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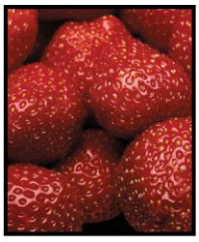


Hemlock Woolly Adelgid
Adelges tsugae Annand

Introduction: The hemlock woolly adelgid (HWA) is a destructive introduced pest of forest and ornamental hemlock trees (*Tsuga* spp.) in the eastern United States. The adelgid feeds at the bases of needles, causing them to desiccate and the tree to take on a gray cast. The result is needle loss, which prevents trees from producing new apical buds. Heavy infestations have killed trees in as little as 4 years, yet some trees have survived infestations for more than 10 years. Other stress factors may affect the tolerance of *Tsuga* spp. to insect attack.

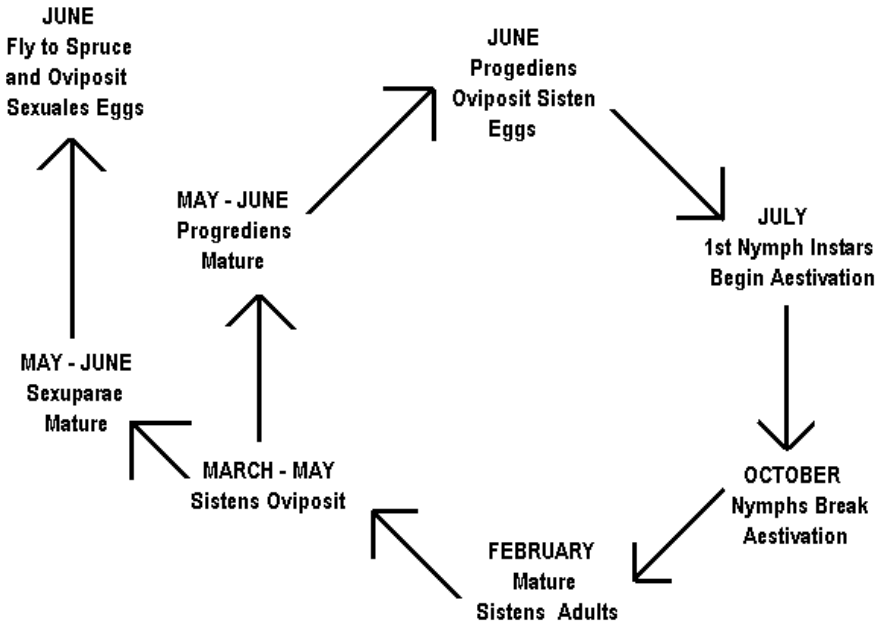
Figure 1. Characteristic white ovisacs of hemlock woolly adelgid. (Michael Montgomery, USDA Forest Service, www.Bugwood.org)

HWA is native to Japan and possibly China where it is a common, but innocuous inhabitant of forest and ornamental hemlock (*Tsuga diversifolia* Masters and *T. sieboldii* Carriere) and spruce (probably *Picea jezoensis hondoensis* [Sieb. & Zucc] and *P. polita* [Carriere]). HWA occasionally attains high densities on hemlock in Japan, but only on ornamental trees that are growing on very poor sites. However, even under these circumstances, Japanese hemlocks are not significantly injured, because of host resistance and several arthropod predators that are believed to help regulate HWA.

HWA was first observed in Western North America in the early 1920's in British Columbia and in eastern North America some 30 years later in Virginia. Although the details of these earlier infestations are unknown, they undoubtedly resulted from accidental introductions from Asia. The first sample of HWA submitted to the Insect and Plant Disease Diagnostic Laboratory at Cornell Cooperative Extension – Suffolk County was in November 1985. Since then this insect has become a significant problem on Long Island.

Hosts and Potential for Spread: In eastern North America, HWA is a destructive pest of eastern hemlock (*T. canadensis* (L.)) and Carolina hemlock (*T. caroliniana* Engelm.). These hemlock species have shown little or no resistance to HWA attack, and many trees growing under a wide variety of natural and ornamental conditions have died. Currently, HWA occupies a small part of eastern hemlock's natural range. However, during the last decade it has spread at a rate of about 20 to 30 km each year and its population levels have increased dramatically. Wind, birds, deer, and humans help spread HWA throughout the Northeast. Because HWA is adapted to high elevations in Japan where winter temperatures commonly drop below –35° C (-63°F), it should continue to spread in eastern North America until it occupies the entire range of eastern hemlock.

