

## Hemlock Woolly Adelgid Biological Control Research

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### Abstract

The hemlock woolly adelgid (HWA), *Adelges tsugae* Annand, is an introduced pest that causes mortality of hemlock in the eastern U. S. Three laboratories have imported and are evaluating predacious beetles for biological control of the adelgid.

The lady beetle, *Pseudoscymnus tsugae* Sasaji & McClure, was imported from Japan by the Connecticut Agricultural Experiment Station in 1994 and was first released in 1995. It has now been released in 11 states from North Carolina to New Hampshire and is considered to be established in seven states. This predator has two generations per year in the field in Connecticut and the adults overwinter on the hemlock foliage during mild winters. Active oviposition occurs from late April through July in Connecticut. Its predation impact is continuous from April to September on the three *A. tsugae* generations that occur in a calendar year.

The USDA Forest Service, Hamden, CT, imported several species of lady beetles from China between 1996 and 1998. Two species, *Scymnus sinuanodulus* Yu et Yao and *S. ningshanensis* Yu et Yao, have been studied in the quarantine laboratory and are undergoing field evaluation in cages. They lay eggs in the spring and are univoltine. The adults become inactive at low temperatures but do not enter diapause. Field cage studies on the numerical impact of the lady beetles on HWA found that a pair of lady beetles confined on a branch with 200-400 ovipositing adelgids significantly reduced subsequent HWA generations compared to controls without beetles. The impact of the beetles was influenced by negative density dependent effects of the adelgid on the host.

The derodontid beetle, *Laricobius nigrinus* Fender was imported from British Columbia between 1998 and 2001 by Virginia Tech for evaluation in quarantine. This species is univoltine. It becomes active in the fall after undergoing an aestival diapause in the adult stage. Adults feed on developing sistens nymphs throughout the fall and winter at temperatures above 0°C. Females begin to oviposit early in the spring. Oviposition by *L. nigrinus* corresponds with onset of oviposition by HWA sistens. Larvae feed on the eggs of the progrediens generation. Mature larvae drop to the soil and pupate. Emergent adults aestivate in the soil during the summer months. Field cage studies, initiated in March 2001, evaluated the impact of a single pair of adults caged on branches infested with ~500 HWA. These consumed all of the HWA in the cages by June, whereas the HWA populations in cages without beetles increased.

Future research plans include evaluation of the efficacy of these predatory beetles in combination on HWA, improving rearing procedures for the beetles, use of field insectaries of infested living hemlocks to produce predators, and developing an optimal release strategy for the predators.