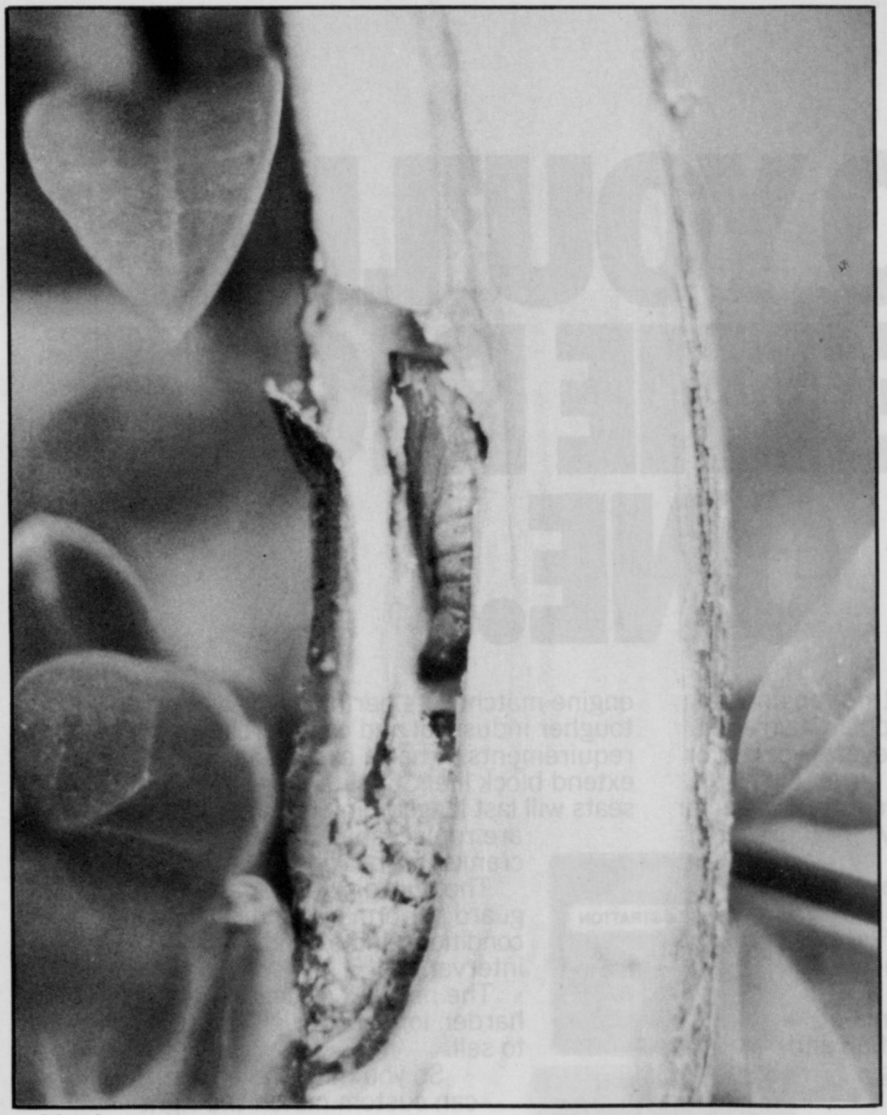

A lilac borer *pupa.*

The Hidden Enemy

Often doing most of their damage undetected, borers are distructive plant pests. Knowing the early signs and symptoms of borer infestation can help save many trees and shrubs.

by David G. Nielsen, Ph.D

Insects that bore beneath cortical tissues of their host constitute one of the most damaging groups of plant pests.

Although damage symptoms eventually become obvious, a borer's activity is often undetected until after significant damage has been done to the tree or shrub. Borers are unique in that they directly destroy vascular tissues and structural integrity while operating beneath bark in a secluded and protected environment.

Their feeding location complicates efforts to control them. The subcortical environment inhabited by borers is an apparent haven, but must be a hostile challenge to colonization.

The larva is small when it invades this center of plant activity, and internal vascular pressures force many larvae to retreat and perhaps die. Toxic chemicals in these tissues may repel or kill larvae. These factors have limited exploitation of sub-cortical tissues of healthy trees by insects. However, protection offered by tree bark must be a powerful evolutionary incentive for colonization by these prolific and adaptive animals.

