

Establishing *Pseudoscymnus tsugae* Sasaji and McClure (Coleoptera: Coccinellidae) for Biological Control of Hemlock Woolly Adelgid, *Adelges tsugae* Annand (Homoptera: Adelgidae), in the Eastern United States

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Abstract

The hemlock woolly adelgid (HWA) is native to Asia, where it is a harmless inhabitant of several hemlock (*Tsuga*) species. HWA was first observed in the Eastern United States around 1950 in Richmond, Virginia. Since then, it has spread into 12 states on the eastern seaboard from North Carolina to New England where it is a serious pest of eastern hemlock, *T. canadensis*, and Carolina hemlock, *T. caroliniana*.

In 1992, Dr. Mark McClure discovered *Pseudoscymnus tsugae* Sasaji and McClure (Coleoptera: Coccinellidae), an effective predator of HWA, in Japan. In 1994, The Connecticut Agricultural Experiment Station and the USDA Forest Service State and Private Forestry initiated a cooperative agreement to explore the potential of *P. tsugae* as a biological control agent for HWA. We found that *P. tsugae* is amenable to mass culturing and possesses other qualities that make it an excellent biological control candidate. *P. tsugae* produces three or more generations each year in the laboratory under controlled temperature conditions, is adapted to a wide range of climate conditions, strongly prefers to feed on adelgids, has a life cycle synchronized with that of HWA, and has a high searching efficiency and dispersal ability. The encouraging results from this project spawned another cooperative effort with the Phillip Alampi Beneficial Insect Laboratory in Trenton, New Jersey to mass rear *P. tsugae*.

Since 1995, 627,000 beetles have been released at 100 sites in 11 Eastern States.

Pseudoscymnus tsugae has overwintered, established, reproduced, and spread at many of these release sites. In forests where *P. tsugae* has been present for at least three years and where at least 10,000 adults were initially released, beetles are now abundant and can be collected from infested trees. Sampling from a bucket truck documented vertical dispersal, overwintering survival, and reproduction of *P. tsugae* up to 65 feet in the canopy. Horizontal dispersal of 0.58 miles also has been documented. Results have been encouraging when HWA densities on hemlock trees in release areas were compared with those in similar control areas (beetles absent in the area) at least half a mile away. HWA densities on monitored branches in release areas were reduced by 43 to 87% in just 5 months by a starting population of only 2,400 adult beetles, indicating a remarkable short-term impact of *P. tsugae* on HWA.

Weather conditions from 1995 to 1999 hampered the biological control effort. A string of mild winters enhanced the survival and growth of HWA populations, and a severe drought in 1999 in the

Eastern United States significantly reduced hemlock health. However, in the Northeast, a 2-week period with subzero (F) temperatures in January 2000 reduced adelgid populations by more than 90%, while *P. tsugae* survived this cold period. With greatly reduced adelgid numbers, hemlocks flourished during the cool, moist spring and summer of 2000 and abundant new growth was evident in spring 2001. Even though milder temperatures during the winter of 2000 to 2001 allowed 50 to 60% survival of HWA, pest densities have remained low in our release areas.

Keywords:

Pseudotsugus tsugae, biological control.