Evaluating a Newly Associated Parasitoid of the Asian Long-horned Beetle

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One of the most challenging goals of modern biology is to understand and manage the success of invasive species in foreign environments. These species are often able to effectively invade a habitat by filling an unoccupied, or sometimes novel, niche, where they are challenged by few predators and little competition. Among some of the most devastating invasive species is the wood-boring insect *Anoplophora glabripennis*, commonly known as the Asian Long-horned Beetle (ALB). The adult ranges from 1.7-3.9 cm in length and is characterized by a shiny, black body complete with multiple white spots and long antennae. It is native to China and parts of North Korea, but was found for the first time outside its natural habitat attacking ornamental trees in New York City and Chicago in 1996. It was likely distributed to North America via the shipment of untreated wooden packing crates that originated in China, and ever since it has become an ecological antagonist to northeastern parts of the U.S. It does so by chewing small pits through the bark of the host tree and laying individual eggs in each separate pit. The eggs hatch larvae within 2-4 weeks and the larvae feed off of the cambial region and the heartwood of the host tree, where they can consume up to 1000 cubic cm of wood in their lifetime. In North America, ALB has established a wide host range that includes tree species in 12 different genera with maple trees being the most ecologically and economically significant. If not eradicated, this beetle could potentially destroy 30.3% of urban trees in the northeastern U.S. as well as cause $669 billion in economic loss. Obviously, there is a cause for concern over this invasive insect, and many researchers have questioned how they can control the outbreak of Asian Long-horned beetles.

There are a few biological methods used to control wood-boring pests. To date, the primary strategy used to manage the spread of ALB is to visually inspect urban trees and remove the ones that are infested. However, the process of detecting *A. glabripennis* visually is only 33-60% effective. As a result, recent research has centered around the investigation of ALB associated parasitoids as control agents, which is what the authors of this research article chose to focus on and experiment with. They specifically look at the parasitoid wasp scientifically known as *Ontsira mellipes.* Since 2010, this wasp has been continually reared on *A. glabripennis* larvae and was recently identified as a potential new-association biocontrol agent. However, little research has been conducted regarding the reproductive and developmental biology as well as the life history of *O. mellipes* when associated with *A. glabripennis* as its host. In order to effectively predict its success against the ALB, the researchers conducted two separate

experiments to investigate the reproductive and developmental biology of *O. mellipes* when using *A. glabripennis* as a host.

The first experiment assessed percent parasitism, female lifetime fecundity, the number of progeny produced, and the longevity of adults provided with *A. glabripennis* larvae every two days in addition to honey and water. The second experiment focused on larval development time, the number of progeny produced, and longevity of host-deprived and starved adult wasps. The researchers collected all *O. mellipes* specimens from Blackbird State Forest in Delaware, and all *A. glabripennis* specimens from a laboratory colony maintained at USDA-ARS BIIRU, which contained beetles that were collected from infested areas in New York, New Jersey, Chicago, and China. ALB specimens were provided with red maple twigs as a food source and larger logs as an oviposition medium. Once the eggs hatched, ALB larvae were transferred to SOLO Cups that contained a cellulose-based artificial diet to mimic that of heartwood. Then, the mature larvae were again transferred into man-made pits located in sticks of red maple. Once the ALB larvae were nestled in red maple, the parasitoid wasps were artificially infested in the same sticks of maple for observation. In the first experiment, 21 male/female pairs of *O. mellipes* were placed into plastic vials until mating occurred and then were placed together in a red maple stick and exposed to ALB larvae every two days. Honey and water were additionally made available near the red maple stick. After a 30-day observation period, the number of parasitoid adults, ALB larvae, and the longevity of adult wasps was recorded, as well as percent parasitism. The second experiment was conducted solely to observe the larval development of *O. mellipes.* Individual parasitoids were observed daily from egg to adult, and adults were subsequently starved. After observation, the longevity of food/host-deprived adults was recorded.

With regards to the first experiment, the researchers found that *O. mellipes* adults parasitized 21% of the beetle larvae that was presented to them throughout their life, and paralysis of larvae occurred 1-2 days after oviposition. More than half of the individual male/female pairs parasitized *A. glabripennis* larvae, with each female producing around 26 offspring throughout her life. In the second experiment, the median development time of *O. mellipes* from egg to adult was about 3 weeks with five larval instars. Additionally, adult *O. mellipes* that were provided with food and water lived 9 days longer than the host-deprived and starved adults (Figure 1). These findings of native North American parasitoids are relevant and of considerable interest because currently no coevolved natural enemies in Asia appear to control the Asian Long-horned Beetle to economically acceptable levels. Thus, no coevolved natural enemies have been introduced in the U.S. either. However, the present study documented several important life history traits of *O. mellipes* when using the invasive host *A. glabripennis*, and may act as a basis for future research on this specific parasitoid or other native parasitoids that contain the ability to parasitize and negatively affect the troublesome Asian Long-horned Beetle. Additionally, the study revealed several important aspects of the

relationship between ALB and *O. mellipes* that will give other researchers valuable information to expand upon when developing possible mass-field studies involving both of these species. Unfortunately, a few important questions still remain: will the effects of ALB larvae spread to an uncontrollable quantity before a successful parasitoid-control agent can be identified and put into fruition? Also, if a parasitoid-control agent is identified, such as that of *O. mellipes*, will it be able to parasitize enough ALB larvae to discontinue the infestation of maple trees in northeastern parts of the U.S.? More research and larger scale field studies must be completed in order to truly gauge the answers to these questions.

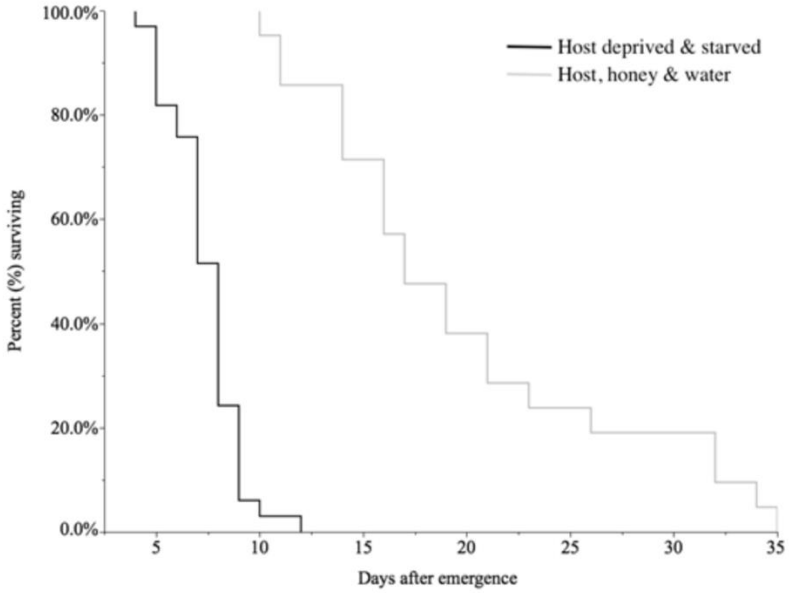

Figure 1. Percent (%) survivorship of adult *O. mellipes* when provided or denied access to host larvae, honey, and water. Adults that were provided with host larvae, honey, and water lived significantly longer than adults who were denied access to these luxuries ($P<0.001$, T-test).