The Tale of Two Beetles

All images courtesy Joe Boggs

By Joe Boggs, Amy Stone, and Dan Herms

Asian longhorned beetle (ALB)—*Anoplophora glabripennis*—was discovered in Toronto in 2003 (Figure 1, page 20). In 2007, emerald ash borer (EAB)—*Agrilus planipennis*—was also spotted in the city (Figure 2, page 21). This was the first time the two non-native tree-killing beetles were known to exist in the same geographical location in North America. It is now known the two insects actually overlapped in Chicago, Ill.; however, it was not known at the time of the ALB discovery in 1998 that EAB had established beachheads in North America.

In 2011, ALB was found in Bethel, Ohio, a small rural town about 40 km (25 mi) east of Cincinnati. EAB had been discovered in the region in 2008; ash trees were being killed by EAB within a few

FIGURE 1

In 2003, Asian longhorned beetle (ALB) was found in Toronto.

miles of the ALB infestation. This was the third time in North America the two non-native tree-killers intersected.

The convergence of EAB and ALB in the same geographical location may create considerable confusion because when people hear 'ALB,' they may think 'EAB' (and vice versa).

Of course, the two beetles are very different in all aspects, including:

- biology;
- behaviour;
- spread;
- distribution; and
- management options.

This geographical overlap between the two beetles will no doubt occur elsewhere as EAB spreads across North America.

EAB and ALB are both native to Asia, with the latter being confined to China and the Koreas. Indeed, ALB is a serious pest in China causing widespread mortality to poplars, willows, elms, and maples. Much of the damage occurs on trees planted along streets, in windbreaks and hedgerows, and in synthetic forests and plantations. EAB is a much less significant pest of its *Fraxinus* hosts in Asia. This difference in pest status in their native Asia is partially responsible for why there was a greater amount of scientific

FIGURE 2

Emerald ash borer (EAB) was discovered in Toronto in 2007.

data on ALB compared to EAB when both beetles were discovered in North America.

Where they came from

Both insects were accidently introduced into North America; however, EAB appears to have had a single point of introduction in a suburb of Detroit, Mich., whereas ALB has been introduced from China to multiple sites in North America. So far, no ALB infestations have been found to be linked to other infestations in North America; all the beetles that began new infestations arrived directly from China. However, there has been a repeating pattern for each new infestation where a single point of introduction from China was then followed by multiple infestations within the region, which was the result of the movement of infested wood or other material before the discovery of ALB in the area.

Although ALB's 1996 discovery came six years before EAB, the latter has become much more widely distributed in North America (even though ALB was introduced to multiple locations). Explanations for this disparity in the current distribution of the two beetles include differences in signs and symptoms, and thus the ability to detect the beetles, as well as their behaviour.

FIGURE 3

EAB creates a characteristic 'D-shaped' emergence hole.

What to look for

EAB is a much smaller beetle, measuring around 10 to 13 mm (0.4 to 0.5 in.) in length. Adults have a flat back and round 'belly' when viewed head-on, which is the orientation of the beetle as it emerges from trees. Thus, EAB creates a characteristic 'D-shaped' emergence hole (Figure 3). Owing to the beetle's small size, the holes are only around 4 to 5 mm (0.2 in.) across the flat side of the 'D.' The relatively small size of the exit holes makes finding them difficult until trees are heavily infested. Adding to the challenge is the tendency for the beetles to first infest the uppermost and outermost branches and then gradually work their way inward and downward with each successive generation. Consequently, exit holes are usually found at eye-level only when infested trees have been almost completely used by the beetles.

ALB is a large beetle, measuring around 25 to 40 mm (1 to 1.6 in.) in length. They have characteristically long antennae, with each one measuring as long as 40 to 50 mm (2 in.) (Figure 4). The beetles produce large, round exit holes that can be almost 10 mm (0.4 in.) in diameter (Figure 5, page 24). Since the larvae feed deep within the xylem, the exit holes extend deep into the tree. Inserting a pencil into an exit hole is a good way to determine whether the hole was produced by a xylem-emerging borer. This is the so-called 'pencil test' (Figure 6, page 24). ALB does not appear to follow the same distribution pattern within a tree as EAB and exit holes are almost as likely to be found at eye-level as they are high in the tree's canopy (Figure 7, page 25).

