ESTABLISHMENT OF *LARICOBIUS NIGRINUS* (COLEOPTERA: DERODONTIDAE) FOR BIOLOGICAL CONTROL OF HEMLOCK WOOLLY ADELGID

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ABSTRACT

Laricobius nigrinus is a natural predator of hemlock woolly adelgid (HWA), native to the western hemlock forests of North America. Research over the past 8 years at Virginia Tech has shown that this prey-specific predator is highly adapted to HWA. Several ongoing studies were reported on and will briefly be mentioned here.

Mass rearing efforts are ongoing at three labs in the southern United States. The objective is to produce as many adult beetles as possible for open release. The 2005 Virginia Tech *L. nigrinus* colony was founded with 713 wild-caught adults from Washington. Larval production was good, with 19,593 mature larvae produced. However, we had significant problems with water saturation and mold growth (*Penicillium* sp.) in the aestivation medium over the summer, resulting in high larval/pupal mortality (82.5%), with only 3,424 adults emerging. We will use a smaller aestivation container with improved ventilation to avoid this problem in 2006.

Between fall 2003 and fall 2005, nearly 12,000 beetles have been released at over 30 separate sites in the eastern U.S. Mausel et al. (this publication) reports on beetle recoveries post-release, and it appears that the insects are surviving and are becoming established at several releases sites. As part of this effort, we are attempting to document all releases of *L. nigrinus* in a database, including past and current releases of insectary-reared beetles and direct releases of field-caught beetles. Releases are being made using a newly revised protocol. Pre- and post-release data will be used evaluate the release protocol and document the overall success of the *L. nigrinus* release program. All release cooperators have agreed to collect and send these data to Virginia Tech for summarizing.

We have been looking at the potential interactions between two prey-specific predators, *L. nigrinus* and *Sasajiscymnus tsugae*, with a generalist established predator, *Harmonia axyridis*. In 2005, single- and paired-predator assays were tested in the laboratory under simulated early spring and late spring conditions. Digital video recordings were captured every 15 min over 24 h. All species exhibited continuous activity patterns punctuated by longer periods of rest. Predator activity and location did not appear to be coordinated to any particular time of day. Under early spring conditions, *L. nigrinus* had greater activity and a more even behavior distribution than that of *S. tsugae* or *H. axyridis*, which were skewed towards resting. Under late spring conditions, a more even behavioral pattern was seen for the latter two species. Paired-predator assays

suggested that conspecifics exert influence on one another, leading to increased dispersal movement and decreased resting, feeding and oviposition. In contrast, heterospecific combinations did not significantly affect behavior patterns. Significant spatial separation was maintained between conspecifics of *L. nigrinus* and *H. axyridis*, and in all heterospecific combinations, supporting our rationale for low-density releases of *Laricobius* adults. Overall, these data suggest that the predators are compatible, as particular temporal and spatial patterns were not coordinated, and avoidance behaviors are likely to keep them from interfering with each other in a field setting. However, the potential negative impacts of conspecifics should be taken into consideration when optimizing mass rearing and release procedures.

The high water-solubility of imidacloprid gives the insecticide desirable efficacy as a systemic insecticide, which is why it is one of the most relied upon insecticides in many insect pest systems. The potential for imidacloprid to be passed through the food chain has not been studied very frequently, and could have many implications for imidacloprid's safety for IPM programs that desire low nontarget impacts to biological control agents, predators, and parasitoids. The effects of systemic application of imidacloprid for control of HWA on its predators, *Laricobius nigrinus* and *Sasajiscymnus tsugae* are being investigated. HWA-infested branches from imidacloprid-treated trees and branches treated in the lab were used as assays for evaluating the impact of the insecticide on the predators. In the lab trials, both species of beetle exhibited a dose-dependent response to imidacloprid doses. Beetles exhibited sublethal effects including tremors and paralysis, and increasing mortality at higher doses. The predators exhibited similar but less pronounced response to feeding on field-treated branches. It appears that imidacloprid can be mediated by the adelgids to predators consuming treated individuals.