POTENTIAL NORTHERN DISTRIBUTION OF ASIAN LONGHORNED BEETLE IN NORTH AMERICA

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ABSTRACT

The Asian longhorned beetle (ALB) (*Anoplophora glabripennis*) is endemic to the Oriental and eastern Paleartic regions. The insect was recently introduced into North America and now infests the urban forests of Long Island, Chicago, New Jersey, and Toronto. Most North American insects from this family (Cerambycidae) normally infest dead and dying material and usually are considered beneficial because they hasten the breakdown of dead trees by opening up the wood to wood rotting fungi. However, members of the Lamiinae subfamily, genus *Anoplophora*, also infest healthy hardwood trees. In its native environment, this insect feeds on more than 24 species of living hardwoods (Yang et al. 1995). In China, its preferred tree species are *Salix* and *Populus* (Li and Wu 1993) whereas in North America *Acer* species are most commonly attacked (Haack et al. 1997, 2006).

Objective

The supercooling point of insects has been used to predict the potential northern distribution of insects susceptible to freezing (Sullivan and Wallace 1972, Roden 1981). So far, the supercooling point has provided a reasonably accurate prediction of the northern distribution of the gypsy moth (*Lymantria dispar*) and the smaller European elm bark beetle (*Scolytus multistriatus*) in North America. While there is no guarantee this is an accurate assumption for all insects because of insect physiological and behavioral adaptations that may differ between species, the determination of an insect's supercooling point provides a useful tool for resource managers unless that species is freeze-tolerant.

The objective of this study was to determine the supercooling temperature of ALB larvae and how this temperature compares to the range and overwintering supercooling point of larvae from a native cerambycid from the same subfamily, the whitespotted sawyer beetle (WSB) (*Monochamus scutellatus)*.

Material and Methods

The ALB larvae used in this experiment were obtained from infested Norway maple (*Acer plantanoides*) collected from Massapequa, NY (40.68N. 73.46W.) on February 27, 2002. Larvae of the WSB were obtained from white spruce (*Picea glauca*), collected near Wharncliffe, ON (46.25N. 83.22W.) on October 18, 2001. The WSB collection material was stored outside at the Great Lakes Forestry Centre in Sault Ste. Marie until the ALB material from Massapequa arrived. Wood containing the two species was moved indoors on March 4, 2002, where it was held at –2 ˚C for 4 weeks before larvae were randomly removed for testing.

Results and Discussion

The mean supercooling points (^{o}C ± S.E.) for ALB and WSB larvae were 25.8 ± 1.1 ^{o}C (n=17) and –35.6 ± 1.9

°C (n=20), respectively. The mean weights (g ± S.E.) for larvae of ALB and WSB removed from the wood were 1.52 ± 0.29g and 0.12 ± .03g, respectively. There was no correlation between larval weight and freezing point for either species as has been suggested by other studies (Johnston and Lee 1990). The correlation coefficients for ALB and WSB were 0.16 and 0.23, respectively. Two female ALB larvae survived freezing and successfully completed development on artificial diet. One of these copulated successfully with an untreated male and laid several eggs.

Eighteen of the WSB larvae survived freezing; most of these actively tunneled in artificial diet for several weeks. However, only one successfully completed development but did not live long enough to mate.

Because two ALB larvae survived freezing and completed development, further studies were initiated to investigate the possibility that ALB may be freeze tolerant. In subsequent studies, larvae were held for 24 hours at -25, -30, -35, and -40 °C. It was anticipated that larvae held at temperatures lower than their supercooling point (-25.8 °C) would either die or emerge from eclosion badly deformed. However, a high percentage of the larvae from each of the different treatments survived freezing; the percentages were: 92, 97, 95, and 95 percent, respectively. The percentages of adults that completed development and mated to produce an F_1 generation successfully in each of these treatments were 33, 46, 27, and 24 percent, respectively.

These results suggest ALB is freeze tolerant. This assumption also is supported by the shape of the freezing curves from our studies, which were classic for freeze-tolerant species (Humble and Ring 1985). In other words, the northern distribution of ALB will not be limited by cold temperature but by host availability. Consequently, ALB may be able to infest its preferred Asian hosts wherever they are present in North America. Survival for the WSB at temperatures below the supercooling point was less than 5 percent—too low to test for an F_1 generation. However, the WSB supercooling point of -35.6 °C was very similar to its northern North American range (Linsley and Chemsak 1985), the distribution of its hosts, and the -35 °C North American isotherm.

Additional Research

Because ALB larval survival is also time dependent, further tests of survival at 2 and 4 weeks at these temperatures are required before it can be ascertained whether these larvae can withstand freezing for longer periods. A 90-plus percent survival rate for 24 hours below the species' supercooling point certainly suggests they can withstand exposure to lethal cold temperatures for short periods. Normally researchers could scan collection records for an indication of an insect's presence and successful development. However, Chinese collection records are often incomplete and difficult to obtain.

Current preliminary studies at the Turkey Lakes Watershed (47.02 N. 84.23 W.) near Sault Ste. Marie, ON, suggest the range and survival of ALB also will be affected by tree diameter. These studies suggest external air temperature may be buffered by as much as 10 °C in large diameter sugar maple. Another year of winter weather data is required to complete this aspect of the study.

Literature Cited

Haack, R.A.; Law, K.R.; Mastro, V.C.; Ossenbruggen, V.C.; Raimo, H.S. 1997. **New York's battle with the Asian long-horned beetle**. Journal of Forestry. 95(12): 11-15.

Haack, R.A.; Bauer, L.S.; Gao, R.-T.; McCarthy, J.J.; Miller, D.L.; Petrice, T.R.; Poland, T.M. 2006 ***Anoplophora glabripennis*** **within-tree distribution, seasonal development, and host suitability in China and Chicago**. Great Lakes Entomologist. 39: 169-183.

Humble, L.M.; Ring, R.A.1985. **Inoculative freezing of a larval parasitoid within its host.** Cryo-letters. 6. 59-66.

Johnston, S.L.; Lee, R.E. 1990. **Regulation of supercooling and nucleation in a freeze tolerant beetle (*Tenebrio molitor*).** Cryobiology. 27: 562-568.

Li, F.; Wu, T. 1993. **Species distribution and host plants of the longhorned beetles injuring poplars.** In: Integrated pest management of poplar longicorn beetles. Beijing, China: Chinese Forestry Publishing House.

Linsley, E.G.; Chemsak, J.A. 1985. **The Cerambycidae of North America.** Part III, No. 1: taxonomy and classification of the subfamily Lamiinae, tribes Parmenini through Acanthoderini, Volume 102. Berkeley, CA: University of California Press.

Roden, D.B. 1981. **The potential for selection for freezing-tolerance in an Ontario population of *Scolytus multistriatus* (Coleoptera: Scolytidae** Canadian Forestry Research Notes. 1(3): 17-18.

Sullivan, C.R.; Wallace, D.R. 1972. **The potential northern dispersal of the gypsy moth, *Porthetria dispar* (Lepidoptera: Lymantriidae).** The Canadian Entomologist. 104: 1349-1355.

Yang, X.J.; Zhou, J.; Wang, F.; Cui, M. 1995. **A study on the feeding habits of the larvae of two species of longicorn (Anoplophora to different tree species.** Journal of Northwestern Forestry Coll. 10: 1-6.