The differences in beetle sizes and exit holes, as well as infestation patterns within

FIGURE 4

ALB are bigger beetles, measuring around 25 to 40 mm (1 to 1.6 in.) in length.

trees, provides a partial explanation as to why EAB went undetected for so long compared to ALB. As a consequence, EAB benefited from years of human-assisted spread before its discovery in North America. In fact, dendrochronology studies indicate the beetle was living in the Detroit suburb for around 21 years before its detection in 2002.

The natural spread of the two beetles is also very different. The much smaller EAB adults are very good fliers and easily disperse. While ALB adults are relatively good fliers, they take flight less frequently than EAB, perhaps because their large bodies require much more energy to launch and remain airborne. Thus, ALB tends to stay and continually reinfest trees until the trees die and are no longer able to support a new generation. As a result, ALB does not spread very fast between trees compared to EAB.

How they kill trees

Both beetles are tree-killers and exhibit no real preferences for stressed versus healthy trees. However, EAB only infests and kills trees in one genus (*Fraxinus*), while ALB infests and kills trees in 13 genera. Trees considered good hosts of ALB include:

- *Acer* (all maple species);
- *Aesculus* (horse chestnuts and buckeyes);
- *Ulmus* (elms); and
- *Salix* (willows).

FIGURE 5

ALBs produce large, round exit holes that can be almost 10 mm (0.4 in.) in diameter.

FIGURE 6

Inserting a pencil into an exit hole is a good way to determine whether the hole was produced by a xylem-emerging borer.

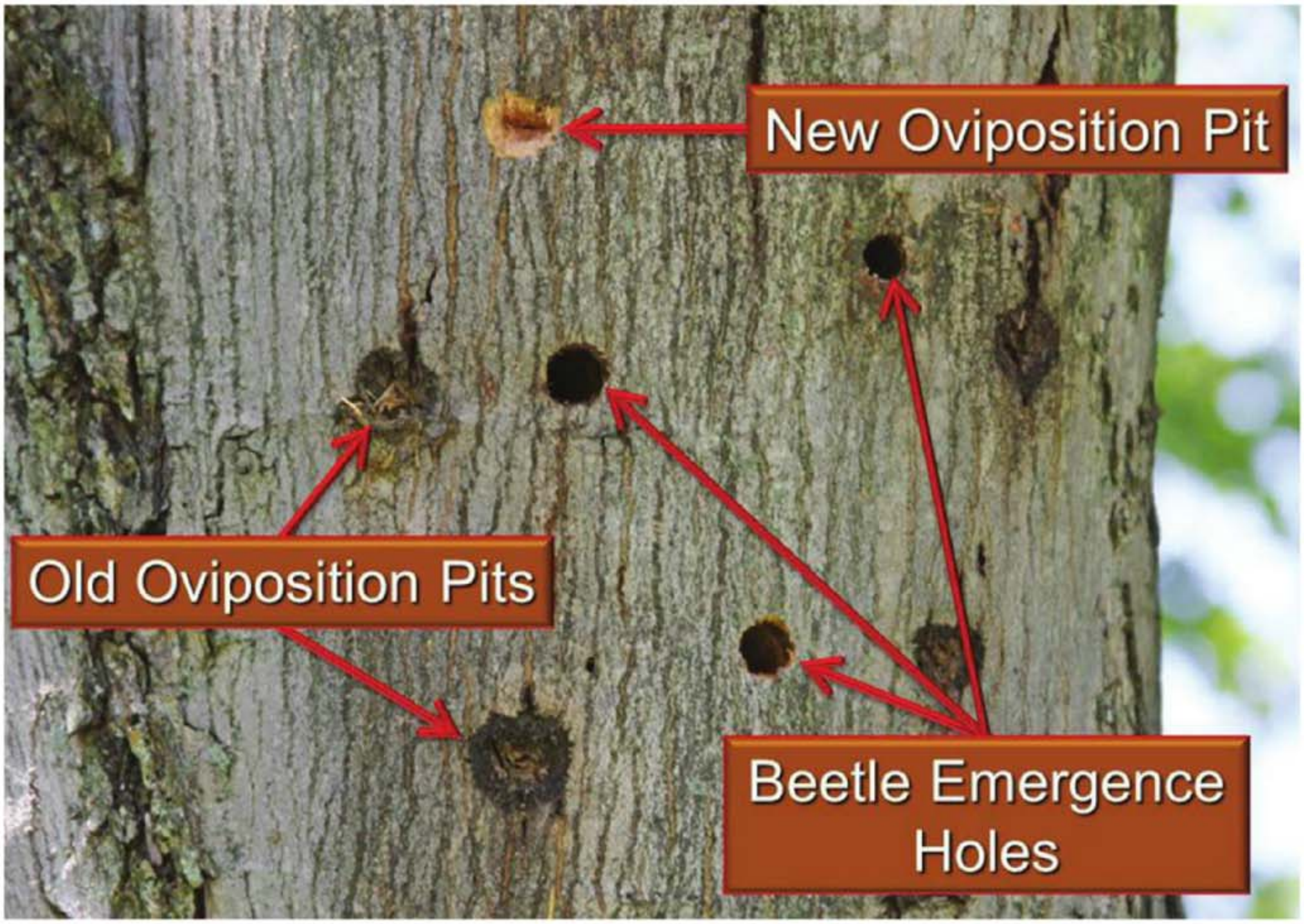
Trees considered 'other' hosts include:

