EMERALD ASH BORER LIFE CYCLE: A REASSESSMENT

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ABSTRACT

To establish the life cycle of EAB was one of the first objectives of EAB research. Our expectation was that *Agrilus planipennis* phenology would coincide roughly with that of well-characterized *Agrilus* species such as *A. anxius* and *A. bilineatus*: 1) mid-summer adult flight and oviposition; 2) complete four stages of larval development by fall; 3) non-feeding prepupal stage overwinter; and 4) pupation in late spring. Evidence in support of this assumption includes observations demonstrating synchronous pupation and adult flight and summer/fall dissection series showing steady progression of larval size. However, several anomalies raised questions about the universality of a synchronous, one-year cycle. At some locations, a majority of larvae failed to complete feeding in the fall. Most conspicuously, winter/spring dissections of very lightly infested trees at outlier sites revealed mostly 2nd and 3rd stage larvae. A dissection series in spring 2004 confirmed that small winter/spring larvae did not complete development before mid-summer, and failed to form pupae during the annual "window" for that life stage.

Several lines of evidence now demonstrate that some fraction of EAB requires two years for development:

1. In a series of dissections of lightly-to-moderately infested trees during spring/summer 2004, we found that 2nd and 3rd stage larvae (oviposited the previous summer) present in April did not complete larval development before the summer pupation window. Prepupae formed by these larvae in late summer had not resulted in adult emergence by October.
2. A 2004 experiment compared larval density between unsprayed trees or trees treated with a Tempo cover spray. Despite bioassay evidence indicating excellent coverage and persistence of toxin, there was no significant effect of the treatment. Subsequent re-examination revealed that the poor performance of Tempo was attributable to protected prepupae present in the trees before the May treatments began.
3. Examination of larval galleries clearly demonstrates two-year development. In the Tempo study and other dissections conducted in fall of 2004, galleries of mature larvae were of

two types: a continuous track contained entirely within 2004 growth tissue (1- or 2-year larvae), or a two-stage track beginning in (now) dead wood overgrown by 2003 tissue and concluding in a final tunnel through 2004 growth (2-year larvae).

We are not yet clear on the mechanisms that determine the proportions of one and two-year EAB. Clearly, the seasonal temperature profile may be important: we know that many insects including other *Agrilus* species have prolonged development where temperatures are lower. However, our data suggest host condition may be key: proportions of two-year larvae tend to be higher in lightly infested trees.

The occurrence of two-year larvae has many implications for research, management, and the containment/eradication effort. The likelihood that trees have some degree of resistance (inhibiting larval development) suggests that there may be opportunities for enhancing resistance via breeding or chemical treatment. The presence of mature larvae in the spring/summer creates a new (and more difficult) target for pesticide applications. Two-year larvae at outlier sites may mean a delay in detection of initial outbreak or resurgence from outliers; on the plus side, dissemination from an outlier will be slowed. Further research will focus on determining the prevalence and underlying mechanism of the two-year phenomenon.