an environmental and economical standpoint, so ranchers and land managers can reclaim rangeland lost to the weed and slow its further spread.

"So far, the project has been a big success," says Spencer. Last summer, TEAM Leafy Spurge distributed for release more than 22 million flea beetles to 206 ranchers and land managers from 50 counties in 7 states.

The *Aphthona* beetles will soon be joined by a gall midge, *Spurgia capitigena*. Unlike flea beetles, the midge prefers moist, shady areas. That will give TEAM Leafy Spurge another tool to slow spurge growth in areas where beetles, grazing sheep and goats, or pesticides aren't effective or practical.

NORMAN REES (K2602-21)



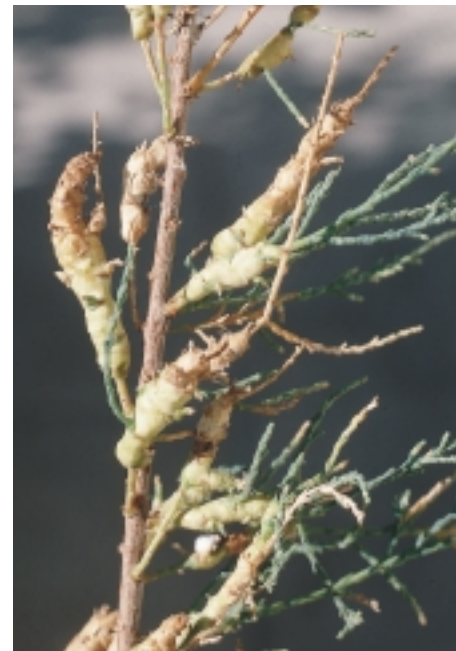
Leafy spurge overtaking a natural hillside in Colorado.

JACK DELOACH (K8836-2)



Mealybugs (*Trabutina mannipara*) are being considered as a biological control agent for saltcedar. These egg sacs are on saltcedar in quarantine at Temple, Texas.

JACK DELOACH (K8836-3)



In Kazakhstan and western China, the midge *Psectrosema noxium* attacks saltcedar and forms galls on it, killing the terminal stems.



Rouhollah Sobhian, an ARS entomologist, has located a good natural source of the midge in southern France. Scientists in Europe and Montana have studied the midge, and Spencer has already obtained a release permit from APHIS.

Chinese Beetles for Saltcedar Control

Landowners in the western United States brought in bushy, deciduous saltcedar (*Tamarix* spp.) trees for erosion control in 1837. Since then, saltcedar has crowded out native trees like willows and cottonwoods along parts of nearly every western river.

In 1987, ARS launched a project to use biological control against the weed. ARS researchers, along with cooperators in China, France, Israel, Kazakhstan, and Turkmenistan, began plant studies and identified potential natural enemies. A leaf beetle, *Diorhabda elongata*, and a mealybug, *Trabutina mannipara*, were

ARS' Foreign Biological Control Laboratories— *Gateways to Domestic Weed Control*

USDA has a long history of foreign exploration for natural enemies of U.S. weed pests.

Biological control agents from virtually anywhere in Europe, Asia, or Africa may make their first stop at ARS' European Biological Control Laboratory in Montpellier, France. EBCL is USDA's largest and only wholly owned laboratory on foreign soil for identifying and testing potential beneficial insects for importation into the United States.

USDA established its first foreign laboratory in 1919 outside of Paris, France. In 1958, the Rome, Italy, location began working on weeds, followed by another established in Greece in 1980.

In 1991, the laboratories in Rome and Paris consolidated to form the ARS European Biological Control Laboratory in Montpellier, France, but are still maintaining small substations in Rome and Thessaloniki, Greece.

In 1999, new construction was completed at the Montpellier site, including a 1,600-square-foot quarantine facility for screening insects and a 400-square-foot facility for plant pathogens. Originally, since the laboratory studied insects and weeds present in France, quarantine was not needed. But now the lab handles insects from several continents, so quarantines were set up to protect the French environment.

The lab has introduced and is currently studying nearly 200 biological control agents that help control at least three dozen crop-damaging insects and weed species.

Major weed targets now include leafy spurge, saltcedar, Russian and yellow starthistle, Russian knapweed, and perennial mustards such as hoary cress.