- *Betula* (birches);
- *Platanus* (sycamore/plane trees);
- *Populus* (poplars);
- *Albizia* (mimosa);
- *Cercidiphyllum* (katsura);
- *Fraxinus* (ashes);
- *Koelreuteria* (golden rain tree);
- *Sorbus* (mountain ash); and
- *Celtis* (hackberry).

While the good hosts in this list of genera are generally considered the trees most commonly attacked by ALB, all these trees can be attacked and killed by ALB.

The speed with which these borers kill trees depends heavily on differences in larval feeding behaviour, which is coupled with morphological differences in their host trees. EAB only attacks ash trees, and all ash species are 'ring porous'. Water and nutrients

FIGURE 7



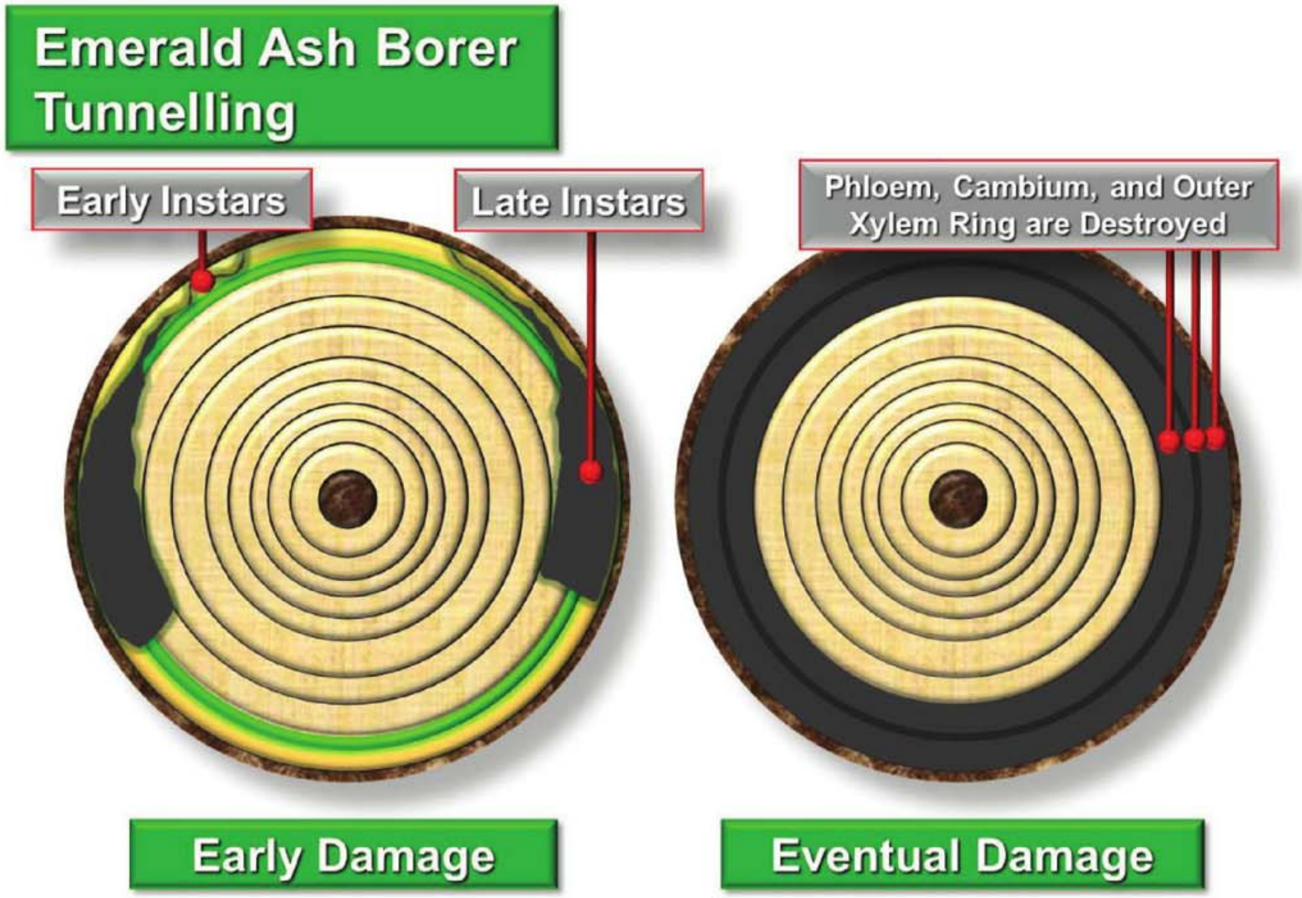
ALB exit holes with new and old oviposition pits.

