(1970) showed that hosts of individual *Spathius* species are restricted to either wood borers of coniferous or deciduous trees. This might indicate olfactory cues are important within *Spathius* in initial host searching.

We are breaking new ground—thus far, successfully—with the discovery of these three EAB biocontrol candidates for release in North America. From the literature, there is scant information to develop a biocontrol program for an invasive buprestid beetle using natural enemies from its native range. The literature is useful in directing current host range and olfactometry testing, but in itself can only assist us in estimating potential nontarget effects for the EAB parasites.

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# *TETRASTICHUS PLANIPENNISIS* (HYMENOPTERA: EULOPHIDAE), A GREGARIOUS LARVAL ENDOPARASITOID OF EMERALD ASH BORER FROM CHINA

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## ABSTRACT

*Agrilus planipennis* Fairmaire, a buprestid native to Asia, was identified in 2002 as the causal agent of ash (*Fraxinus* spp.) decline and mortality in Michigan and Ontario. Since then, infestations have been found in Ohio, Indiana, Maryland, Virginia, and Illinois. Efforts to contain and eradicate this pest in North America are proving difficult due to the size of the infestation and lack of effective detection and control methods. As managers shift from a

policy of eradication to one of management, biological control may become an increasingly important method of controlling and slowing the spread of *A. planipennis*. With few natural enemies attacking this aggressive buprestid in North America, our research expanded to China where two new parasitoid species, *Tetrastichus planipennisi* Yang (Hymenoptera: Eulophidae) and *Oobius agrili* Zhang and Huang (Hymenoptera: Encyrtidae), were found attacking *A. planipennis* larvae and eggs, respectively (Liu et al. 2003; Bauer et al. 2006). In Jilin province field sites, where the distribution of these two parasitoids overlap, we estimate their combined impact resulted in ca. 74-percent reduction in local *A. planipennis* populations during 2005.

*Tetrastichus planipennisi*, a gregarious endoparasitoid of *A. planipennisi* third- and fourth-instar larvae, was discovered while surveying infested ash trees in Jilin and Liaoning provinces during 2003 (Liu et al. 2003) and later described (Yang et al. 2006). Field studies during 2005 in Jilin province showed parasitism rates by *T. planipennisi* increased from 16 percent in July to 40 percent in August, when the majority of host larvae were fourth instars. Each host larva produced an average of 35 parasitoids, with a range of five to 122; larger host larvae tended to produce more, but smaller, parasitoids. In the field, *T. planipennisi* completes at least four generations per year and overwinters as larvae.

We developed a standard rearing protocol for *T. planipennisi* in our containment room in Michigan using *A. planipennis* larvae dissected from infested ash logs and implanted in small ash branches. In the laboratory, *T. planipennisi* completes one generation in 20-25 days at 25ºC, and the average longevity for adults fed honey and water is 24 days for females and 14 days for males. The sex ratio for *T. planipennisi* is 3.5:1 (female:male).

We evaluated the host specificity of *T. planipennisi* using no-choice laboratory assays. In these assays, groups of female and male *T. planipennisi* were exposed to actively-feeding larvae of eight buprestids (*Agrilus anxius*, *A. bilineatus*, *A. ruficollis, A. subcinctus, A.* sp., *Chrysobothris femorata, C. floricola, C. sexsignata*), five cerambycids (*Neoclytus acuminatus, Megacyllene robiniae, Astylopsis sexguttata, Monochamus scutellatus, unknown sp.* in maple), or a sawfly (*Janus abbreviatus)* all implanted in small branches of their respective host plants. We also assayed larvae of a tenebrionid (*Tenebrio molitor)* and two lepidopterans (*Galleria mellonella, Manduca sexta*) by implantation in small ash branches; *Manduca sexta* larvae were also tested by exposure on tomato leaves. *T. planipennisi* rejected all species except actively-feeding *A. planipennis* larvae implanted in ash branches. These results suggest *T. planipennisi* is a good candidate for the biological control of *A. planipennis* in North America.

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