

POPULATION BIOLOGY OF EMERALD ASH BORER AND ITS NATURAL ENEMIES IN CHINA

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ABSTRACT

Agrilus planipennis Fairmaire (Coleoptera: Buprestidae), also known as emerald ash borer (EAB), was first discovered in Michigan and Ontario, Canada, in 2002 following investigations of declining and dying ash trees (*Fraxinus* spp.). *Agrilus planipennis* has also spread to Ohio, Indiana, Maryland, Virginia, Illinois, Pennsylvania, and West Virginia by natural dispersal and transport of infested ash materials. As of 2007, over 25 million ash trees have been killed by this pest in Michigan alone. The adverse effects of *A. planipennis* on forest biodiversity, ash resources, and urban areas in North America are high as ash trees are widely distributed and planted throughout North America.

In its native country of China, *A. planipennis* was considered only a minor and periodic pest of ash trees—presumably due the presence of natural enemies and host resistance. The introduction of North America ash species in recent decades, however, elevated *A. planipennis* to pest status in some areas and increased its distribution to additional locations in northern China.

In 2003, we initiated a classical biological control project for *A. planipennis* by studying its population dynamics and natural enemy complex in China. During our initial exploratory surveys for ash trees and *A. planipennis* in northeastern China, including Jilin and Liaoning Provinces, we found two parasitoid species attacking third- and fourth-instar larvae on Manchurian ash (*F. mandshurica*) (Liu et al. 2003). One of these parasitoids was a previously unknown gregarious larval endoparasitoid, *Tetrastichus planipennisi* Yang (Hymenoptera: Eulophidae), which we found in both provinces during the course of our study (Liu et al. 2003). The other parasitoid was a gregarious larval ectoparasitoid, *Spathius agrili* Yang (Hymenoptera: Braconidae). This finding expanded the known range for *S. agrili*, which was previously known only from the more southerly Tianjin City, where it attacks *A. planipennis* larvae in stands of Arizona ash (*F. velutina* Torr.). In 2004, we discovered *Oobius agrili* Zhang and Huang (Hymenoptera: Eulophidae), a previously unknown solitary and parthenogenic parasitoid that attacks the eggs of *A. planipennis* (Zhang et al. 2005), in Jilin Province.

For this study, we surveyed field populations of *A. planipennis* in Jilin Province, China, during 2004 and 2005 and studied: 1) the seasonal dynamics of *A. planipennis*; 2) seasonal abundance of its egg parasitoid, *O. agrili*; 3) seasonal abundance of its larval endoparasitoid, *T. planipennisi*; and 4) impact of these two parasitoids on host populations in the field. Results showed that in our field site in Jilin Province, *A. planipennis* had an asynchronous, one-year life cycle in green ash trees (*F. pennsylvanica*), with larvae overwintering in all four instars. At least two generations of *O. agrili* were observed on *A. planipennis* during the egg period in 2005, with parasitism reaching 56.3% in July and 61.5% in August. A portion of the *O. agrili* population diapaused within host eggs in the fall and winter months and emerged the following spring and summer, resulting in post-season parasitism of 28.6% in June of 2004, 12.0% in May of 2005, and 43.8% in November of 2005. Up to four generations of *T. planipennisi* emerged from host larvae, with an average larval parasitism of 22.4% within a range of 0 to 40.4%. *Tetrastichus planipennisi* overwinter as larvae within the host or host galleries and emerge the following spring.

These two parasitoids were important in the population dynamics of *A. planipennis* on green ash, with an estimated 73.6% reduction of EAB population densities during 2005 (Liu et al. 2007). The characteristics of these parasitoids—such as high parasitism rates, short generation time, high reproduction rate, parthenogenesis in *O. agrili*, and life-cycle synchrony with host—suggest these parasitoids may prove useful in the management of *A. planipennis* in North America as biocontrol agents.

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