are only transported through the outermost xylem (*i.e.* white wood) ring. EAB is a phloem-feeder, however, and as the larvae gain size, they start etching the outermost xylem ring. Consequently, trees may die quickly as EAB larvae girdle trees by consuming the phloem and etching the single functioning xylem ring (Figure 8, page 26) to destroy the trees' 'plumbing.'

Although ALB infests some ring porous trees, maples are most commonly attacked and are 'diffuse porous' because water and nutrients are carried by four to five of the outermost xylem rings. Although ALB larvae bore into the xylem (Figure 9, page 27), their tunnelling causes less disruption of the xylem vascular flow compared to damage caused by EAB in a ring porous tree (Figure 10, page 28).

In the end, the ALB larval damage does kill trees, but infested trees may linger for many years, giving the false impression they are not being killed. Of course, as they linger, the trees are a constant source of new beetles. While canopy-thinning is a key symptom used to detect EAB, it is not a dependable way to detect ALB infestations. A much more dependable symptom for discovering new ALB infestations is branch breakage, which is a

FIGURE 8



A depiction of EAB larval feeding damage.

result of the structural branch weakening caused larval feeding damage to the xylem (Figure 11, page 29).

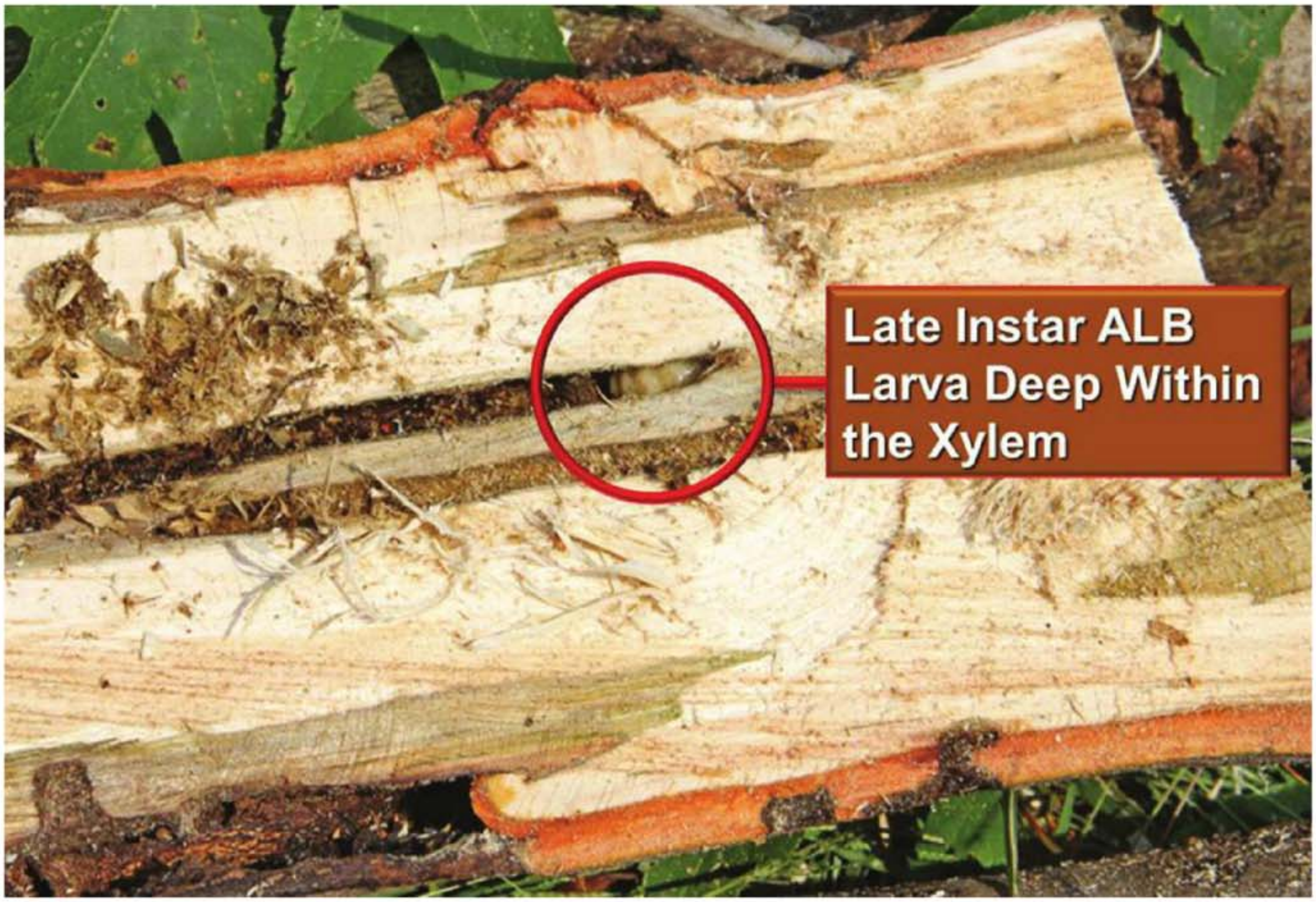
How management options differ between beetles

