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THE INFLUENCE OF HOST CONDITION ON POST FIRST INSTAR DEVELOPMENT OF THE BRONZE BIRCH BORER, *AGRILUS ANXIUS* (COLEOPTERA: BUPRESTIDAE)

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ABSTRACT

The bronze birch borer is a contributing factor in birch dieback. It is believed that host condition has a major influence on the development of the borer. We found that the host tree's apparent condition does not appear to influence post first instar development.

Birch dieback is a major ornamental problem in the Midwest. It is one of the complex declines that cannot be traced to a single cause. Declines generally begin with an environmental stress, followed by colonization by an insect or disease. The organism associated with birch dieback is the bronze birch borer (*Agrilus anxius* Gory). This small, bronze buprestid is native to the northern forests of North America. It is host-specific to birch (*Betula* spp.); the principal urban host is the European white birch (*B. pendula* Roth).

Host condition has long been considered an important influence on bronze birch borer development. A healthy tree may influence the survival and development of the larvae. Balch and Prebble (1940) found that larvae in healthy trees died after producing galleries one or two feet long (30.5–61.0 cm). Barter (1957) observed that while the first instars normally feed for a distance of three inches (7.5 cm) before molting, they may die after feeding only a short distance in a healthy host.

Larvae feed on living phloem tissue (Anderson 1944) and tend to feed toward fresh tissue (Barter 1957). Dead phloem tissue is unsuitable for larval development (Barter 1957). However, Balch and Prebble (1940) stated that maturing larvae can not reach the pupal stage in a living branch. Therefore, according to these reports, the adult borer must seek out a living tree for the larva but the tree, or the portion of it, containing the larva must die for the borer to complete its life cycle.

Why they believed the phloem must die before the borer can emerge is unclear. In a study of the bronze poplar borer (*A. ligarus*) Barter and Brown, Barter (1965) found it could pupate in living tissue but had difficulty emerging. This was due to the callus that developed around the emergence hole. The emergence hole for the bronze birch borer and bronze poplar borer is cut to just beneath the bark by the larva before pupation (Barter 1957).

The host condition is considered to be the doninant factor in the interaction of the birch and the borer (Carlson and Knight 1969). However, at which life stage resistance is occurring and what plant resistance mechanisms are involved have not been studied in detail. We elected to study the role of host condition in influencing the post first instar development of the borer.

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Table 1. European white birch crown vigor classification

Class	Criteria
1	A full crown.
2	Scattered flagging at top of crown.
3	Upper crown twig and small branch dieback.
4	Dieback of at least 1 m in several branches.
5	More than one-half of the crown devoid of foliage, but still having at least several branches with foliage.

METHODS

The study was conducted in an abandoned tree nursery in Richland, Michigan. Twenty European white birch trees representing four different stages of dieback were selected; five trees each represented classes 1 through 4 (Table 1) (Ball & Simmons 1980). The trees were 4–10 cm DBH and 10–15 years old. To test the influence of host tree condition on the borer, larvae were implanted into the trees (Barter 1957, Carlson and Knight 1969). Transfer techniques were similar to those of Barter, but the bark was held in place by duct tape rather than beeswax. On 1 August 1981, a class 3 European white birch was felled. Branches were cut and carried to the nursery where they were peeled to obtain bronze birch borer larvae. Once a larva was located, the urogomphi length was measured to determine the instar. Second instars were then placed into a 3-cm V-shaped groove cut into the cambium region approximately 50 cm from the base of the tree. The bark was replaced over the cut and covered with duct tape. First instars would have been utilized in this study but we were not able to successfully remove them from the host tree.

Since the purpose of the implant operation was to examine the effects of host condition on borer development and survival, we did not want to altar the tree condition. A large larvae population could girdle a tree, adversely affecting tree health. To reduce this possiblity, only one larva was transferred into each tree.

The following May (1982) cages were placed on the trees to collect emerging adults. The cages were 70 cm long, with separate zippers along one side. Cages were placed over possible emergence sites for the implanted borers. Locating the sites did not present any difficulties. A rusty brown spot often appears on the bark covering the pupal cell (Slingerland 1906). This stain was a reliable indicator of a borer's location. The faint outline of a D-shaped hole often was spotted in the stain. Cages were positioned over the stains and checked daily.

At the end of June 1982, the trees were felled and the bark peeled back to expose the cambium region. Galleries of the implant borers were measured with a plan measure (Dietzgen model 1719B). The galleries were also followed to make sure the borers exiting were the same ones implanted.

RESULTS AND DISCUSSION

Two days after the implant operation, the implanted larvae were checked. Most had already moved into the tree, but seven had been crushed when bark was positioned over the cut. This left three trees from each class successfully implanted, with four in class 3.

Thirteen of the implanted larvae completed their development and emerged. Our sample size was small and our results and data interpretation must be viewed in that light. However, in five trees that were otherwise not attacked, the implanted larvae successfully

Table 2. Average gallery length (± SE) of *Agrilus anxius* in different crown vigor classes of *Betula pendula*.

Classes	Average gallery length (cm)	n	*t*-statistic
1 and 2	26.33 ± 1.62	6	−0.71[a]
3 and 4	27.81 ± 1.36	7	

[a]Not significant at 0.05 level.

completed their development. The condition of the tree did not appear to influence the survival of the borers. There was no significant difference in gallery lengths of larvae in high-vigor trees (class 1 and 2) versus low-vigor trees (class 3 and 4) (Table 2). The beetles showed no apparent difficulty in emerging from healthy trees. The implants were not prevented from emerging by tree growth. Generally, the area around the cell died rather than producing callus tissue.

Our observations of the felled trees showed that borers only colonized class 3 and 4 trees. The class 3 trees had an average borer/bole density of 0.6 borers/100 cm^2 of inner bark, while class 4 was slightly higher, 10 borers/100 cm^2. A single borer was found in a class 1 tree; otherwise the class 1 and 2 trees were not colonized, other than by the implant operation. This is consistent with what we observed in an earlier study (Ball and Simmons 1980). But if implant larvae were capable of surviving in all trees, regardless of their condition, why weren't successful attacks found in all trees?

Healthy trees may prevent successful attack by killing the larvae before they reach the second instar. Resistance could occur either before or after the first instar penetrates the bark surface. Heering (1956) observed the newly hatched *A. viridis* L. larvae could be repelled by sap flow as they attempted to penetrate the bark. The other possibility is that the larvae may penetrate the bark but die soon after. However, Barter (1957) found that early instars were better able to survive more vigorous inner bark than later instars, though how he determined this was not stated.

The possibility exisits that the bronze birch borer may not be able to successfully attack healthy trees because of resistance during the first instar. This will be examined in a future study.

SUMMARY

The bronze birch borer is believed to be unable to complete its development in healthy birch. However we found that second instars could complete their development in healthy trees. The length of their galleries was not influenced by the condition of the host nor were the adults prevented from emerging.

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