Boring insects thought to be primary invaders, capable of reproducing in so-called healthy trees, are far outnumbered by those considered to be secondary, capable of reproducing only in weakened trees. If healthy trees are not susceptible to primary borer attack, then trees harboring larvae must be stressed or in an altered state of vitality. This fact should always be kept in mind when designing a borer control program, or a tree management program designed to reduce insect problems. This topic will be covered later in this article.

Two very different kinds of insect borers will be discussed to present principles associated with controlling the most common and important kinds of borers that attack landscape trees. Much of the information presented can be extrapolated to other kinds of borers.

Clearwing moth borers

Clearwing moths (see table for important species) in the order *Lepidoptera* and Family Sesiidae comprise one of the most homogeneous groups of insects known.

In other words, they are more alike, as a group, than are most other families of insects. This fact is important for us to know when defining re-

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search protocols and formulating control strategies.

For example, we have learned that all clearwing moths use long-range chemical communication to facilitate mate location. Females emit perfumes called pheromones that are carried downwind where they are detected by waiting males. When a male detects the presence of the right pheromone, he begins a highly programmed response that leads him to the odor source, an unmated female of his species.

We also know that many, if not all, of the clearwing moths that attack trees and shrubs produce similar pheromones or pheromonal components. This fact has enabled us to develop sex attractants for a number of economically important clearwing borers with minimal effort. And, finally, if an insecticide is effective against one species of clearwing moth it will also be effective against other members of the family.

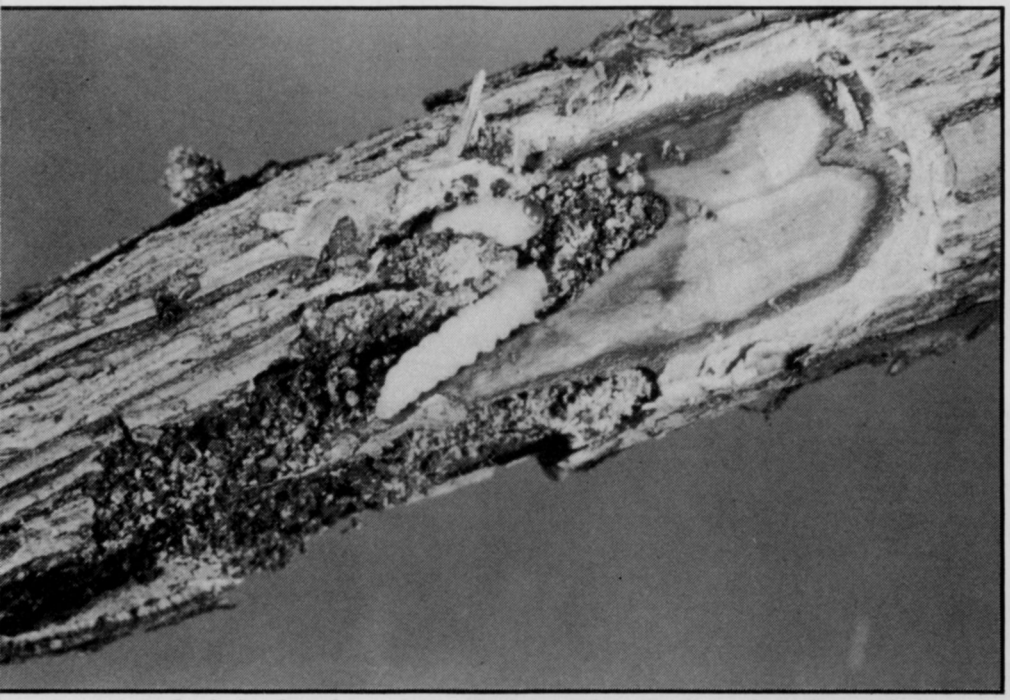
This has obvious benefits when attempting to develop chemical insecticides as borer control agents. Clearwings overwinter as larvae in the woody tissues of their hosts; they are relatively host specific.

For example, lilac borer may inhabit lilac, ash, and privet, but not oaks, maples, pines, etc. The most common scenario for clearwings in trees and shrubs is to complete one developmental cycle or generation each year. After overwintering successfully, the larva either resumes feeding to complete development or becomes a pupa, the transitional stage between the damaging larval stage and the adult.