EAB is now found in multiple locations in North America, with very large populations in many U.S. states, as well as Ontario. Therefore, the beetle represents a clear and present danger to ash trees throughout a large area of North America. ALB was first found on the continent in 1996; even now, populations remain small and isolated compared to EAB.

The management strategy for ALB is eradication with the overarching goal to eliminate ALB from North America. It has successfully been eradicated from Chicago, Ill., Staten Island, Manhattan, and Islip, New York, two locations in New Jersey, and from Toronto. However, successful eradication depends on continued vigilance and early detection. While ALB was declared eradicated from Toronto, an infestation was recently found in Mississauga, which is located just west of Toronto. This new infestation will be targeted for eradication.

Although EAB cannot be eradicated because it is so widespread, ash trees can be

FIGURE 9



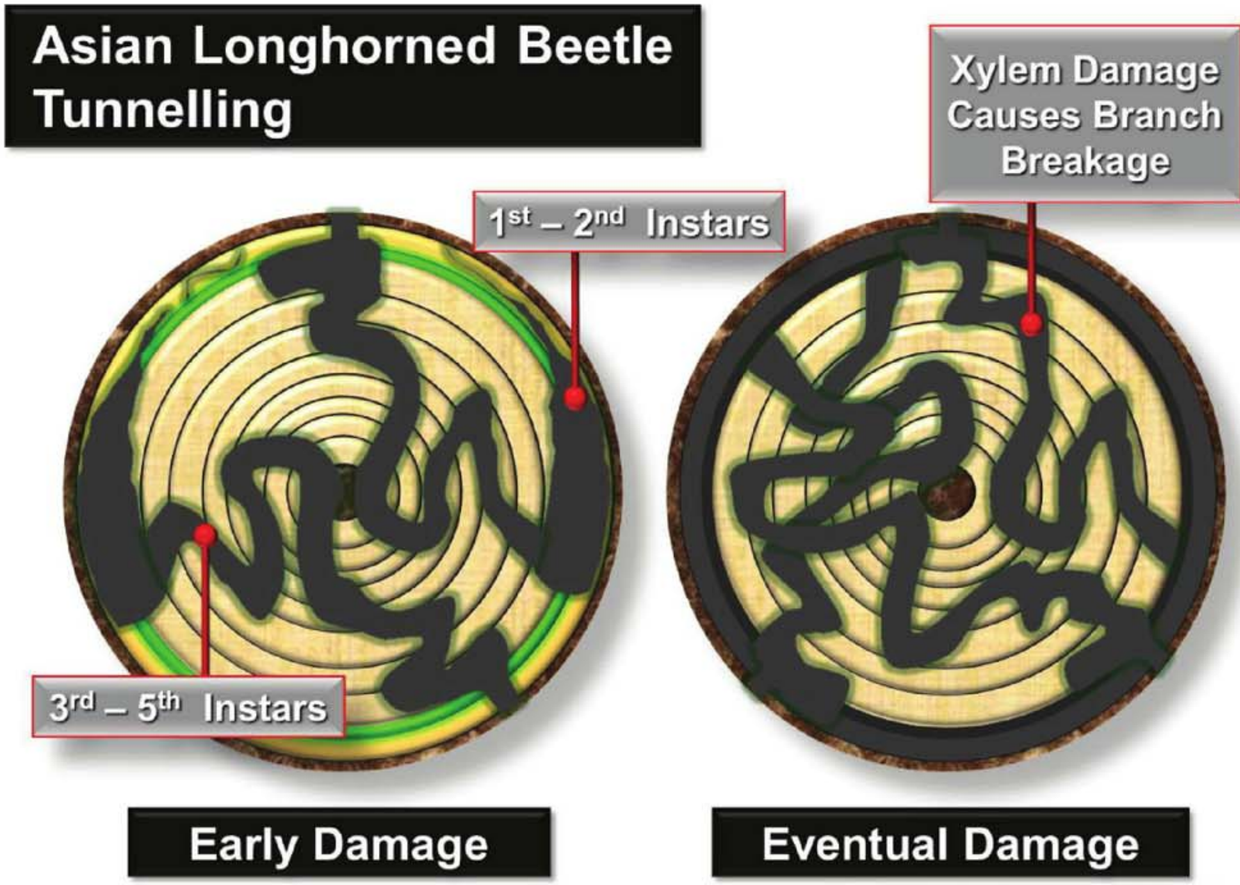
ALB larva located in the xylem (wood).

successfully protected against EAB through treatments with systemic insecticides. However, it is important to remember treatment success is measured by the health of the canopies, and not by the number of beetles killed. EAB larvae feed exclusively on the phloem where they are vulnerable to systemic insecticides. Adult EAB beetles are also killed when they feed on the leaves of systemically treated trees. Systemic insecticide treatments are highly effective in EAB suppression; however, the overarching management goal is very different from ALB. Maintaining a full canopy does not require 100 per cent efficacy as every EAB beetle does not need to be killed.

Eradication using insecticides means the treatments must be 100 per cent effective, or very nearly so. While ALB larvae start out feeding on the phloem, they quickly bore into the xylem. Unfortunately, this places the larvae out of the reach of systemic insecticides. If a tree already has ALB larvae in the xylem, the insects will successfully complete their development, pupate, and new adults will emerge and disperse even if the tree is treated.

