



Biological Control of Hemlock Woolly Adelgid in North Carolina: Efforts of the NCDACS Beneficial Insects Laboratory



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Biological control is a crucial strategy in the long-term management of hemlock woolly adelgid, *Adelges tsugae* (Hemiptera: Adelgidae) (HWA) (Fig. 1A), in eastern North America. Since 2002, the Beneficial Insects Laboratory (BIL) of the North Carolina Department of Agriculture and Consumer Services (NCDACS) has been involved in biological control programs targeting HWA. While past efforts focused on rearing predators, current work has expanded to conducting field studies with HWA predators, as well as enhancing the network of field insectaries within North Carolina.



Figure 1. A) Eastern hemlock infested with hemlock woolly adelgid, B) adult *Sasajiscymnus tsugae*, C) adult *Laricobius osakensis*, D) adult *Leucotaraxis argenticollis*.

Initial rearing and release efforts of the NCDACS BIL focused on *Sasajiscymnus tsugae* (Coleoptera: Coccinellidae) (Figs. 1B & 2A), a predator of the spring generation (progrediens) of HWA. Over 640,000 *S. tsugae* were reared at the BIL between 2002 and 2015 for release in North Carolina and other states. Surveys in 2022 and 2023 found *S. tsugae* in 17% of 52 historic release areas (Fig. 2C). Recoveries were from sites where releases of *S. tsugae* were made between 2004 and 2009, indicating long-term establishment.



Figure 2. A) Larva of *S. tsugae* feeding on HWA eggs, B) beat-sheet sampling for *S. tsugae* at historic release site, C) map of historic release sites surveyed and *S. tsugae* recoveries.

We are also assessing the feasibility of conducting egg releases of *La. osakensis* to reduce the time beetles slated for release spend in laboratory conditions. *La. osakensis* eggs are released as HWA initiate egg production (Figs. 4A & B). Soil emergence cages are deployed the following fall underneath egg release branches to intercept adult *La. osakensis* emerging from the soil and estimate beetle survival to adulthood (Fig. 4C).



Figure 4. A) *La. osakensis* oviposition jars (inset: *Laricobius* eggs), B) deploying hemlock twigs with *La. osakensis* eggs on tree in field, C) soil emergence cages placed under egg release trees; emergence cages monitored regularly throughout the Fall.

Beginning 2015, rearing efforts shifted to beetles in the genus *Laricobius* (Coleoptera: Derodontidae) (Figs. 1C & 3B), a predator of the winter generation (sistens) of HWA. Current rearing and release efforts are focused on *La. osakensis*. In addition to initiating *La. osakensis* colonies in the laboratory (Fig. 3A), efforts are underway to increase field insectaries where *La. osakensis* can be collected and redistributed to areas of interest (Fig. 3C).



Figure 3. A) Soil cups containing *La. osakensis* aestivating during summer months, B) adult *La. osakensis* held in rearing containers, C) planted and existing eastern hemlock at site of future field insectary.

To provide additional predation on HWA progrediens, predatory flies in the genus *Leucotaraxis* (Diptera: Chamaemyiidae) are being developed as biological control agents (Figs. 1D & 5C). We are using whole-tree cages (Fig. 5A) to evaluate the potential for establishment of these predatory flies in the field to further suppress HWA populations. Monitoring techniques include visual examination of the foliage, as well as eDNA sampling (Fig. 5D).



Figure 5. A) Deployed whole-tree cages, B) releasing *Le. argenticollis* in whole-tree cage, C) larva of *Le. argenticollis* recovered in post-release sampling, D) processing eDNA samples collected from study trees.

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