Tiny wasp sniffs out, picks up 'good vibrations' to battle ash borer

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Spathius galinae has been approved for release to help control the emerald ash borer, an invasive beetle that has devastated ash tree populations across the US. Credit: USDA and University of Delaware

With the emerald ash borer beetle devastating ash tree populations

throughout the United States—from locations as far north as Massachusetts and as far south as Louisiana—solutions to help fight the insect are critical.

Thanks in part to research from the University of Delaware and the United States Department of Agriculture (USDA) Agricultural Research Service (ARS), a host-specific parasitic wasp so new and obscure that it doesn't even have a common name—known only by its scientific name Spathius galinae—has been approved for release to help control the invasive beetle.

Some of those research findings were recently released in the May edition of the journal Biological Control and looked at the environmental parameters, specifically the temperatures, under which this parasitoid worked best.

Timothy Watt, who received his master's degree from UD in 2014 and who also worked at the USDA Beneficial Insects Lab on campus starting in 2011, was the lead author on the paper and worked with Jian Duan, a research entomologist and lead scientist with the USDA ARS Beneficial Insects Introduction Research Unit, and Doug Tallamy, professor of entomology in the Department of Entomology and Wildlife Ecology in the College of Agriculture and Natural Resources, both of whom co-advised Watt during his time as a graduate student at UD from 2012-14.

Watt said that this latest paper was the third chapter of his thesis, with one paper outlining research they conducted looking at the factors of emerald ash borer host size to determine the best quality larval size and age for rearing Spathius galinae and the other looking at factors encountered when rearing any insect natural enemy—predator or parasitoid—such as host density and parasitoid density.

This latest paper looked at the effects of temperature on the parasitoid's

development in reproductive biology.

"You've got to know the biology but then you also have to know the environmental factors and for this one, we just focused on temperature because you can start to get into all sorts of other studies and data analysis when you add other variables," said Watt.

Optimal temperature

Watt said that temperature is an integral piece of the puzzle for understanding insects in general.

"Insects in general are ectothermic—they're basically controlled by temperature. Their physiology and metabolism are strongly influenced by ambient temperature, almost like they're programmed in a way," said Watt.

Duan said that knowing which temperature works best for Spathius galinae is critical to developing a rearing program as well as a strategy with regard to where to release the parasitoids.

The researchers tested five different temperatures - 15, 20, 25, 30 and 35 degrees Celsius - and from those temperatures, they found that 25 degrees was the most optimal temperature as it would minimize the wasp's immature development time and maximize female reproductive output.

Host specific parasitoid

The researchers also spent a great deal of time making sure that the parasitic wasp was host specific to emerald ash borer and wouldn't impact any other similar species.

"There's a lot of behavior and ecological mechanisms to prevent this wasp from attacking other insects," said Duan. "Prior to the regulatory approval, we conducted extensive host specificity testing against 14 different non-target beetle species in the quarantine laboratory. Only one of the 14 non-target beetles was impacted, and that was the gold spotted oak borer, which itself is a serious invasive pest of oak trees in California. But that's under laboratory conditions. In general, this is one of the most host specific wasp species of emerald ash borer natural enemies."

They are also aware that the name "wasp" might conjure images of stinging insects being released upon an unsuspecting population and made it clear that these wasps are different than a typical wasp.

"These wasps do not sting human beings. They don't even sting 'naked' emerald ash borer larvae dissected out of the bark," said Duan. "They simply lay eggs on it."

Tallamy added, "People worry because it's a wasp; they wonder 'will it sting my kids?' They're picturing bigger wasps. These are tiny. Nobody would look at them and recognize them as a wasp. They'd think it's a little gnat or something. They will never sting you. They couldn't sting you."

Watt said that it can take up to four or five years of research conducting non-target testing before a biological control measure is even considered for release.

"A lot of our work focuses on non-target testing, looking to see if the parasitoid might seek out other insects that live in the same habitats or are taxonomically related to the target pest. There is a very rigorous testing model in place to make sure that these organisms aren't all of a sudden going to go attack another insect that's out there once we release

them into the wild," said Watt.

Bark vibrations

As for how the parasitic wasps find and prey upon the emerald ash borer, Duan explained that the wasp is a larval parasitoid, attacking primarily medium to large emerald ash borer larvae.

When emerald ash borer feeds under the bark of an ash tree, the parasitoid locates the larvae first by smelling the ash tree—which gives off a different scent when infested— and then by walking on the tree's trunk and using sensors in their legs to detect the vibrations of the emerald ash borer larvae feeding.

Once a wasp feels larval vibrations it uses its ovipositor which is normally 3-5 millimeters long to drill through the bark and lay eggs—normally a clutch with 9-15 eggs—on the surface of the emerald ash borer larvae. Once the parasitic wasp larvae hatch, they begin to feed on and suck the juices out of the emerald ash borer larvae.

Now that the studies have been complete, the Spathius galinae has been approved for release and is currently being reared in the USDA Animal and Plant Health Inspection Service (APHIS) lab in Michigan.

"Because we have done all these studies, we have developed an effective rearing program and USDA APHIS approved it for release in the United States as of May 2015. The parasitoid colony has been transferred to USDA-APHIS lab in Brighton, Michigan, where APHIS has a mass rearing facility for all emerald ash borer parasitoids including this one. The plan is, they're going to produce tens of thousands of these parasitoids and send them to northeastern states to release," said Duan.

As for the collaboration between the USDA and UD, Duan said that it is

a really beneficial partnership for everyone involved.

"I currently have four UD students working on my projects and they get hands-on experiences that they won't get in the classroom," said Duan.

More information: Timothy J. Watt et al, Reproductive and developmental biology of the emerald ash borer parasitoid Spathius galinae (Hymenoptera: Braconidae) as affected by temperature, *Biological Control* (2016). DOI: 10.1016/j.biocontrol.2016.01.011

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