Field experiments conducted in China under highly controlled conditions using

FIGURE 10



A depiction of ALB larval feeding damage.

small (*i.e.* 50 to 100-mm diameter) uniform trees found ALB density was reduced by 71 to 90 per cent. While this level of control may be sufficient for protecting trees, it is not adequate when the goal is eradication. Additionally, the effectiveness of insecticides for controlling wood-borers declines as the size of the tree increases.

Insecticides have been used in ALB eradication programs in North America, but the adult beetles are the primary target. They feed on twig and leaf tissue during the maturation period, which is the time required for eggs to develop inside the females. Unfortunately, while some ALB adults are killed by systemic insecticides during maturation feeding, the number of adults killed will not meet the standards required for eradication. Achieving high adult mortality is challenged by the extended period that adults are active during the season, limitations associated with product label restrictions, and the fact that size matters. Efficacy is uncertain on large trees. This is why insecticides have always been used in a support role in conjunction with other eradication tools and primarily outside of the core infestation zones.

The most effective ALB eradication approach in terms of the time required to

FIGURE 11

Structural weakening of the wood caused by ALB larval feeding damage.

complete the eradication has been the removal and destruction of infested trees as well as high-risk host trees located within a prescribed distance to known infested trees. This provides a 'safety' buffer in case lightly infested trees escape detection. Unfortunately, this approach may translate into the loss of large numbers of trees. Although the overarching goal is to prevent ALB from escaping eradication to follow the same spread trajectory as EAB in North America, gaining public acceptance of the 'greater good' associated with suffering a heavy loss of trees to the chainsaw can present a challenge.

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