

**Behavioral Response of Three Predator  
Beetles to Hemlock Woolly Adelgid  
(*Adelges tsugae*) and Eastern Hemlock  
(*Tsuga canadensis*)**

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Predator Beetle Lab

Starting in Virginia in the 1950's, the invasive Hemlock Woolly Adelgid (HWA) has been devastating eastern and Carolina hemlock stands along the eastern United States. This aphid-like insect has since spread north to Maine, west through the smoky mountains, and in 2003, HWA reached north Georgia. In order to try and create a balance in the forest to save the hemlocks, predator beetles have been introduced that specialize in eating adelgids. To better understand this predator-prey relationship, a behavioral study will be conducted using 3-4 predator beetle species and the different life stages of HWA.

The beetles are *Sasajiscymnus tsugae* (St), *Scymnus coniferarum* (Scw), *Laricobius nigrinus* (Ln), and *Laricobius rubidus* (Lr). Both St (Japan) and Ln (Pacific Northwest) have been mass reared and released along the east coast, and for five years here in Georgia. Scw is another predator beetle, native to the Pacific Northwest, that preys on adelgids and is being considered as a possible addition to the predator beetle complex. Lr is the native east coast *Laricobius* species that feeds on pine bark adelgid, but is showing up on HWA infested hemlock trees and could play an important role as well. This predator beetle complex allows for a year round attack since different species are active at different times.

A Wards Animal Behavior Investigating Tray (right) will be used to test the behavioral response of the beetles. The tray would be positioned with the four corners representing a cardinal direction. Banks of

fluorescent lights will be positioned above the tray at equal distance and height and covered with mesh to provide diffused light. This would prevent any response from the beetle to move towards the light.

Three components of hemlocks and or adelgids, such as hemlock bark, adult adelgids, adelgid egg, etc. (see trial schedule), would be collected from E. hemlock and used within 48 hours. These components would randomly be assigned to three of the outer circles of the tray depending on the trial. The fourth outer circle would be left blank as a control. An individual beetle, starved for 18-24 hours prior, would be placed in the center circle and allowed 5 minutes to move around and make a choice. Since the beetle species have different optimal temperature, St and Scw will be tested between 70-77°F while the *Laricobius* species would be tested between 50-60°F. In order to achieve this, each trial will be split between 2 days, testing the two warmer species one day and the cooler species the next, using a heater or A/C unit to control the temperature. To test to see if there is a difference in activity during the day, 5 beetles will be tested in the morning and a different 5 beetles would be tested in the afternoon. Therefore, a total of 20 beetles per species would be tested at each trial since there is a part A and part B (see trial schedule). In order to have a large sample size each trial will be replicated three to four times. Also to prevent the possibility of a beetle following pheromones left by another, the trays will be cleaned out with acetone between each beetle.

To record both direction of movement and pathway taken an overhead transparency, with a numbered grid printed on it, would be used to record the movement of the beetles. This would be done by recording each number the beetle walks in to. A square will be entered only after the thorax (middle segment of the beetle) passes through and remains there for at least 2 seconds. The time spent in each square would be recorded as well.

The goal of this research is to better understand how HWA predator beetles behave to both eastern hemlock and the hemlock woolly adelgid. This research could provide important information regarding the effectiveness of these predator beetles on their ability to detect the prey. It could provide data that might result in finding a specific component of the prey or host tree that the beetles hone in on. Knowing if there is a certain component of the tree or adelgid could help in creating a pheromone trap that would aid nationwide in

assessing establishment in the field or assist in the collection of these predators from their natural habitat.

Besides the important information this study can provide it would also lend additional information to multiple experiments going on at the NGCSU predator beetle lab. At NGCSU two experiments are being conducted, an olfactory experiment and an Ln emergence study. The olfactory experiment would use these beetles to determine if they react, positively or negatively, to the smell of the eastern hemlock and adelgid while this behavioral study would also include their ability to visually choose (or not choose) a specific component. In relation to the other study, *Laricobius* species spend the summer underground and emerge in the fall. In the Pacific Northwest this emergence is synchronized with the adelgid breaking its own summer dormancy. However, the Georgia summers are quite different and this synchrony might not exist. If the beetle emerge before HWA breaks aestivation it is important to understand if Ln can locate the dormant adlegid and survive on it.

The behavior research would be conducted by an undergraduate student that would commit to the whole duration of the experiment (September to May). There would be some supervision and assistance from the lab manager but the student would be in charge of setting up the trials, conducting the research, recording data, and cleaning up. Additional duties might include caring for the beetles or assisting in additional research at the lab. There would also be an opportunity to continue this research the following year by looking at age and sex of the beetles or behavior to different life stages of adelgids removed from hemlocks.

At the end of this project, May 2012, data will be compiled, analyzed, and written up in a report. The results would be presented at the CURCA poster session, Hemlockfest, and any additional outreach presentation that could include Trout Unlimited and Georgia Native Plant Society. There is potential for the undergrad to also present in the summer of 2012 at the Southern Forest Insect Work Conference (SFIWC) along with other entomological and biological gatherings such as the Southern Appalachian Entomologist/Pathologist Symposium (SAEPS) and Invasive Species Conference.

**Budget:**

Student employment:

\$8/hour for 4 replications of 4 trials taking 6 hours: Total: \$1,536

Supplies:

| Item                | Quantity    | Price    | Shipping and Handling | Total               |
|---------------------|-------------|----------|-----------------------|---------------------|
| Wards Behavior Tray | 10          | \$31.00  |                       | \$310.00            |
| Stop Watch          | 3           | \$12.95  | \$41.86               | \$38.85<br>\$41.86  |
| Field Scale, 1000g  | 3           | \$43.80  | \$11.29               | \$131.40<br>\$11.29 |
| Acetone             | 1 Liter     | \$90.37  | N/A                   | \$90.37             |
| Transparency Paper  | 1 box of 50 | \$39.99  | N/A                   | \$39.99             |
| Small A/C Unit      | 1           | \$249.00 | N/A                   | \$249.00            |
| Humidifier          | 1           | \$24.99  | N/A                   | \$24.99             |
| Light Bulbs         | 8           | \$10.00  | N/A                   | \$80.00             |

**Total Requested Budget: \$2555.00**

Wards Behavior Tray: house experiment

Stop Watch: To record time spent in each square as well as duration of trail

Field Scale: To measure the weight of product (hemlock) used

Acetone: To clean out the behavior trays

Transparency paper: to record movement of the beetles

Small A/C unit: to control the temperature

Humidifier: to provide optimal air conditions for the beetles

Light bulbs: used to provide diffused light

**Timeline:**

**Trial Schedule:** Each trial will be replicated 4 times

Trial 1: (during September or October)

A: Eastern hemlock with aestivating (dormant) adelgid

Eastern hemlock with no adelgid

Eastern Hemlock Bark

Blank

B: Aestivating (dormant) adelgid

Infested Eastern hemlock with no adelgid

Eastern Hemlock Bark

Blank