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Introduced Biological Control Agents for Hemlock Woolly Adelgid (HWA)

There are currently a number of introduced insect species that have been mass produced and released as biological control agents to help control HWA in the eastern United States.

One of the most promising biological control agents against HWA is *Sasajiscymnus tsugae* (Sasaji and McClure) (previously *Pseudoscymnus tsugae*). This beetle is a small oval "sesame-seed sized" black lady beetle from Japan that is approximately 1/20 inch in length (Fig.1). Eggs of S. tsugae are small oval orbs. The reddish-orange eggs are laid singly or in groups in the cracks and crevices in hemlock bark and twigs. Larvae (Fig.2) change from reddish-brown to grey during four developmental stages. The pupa (Fig.3) is reddish-brown and about 1/20 inch long. Both, adults and larva are highly mobile and feed on all HWA stages. S. tsugae's life cycle is highly synchronized with HWA. S. tsugae produces multiple generations per year (2 to 3 in the southern Appalachians), adapts to a variety of climatic conditions, and possesses excellent searching and dispersal abilities. S. tsugae specialize on adelgids and require HWA to develop and mature to adults.

Fig. 1 *Sasajiscymnus tsugae* adult.

Fig. 2 *Sasajiscymnus tsugae* larva.

Fig. 3 *Sasajiscymnus tsugae* pupa.

Scymnus sinuanodulus (Fig. 4) and *Scymnus ningshanensis* (Fig. 5) are lady beetles introduced from China to help control HWA. Both beetles are small, elongated oval in shape, and measure 1/16 inch in length. These brownish-orange lady beetles have dark brownish-black body markings. *S. sinuanodulus* females have black heads and males have brown heads. Egg and immature stages are similar in both species. Eggs are laid singly in hemlock bud scales or other concealed locations. Eggs are yellow-orange becoming dark brown after one day. Larvae are elongate and appear yellow to reddish brown. Larvae have a waxy coating on the cuticle that is more noticeable in later instars. The pupa is covered with course hair that has viscous droplets on the tips. Both species have one generation per year and begin laying eggs in the spring after

Fig. 4. *Scymnus sinuanodulus* adult.

Fig. 5 *Scymnus ningshanensis* adult.

overwintering. Both species specialize on adelgids and require HWA to develop and mature to adults.

Laricobius nigrinus is native to Western North America. The adult *L. nigrinus* (Fig. 6) is elongate reaching from 1/12 to 1/8 inch in length and covered with fine erect hairs. Eggs are yellow ovals. Eggs are laid singly within the woolly adelgid covering. *L. nigrinus* larvae (Fig. 7.) are elongate, yellow-green to brown with scattered short hairs. Larvae grow from about 1/16 to 1/6 inch during four developmental stages. The last instar burrows into the ground to form a yellow pupa. *L. nigrinus* has one generation per year and its life cycle is timed with HWA. This beetle becomes active when the adelgid comes out of dormancy in October. *L. nigrinus* is host specific for HWA and survives through the winter.

Fig. 6. *Laricobius nigrinus* adult.

Fig. 7. *Laricobius nigrinus* larva.

Other resources:

http://na.fs.fed.us/fhp/hwa/index.shtm
http://entweb.clemson.edu/cuentres/eiis/pdfs/ni4.pdf

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