More Troublesome Water Weeds Targeted by Researchers

A pleasant saltwater lagoon on the sunny coast of southern California made botanical history last year when a dreaded marine alga, ***Caulerpa taxifolia,*** showed up there. The infestation at Agua Hedionda lagoon in Carlsbad, about 30 miles north of San Diego, was the first discovery in the Western Hemisphere of the Mediterranean strain of this notorious alga.

Caulerpa was next detected in Huntington Harbor, a small, isolated marina near Long Beach, California.

ARS plant physiologist Lars W. J. Anderson, together with industry, university, state, and federal colleagues, worked quickly to quash the weed before it could spread farther up the coast.

(K9677-1)

Marine alga, *Caulerpa taxifolia.* Photo by Rachel Woodfield, Merkel & Associates.

In preliminary experiments, Anderson and co-researchers tried several commonly used aquatic herbicides but found that liquid chlorine, injected under 10- to 20-foot-square black plastic tarpaulins spread atop the weed, worked best at Agua Hedionda. At Huntington Harbor, they used solid, puck-shaped disks of chlorine instead of liquid. Both killed the algae. "Nothing else seemed to work," Anderson says. He is with the ARS Exotic and Invasive Weeds Research Unit, stationed at Davis, California.

C. taxifolia is one of about a half-dozen water weeds that Anderson and other scientists in the research unit are investigating. The unit is headquartered at the ARS Western Regional Research Center in Albany, California.

PEGGY GREB (K9658-1)

Close-up of yellow starthistle *(Centaurea solstitialis).*

Conquering *Caulerpa*—A Marine Miscreant

Sometimes referred to as "killer algae," *C. taxifolia* flourishes in warm saltwater harbors, bays, and lagoons. It spreads remarkably fast, crowding out native species of algae and sea grasses. "*Caulerpa* essentially ruins conditions for a whole host of marine animals, such as small mollusks," says Anderson.

"No one knows exactly how it ended up at the lagoon or at Huntington Harbor," he says, "but we suspect that someone dumped the contents of an aquarium." *Caulerpa* was listed by the federal government as a noxious weed in 1999, which means that it is illegal to sell it in the United States. However, there is still a market for it. People like to have this weed in their fish tanks because it grows so well. They may not even be aware of the effects it can have if it escapes to the outdoors.

Today, the black plastic tarps still remain in place. The scientists and their collaborators continue to monitor the outbreaks regularly. "We know that chlorine kills the top of the *Caulerpa* plants," Anderson explains, "but the real question is what's happening below, in the mud. We know that the plant forms structures called rhizoids that could produce new growth. We need to be sure that the chlorine kills them."

In testing the viability of the rhizoids after aboveground parts of the plant have been killed, Anderson is collaborating with Susan Williams, director of the University of California at Davis Bodega Marine Laboratory, just north of San Francisco. "We're also looking at other algicides," notes Anderson.

Arundo donax Raises Cain

Unlike the algal newcomer *Caulerpa*, a bamboolike invader called giant reed or giant cane has been an unwanted intruder in California for at least 100 years. Known to scientists as *Arundo donax*, this member of the grass family can grow 3 to 7 inches a day, reaching 30 feet in height. Plants sport feathery white plumes called panicles.

Arundo is used as an ornamental plant for landscaping and as a source of reeds for musical instruments, such as bassoons and bagpipes. Its cellulose can be used for papermaking.

Found from Maryland to California, *Arundo* thrives along streams and ditches. A fierce invader of freshwater ecosystems, *Arundo* crowds out riparian regulars like alders, cottonwoods, and willows that would otherwise provide a home for wildlife and cooling shade vital for fish and other aquatic creatures. The plant recovers rapidly after wildfire, sending up hardy new sprouts from its roots. What's more, bits of *Arundo* that break off and travel down creeks and streams can readily start new infestations.

PEGGY GREB (K9656-1)

Ecologist Ray Carruthers examines saltcedar *(Tamarix parviflora)* along Cache Creek.

Despite the weed's long history in the United States, there's very little published information about its basic biology and ecology, according to David F. Spencer. He is with the ARS team at Davis.

