Nematode Takes On Japanese Beetle Grubs

The nation's golf courses have become the unlikely site of a showdown in the push for effective biological controls against insect pests. And ARS entomologist Michael G. Klein is right in the middle.

He has identified a tiny nematode, *Steinernema glaseri,* as the foot soldier in the ongoing battle against destructive larvae of the Japanese beetle, *Popillia japonica.*

Commonly called white grub, Japanese beetle larvae inflict millions of dollars worth of damage annually on golf courses, cemeteries, sod farms, and lawns. They feast on turf roots, causing the turf to die and turn brown. The grub-infested turf attracts raccoons, skunks, and birds, which dig it up in search of the larvae—a delicacy for them.

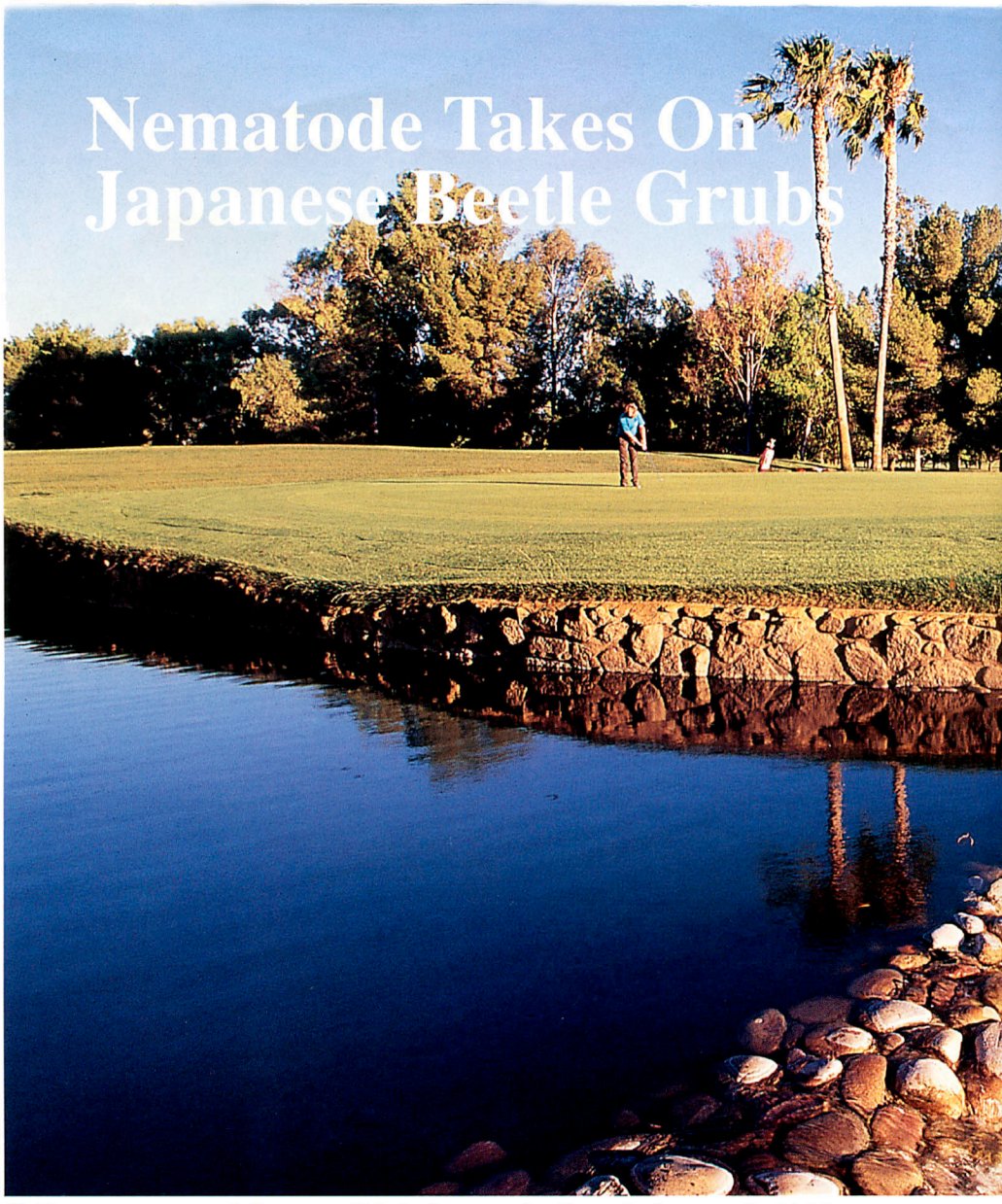
Golf courses are especially susceptible to white grubs because the highly groomed grass is a virtual smorgasbord for the insects, Klein explains.

