The Two-lined Chestnut Borer

(& Associated Partners in Tree Crime)

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Dr. Roberts retired from Michigan State University in 2018 after committing four decades to advancing MSU's Land Grant Mission, originally signed into law by President Abraham Lincoln during the midst of the American Civil War. He has published hundreds of articles and has taught hundreds of lectures and workshops.

Dr. Roberts has researched many issues in Michigan's plant industry, including Oak Wilt, Dutch Elm Disease, Diplodia Tip Blight of Pines, along with a variety of cultural problems such as plant nutrition and herbicide toxicity. During his career, he has discovered a variety of new diseases and pests such as Phomopsis Canker of Spruce and the first bacterial wilt disease of turfgrasses in North America.

In the early 2000s, his research on Ash Decline in Southeast Michigan led to the discovery of the invasive Emerald Ash Borer in North America.

In his retirement, Dr. Roberts intends to remain active with the Arboriculture/Landscape/Nursery industries. Dr. Roberts is President, CEO and CBW (Chief Bottle Washer) of The Plant Doctor, LLC…aka The Tree Doctor.

P1 "The Look" of TLCB exhibits gradual decline starting from the top of oak trees. Such appearance of afflicted trees is common throughout Michigan and, in the author's opinion, is responsible for the decline and death of many oak trees.

P2 This collage of photos shows the adult, larva and emergence holes of TLCB. (Adult and larva photo credit: Dr. Robert Haack, retired from the U.S. Forest Service)

P3 The Emerald Ash Borer, Two-lined Chestnut Borer and Bronze Birch Borer belong to the insect genus *Agrilus* and hence, are all related. They are flat-headed wood boring beetles (the reason for "D-shaped" emergence holes) that feed in the cambium tissues of their host trees. Their feeding habit in live plant tissues implies that they do not linger in their host trees after their host trees have been killed.

P4 TLCB is common throughout Michigan. This tree near Glen Arbor, Michigan was initially thought to have been killed by Oak Wilt. Closer inspection revealed D-shaped emergence holes at eye (ground) level. Other clues include extensive bark sloughing from the upper branches (not typical of Oak Wilt) and wilted foliage lower on the tree (barely visible in this photo).

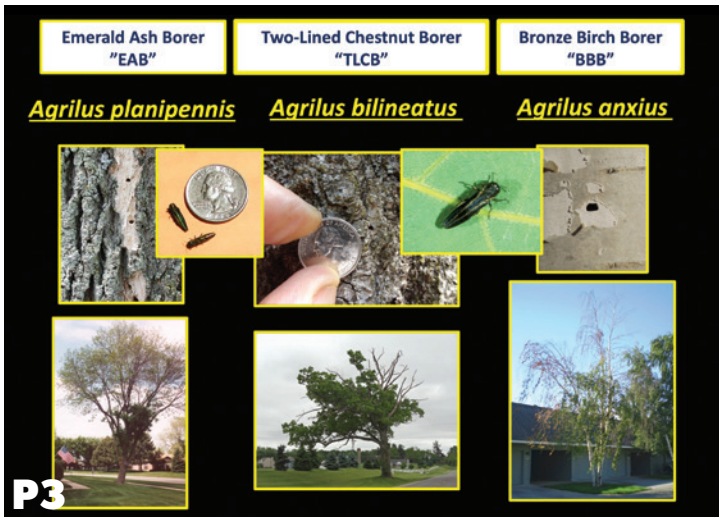
Introduction:

The Two-lined Chestnut Borer (*Agrilus bilineatus* =TLCB) is purported to be native to North America. The pest initially tends to attack stressed trees and contributes to decline and death of those trees (Photo 1). The TLCB was first likely described on American Chestnut (hence, its name sake) before the dreaded invasive Chestnut Blight practically eliminated that species from America's natural and urban forests. The primary host trees for the TLCB (Photo 2) are oaks, chestnuts and beech.

To place the TLCB in perspective, another native insect and "cousin" of the TLCB is the Bronze Birch Borer (*Agrilus anxius*=BBB), an insect borer that attacks *Betula* species, particularly introduced birch species such as European White Birch. Another relative of the TLCB is the introduced Emerald Ash Borer (*Agrilus planipennis*=EAB). All three insects are flat-headed wood boring beetles which derive sustenance from tunneling in cambium tissues of live trees and whose exit holes from trees are "D-shaped" (Photo 3).