Life Cycle of Hemlock Woolly Adelgid



Life Cycle of Hemlock Woolly Adelgid
(*Hemlock Woolly Adelgid*. USDA Forest Service. FHTET-2001-03 March 2001

HWA has a complex life cycle that may involve both hemlock and spruce (*Picea* spp.) as hosts. In North America including Long Island HWA has three generations that develop each year on hemlock. Two generations develop simultaneously in the spring. These are called sexuparae, which contain wings and progrediens, which do not contain wings. The sexuparae adults will leave the hemlock in search of a spruce on which to oviposit (lay their eggs). Their progeny (offspring) are called sexuales, and the sexuales generation has not been observed to develop successfully on any spruce species in North America. Those that leave hemlock in search of a suitable spruce presumably die. The few that remain on hemlock will also die without laying eggs. Progrediens progeny are called sistens. The sistens generation develops (on hemlock) during autumn and winter, following a summer aestivation (passing the summer in a dormant state) period.

The seasonal development of HWA on hemlock in Connecticut is characterized by overlapping life stages. Seasonal development on Long Island would be similar. Most sistens mature into adults in February, and from March through May each sisten will produce a single white ovisac, which can contain up to 300 eggs. The white ovisacs (**see Figure 1.** and **Figure 2.**) are very apparent and provide an easy way to identify hemlock, which are infested with HWA. Nymphs of both types (sexuparae and progrediens) begin hatching from these eggs in April. These nymphs are referred to as crawlers and search for a suitable site to settle and feed. This feeding site will always be at the base of a needle. The insect will deplete food reserves from the tree's storage cells via a long stylet (mouthpart). The nymphs quickly develop through four instars (molts) and mature (into sexuparae and progrediens) in June. Progredien adults will remain on hemlock and sexuparae adults leave hemlock in search of a suitable spruce. Progredien adults produce the characteristic white cottony ovisacs (see **Figure 3.**) during June and July. Sexuparaes as earlier stated presumably die without finding a suitable spruce. Sisten crawlers hatch from the eggs produced in June and July and settle at the base of a (hemlock) needle where they feed for a few days. After feeding for this short period of time they will enter the summer aestivation period where they remain until October. In October these nymphs resume development and

Figure 2. Close-up of white ovisacs. (Chris Evans, River to River CWMA, www.Bugwood.org)

will mature into sisten adults by early February. These adults will oviposit their eggs from March through May, which is the beginning of a new generation of HWA.

Impact on Hemlock: Feeding by HWA causes the needles on infested branches to dessicate, turn grayish-green color, and then drop from the tree, sometimes within months. Most buds on infested branches are also killed as a result of feeding so little if any new growth is produced on these branches. Dieback of major limbs can occur within two years and progresses from the bottom of the tree upward, even though the infestation may be evenly distributed throughout the tree. Trees may die within four years, but as some homeowners have seen, some may survive longer with only a sparse amount of foliage at the very top of the tree. There is some evidence that some trees weakened by a HWA infestation may recover, although the factors that lead to such recovery are not well understood.

Figure 3. Close-up of adult (black) HWA and eggs (orange) inside an ovisac (Michael Montgomery, USDA Forest Service, www.Bugwood.org)

Management Options in Landscapes: Hemlocks infested with HWA can be kept healthy in a landscaped setting by using an integrated management approach that includes:

- Taking care when moving plants, logs, firewood, or bark chips from infested to uninfested areas, especially from March through June when adelgid eggs and crawlers are abundant.
- Water hemlocks during periods of drought. On Long Island in most seasons the critical months for watering established hemlock are June, July and August. Deep watering rather than frequent, shallow watering is recommended. Prune off all dead and dying branches. Although HWA is capable of killing hemlock growing in seemingly optimal condition those trees experiencing stress from drought and other factors succumb to adelgid attack more quickly.
- Fertilizing hemlock trees **after HWA has been completely controlled** can help encourage growth and stimulate recovery. Fertilizing infested hemlocks with nitrogen enhances HWA survival and reproduction. Therefore, nitrogen fertilizer **should not** be applied to infested hemlock.
- If you need to replace dead hemlock consider using Western species (*Tsuga mertensiana* (Bong.) (Carr.) or *T. heterophylla* (Raf.) (Sarg.)). You may also refer to *Pest Resistant Hedges and Screens for Privacy* for more suggestions. This list is available from Cornell Cooperative Extension – Suffolk County for a slight charge.
- Applying chemical insecticides is an essential component of any integrated approach to managing populations of HWA. Even if you follow all of the measures described above, infested trees are usually unable to survive for more than a few years if chemical insecticides are not used to control the infestation.

