Coexistence of two introduced Predatory Beetle Species of Hemlock Woolly Adelgid on Eastern Hemlock

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Abstract

The invasive insect hemlock woolly adelgid (HWA), *Adelges tsugae* Annand (Hemiptera: Adelgidae), is a serious threat to eastern hemlock, *Tsuga canadensis* (L.) Carrière, throughout the eastern U.S., including the southern Appalachians (Ward et al. 2004). In 2002, HWA was first documented in the Great Smoky Mountains National Park (Lambdin et al. 2006, Grant 2008). Although more than 500,000 adult *Sasajiscymnus tsugae* (Sasaji and McClure) (Coleoptera: Coccinellidae) and ca. 7,000 adult *Laricobius nigrinus* Fender (Coleoptera: Derodontidae) have been released on adelgid-infested eastern hemlock in the Great Smoky Mountains National Park (GRSM), as part of an integrated management plan, few, if any, records exist of these species co-occurring or establishing on the same trees in the same location. The purpose of this study was to assess establishment of these introduced predatory beetles after removal of whole-tree enclosures from eastern hemlock.

Fifteen eastern hemlock trees (ca. 8 m tall) were selected in Walland, Blount County, Tennessee, and 12 of these trees were caged using whole-tree enclosures (dimensions: ca. 8.26 m tall, 6.35 m basal diameter, made of lightweight Nylon netting and constructed by Camel Mfg.). Between December 2007 and/or March 2008, *L. nigrinus* (n = 190/caged tree, three trees), *S. tsugae* (n = 300/caged tree, three trees), and *Scymnus sinuanodulus* Yu and Yao (n = 90/caged tree, three trees) were released onto hemlock trees within the whole-tree canopy enclosures. Adults of *L. nigrinus* and *S. tsugae* were obtained from Lindsay Young Beneficial Insects Laboratory, University of Tennessee, and adults of *S. sinuanodulus* were obtained from the University of Georgia and the USDA Forest Service Northern Research Station, Connecticut. Three caged control (no beetles) and three open control (no cages) trees also were established. Cages were removed from trees in July 2009, and weekly beat-sheet sampling (five beats per tree) was conducted from January through July 2010 to assess establishment of these introduced predatory beetles.

Adults of *L. nigrinus, S. tsugae,* and a native species *Laricobius rubidus* (LeConte), as well as larvae of *Laricobius* species and *S. tsugae,* were collected in beat-sheet samples from eastern hemlocks after the whole-tree canopy enclosures had been removed. Both *L. nigrinus* and *S. tsugae* were found on four trees, and these two introduced predator species and the native predator species were also found on one tree. *Laricobius nigrinus*

and *S. tsugae* dispersed throughout the site and were recovered from two and five non-release trees, respectively, within a distance of 50 m of original releases. These two introduced predator species were recovered within two years following releases. However, while both beetle species have been recovered in some of their respective release sites in GRSM, many of the recoveries of *S. tsugae* in GRSM have been within 5 to 7 years after releases (Hakeem et al. 2010). The whole-tree cages may have enhanced the ability of these introduced predators to find food and mate. Thus, releases of these natural enemies, especially *S. tsugae,* in large whole-tree canopy enclosures, placed over hemlocks in a forest may better acclimate the released beetles to field conditions, increasing their establishment and effectiveness.

Recovery of *L. nigrinus* and *S. tsugae* on the same trees indicates that they can coexist and are compatible. This coexistence may be due, in part, to minimal overlap in their biology. These multiple predator species could provide prolonged predation of HWA, and their coexistence may enhance management of HWA using biological control programs.

Keywords

Sasajiscymnus tsugae, *Laricobius nigrinus*, *Laricobius rubidus*
hemlock woolly adelgid, coexistence, predators, biological control