Our native oak trees exhibit some tolerance to the TLCB. Yet, our native ash trees exhibit little resistance to the introduced EAB. Hence, it is easy to surmise that **EVOLUTION** (adaptation or whatever) has played an important role in the susceptibility of our forests to various pests: native insects generally do not cause widespread destruction of their native host plants. Conversely, whenever a native insect is exposed to an introduced host plant or whenever an introduced insect encounters a native host plant, widespread destruction of host trees may occur.

I have frequently witnessed and confirmed TLCB in all regions of the State of Michigan (Photo 4 and Photo 8). In my opinion, the TLCB is a much more common and significant problem in Michigan and neighboring states than many arborists and foresters realize. Although usually found on larger trees in urban and natural forests, the TLCB may attack smaller nursery-sized trees in certain situations.

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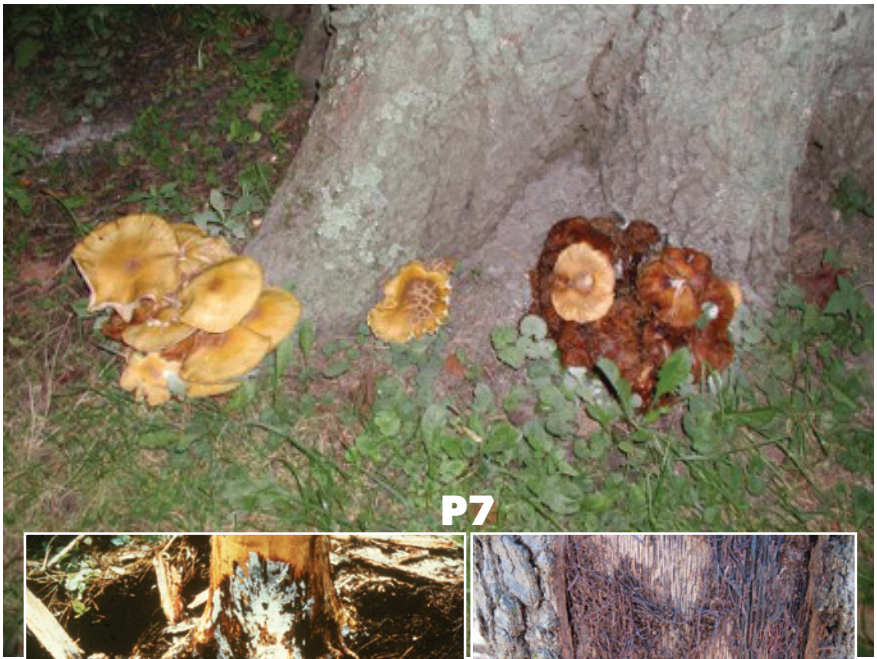
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Symptoms and Insect Cycle:

The TLCB typically attacks stressed trees first (see "Predisposition of Trees To TLCB", below). The life cycle of the TLCB is like that of the EAB. Adults usually emerge in May and June and begin feeding on foliage; the time of emergence can vary depending on the temperature and accumulation of heat units in the spring. Subsequently, adult male and female TLCB entertain romantic notions that lead to mating. Adult TLCB measure approximately 3/8 inches long and 1/8 inches wide and appear bullet-shaped. Adult TLCB tend to be smaller than the adult EAB… as do their corresponding emergence holes (Photo 2). The TLCB can detect trees in stress by various mechanisms but especially from chemicals given off from those stressed trees. TLCB females lay their eggs in rough bark areas of stressed host trees. After the eggs hatch, the tiny larvae bore through the bark to the inner bark tissues where they begin tunneling in a haphazard, wandering manner, consuming the rich nutritious components of these plants' conductive tissues (xylem and phloem). Larvae feed from June through August (and later depending on temperature), all the while increasing in size and voraciousness. Larvae exhibit large flat heads when compared to the rest of their segmented bodies, reach approximately 1¼ inches, are white to translucent in color, and possess two spines at the tip of their abdomen (Photo 2). With some exceptions such as vigorous host health (which tends to slow their development), later egg laying in the season, or development in cooler conditions, the TLCB usually completes its life cycle in the northern U.S. and most of Michigan in one year.

