ANOTHER UPDATE REGARDING ONGOING EMERALD ASH BORER RESEARCH AT DOE FARM

By Todd Johnson, Postdoctoral Research Associate, Dept. of Natural Resources and the Environment, UNH. 2 September 2020

Welcome to another update regarding our ongoing research project studying the emerald ash borer and the ash trees it attacks at Doe Farm. If you have missed any of our previous updates, you can find our initial project outline here, and our last two updates from June and July on the Doe Farm website.

We recently completed our sampling of the chemical defenses produced by ash trees at Doe Farm (detailed in our July update). Now we have begun the second phase of our study, which investigates the impacts of ash trees on the larvae of emerald ash borer that survive the presence of defensive toxins. While the larvae of emerald ash borer may be able to tolerate and survive the presence of some toxins within ash trees, it doesn't mean that these toxins don't affect them. There have been numerous studies on organisms (especially the impacts of pesticides on insect pollinators) that experience what are known as 'sublethal effects'. These phenomena include but are not limited to, changes in the physiology and behavior of organisms after exposure to toxins. We are particularly interested in how larvae of the emerald ash borer may develop at different rates (e.g., they develop more rapidly or more slowly) or alter their feeding behavior when in trees of different sizes, and how these changes may alter their suitability to introduced biological control agents. This is also the subject of other ongoing studies in our laboratory that focus specifically on impacts of pesticides on larvae and adults of emerald ash borer. Changes that we observe in the development and behavior of our larvae may also be attributed to variable amounts of essential nutrients present in trees of different sizes or ages, and this may be another important angle to study in the future.

In the last week of August we began releases of *Spathius galinae* and *Tetrastichus planipennisi*, two species of parasitic wasps (also known as parasitoids) that are native to Asia and have evolved over many years of evolutionary time with their host, the emerald ash borer. Unlike organisms that are predators, parasitoids complete their development on or inside a host organism, usually resulting in the death of the host. This unique lifestyle often leads to parasitoids being highly specialized to locate and develop on the specific physiology of their hosts, making them good candidates for biological control, especially in places like forests where humans cannot easily locate and control pests.

Research has shown that parasitoids are highly adapted to locate and attack the emerald ash borer. First, parasitoids locate where the emerald ash borer is feeding by flying towards odors produced by the foliage of ash trees. After landing on a tree, it is believed that these wasps then use vibrations created by feeding of their host to locate the emerald ash borer. Vibrations produced by insects feeding in trees are produced at very specific frequencies and occur at specific intervals, allowing parasitoids to assess the identity and size of their target without actually seeing them. These wasps may also be attracted to odors from the waste produced by the larvae (called frass) of emerald ash borer as they

feed. After locating a potential host, parasitoids conduct an assessment of the quality of that larva before laying their eggs on or inside of it.

On a larger larva of emerald ash borer, a parasitoid may lay more eggs, as there will be more nutrients for their young. When evaluating a smaller larva of the emerald ash borer, a parasitoid may lay fewer eggs. These decisions ultimately affect the rate of growth of populations of biological control agents, which then influences how effective wasps may be at reducing the population of emerald ash borer within a region. Thus, releases of parasitoids may be more or less effective in some forests, depending on the size and ages of the ash trees there and how potent their defensive chemistry is to emerald ash borer. We will be conducting a total of three releases of parasitoids at Doe Farm to increase the chances that parasitoids will survive and parasitize emerald ash borer in our study. An added benefit of these releases is that parasitoids may also attack emerald ash borer that naturally occur at Doe Farm. This will allow populations of beneficial parasitoids to build and slow the growth of populations of the beetle in the area.

Biological control has been one of the preferred tools for the management of emerald ash borer in North America since its discovery in Michigan in 2002. Because the invasive beetle can attack and kill any ash trees it encounters, it is particularly difficult to manage. When trees planted along streets or are growing in parks become stressed or damaged, arborists can treat these trees with pesticides or fungicides to remove insect or fungal stressors, water plants that are experiencing drought, fertilize plants when needed, and remove trees before they die and become hazards to people or property. This type of management is nearly impossible to do when trees are growing in natural or managed forests such as at Doe Farm and many other locations throughout New Hampshire. Thus, introducing parasitoids that have adapted to locate and develop on the emerald ash borer allows management to occur in many locations where it would be very challenging to do otherwise.

When parasitoids are introduced for biological control from outside of regions where they are native, it is called classical biological control. Ideally, classical biological control allows natural enemies (*i.e.*, the organisms that feed on or develop on another organism) to become re-associated with their prey or hosts, leading to a reduction in the population of this target pest. Before non-native organisms are released in the United States, they undergo rigorous and careful host-specificity tests that confirm that they will not attack non-target organisms. In the case of the emerald ash borer, each of its introduced biological control agents were tested against numerous species of insects that could potentially co-occur in ash, occur in forests where ash grows, or are closely related to the emerald ash borer. Studies that evaluate the host-range or breadth of organisms that biological control agents can feed or develop on are conducted for each species that may be released, and releases are not conducted of these organisms unless they have been determined to not cause ecological harm.

After we complete the releases of our parasitoids we move into our final (and arguably the biggest part) phase of our project. In mid-October we will return to Doe Farm to cut down all of the ash trees we artificially infested with emerald ash borer. We will then

take these trees and carefully scrape their bark. This will allow us to evaluate the survival, development, and behavior of emerald ash borer larvae in our trees, as well as evaluate of the impact of our parasitoid releases. Stay tuned for that update in October.