Approximately 10-14 days after pupation, the pupa wriggles about half way out of the tree, the pupal skin splits, and the adult emerges. Clearwings we have studied emerge in the morning. Shortly after a female emerges she begins to emit her pheromone, and within a few minutes one or more males arrive and coupling occurs. The mated pair will remain coupled for 60 to 90 minutes during which time sperm is transferred. Females mate only once; males will mate several times.

Soon after the pair separates, the female begins laying eggs on the tree where she mated. If disturbed, she may fly to another area resulting in oviposition on a nearby host tree. Eggs are laid singly and require 10-14 days to hatch. Larvae hatch and crawl over the bark surface for some time before selecting a location for their entrance hole. Feeding continues until cold temperatures prevail in fall.

Clearwings commonly appear to colonize so-called healthy trees, but are not pests of trees on native, undisturbed sites. So, they are probably secondary pests, but appear to be infesting otherwise healthy trees.



A rhododendron borer *larvae is shown above with resulting larval damage.*

Metallic wood borers

Metallic wood borers (see table for important species) in the order *Coleoptra* and family *Buprestidae* are some of the most beautifully irridescent organisms on earth, but their larvae, known by the misnomer flatheaded borers, are destructive pests of landscape trees.

Actually, the head of the larva is round and relatively small. It is dwarfed by flattened thoracic segments that give the larva its common name.

Very little is known about buprestids and their relationship to host plants. Although there has been one report that a certain species uses pheromones to facilitate mate location, we have been unable to detect such a system with bronze birch borer, the most common and destructive flatheaded borer in the landscape.

Instead, it appears that adults are host-oriented, locating a mate that has also congregated on a suitable host tree in response to cues or signals emanating from the tree.

Since no one has identified cues that trigger buprestid congregation, it is not possible to monitor easily seasonal flight and abundance of bronze birch borer adults, as can be done for several economically important clearwing borers.

The two most common and destructive flatheaded borers in the United States are bronze birch borer and a close relative, the 2-lined chestnut borer. Both are native to North America.

The latter is a pest of seriously weakened trees, causing mortality of defoliated or otherwise disturbed oaks. The former is probably beneficial in the forest, speeding decay of overmature and otherwise unproductive birches.

However, it colonizes and kills what appear to be healthy landscape birches, especially the popular white-barked species, European white birch, and canoe or paper birch. The only common landscape birch that is obviously resistant to bronze birch borer is river birch.

Although a cultivar of this species is advertised as having white bark, it is certainly not a replacement for the whiter-barked species that are so popular.

Bronze birch borer is distributed in the northern half of the United States and southern Canada from the east coast to the Cascade Mountains of Oregon and Washington. Most populations complete one generation each year; throughout its range larvae overwinter.

If the larva is in a part of the tree with thick bark it may overwinter in the phloem or inner bark. Otherwise, larvae construct an overwintering chamber within xylem (wood).

In any case, it appears that larvae

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construct a frass-packed tunnel from the chamber to the outer bark cortex before overwintering. This larval channel undoubtedly expedites and facilitates emergence by the adult the following spring.

Larvae pupate in May or June. Ten to 14 days later, the adult chews a D-shaped emergence hole that conforms to the shape of the thorax before emerging. If the hole is not shaped properly before the beetle tries to climb free, it may become permanently stuck in the hole.

Most adults emerge during a 4 to 6 week period in late spring and early summer and must feed at least 8 to 10 days before they are capable of laying eggs. Females are apparently discriminating egg layers because each produces only 10 to 40 eggs during a 3 to 6-week life time.

Eggs are glued to bark surfaces, usually near the v-shaped, black areas at the junction of branches with limbs or limbs with the trunk. Larvae hatch by chewing through the egg chorion at its point of attachment to the bark after a 1 to 2 week incubation period.

Larvae feed initially in the cambial zone, stimulating some trees to form a callus-like tissue that shows-up as ridges in the bark. Since larvae feed horizontally and switch directions at acute angles, the raised areas on the bark are in a zigzag pattern.

Other researchers have hypothesized that this feeding pattern minimizes vascular pressures on larvae, improving their chances of surviving the tree's natural resistance.

The primary symptom of bronze birch borer attack is dieback of the uppermost branches of the tree. When this is noticed, the bark should be inspected for the presence of narrow, raised areas in an S-shaped configuration.

If this symptom is present on birches with top-dieback, you can be certain that bronze birch borer is the culprit. If D-shaped emergence holes are detected, you know that the infestation must be dealt with immediately if there is any hope of saving the tree.