The initial symptoms of TLCB attack are usually evident in mid-summer. Egg laying and larval feeding begin in the upper branches and due to destruction of the tree's vascular system, the foliage becomes sparse and is stunted or discolored or wilted. Branch dieback typically follows. Foliage (tan) may remain attached to infested branches into the fall. Eventually, as the insect attack moves downward, the entire tree may be killed over time (Photos 4 & 5). Because of high populations of TLCB in the vicinity of the infested, stressed and dying trees, the insect may start attacking less stressed, healthier trees. In forest environments and wooded residential sites, an expanding pocket pattern (epicenter) of declining and dead trees may develop, much like that of the EAB (Photo 6).

Predisposition of Trees To TLCB:

Stressors that predispose trees to TLCB attack include: excess moisture (flooding, irrigation, etc.), construction damage, drought, compaction, soil/root disturbances, diseases (especially root rots), grade changes, excess fertilization, cultural practices that favor turf culture in landscapes rather than tree culture, and defoliation from insects and diseases, etc. Occasionally in vigorous, healthy trees, TLCB attack may be limited to broken or injured branches. There is a strong correlation of TLCB attack with *Armillaria* root rot (Photo 7 and insets) and, perhaps, both working in conjunction to cause tree decline and death. The TLCB has often been confused with Oak Wilt, *Armillaria* root rot, anthracnose and other stresses and decline factors.


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Diagnosis of TLCB:

Thorough inspection and implementation of diagnostic procedures should assist in distinguishing between the TLCB and other various potential causes of tree decline and death, particularly in oak trees. It is important to understand that, similar to ash and EAB, TLCB attack starts at the top of trees and gradually moves downward. Hence, to confirm the presence of early TLCB infestations, upper branches will need to be examined for the presence of the insect (Photo 2) and/or its activity such as tunneling (Photo 8) and/or emergence holes (Photo 2). In my experience, the presence of the TLCB will not be detected at ground/eye level until the tree is practically dead.

The Story of the Million-Dollar Bur Oak:

An upscale outdoor mall was constructed in Southeast Michigan about 18 years ago. On the property, a large Bur oak had resided there for more than 300 years (Photo 9). The oak was considered such a landmark that it was insured for ***one million dollars***.


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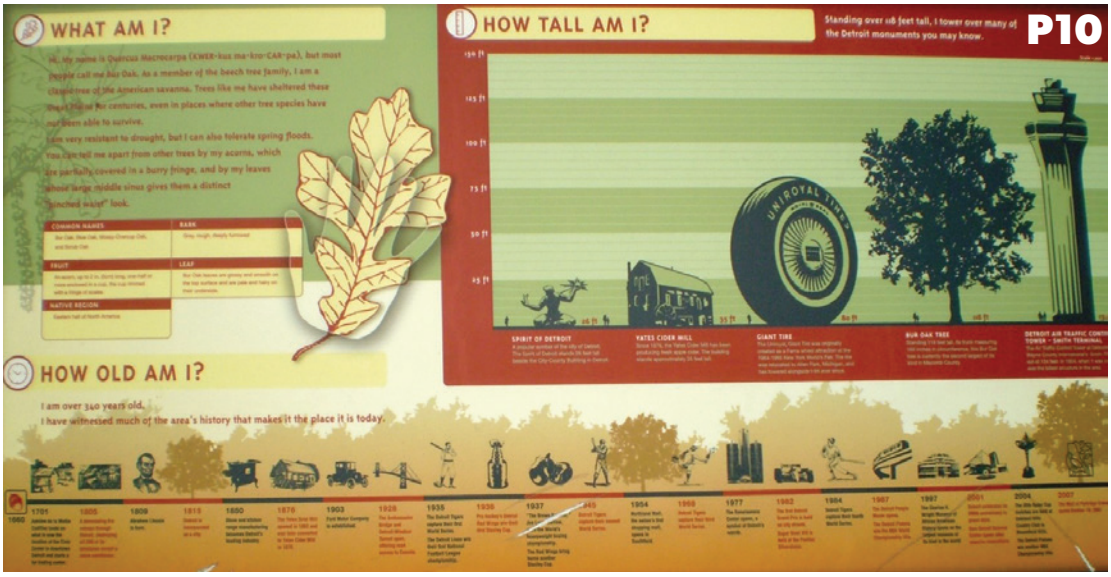

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P5 In the author's opinion, TLCB is undoubtedly a major contributor to the decline and death of many old oaks such as this large tree, known as the "Century Oak", in Bloomfield Hills, Michigan. Note author next to tree for size comparison.