To help fill in the gap, Spencer and colleague Greg G. Ksander, also at Davis, are gathering data needed for equations that can be used to predict *Arundo's* growth at various stages of its life cycle under various environmental conditions. Explains Spencer, "Some of *Arundo's* life stages may be more susceptible than others to certain control tactics, like herbicides or biological control. And environmental conditions such as temperature are likely to influence growth and development, but we don't have specific details."

As a starting point, Spencer and Ksander looked at the effects of temperature and soil nitrogen levels on sprouting. "We want to determine the environmental conditions that cue *Arundo* to produce new sprouts from its rhizomes." Those thick, underground stems are critical to *Arundo's* long-term persistence.

In tests of rhizome sections and stem cuttings kept indoors for 12 weeks at 44.6˚F, 57.2˚F, or 68˚F, the researchers found that new shoots emerged and survived at 57.2˚F and 68˚F and emerged sooner at the higher temperature. At 44.6˚F, no shoots grew from rhizome sections; only a single shoot sprouted from a stem cutting but soon died.

In a second experiment, the scientists varied the level of the nitrate form of nitrogen applied to rhizome sections during weekly watering. Notes Spencer, "Some studies done at other labs have indicated that nitrate in the soil, which may fluctuate seasonally, stimulates some seeds to germinate."

The researchers exposed rhizome sections to 46.4˚F or 60.8˚F for 14 weeks and applied concentrations of nitrate ranging from 0.3 to 6.0 milligrams per liter of water. "New shoots emerged at 60.8˚F but not at 46.4˚F," reports Spencer. "Neither the number of shoots that emerged nor the length of time it took for them to appear was influenced by the amount of nitrate that we applied."

In an experiment with rhizomes planted outdoors at Davis, the scientists found that shoots first appeared in late March, when the average weekly temperature was 52.7˚F. New shoots continued to emerge until November.

"With this new information, we can develop equations that relate sprouting to temperature over time, or what's known as accumulated degree-days," Spencer says. "Because nitrate—

PEGGY GREB (K9657-1)

Ecologist David Spencer (right) and technician Greg Ksander collect an *Arundo donax* leaf sample for tissue nitrogen analysis.

at the levels we applied—didn't stimulate sprouting, the equations won't have to include nitrate fluctuations."

Fish and wildlife specialists, water district managers, and other streamkeepers throughout the United States can use the information from the equations. It will help them decide the best timing for whatever management technique they choose to bring this aggressive weed under control.—By **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.

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PEGGY GREB (K9655-1)

Ecologist Ray Carruthers measures plant and flower head density of yellow starthistle while technician Justin Weber uses a sweep net to sample populations of biocontrol agent *Chaetorellia succinea.*

Tackling a Tough Trio

As if giant reed weren't enough of a problem, this rugged invader often grows interspersed with another waterside menace, saltcedar, or *Tamarix parviflora*. These weeds may leave off further inland, but then another unwelcome intruder, called yellow starthistle, *Centaurea solstitialis,* often takes over.

"These exotic species are thought to be the three most serious plant invaders in riparian ecosystems and adjacent uplands in the West," says ARS ecologist Raymond I. Carruthers. He is leader of the ARS Exotic and Invasive Weeds Research Unit, based at the Western Regional Research Center in Albany, California.

Funded in part by a grant from the Initiative for Future Agriculture and Food Systems, Carruthers co-manages a unique research project aimed at helping land managers tackle all three problem weeds at once in what's known as an ecosystem-level approach. At least three dozen federal, state, and private agencies, universities, and organizations are working together to develop the best biological control strategies for combating these weeds and restoring native plants.

"People have joined this team effort because they're convinced that biological control has the ecological and economic potential to fight established invasive species," says Carruthers.

Program participants are sharing the work of evaluating the risks and effectiveness of biological control agents such as weed-eating insects. They are also helping develop innovative techniques to prevent the weeds from successfully reinvading. And they're helping make sure that land managers have the newest and best available information about successful weed-management strategies.

"Results of this project," notes Carruthers, "may provide a model that people elsewhere can use to get the upper hand with other groups of invasive plants."—By **Kathryn Barry Stelljes,** formerly with ARS.

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