Control strategies

There are four factors that are of primary importance in developing a borer control strategy:

1 maintaining plant vitality,
2 knowing when adults begin emerging and for how long emergence continues,
3 knowing which labeled insecticides are most effective, and
4 achieving thorough coverage of all bark and leaf surfaces.

Maintaining plant vitality

Many people do not realize that the urban forest is a hostile environment for woody plants. Soil texture, grade, and chemistry have often been dramatically altered by activities of urbanization, and exotic trees are planted in locations for which they are not adapted.

Landscape architects and others who choose trees for specific sites should do a better job of selecting trees that can be expected to thrive, or at least survive, in the area where they will be planted.

Very little is known about buprestids and their relationship to host plants.

Whenever possible, sites should be altered to meet the requirements of the tree to reduce long-term maintenance costs associated with weakened trees.

Recognizing that borers are opportunists that exploit weakened trees, it should be obvious that anything we can do to improve tree vitality will reduce borer infestation and damage.

The following cultural practices will improve or help maintain tree vitality, helping the tree to help itself in its battles with borers and perhaps other insects and diseases.

Pruning

Landscape trees should be pruned properly and on a timely basis following recommendations recently published by Dr. Alex Shigo of the Northeast Forest Experiment Station in Durham, NH.

Trees like birch should be pruned after August 1 to minimize bleeding and problems with canker-causing fungi. Proper pruning will improve both the confirmation of the canopy and the energy economy of the tree, leading to improved vitality.

Fertilization

In native habitats (i.e., forests there is a cycling of nutrients as leaves and branches are shed, fall to the ground, and decompose. The same process occurs with understory plants, including shrubs, forbs, and grasses, resulting in a continuous supply of nutrients.

This cycling does not occur in much of the urban forest because leaves and other refuse are discarded annually. Competition by dense plantings of grasses further depletes soil nutrients. Consequently, urban trees will benefit from fertilization.

An inorganic, slow-release fertilizer should be used in fall after one or two hard frosts. It can be broadcast on the soil surface, injected under pressure, or placed in drill-holes. If annual fertilization is practiced, 4 pounds of actual N per 1000 square feet should be used. I recommend 6 pounds of N per 1000 square feet every other year.

Top-dressing may be the most cost-effective method, but aerification supplied by injection or drill-holes may provide additional benefits.

Mulching

Bark damaged by maintenance equipment commonly serves as an oviposition site for borers.

Whenever possible, trees that are known to be hosts of clearwing borers should be mulched so that equipment does not need to be used close to the tree trunk. Of course, mulching also reduces evaporation of water from the soil, minimizes rapid changes in soil temperature, and reduces weed competition.

Mulch should not be more than about two inches in depth to minimize chances of creating an environment at the base of the trunk where microorganisms may flourish and eventually invade the tree.

Watering

There is a common misconception that large trees have deep roots, so they are not impacted by drought.

The reality is that large trees often suffer more from periods of low rainfall than smaller trees. In any case, trees will benefit from weekly watering whenever summer or fall drought occurs. Watering should be done slowly so that it percolates to the roots rather than running-off to areas that will not benefit the target tree.

This is one tactic in which the client can participate, if they are willing.

Debilitating insects

Defoliators and sucking insects should not be allowed to reach levels that debilitate trees, thereby reducing their natural resistance to opportunistic pests like borers. A high degree of control is not necessary because low levels of pests usually do not reduce tree vitality significantly. Consequently, insecticidal soaps, horticultural spray oils, and bacterial insecticides can be used to minimize reliance on conventional insecticides.

Implementation of a tree care program that includes the above prac-

tices will lead to a more vital urban forest and a reduction in insect pest problems. But, there will always be times when a borer infestation must be dealt with aggressively to save the tree.

Defining adult emergence

Detection of presence and delineation of the emergence period for several clearwing moth borers can be accomplished with pheromone traps. Conrel Clearwing Borer Traps (available from Conrel, 110 A St., Needham Heights, MA 02194) can be used to capture male moths of the following borers: banded ash clearwing (looks much like lilac borer but emerges in August and September rather than May and June), dogwood borer, lilac borer, lesser peachtree borer, peachtree borer, an oak borer, and rhododendron borer.

The traps are simply placed in a convenient location in your service area and checked periodically beginning about two weeks before emergence of the target borer species is expected. Directions provided in the trap kits and color photographs make the traps useful even to practitioners who are unfamiliar with insects.

