Asian Longhorned Beetles

Researchers Scramble To Find Controls for the New Woodlands Invader.

PEGGY GREB (K8910-1)

Technician Joe Tropp examines an Asian longhorned beetle larva crawling on a poplar cutting in a test tube.

Monitoring the munching sounds made by Asian longhorned beetles (ALB) may help scientists home in on which trees are infested. This is just one of several new tactics that Agricultural Research Service scientists are now exploring to find ways to control these wood-boring pests.

"Trees infested by the Asian longhorned beetles were first found in the United States in New York in 1996 and then in Chicago in 1998," says ARS entomologist Michael T. Smith. "Adult beetles have also been intercepted at ports in 17 states."

According to reports from USDA's Animal and Plant Health Inspection Service (APHIS), if this beetle spreads unchecked, it could cause billions of dollars in damage to ornamental trees and forests and to the maple syrup, lumber, and tourism industries.

Two highly prized and well-known urban parks in the United States—New York City's Central Park and Chicago's Lincoln Park—are presently at risk. Trees bordering these parks or in very close proximity have been found to be infested with ALB. While the infested trees have been removed, there is concern that the insects may have already spread to other trees in the parks.

Smith, who works at the ARS Beneficial Insects Introduction Research Laboratory in Newark, Delaware, is fast becoming one of the world's experts on these pests. He has spent considerable time over the past 2 years in interior China, conducting collaborative field studies with his Chinese colleagues on key aspects of the beetle's behavior, as well as its natural enemies. He and his colleagues are simultaneously carrying out additional studies here in the United States.

Native to China and Korea, *Anoplophora glabripennis* causes widespread mortality of poplar, willow, elm, and maple throughout vast areas of China.

"Most of the damage can be found in trees along streets, windbreaks around agricultural fields, hedgerows, plantations, and manmade forests," says Smith. Together with the large number of hardwood tree species thus far found infested in the United States—maple, elm, horse chestnut, and ash, to mention a few—this beetle can probably survive and reproduce in most sections of the country where suitable host trees exist.

The adult—over an inch long—is coal black with yellow or white spots and has long antennae with white bands. A female beetle spends considerable time chewing a small groove and hole through the bark to the cambium. Then she carefully inserts a single egg about the size of a rice grain through the hole and underneath the inner bark onto the outer surface of the wood, or xylem. She plugs the hole with digested wood known as "frass."

"Because of her efforts, young ALB are safe and well hidden," Smith says. He has documented female beetles taking 50 to 72 minutes to complete egg-laying. He is currently studying hours of video data of this and other ALB behaviors, so he considers these results to be preliminary.

"Based on published Chinese research, a female lays an average of about 35 eggs during her approximately 42-day life. They hatch in about 11 days," he says. "Then, the young grubs, or larvae, start eating the tree's cambium, first disrupting its nutrient-transporting

CHARLES HARRINGTON

Above, an Asian longhorned beetle adult crawls on a cross section of a tree damaged by larvae of the species.

At the Beneficial Insects Introduction Research Laboratory in Newark, Delaware, Asian longhorned beetle larvae are maintained on cuttings made from twigs of various tree species.

PEGGY GREB (K8909-1)

vessels. After shedding their skin twice, the larvae start boring into the wood of the tree, gnawing into the tougher, water-transporting vessels deeper inside."

So far, the only solution has been to cut down and remove infested trees. In the U.S. eradication program, infested trees are also chipped into tiny pieces after they are taken down. Chips are sometimes even incinerated.

A method for detecting and monitoring adult ALB is needed. One such method may be a pheromone lure—a scent produced by one sex to attract the other.

Last May, ARS entomologist Jeffrey R. Aldrich and chemists James E. Oliver and Aijun Zhang of the ARS Insect Chemical Ecology Laboratory in Beltsville, Maryland, isolated, identified, and synthesized two compounds from quarantined ALB as potential lures. In preliminary laboratory tests, these compounds appeared to stimulate flight and walking in both sexes.

However, field tests in China last July failed to demonstrate that the beetles are attracted to either compound. Additional field tests are planned. Stephen A. Teale, an entomologist at State University of New York-Syracuse, has been working for more than 2 years on this as well. He has isolated several compounds that he's been testing in China.

How Do You Detect Them?

Detection of ALB-infested trees has largely depended on visual examination of trees. Trunks are checked for insects and telltale signs—a small slit left by the female when she lays an egg, sawdust or sap coming from this slit, or dime-sized holes made by new adults emerging from the tree, says Smith.

APHIS estimates that inspectors identify only about one-third of the beetle-infested trees in situations where inspectors stand below and use binoculars to examine the trees. This has been the primary method used since 1996 in the New York infestation.

In Chicago, cherry pickers and tree climbers have been used to detect infested trees, and APHIS has reported improved detection efficiency from this method. The procedure, however, is quite costly and time-consuming.

Smith has been working with Teale to find a better system for detecting infested trees. They're developing an acoustic beetle detector that homes in on the beetle's munching sounds as they tunnel.

"The pest spends most of its life—about a year—as a larva inside a tree before emerging as an adult. We're working on a device that can pick up the sounds of tunneling larvae," says Smith.

So far, they've successfully recorded the beetles within standing live poplar and willow trees in China. These recordings were made under fairly noisy conditions to better simulate those under which this system is needed to operate in the United States.

In addition, successful recordings were made of ALB feeding up to 6.5 yards away from the recording device. "This will be particularly important since one of our goals is to provide a tool that inspectors could use to check trees without initially having to climb them," he says.

To distinguish beetle-chewing sounds from various environmental noises, Smith and Teale are working with a specialist on a feeding-noise recognition system. "It would generate an acoustic

fingerprint of the beetle as the larvae feed on the two tree tissues they commonly inhabit—inner bark and inner wood," he says. "Besides recording the chewing sounds of the beetles, we will be recording and developing an archive of the insect-munching sounds created by other chewers that also inhabit trees commonly infested by the beetle.

If successful, Smith and Teale hope that by early this fall they will have a functional prototype system for identifying ALB-infected trees by the chewing noises coming from them.

MICHAEL T. SMITH (K8916-1)

Entomologist Michael Smith patiently listens and records sounds produced by Asian longhorned beetle larvae as they feed within an infested willow tree in Gansu Province, China.

Other Control Tactics

Smith is also examining the biology of invasion for this beetle, which includes studies being conducted under natural field conditions in China in cooperation with Gao Ruitong and Li Guohong of the Chinese Academy of Forestry in Beijing, China.

"We hope to find exploitable nicks in the pest's armor—points in its life cycle we can take advantage of—to develop eradication or management tools," he says.

First, he is studying the behavior of adult beetles while they inhabit the tree, including how male and female beetles find, recognize, and mate with one another and the steps leading to egg laying, feeding (by adults), and host tree selection.

To date, Smith has uncovered new information never before recorded on ALB behavior, as well as identified several behaviors that are potentially exploitable for eradication or management.

Second, by observing the beetles' flight behavior in a single flight, he is assessing their ability to fly (distance, rate, in-flight orientation, etc.).

"Thus far, preliminary data analysis indicates that the average distance a beetle flies in a single flight is about 50 yards," Smith says. "However, since single flight distance may be largely influenced by the distance between trees within the landscape, this may underestimate the average single flight distance in urban landscapes where trees are more widely spaced. Our data show that ALB are capable of single flights of over 437 yards."

Third, Smith is also studying population dispersal behavior under natural field conditions in China. He wants to show how groups of ALB move over an entire season (in multiple flights).

"We're uncovering new information on the potential rate of population spread," says Smith. "It's particularly important that we conduct our initial studies in areas where the trees are spaced about the same as they are in the areas infested in the United States."

The immediate use of this information is to help APHIS, which oversees the ALB eradication program, establish the outer boundaries of its quarantined areas, as well as predict the direction and rate of spread from infestations in New York and Chicago.

Results from these studies will also be used by ARS entomologist Jay S. Bancroft at the Newark laboratory to develop models for predicting ALB population dispersal within various landscapes—such as parks, woodlots, plantations, and forests—that are at risk within the United States, according to Smith.

"While this is the first year of our multiyear study, preliminary dispersal results indicate that adult beetles are stronger flyers than previously thought," says Smith. "Preliminary analysis indicates that they are capable of dispersing an average of 328 yards over an entire season. However, the maximum dispersal distance recorded in this study was over 1,530 yards." The study will be repeated in the year 2000.

A recent report listed the ALB flight distance as only 40 to 50 feet. Referring to this report, Smith says, "based upon our 1999 studies of both population dispersal and individual flight behavior, ALB is certainly capable of dispersing or flying well beyond 50 feet." He is apprehensive that these flight distances underestimate the insects' flight ability or range.

To complement these field studies, lab studies of key aspects of ALB biology are being carried out with Smith's ARS biological technician Joseph M. Tropp at Newark.

"These studies will provide new information on the daily reproductive capacity of adult female beetles over their life span," Smith says. This is particularly important in light of the beetle's host-tree preference and the select group of tree species found infested in the United States.

Finally, ARS entomologist Keith R. Hopper at the Newark laboratory, whose expertise is in the population biology of invasion, is collaborating with Smith on