"The varying topography of a golf course provides a very favorable environment for the beetles to feed and reproduce.

"For example, they can lay their eggs in various areas where plant life and soil temperatures are conducive to incubating them. After they hatch, the young do not even have to move to find adequate food supplies."

The Japanese beetle was discovered in the United States in 1916 and is believed to have hitchhiked in the soil of ornamental plants imported from Japan. Because of a lack of natural enemies, the insect gained a firm foothold in this country—including on golf courses. Ironically, the insect has only recently become a pest in its native land as the Japanese have taken up golf.

The need for an effective biological control for white grubs was intensified in 1969 by the removal of the chemical chlordane from the market. Chlordane had been a primary weapon against the pest. By the mid-1980's, the push was on to also replace other chemical pesticides with effective biocontrols.



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Golf courses are especially susceptible to Japanese beetle grubs because the highly groomed turf is a buffet meal for the insects. (K7086-1) Inset, facing page: Grub infected with nematodes.

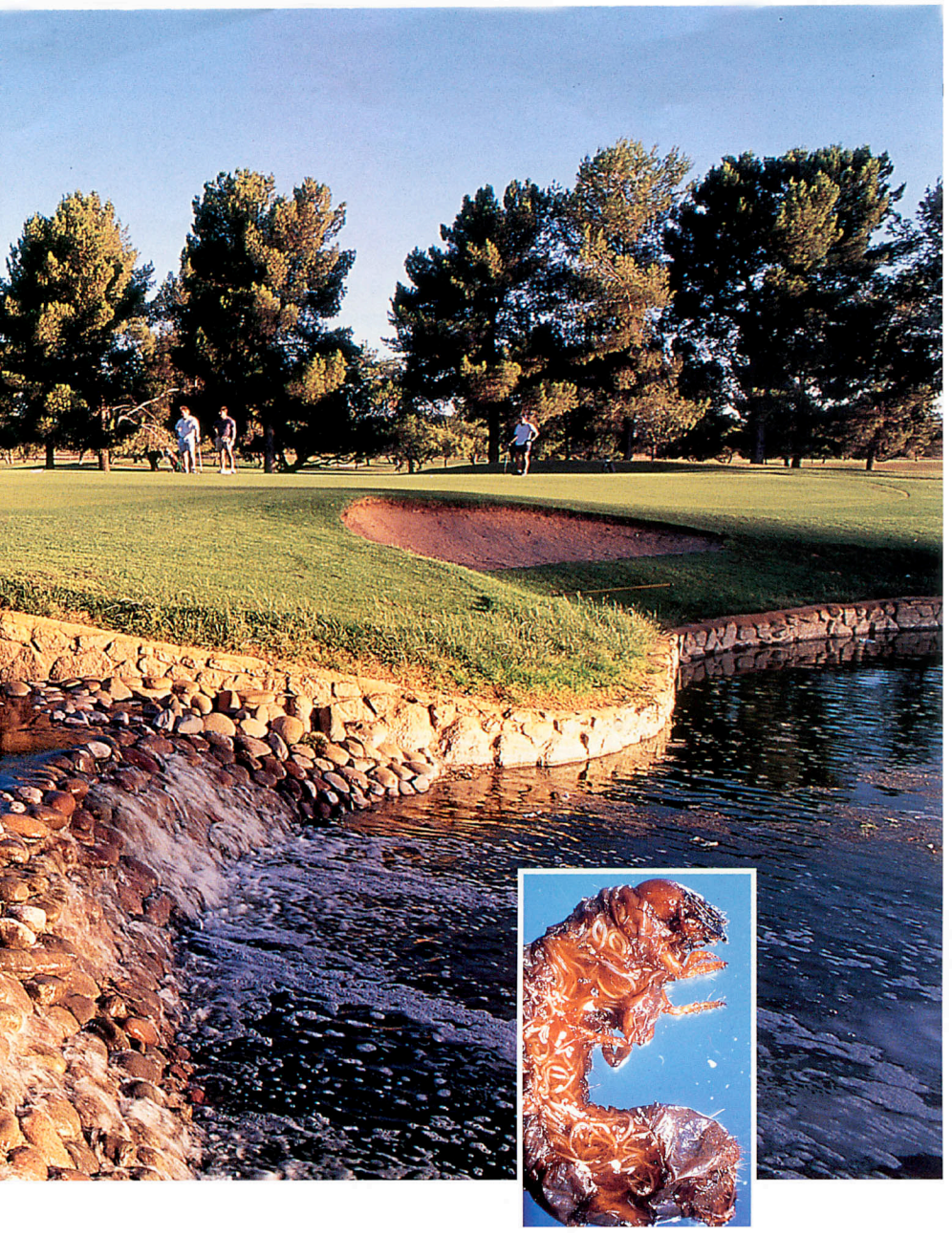
Working under a cooperative research and development agreement with the U.S. Golf Association, ARS researchers set out to find a better way to battle the white grub.