Borer sprays are applied at specified time intervals after the first male moth is captured.

In most cases, clearwings that attack trees can be controlled with a single application of an effective insecticide, if it is timed properly.

We have been unable to detect the presence of long-range sex attraction with bronze birch borer, so monitoring adult emergence is laborious, requiring daily or weekly inspection of infested trees or bolts.

Recently, we have described a way to predict bronze birch borer emergence based on local temperature. Degree-Day (°D) insect activity models are based on a threshold temperature and a starting date (the date on which you begin accumulating °D above the developmental threshold).

Careful analysis of several threshold temperatures and starting dates in Columbus and Wooster, OH, indicate that these values must be prescribed for a given geographical area.

For example, in Wooster which is about 50 miles south of Lake Erie, the best threshold temperature for predicting 10 percent adult emergence was 10°C (50°F) with a starting date of April 1. In Columbus which is latitudinally about 50 miles south of Wooster, the best threshold temperature was 8°C (46°F) with a starting date of May 1.

We don't know how well these models will fit other locations. Someone in each area of the country who wishes to develop this kind of model for predicting bronze borer emergence will need to collect infested wood in early spring, record seasonal emergence and temperature, and then work with a statistician to determine if one of our models accurately describes birch borer emergence in their area.

The importance of using a predictive model based on local temperature is that a borer population may emerge as much as two to three weeks earlier or later than usual during a particular year. This accelerated or delayed emergence is directly related to temperature and will directly influence the success of your borer control program.

Effectiveness of available insecticides

Dursban (chlorpyrifos), Turcam and Dycarb (bendiocarb), lindane, and Thiodan (endosulfan) are registered for use against borers. I have not worked extensively with Thiodan but believe the other materials to be at

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least as effective or better.

Chlorpyrifos is available in three formulations (Dursban 2E, 4E, 50WP) and is registered for use against all borers on all trees and shrubs. The usage rate is commonly one pound of active ingredient per 100 gallons of water applied to runoff. Currently, Dursban is the best choice for controlling clearwing borers. In my experience, a single application of Dursban, 10 to 14 days after first adult emergence as monitored by a pheromone trap, will provide season-long protection.

The exception would be lesser peachtree borer that emerges from May through September in much of its range. Two or three applications at 5-week intervals may be required to control this species. Lindane is somewhat hard to find these days but is an effective borer control product with an excellent safety record.

The most commonly used formulation is the 20 percemt liquid that contains 1.8 pounds of insecticide per gallon. It can be substituted for Dursban at the one pound of active ingredient per 100 gallons of water usage rate for controlling clearwing borers. To my knowledge, products containing bendiocarb have not been evaluated against clearwing moths. We plan to do this in the near future.

Turcam 76WP (or Dycarb) is my choice for controlling bronze birch borer, although Dursban has also provided excellent control. Again, the one pound active ingredient usage rate applies. The initial thorough-coverage spray should be applied just prior to first adult emergence.

In northeastern Ohio this is usually in late May (20-25). Two repeat applications are made at two-week intervals. The spraying should be initially focused on bark of the trunk and all branches, even in the top of the tree, but leaves should also be sprayed because adults must feed for at least several days before laying eggs.

By spraying before adults begin emerging, repeating the application throughout the major emergence period, and covering both bark and leaves thoroughly we:

1 kill adults as they construct their exit hole,

2 perhaps kill eggs or larvae when they eat sprayed bark while chewing through the egg chorion at its point of attachment to the bark, and

3 kill adults when they contact bark or consume or contact treated foliage.

When spraying trees to control clearwing borers, application can be delayed until after oviposition, because larvae hatch and then crawl over the bark surface before choosing an entrance site.

However, with flatheaded borers, the spray must be applied before oviposition, since larvae construct their entrance hole at the point on the bark where the egg is attached. Any borer control strategy should be coordinated with a tree health care program, including removal and destruction of borer infested wood for top-killed and dead trees, and cultural practices that have already been enumerated.

Borer control procedures have now been developed that can be used by arborists and other landscape managers to minimize damage done by borers, some of the most damaging insect pests in the urban forest. **WT&T**

The author encourages all applicators of insecticides to read the container label carefully, following all instructions. Recommendations provided in this article are based on experience by the author. The author wishes to thank Rodney C. Akers for providing information on D models for predicting emergence of bronze birch borer adults.