OVERVIEW OF HWA BIOLOGICAL CONTROL ACTIVITIES WITH *LARICOBIUS* SPP.

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ABSTRACT

Laricobius nigrinus, a little known Derodontid beetle, is consistently found associated with hemlock woolly adelgid (HWA) in western hemlock seed orchards in British Columbia (Humble 1994). It turns out that *Laricobius* spp. are prey-specific predators of Adelgidae (Zilahi-Balogh 2004). In collaboration with Forestry Canada, we began studying the potential of *L. nigrinus* as a biological control agent for HWA in the eastern U.S. Field studies conducted in British Columbia showed that the phenology of the predator and the prey were highly synchronized (Zilahi-Balogh et al. 2003):

1. Predator adults are present and active in the winter to feed on developing HWA sistens.
2. Predator eggs are laid in HWA ovisacs, where hatching larvae feed on HWA eggs.
3. Predator larvae drop from the tree into to the soil to pupate and eclose into adults, where they aestivate at the same time and for the same duration as do HWA.
4. The predator adults and HWA sistens emerge from aestivation at the same time.

Laricobius nigrinus adults and larvae both feed almost exclusively and survive only on HWA (Zilahi-Balogh et al. 2002), making them virtually risk free when released. In field-cages, *L. nigrinus* can survive the winter and significantly impact HWA sistens and progrediens densities (Lamb et al. 2005). In these cages, egg densities increase when adult *L. nigrinus* females are added, but impact on HWA density does not (Lamb et al. unpublished data), suggesting optimal predator densities are fairly low.

Rearing this predator is challenging (Lamb et al., this issue), yet most issues have been worked out. One of the last major hurdles has been to overcome the early emergence of adult predators in the insectary. Without adequate food, mortality of emerging predators was very high. Lamb et al. (unpublished data) determined that aestivating adults held at a relatively warm temperature for this insect (19°C), followed by exposure to cooler temperatures (13°C), enables us to extend their dormant period until adequate food (i.e., developing HWA sistens) becomes available.

Beginning in 2003, *L. nigrinus* has been released in numerous sites ranging from Massachusetts to Georgia. David Mausel is studying the colonization, establishment, and spread of the predator (Mausel et al. this proceedings). He is also testing optimal release strategies that can be used on a large scale as more beetles become available.

Recovery of F_1 and F_2 beetles has already been obtained from some sites. One release site was a field insectary in Virginia Tech's Kentland Farms. Established in 2001 (Kok and Salom 2002), this 0.4 ha plantation of young eastern hemlocks infested with HWA, a site where 252 beetles were released in November, 2003. In January 2005, 25 F_1 adults were recovered from branches of release trees on a day when temperatures rose to as high as 18°C.

Other ongoing projects with *L. nigrinus* include an evaluation of potential competitive interactions involving *Sasjiscymnus tsugae*, and *Harmonia axyridis* in lab and field studies (Flowers et al. in this proceedings). We are also investigating the residual effects of imidacloprid treatments for HWA on *L. nigrinus* and *S. tsugae* (Eisenback et al. in this proceedings).

Work with other *Laricobius* spp. include our foreign exploration efforts in China, where two new species were discovered in 2002 (Gatton et al. 2004). Development, reproductive biology, and host-range testing studies for one of these species, *L.* sp. n. *kangdingensis* is being carried out in quarantine (Gatton 2004). Our goal is to get this predator released from quarantine and added to the complex of predators currently being released to control HWA.

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