ALTERNATE METHODS FOR MANAGING ALB POPULATIONS

D.R. Lance[1], J. Francese[1], B. Wang[1], Z. