Views from the Canopy

Asian Longhorned Beetle:
Arming the Public for Early Detection and Eradication

The Agricultural Research Service (USDA-ARS), in collaboration with its many partners, has been conducting research on the Asian Longhorned Beetle (ALB) since 1998 in an effort to develop methods that can be used in the:

- early detection of ALB infestations
- eradication of known ALB infestations
- control of ALB should eradication efforts fail.

More specifically, a large part of the ARS efforts have been directed towards development of methods that can be used to **determine where, when and how to detect ALB infestations,** including both the detection of ALB-infested trees and the detection of adult beetles, as well as to **provide guidelines on where, when and how to implement survey, detection and control strategies**.

I. WHERE

Knowing where to look for ALB-infested trees and adult beetles can greatly increase the odds of early detection, including:

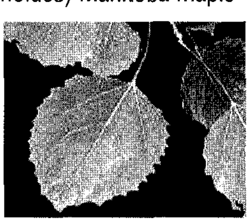
- what tree species are commonly attacked
- where within different types of landscapes do ALB typically first attack
- where within trees do ALB typically first attack
- how adult beetles move through different landscapes (pattern and distance of movement).

To address these questions, a series of complementary studies were conducted under epidemic population conditions in China and under low population conditions in the ALB infestation in Toronto, Canada.

A. Tree Species Most Commonly Attacked

1. In China, ALB commonly attacks poplar (Populus spp.), willow (Salix spp.), elm (Ulmus spp.) and maple (Acer mono, A. truncatum, etc.).

2. In the U.S. and Canada, ALB has commonly been found attacking maples [i.e. Norway maple (Acer platanoides) Manitoba maple (boxelder, ash-leaf maple: A. negundo), silver maple (A. saccharinum), sugar maple (A. saccharum), Japanese maple (A. palmatum), red maple (A. rubrum), amur maple (A. ginnala)], as well as Horsechestnut (Chinese buckeye: Aesculus chinensis; Ohio buckeye: Aesculus glabra), Goldenraintree (Varnish tree, Pride of India: Koelreuteria paniculata), Birch (water birch: Betula occidentalis; Gray birch: Betula papyrifera; Paper birch: Betula populifolia); London Planetree (Platanus acerifolia); Willow (white willow: Salix alba; Babylon Weeping willow: Salix babylonica); and Basswood (American linden: Tilia americana).



Poplar

B. Where within different types of landscapes do ALB typically first attack

Results from our studies have thus far shown that during the first few years of attack, ALB typically attacks open grown trees and trees along edges. Therefore, while focusing attention on the known host tree species listed above, detection efforts should concentrate on:

- open-grown trees, such as street trees, courtyard and backyard trees, and trees growing in neighborhood parks, cemeteries and in other similar green spaces
- trees growing along the edges of right-of-ways (i.e. roads, power lines, railways).

Photo: M. Bohne

However, within closed-canopy areas, such as forests, woodlots, drainage ditches and ravines, the trees most likely found infested during the first few years of invasion are normally found along the edges, but may extend up to about 50m into these wooded landscapes. Therefore, in closed canopy areas, detection efforts should be concentrated along the edges and extend about 50m into the wooded landscape.

C. Where within trees do ALB typically first attack

Results from our studies have thus far shown that during the first few years of attack, the signs of attack are most likely detected if efforts are focused as follows:

1. Oviposition Scars, Exit holes and Sap Flow:
   a. on sections of the trunk, beginning with the lowest branches and extending up into the mid-canopy (ALB typically avoids laying eggs into very deep furrowed bark)

Oviposition scars and exit holes on underside of branches and on the trunk

b. on sections of branches that are greater than 3-4" in diameter

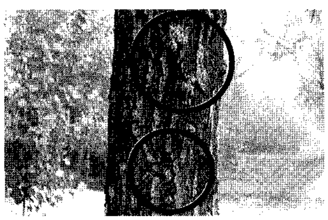
c. on very small diameter trees (< 2.5" dbh), initial attack is typically on the lower sections of the trunk, including just above ground level and extend up to the lowest branches.


Oviposition scars and exit holes on the lower section of trees, near ground level

2. In addition to the widely publicized oviposition scars, exit holes and sap bleeding from oviposition scars, **three other signs of attack can be extremely useful in early detection** of ALB and ALB-infested trees, and an understanding of where to look for them will increase the chances of early detection:

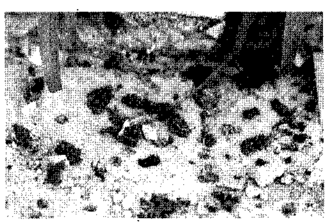
a. frass and feces of ALB may accumulate within branch crotches, within bark crevices, and on the ground around the base of infested trees. It is also important to know that different types of frass differ greatly in appearance:

- dark brown or black pellets
- light brown or cream colored strands
- light cream colored splitters.


Frass pushed out of ovip scars on trunk by ALB larvae in summer (willow) - in this image, most of the frass is dry and stringy

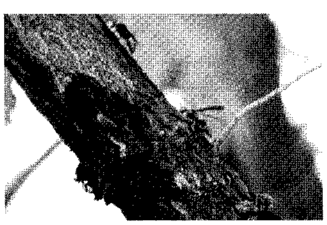

Frass pushed out of ovip scars on trunk by ALB larvae in summer (willow) - in this image, most of the frass is dry and stringy


Frass pushed out of ovip scars on trunk by ALB larvae in summer (maple) – in this image, the frass is moist and beginning to dry

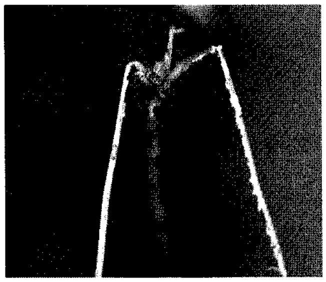

This is a close up of some dry clumps of brown frass that was originally pushed out wet....thus it dried in small clumps

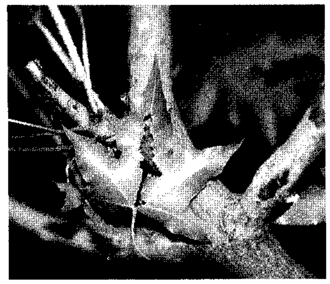
b. Other insects are sometime found associated with ALB or other wood boring insects, including ants, flies, scarab beetles and wasps.


Scarab Beetles


Wasps

c. adult beetle feeding scars can be found on twigs, leaves and leaf stems (petiole). Adult leaf feeding damage is generally readily visible and very easy to recognize.





D. Where to look for adult beetles

In addition to detection of the signs of attack discussed above, an understanding of where to look for adult beetles within trees may be useful in early detection as well. Based upon our field studies of the daily patterns of behavior of adult beetles, the following patterns were noted:

1. adult beetles tend to be found in sun-exposed areas of the tree, such as at the tips of branches (they are trying to warm up) in early morning hours (sunrise to about 8:30am), particularly in locations where night-time temperatures tend to be cool.
2. adult beetles tend to be found in the coolest parts of the tree, such as the interior and/or lower canopy and/or on the lower trunk in the hottest times of the day,


Beetles in trees

As beetles engage in any one of a number of behaviors throughout the day, including feeding on leaves, beetles may be found moving about almost anywhere on a tree. However, beetles are stationary (motionless) most of the time.

E. Distance of Movement or Dispersal:

Field studies conducted in China on the process of seasonal dispersal and population spread showed that:

- 98% of beetles disperse less than 920m over a season
- dispersal potential (maximum measured) within the course of a season for male and gravid female beetles was approximately 2,400m and 2,600m, respectively
- the average dispersal rate was 30m/day
- 34% of ALB fly to nearby host-trees on a daily basis and therefore, there is far more movement from tree-to-tree, even on a local scale, than previously thought.

Collectively, these results have been used by APHIS and the CFIA in the U.S. and Canada, respectively, in setting science-based survey and quarantine boundaries. For example, in both New Jersey infestations and in the Toronto infestation, the above results were used in part to formulate and implement the following eradication protocol:

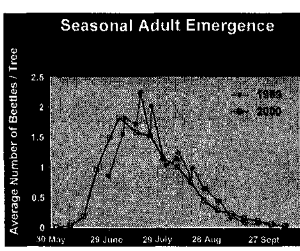
1. Tree-Removal-Zone: remove all host trees within 400m of any tree found to possess an exit hole (Canada) or egg scar (U.S.)
2. Treatment-Zone: treat all host trees within 400m beyond the outer limits of the Tree-Removal-Zone as follows:
   a. New Jersey: apply systemic insecticide
   b. Canada: intensively survey all host trees 2-3 times per year.

As such, 800m of the estimated 920m annual dispersal distance was adopted for treatment.

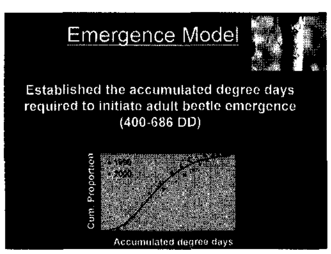
> **Equipment:**
> A good pair of binoculars, preferably with 10 x 50 specifications, not only provides adequate magnification, but also has an excellent light capturing capacity that allows you to see deep into dark spaces within the canopy of trees.

II. WHEN

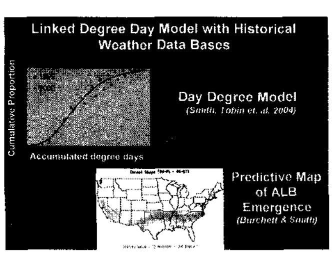
We have conducted studies to determine when during a given year adult beetles are most abundant and most active. More specifically, we have developed a degree day model that predicts when each year adult beetles exit trees that were attacked the previous year. When linked with a risk mapping system, developed in collaboration with NC State and APHIS, one can effectively predict when survey, detection and control methods that target adult beetles should be implemented regardless of location.



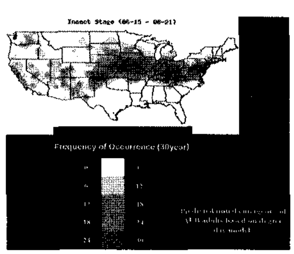
Seasonal abundance graph



DD Model graph



DD Model graph

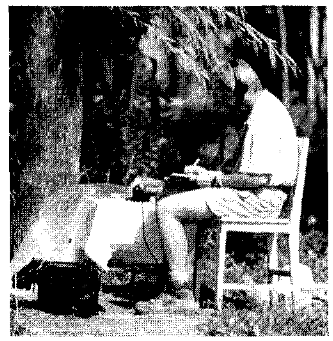


Predictive Risk Maps

III. TOOLS ON THE HORIZON

1. Detection of Infested Trees:

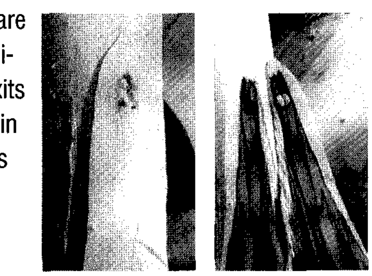
a. Acoustic Detector: In collaboration with colleagues at SUNY ESF (Syracuse, NY) and PKI, the first prototype unit of a neural network-based system has been completed and built. However, this neural net unit must now undergo intensive field testing to determine its efficacy at detecting ALB larvae feeding within infested trees. As such, we plan to conduct such tests in China in 2005, specifically within naturally infested maples and willow trees. Secondarily, we plan to evaluate the sensitivity of our current sensor relative to other sensors.


Tests conducted in China

b. Visual Detection: In collaboration with our Canadian colleagues (CFS, CFIA, City of Toronto), we are developing a guide to the visual signs of attack across a wide variety of tree species. This guide will include the variation found in the appearance of:

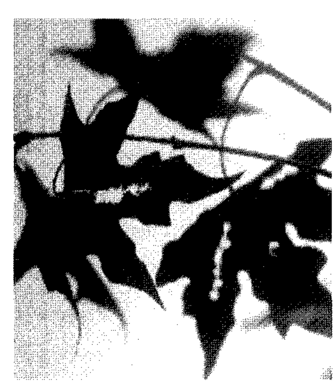
(1) oviposition scars (oviposition scars are more circular on thicker bark, and are more slit-like on thinner bark)

(2) exit holes (exit holes are perfectly round immediately after the beetle exits the tree; exit holes begin to fill in (callus over) as the tree continues to grow, and can in fact completely disappear from external view within a few years, even on maples).



(3) In addition, we plan to include images of the: (1) different types of frass found on or around the base of the tree; and (2) various types of adult feeding damage. Included among the latter will be the:

(a) feeding scars found on the surface of twigs;
(b) the feeding scars found on the outer surface of the leaf petiole (the stem of the leaf), and
(c) leaf feeding damage that results in removal of primary leaf veins, as well as leaf tissue.

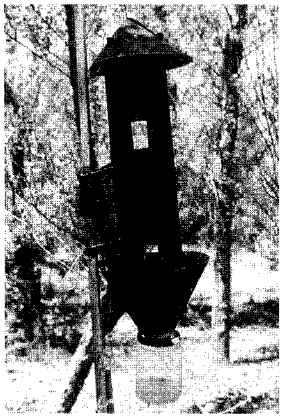


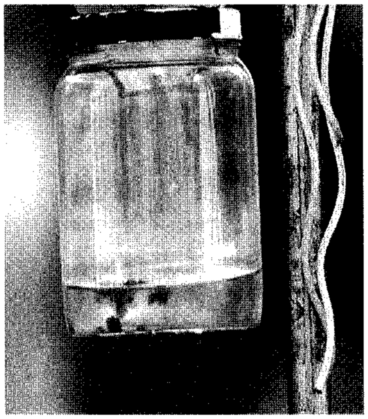
2. Detection of Adult Beetles

a. Sentinel Trees: A highly attractive tree species has been identified in field tests, and the attraction has been shown to be based upon behavioral response to host odors. Studies will be initiated in 2005 so as to compare the attraction of adult beetles to this attractive tree species versus Norway maple, as well as to other tree species commonly attacked in North America and China.

Pilot test conducted in NY in 2004

b. Artificial Lures: Based upon the initial results from our sentinel tree studies (mentioned above), collaborative efforts were initiated in 2003 to isolate and identify the tree odors responsible for the attraction of adult beetles to this tree species. To date, results have shown that adult beetles are attracted to and captured within traps (placed 3-5m from infested poplar or willow trees) that have been baited with different blends of specific chemical host odors. However, additional studies are required, including efforts to determine if the artificial lures can attract adult beetles living within the canopy of large infest maple trees. Furthermore, considerable efforts are also required to optimize the lure formulation and release rate, as well as to determine the attractive radius of the lure (this latter information is critical since it will play a role in determining how many traps are needed within a given area).





c. Attract-Kill-Detect: We have evaluated the efficacy of an insecticide that is encapsulated within microscopic beads to kill adult beetles. Basically speaking, when the adult beetle steps onto the beads, the insecticide is released in very minute amounts. The chemical is immediately absorbed by the beetle, thereby resulting in paralysis and death. As such, we have recently completed studies to determine the dosage necessary to paralyze the beetle within 1 minute; to kill the beetle within 24 hours; and to do so for 90 days (residual effects) under natural field conditions. In anticipation that spraying large urban trees with an insecticide might be unacceptable, we had the idea of applying the insecticide to an artificial material that could then be wrapped as 'bands' around branches within trees. As such, when the beetle walks across the band, the beetle would be quickly paralyzed, fall and die. Furthermore, we also had the idea to combine this insecticide band with a trap that could be used to catch the paralyzed beetle as it falls from the tree. Therefore, if successful, this system would serve as a detection method. However, this insecticide band-trap system also requires behavioral studies so as to: (1) determine the appropriate type of material to use, since adult beetles will not walk onto just any surface; (2) determine where and how many bands to hang within trees; and (3) design various traps that can fit most tree and landscape conditions.

As such, we have been conducting behavioral studies to answer all three of these questions. In particular, our field studies are designed to determine where within trees (including maples) beetles begin colonization during the first year of attack. These studies will be continued in 2005. In closing, it should be noted that applying this insecticide as a 'spot spray' or as a 'canopy spray' may offer viable alternatives to the banding method under specific tree and/or landscape conditions.

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1. Canadian Forest Service
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11. Chinese Academy of Agricultural Sciences
12. Sino American Biological Control Laboratory

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