P6 At this golf course and residential site near Ann Arbor, Michigan, many oak trees were under attack by the TLCB in an apparent localized, epicenter manner. Many of the oak trees within several blocks of these trees were highly infested with TLCB. Several large trees were dead.

P7 *Armillaria* root rot is strongly correlated with TLCB infestation. *Armillaria* likely stresses the trees, which are subsequently attacked by TLCB. Other stressors may predispose trees to TLCB attack as well. In inset left, the white "mycelium" of *Armillaria* is evident under the bark at the root collar area, which may also contain rhizomorphs of the fungus (inset right).

P8 "Windows" cut into trees suspected of being infested with TLCB may reveal extensive tunneling by the larvae, in this case the tree in Photo 4 at ground level. Early stages of TLCB infestations will be limited to the upper portions of afflicted trees.

P9 This 300+ year-old Bur oak, insured for $1 million, declined after construction of a new mall in its vicinity. The change in grade on three sides did not provide for sufficient drainage, which subsequently attracted the TLCB to this stressed tree. Note author standing next to the tree.

P10 To educate the public about the age and size of the Bur oak in Photo 9, a plaque was erected showing a historical timeline and comparative size to other area landmarks.

A plaque was established to educate people about the size and age of the tree, which germinated from an acorn 100 years before Abraham Lincoln was born (Photo 10). While an extensive area was left undisturbed around the tree for its optimal health and hopeful survival and preservation, the soil grade was changed on three sides. The grade change did not allow sufficient drainage of water from around the roots of the tree, and the tree gradually declined over the next ten years. By the time I was called in to assist with the tree, it was almost dead (Photo 9). In such a state, I expected to find Phytophthora root rot and TLCB (confirmed, Photo 2).

TLCB Management:

Obviously, prevention is the optimal approach for TLCB management. Avoid any of the stressors (grade changes, water management, injury, etc.), outlined above, that may attract the TLCB to host trees. In landscape situations, increasing the vigor of trees through appropriate water management (irrigation during drought, drainage in areas prone to flooding, etc.) and fertilization may help to ward off attack by the TLCB. Trees that are highly infested with and severely declined from TLCB should be destroyed by burning, burial or removal to offsite locations; this procedure will help reduce TLCB populations and potential attack of nearby trees. Removal and proper disposal of infested trees, particularly in forests, woodlands and low economic value situations, may help reduce populations of TLCB and short-circuit the epicenter phenomenon. The TLCB typically does not reduce the lumber value of afflicted trees provided that the trees are harvested in a timely fashion.

In some instances, especially with valuable landscape trees, chemical treatments may be employed to help trees recover from environmental, cultural or biological stresses…and TLCB infestation. Similar treatments effective for EAB management may be useful: trunk and foliar sprays, trunk injections and soil treatments. As with EAB, trunk injection of emamectin benzoate, a "tree-mendous" insecticide for TLCB, will likely provide multi-year efficacy from a single treatment (Photos 11, 12 & 13). When using chemicals for the treatment of TLCB, be sure to follow label directions.

P11 Arborjet Inc. was the first company to market emamectin benzoate trunk injections for control of the EAB. Because the TLCB is a close relative of the EAB, similar treatments could represent great potential for protecting valuable oak trees from TLCB attack. Joe Aiken from Arborjet demonstrates one of their injection systems.

P12 ArborSystems' Wedge can deliver many fine products but can now also administer emamectin benzoate. Here, Dan Banks with Banner Sales & Consulting demonstrates the Wedge injection system.

P13 Not wanting to have to take a risk of examining branches in a very tall, old oak tree in Bloomfield Hills, an arborist decided to trial-inject the declining tree with emamectin benzoate. The following year, flushes of new growth developed, likely indicating recovery from TLCB attack.