"This unique resource has paid for itself many times over by enabling researchers to find and test natural enemies of weeds," says Paul C. Quimby, the ARS weed scientist who runs EBCL. "With our new quarantine facility, the lab will provide an even greater service."

ARS also supports biological control laboratories in Asia, Australia, and South America.

USDA's Asian Parasite Laboratory, originally located in Japan and then moved to South Korea, performed biological control studies from 1922 to 1993 (with a gap between 1941 and 1975). Researchers at this laboratory helped discover and test agents for control of leafy spurge and saltcedar—today's emerging success stories.

To continue research in Asia, ARS and the Chinese Academy of Agricultural Sciences established the Sino-American Collaborative Biological Control Laboratory in Beijing, China, in 1988. Today the lab works on agents to control saltcedar, leafy spurge, several aquatic weeds, and some insect pests.

In 1989, ARS opened the Australian Biological Control Laboratory near Brisbane, in cooperation with the Commonwealth Scientific and Industrial Research Organization (CSIRO). The mission of this lab is to evaluate biological control agents for weeds of Australian and Southeast Asian origin. Researchers there have discovered biological controls for many of the invasive wetland and aquatic weeds in the southern and western United States, such as melaleuca, Old World climbing fern, and hydrilla. Onsite CSIRO quarantine facilities allow ARS researchers to rear insects for preliminary testing.

The ARS South American Biological Control Laboratory near Buenos Aires, Argentina, opened in 1962 to tackle alligatorweed and water-hyacinth. Research there has since expanded to include waterlettuce, tropical soda apple, and other tropical weeds, rangeland weeds, and insect pests such as fire ants.

shipped to ARS quarantine labs in Albany and Temple for further study.

Last summer, the beetle was approved as the first biological control agent for saltcedar. The adults and young feed on saltcedar leaves, repeatedly defoliating the tree and depriving it of nutrients.

Normally, control agents are approved for direct release into target areas. But this time, researchers faced a unique complication.

"Saltcedar replaced native willows that an endangered bird—the southwestern willow flycatcher (*Empidonax traillii extimus*)—relied on for nesting," says ARS entomologist Jack DeLoach. "The bird has since adapted to nesting in saltcedar, so we have to ensure that the beetles won't remove the weed faster than we can reestablish native plants for the birds." DeLoach is in the ARS Grassland Protection Research Unit at Temple.

To protect the bird while controlling the weed, the scientists implemented an extra step, in concurrence with APHIS and the U.S. Fish and Wildlife Service: a 3-year experimental phase that begins

with the beetles in cages. This will allow scientists to monitor the rate at which the beetles damage the saltcedar before the insects are relocated to other critical habitats.

A consortium of experts from more than two dozen federal, state, and local agencies; universities; and conservation organizations meets periodically to develop monitoring protocols, review progress, and address concerns.

Despite the endangered species concerns, scientists are confident that the biological control approach is the right choice for managing saltcedar.

"Saltcedar is an Old World plant with no close native relatives here," says ARS entomologist Raymond I. Carruthers. "More than 200 natural enemies of saltcedar have been found in China and the former Soviet Union. Insects like the *Diorhabda* beetle feed exclusively on saltcedar, making them ideal for biological control." Carruthers leads the Exotic and Invasive Weed Research Unit at Albany.

The next likely candidate will be a weevil from France, China, and Kazakhstan, belonging to the genus *Coniatus*. Like the *Diorhabda* beetle, the larvae eat the foliage. But young *Coniatus* pupate on the tree before they emerge as adults, while *Diorhabda* fall to the ground to pupate and can be drowned in wet areas.

Both the leafy spurge and saltcedar projects are using high-tech tools such as aerial photography, remote sensing, and geographic information systems (GIS), to map the weeds over vast areas.

ARS ecologist Gerry Anderson in Sidney and ARS rangeland scientist Jim Everitt at Weslaco, Texas, coordinated some of the mapping.

"It is often difficult to determine the extent and distribution of weed populations on rangelands because of the expanse and inaccessibility of these areas," Anderson says. "These technologies will provide a comprehensive way to measure the rate at which the weeds spread and the long-term effectiveness of biological control over wide regions."

