

EMERALD ASH BORER BIOLOGICAL CONTROL: REARING, RELEASING, ESTABLISHMENT, AND EFFICACY OF PARASITOIDS

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ABSTRACT

The emerald ash borer (*Agrilus planipennis* Fairmaire) (EAB) is an invasive buprestid native to Asia that has killed millions of ash (*Fraxinus* spp.) trees in North America. It was first discovered in 2002 in areas of southern Michigan and Ontario, and infestations have since been found in Ohio, Indiana, Illinois, Maryland, Virginia, Pennsylvania, West Virginia, Wisconsin, Missouri, and Quebec. Due to extent of the outbreak and the challenges of locating and eradicating new infestations, regulatory agencies are now seeking methods for managing this destructive pest throughout North America. We began our search for EAB natural enemies in Michigan and in China in 2002. After finding only incidental parasitism of EAB in Michigan, we focused our research efforts on classical biological control of EAB using two EAB parasitoid species discovered in China. We are also collaborating with USDA APHIS (J. Gould) on a third EAB parasitoid species from China, as well as with scientists at Michigan State University (D. McCullough, D. Cappaert) to investigate the possible use of other EAB natural enemies in North America.

In southeastern Michigan from 2002-2004, no egg parasitoids were found and less than 1 percent of EAB larvae were attacked by parasitoids of other wood-boring insects. Through laboratory rearing, the following hymenopterans have been confirmed to parasitize EAB: three braconids *Atanycolus hicoriae*, *A. simplex*, *Spathius floridanus*=*simillimus*; one chalcid *Phasgonophora sulcata*, and native and exotic eupelmids, *Eupelmus pini* and *Balcha indica*, respectively (Liu and Bauer, unpublished data). Except for the two eupelmid species, these are known parasitoids of other *Agrilus* spp. in

North America. All are ectoparasitoids except *P. sulcata*. Another possible parasitoid of EAB reared from infested ash is the ichneuemonid *Dolichomitus dolichosoma*, however, parasitism of EAB is unconfirmed.

Although the diversity of parasitoids attacking immature EAB in Michigan was relatively high, prevalence of parasitism was lower than determined for EAB in China and for our native *Agrilus* spp. However, the recent discovery of 15 to 56 percent parasitism by *A. hicoriae* at two sites in southeastern Michigan from 2007 to 2008 has renewed interest in the potential of native parasitoids as EAB natural enemies (Cappaert and McCullough, unpublished data). They found this parasitoid also attacks several species of native *Agrilus* in Michigan, and it is likely that some parasitoids of wood-boring insects are more specific to niche than to host species. We developed a laboratory-rearing method for *A. hicoriae*, which can be used to elucidate its biology, behavior, host range, and potential for augmentative release against EAB.

In China, we found three hymenopteran parasitoids for use as EAB biocontrol agents in North America. These included: a gregarious larval endoparasitoid *Tetrastichus planipennisi* (Eulophidae), a gregarious larval ectoparasitoid *Spathius agrili* (Braconidae), and a solitary, parthenogenic egg parasitoid *Oobius agrili* (Encyrtidae). In our laboratory and in China, we studied *O. agrili* and *T. planipennisi* biology, developed rearing methods, quantified their effects on EAB and ash health in China, and evaluated their host specificities (Liu and Bauer, unpublished data). Similar research was completed for *S. agrili* by J. Gould and scientists in China.

In January 2007, we submitted permit requests and risk benefit analyses to APHIS to release the EAB parasitoids in Lower Michigan. This information was compiled into an environmental assessment and posted on the Federal Register for public comment. After review by researchers, land managers, and the public, APHIS issued a “Finding of No Significant Impact”, and granted release permits in July 2007. *O. agrili* and *T. planipennisi* were each released at two different sites in central Lower Michigan. The next year, *O. agrili* was recovered at both sites confirming successful reproduction and overwintering at these sites. *S. agrili* was released at three Michigan sites and later recovered at one.

In 2008, parasitoid release permits were requested and approved for release of EAB biocontrol agents in Indiana and Ohio. In collaboration with C. Sadoff (Purdue University), *O. agrili* was released at two sites in Indiana. In Ohio, *O. agrili* and *S. agrili* were released at two sites. In Lower Michigan, we established additional release sites at different EAB-population densities,

and in collaboration with J. Duan, J. Gould, and R. Van Driesche (University of Massachusetts), we started an EAB life table study to determine stage-specific parasitism by each parasitoid.

In addition, APHIS and Forest Service developed an EAB Biological Control Program designed to facilitate rearing, releasing, and evaluating establishment and efficacy of the three parasitoids species from China to reduce ash mortality in the United States. To help accomplish this, a parasitoid mass-rearing laboratory was built in Brighton, MI, and became operational in January 2009. Despite the challenges associated with rearing these parasitoids, we anticipate production scale-up and greater parasitoid availability over the next few years. To evaluate the efficacy of these EAB biocontrol measures, we are collecting field data, including ash health and EAB population densities at both release and control sites. This information will allow us to evaluate and optimize future EAB parasitoid releases.

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