"A lot of golf course managers don't have the resources to keep treating with chemicals," Klein says. "They need alternative ways of dealing with pests."

S. glaseri is not the first biological control to be used on turf pests. *Bacillus popilliae,* a bacterium identified by ARS scientists in the 1940's, causes "milky disease" in white grubs. The bacterium has been commercially available as a biocontrol for Japanese beetles and other pests for several decades.

Certain nematodes have long been favored as a natural pest control because they attack only specific insects or groups of insects and therefore pose no threat to plants or nontarget insects. An economical alternative to costly chemicals, nematodes can be raised in large quantities and applied with regular pesticide sprayers.

In collaboration with researchers at Rutgers University in New Jersey and the University of California at Davis, ARS scientists pinpointed *S.*



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glaseri, a nematode native to New Jersey that is superior to other strains at killing grubs. The nematode is so host-specific in its tastes that it quells another fear of turf managers; it won't attack the turf itself.

Steinernema glaseri tracks white grubs by following the insects' carbon dioxide trail released through their breathing vents, called spiracles, says Klein. In fact, it was the nematode's powers of CO_2 detection that brought it into the spotlight.

Scientists learned of *S. glaseri's* taste for CO_2 by placing waxworms in soil samples taken from various golf courses. Waxworms exude a high CO_2 concentration, attracting any nematodes present in a soil sample. So a variety of nematodes was tested for behavior on white grubs before *S. glaseri* was isolated, says Klein.

In field trials, *S. glaseri* killed up to 50 percent of the white grubs in a 10-square-foot plot.

The secret of *S. glaseri's* success is sheer numbers, says Klein. "We're raising the number of nematodes to a level that simply overwhelms the defense mechanisms of the grub."

Parasitic nematodes normally enter their prey through the larva's breathing vents. But Japanese beetle larvae have protective plates over their breathing vents, so *S. glaseri* must enter these larvae through their mouthparts. "White grubs are pretty sensitive to nematodes crawling on them and clean their mouthparts frequently," says Klein. "Still, they manage to get in."

Once inside the grub, *S. glaseri* sets up housekeeping by releasing the bacterium *Xenorhabdus poinarii* into the grub's bloodstream. This kills the grub within 24 hours and liquefies its internal structures. The nematode then uses the grub's body to reproduce and to produce more grub-killing nematodes and bacteria. The next generation of *S. glaseri* emerges about 2 weeks later to begin its quest for prey.

Japanese beetle adults begin emerging in late May or early June in the southern United States.

During their 6- to 8-week lifespan, they feed on more than 200 different plants, and the female beetles lay eggs several times.

The larvae hatch and begin feeding in midsummer. Eventually they grow into the familiar white grubs visible just below the soil surface.

Klein recommends turf managers begin scouting for white grubs in mid-to-late summer, when they are more visible. "A threshold of 10 to 12 grubs per square foot is considered the benchmark for treatment," he advises.

Scientists are currently perfecting the delivery system for *S. glaseri.*

"The original plan was to deliver it in bulk tanks to be used within 24 hours, but this proved to be impractical," says Klein. "We're now working on a new system to get the product from the producer to the customer."—By **Dawn Lyons-Johnson**, ARS.

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