Showing Promise for Water Weeds and Melaleuca, Too

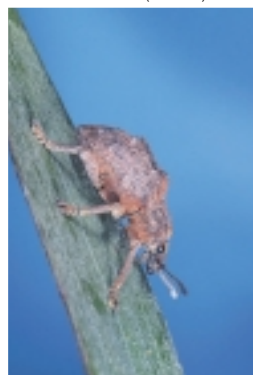
Foreign aquatic plants have also invaded and become weeds. ARS began its search for biological control agents of water weeds by establishing laboratories in Florida in 1959 and Argentina in 1962. Water-hyacinth was one of the original targets and remains a high priority today.

By 1992, water-hyacinth had invaded hundreds of lakes and streams throughout the South and parts of the West and Hawaii. The weed impedes water's natural flow and can destroy native communities of aquatic plants and animals. Biological control has already greatly reduced water-hyacinth in Florida, Louisiana, and Texas, but more agents are needed.

ARS researchers here and abroad are discovering and testing what they hope will be a new South American team of natural enemies (see story on page 10 in this issue).

Also under way is a promising project to curb melaleuca, *Melaleuca quinquenervia*. A tiny, grey-brown weevil called *Oxyops vitiosa* is now thriving in at least 50 sites in south Florida, thanks to more than a decade of work by ARS scientists there and in Australia. Researchers hope the leaf-eating *Oxyops* will stop the spread of melaleuca, a fast-growing tree that crowds out native vegetation and is threatening to take over Florida's Everglades.

GARY BUCKINGHAM (K7658-2)



***Oxyops vitiosa*, a leaf weevil, is thriving on invasive melaleuca in southern Florida.**

BOB RICHARD, APHIS (K8836-1)



The leaf beetle *Diorhabda elongata* is the first approved biological control agent for saltcedar in the United States.



Near Fort Lauderdale, Florida, 50-foot-high melaleuca trees threaten to destroy the delicate ecosystem of the Everglades.

Both melaleuca and *O. vitiosa*, the melaleuca leaf weevil, are native to Australia, but neither is a pest there. ARS scientists turned the 1/4-inch-long weevil loose at 13 melaleuca-infested sites in Florida in 1997, after exhaustive greenhouse testing and investigations by colleagues in Australia showed the insect would not attack other plants. (See “Aussie Weevil Opens Attack on Rampant Melaleuca,” *Agricultural Research*, December 1997, pp. 4-7.)

“Although it’s too early to call the weevils a success,” says ARS entomologist Ted D. Center, “all indications are that they are doing great.” Center leads the ARS Aquatic Weed Control Research Unit at Fort Lauderdale.

“One site where we originally released 3,300 weevils,” he says, “now has

about 80,000. We collected about 20,000 weevils there and relocated them to 30 new sites. That means we’ve now placed weevils throughout melaleuca’s entire Florida range.

“In general,” Center says, “the weevils have done well at sites that are dry or only seasonally wet. But at permanently inundated areas, they may drown when trying to find soil in which to pupate.”

But other biological control agents that might thrive at those soggy sites could be waiting in the wings. After all, the melaleuca-munching weevil was only one of more than 450 plant-eating critters that scientists at the ARS Australian Biological Control Laboratory in Indooroopilly, near Brisbane, found feeding on melaleuca. Today, the team is focusing its melaleuca research on six of

KEITH WELLER (K8798-15)



The Scotch thistle weevil from Spain is being evaluated in the Albany quarantine facility to determine if it is safe for release in the United States.

the most promising agents—some of which have already been shipped to Gainesville, Florida, for in-quarantine scrutiny by a team of ARS scientists led by entomologist Gary Buckingham.

“Our ongoing field research in Australia ensures that ARS scientists in Florida have the widest possible array of biological control agents to work with,” says entomologist John A. Goolsby, director of the ARS Australian Biological Control Laboratory. “This dual-continent approach,” he says, “invites success.”—**By Kathryn Barry Stelljes and Marcia Wood, ARS.**

This research is part of Crop Protection and Quarantine, an ARS National Program (#304) described on the World Wide Web at <http://www.nps.ars.usda.gov/programs/cppvs.htm>.

Scientists mentioned in this story can be contacted through Kathryn Barry Stelljes, USDA-ARS Information Staff, 800 Buchanan St., Albany, CA 94710; phone (510) 559-6069, fax (510) 559-5882, e-mail stelljes@asrr.arsusda.gov. ♦