Investigating Genetic Resistance of *Tsuga* to Hemlock Woolly Adelgid

S.E. Bentz[1], A.M. Townsend[1], Robert J. Griesbach[2], Margaret R. Pooler[3]

[1] USDA-ARS, U.S. National Arboretum
11601 Old Pond Drive,
Glenn Dale, MD 20769

[2]USDA-ARS, U.S. National Arboretum
Beltsville Agriculture Research Center-West,
Beltsville, Maryland 20705

[3]USDA-ARS, U.S. National Arboretum
3501 New York Ave., N.E,
Washington, DC 20002

KEYWORDS

Tsuga chinensis, breeding, hemlock hybridization.

INTRODUCTION

Research on the nature of genetic resistance of hemlock to hemlock woolly adelgid (HWA), *Adelges tsugae* (Annand), at the U.S. National Arboretum focuses on three areas of investigation: 1) create, plant and evaluate hemlock hybrids and parent species for HWA resistance and landscape merit; 2) investigate the nature of the apparent crossability barrier between *T. canadensis* (L.) Carrière, and *T. chinensis*; and 3) Plant and evaluate wild-collected *T. chinensis* germplasm for landscape suitability and HWA resistance.

CREATE, PLANT, AND EVALUATE HEMLOCK HYBRIDS

In 2002, we reported on the extent of self compatability and hybridization from controlled pollination of several hemlock species (Bentz et al. 2002, Pooler et al. 2002). Authentic hybrids were identified from crosses between the *T. caroliniana* (Engelm.) and *T. chinensis* and between the Asiatic species, *T. chinensis*, *T. diversifolia* ((Maxim.) and *T. sieboldii* (Carrière). In 2002, the parents, their hybrids, and self-pollinated progeny were planted in a randomized block design at the USDA's South Farm, Beltsville, Maryland. Beginning in 2004, data collection began on important horticultural attributes of each tree including survival, growth rate, form, phenology, injury from cold, heat or pests, and evidence of natural adelgid infestation. When plants are of suitable size, HWA will be introduced into mesh bags attached to each tree, and data will be collected for such factors as adelgid survival, number of ovisacs produced, number of eggs per ovisac, number of crawlers, and feeding injury. The research will be in cooperation with Michael E. Montgomery, USDA Forest Service, Center for Forest Health Research, Hamden, Connecticut. Data will be analyzed for variation not only among trees of the same progeny group, but also among progeny groups.

INVESTIGATE THE NATURE OF THE CROSSABILITY BARRIER BETWEEN *T. CANADENSIS* AND *T. CHINENSIS*

No hybrids resulted from crosses made between the HWA susceptible *T. canadensis* and the HWA-tolerant *T. chinensis.* In order to determine whether the failure to achieve seed set was due to the lack of fertilization or from zygote/embryo abortion, a series of controlled pollinations was carried out in 2003. Crosses included self-pollinations, intra-species crosses, *T. chinensis* x *T. caroliniana,* and *T. canadensis* x *T. chinensis* cross. Parents were located at the U.S. National Arboretum, Washington, D.C., and Longwood Gardens, Kennett Square, Pennsylvania. Cones were collected at 0, 3, 6, 9, and 24 weeks post pollination from all crosses attempted as well as from normal, open-pollinated controls from the parent trees.

Six weeks post-pollination, donor pollen tubes of sufficient length for fertilization were observed. Even though pollen tubes were of sufficient length, fertilization may not have occurred. Nine weeks post pollination, immature ovules were observed for both viable and unviable crosses. Further ovule development only occurred in viable crosses. Because ovule development occurred in the unviable crosses, these observations suggest that fertilization may have occurred. Rarely does an ovule develop without fertilization. The data suggest that hybrid ovules are aborting due to zygotic failure and not due to lack of pollen germination and subsequent pollen tube growth.

PLANT AND EVALUATE WILD-COLLECTED *T. CHINENSIS* GERMPLASM

Twenty accessions of wild-collected *T. chinensis* varieties and relatives are being planted in a randomized block design in fall 2004-spring 2005 at the USDA's South Farm site. The germplasm collected includes accessions from two explorations to the Peoples Republic of China sponsored by the North American China Plant Exploration Committee (NACPEC) in 1996 and 1999 and accessions collected by Dr. Michael Montgomery. Germplasm planted represents regional and elevation variations which may affect the hardiness and/or suitability of *T. chinensis* in landscape or forestry applications.

ACKNOWLEDGEMENTS

Thomas Abell, U.S. National Arboretum, Glenn Dale, Maryland; Dr. Casey Sclar, Longwood Gardens, Kennett Square PA 19348; Dr. A. M. Townsend, U.S. National Arboretum, on his retirement and for his leadership and support of this project.

REFERENCES

Bentz, S.E. and L.G.H. Riedel, M.R. Pooler, A.M. Townsend. 2002. Hybridization and self-compatibility in controlled pollinations of eastern North American and Asian hemlock (*Tsuga*) species. *J. Arboriculture* 28:200-205.

Pooler, M.R. and L.G.H. Riedel, S.E. Bentz, A.M. Townsend, 2002. Molecular markers used to verify interspecific hybridization between hemlock (*Tsuga*) species. *J. Amer. Soc. Hort. Sci.* 127(4):623-627.

Identification of Predatory Insects and Spiders in *Sasajiscymnus tsugae* Rearing Boxes

LayLa Burgess

Clemson University

laylab@clemson.edu
864-656-5071

During 2004, Clemson University initiated mass rearing of the biological control agent *Sasajiscymnus tsugae* Sasaji and McClure (Coleoptera: Coccinellidae) for release against the hemlock woolly adelgid (HWA) *Adelges tsugae* Annand (Homoptera: Adelgidae). Several species of predatory insects and spiders were found on eastern hemlock (*Tsuga canadensis* (L.) Carriere) and Carolina hemlock (*Tsuga caroliniana* Englemann) branches infested with HWA in the rearing boxes that were brought in from the field. HWA poses a serious threat to the health and sustainability of the eastern hemlock forests. Native predatory insects and spiders may have an impact on HWA and can cause problems in the mass rearing of *S. tsugae*.

Samples of predatory insects and spiders were collected from rearing boxes and the breakdown of those boxes during the 2004 rearing season. Predatory insects were collected and identified to order, family, genus, and species depending on the taxa. Spiders were identified to order and family.

Predatory insects and spiders from mass rearing boxes of *Sasajiscymnus tsugae* fed with infested branches may or may not be predacious on HWA; however after examination under the microscope, punctures to the eggs of *S. tsugae* were found. Though the specific impact of these predatory insects and spiders have on HWA is uncertain, they can disrupt the life cycle of *S. tsugae* under laboratory conditions and most likely in nature.