It is necessary to thoroughly drench infested trees with a recommended insecticide to achieve effective results. Be sure to spray trees from top to bottom as well as on all sides. Homeowners should hire certified pesticide applicators that have the proper equipment if the trees are too tall or many trees need to be treated. Two spray treatments each year are usually necessary if a hemlock tree has a HWA infestation.

Insecticide treatments suggested to homeowners: At the dormant stage (late April to early May), apply horticultural oil. In late June or late September and the following year in early June, treat with insecticidal soap. Thorough coverage with oil or soap is necessary.

Certified pesticide applicators should refer to a current copy of *Pest Management Guidelines for Commercial Production and Maintenance of Trees and Shrubs* for insecticide recommendations. Copies of this publication are available from Cornell Cooperative Extension – Suffolk County.

Figure 4. *Scymnus suturalis* Thunberg adult on hemlock twig. (Suzanne Lyon, University of Massachusetts, www.Bugwood.org)

Certified pesticide applicators have the option of applying certain systemic insecticides into the roots of infested hemlock trees as an alternative to foliar sprays to protect trees that can not be sprayed thoroughly. Such an insecticide is taken up by the roots and distributed through the tree where it can control HWA for several months. However, trees must have a healthy sap flow for these soil techniques to be effective. It is recommended that certified pesticide applicators refer to a current copy of *Pest Management Guidelines for Commercial Production and Maintenance of Trees and Shrubs* for such insecticide recommendations. In addition those applicators should follow the recommendations outlined in the *Best Management Practices for Long Island, New York Arboricultural Uses* for such soil treatments (copies are available from Cornell Cooperative Extension – Suffolk County or visit the CCE web site http://ccesuffolk.org/best-management-practices-for-long-island-ny/

There are several native species of insects that are occasional predators of HWA in North America. Unfortunately none of these predators has had a significant impact on adelgid populations or has shown much potential for biological control. For this reason the focus is on introduced predators and the coccinellid or lady beetle (*Pseudoscymnus tsugae Sasaji* and McClure n. sp.) shows the most promise. Both the larvae and adults actively prey on all stages of HWA on hemlock branches. Three lady beetles in the genus *Scymnus,* (**Figure 4.**) which have been imported from China, prefer to feed on HWA eggs, but will feed on other life stages as well. So far *P. tsugae* is the only non-native predator that has been released into the environment and results have been encouraging

Information obtained from *Hemlock Woolly Adelgid*. Mark S. McClure, Scott M. Salom and Kathleen S. Shields. USDA Forest Service. FHTET-2001-03 March 2001.

Pesticide recommendations obtained from *Part II Guide to Pest Management around the Home – 2009-2010 Pesticide Guidelines,* Cornell Misc. Bulletin S74II. Copies of this publication are available from Cornell Cooperative Extension – Suffolk County.

The Pesticide Management Education Program (PMEP), in cooperation with the New York State Department of Environmental Conservation (NYSDEC), maintains a web site with a searchable database for pesticide products currently registered in New York State. Individuals who have Internet access can locate currently registered products containing the active ingredients suggested above at http://pmep.cce.cornell.edu/pims/current (NYS PIMS).

This publication contains pesticide recommendations. Changes in pesticide regulations occur constantly and human errors are still possible. Some materials mentioned may no longer be available, and some uses may no longer be legal. All pesticides distributed, sold or applied in New York State must be registered with the New York State Department of Environmental Conservation (NYSDEC). Questions concerning the legality and/or registration status for pesticide use in New York State should be directed to the appropriate Cornell Cooperative Extension Specialist or your regional NYSDEC office. Read the label before applying any pesticide.

TK: 1/2010