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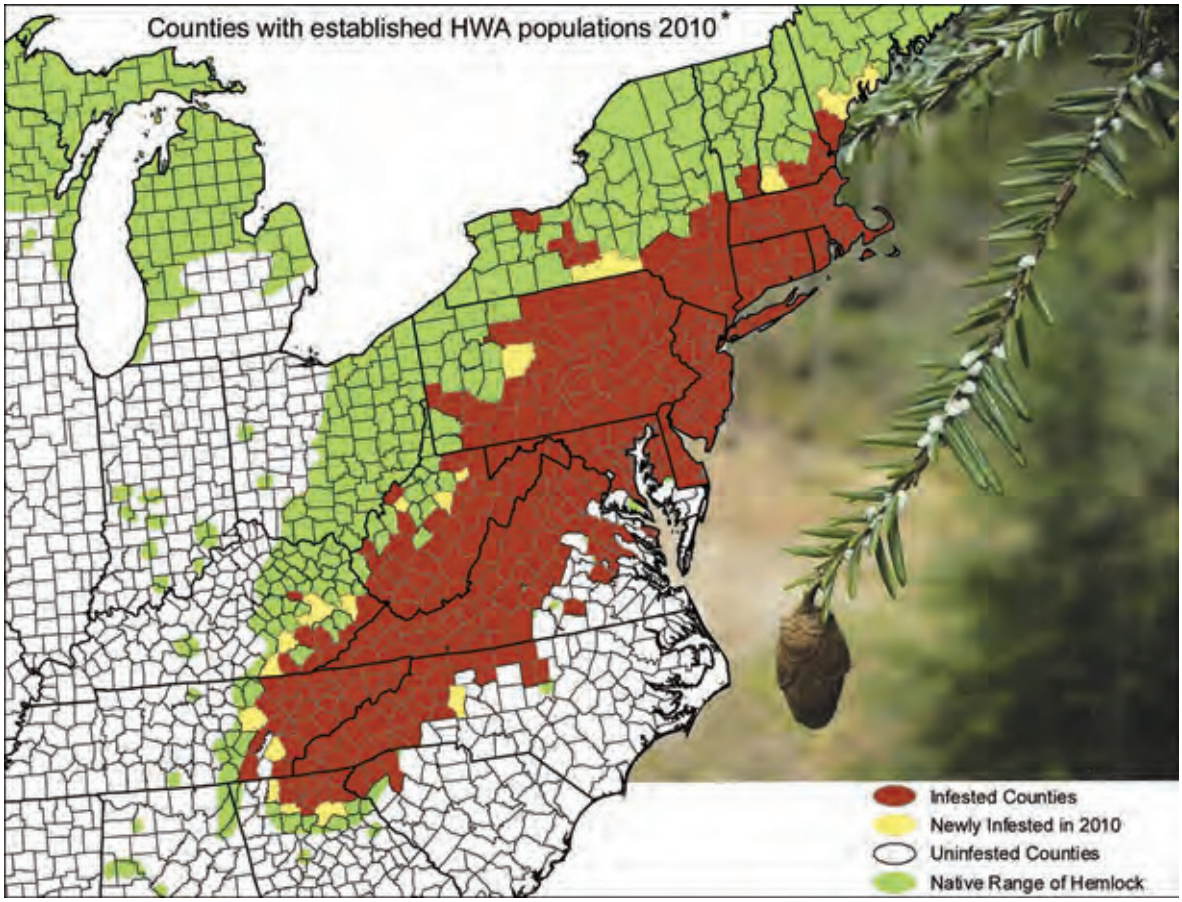

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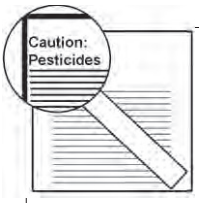

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***Cover map**: Produced by USDA Forest Service, 2010. The map depicts counties with established populations of hemlock woolly adelgid (HWA) that have been confirmed by state forest-health officials. The coarse nature (scale) of the map does not provide information below the county level; highlighted counties are not necessarily entirely infested with HWA.

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Foreward

This is the 5th HWA symposium; the first meeting was held in Charlottesville, Virginia in 1995. Over the past fifteen years we have seen HWA spread like wildfire in the south, invade six additional states, and cause extensive tree mortality throughout the mid-Atlantic and southern regions. Sounds rather hopeless and yet we remain optimistic, and here's why.

During the first seven years (1995-2002), there were but a handful of scientists, forest health specialists and resource managers working on the HWA research and management issue. Investigations into biological control were limited and in its infancy, there were no chemical control options for protecting hemlocks in a forest environment, no standardized sampling methods, impacts to hemlock forests remained scattered regionally and until the late 1990s, some forest health specialists were even skeptical that HWA was really that big of a threat to hemlocks! Our basic knowledge of HWA biology was limited as was the consistency of funding to support the needed research and methods development. In 2001, a formalized plan, *An Exotic Pest Threat to Eastern Hemlock: An Initiative for Management of Hemlock Woolly Adelgid* was put forward and more stable levels of funding were made available annually by the USDA Forest Service beginning in 2003. This was the beginning of the HWA Initiative and the accelerated effort to research and develop management solutions. An effort that now involves 24 universities, seven institutions in China and Japan, 20 state agencies, four federal agencies and nine private institutions.

In the last eight years we have seen several effective systemic insecticides become labeled for forest applications resulting in tens of thousands of hemlocks treated and protected annually. Standardized survey methods have been developed, and thanks to investigative DNA technology, we now know that all HWA are NOT created equal and that the origin of HWA found in the East is southern Japan. We now have six institutions rearing HWA predators and we are seeing predators becoming established in many areas from Maine to North Carolina. The cold tolerant *Laricobius nigrinus* found in the interior west has been recently released is now becoming established in areas where the coastal strain of this beetle was difficult to establish. With all this, we also have approval to begin rearing and releasing the newly discovered beetle predator from Japan, *Laricobius osakensis* which has proven to be very promising.

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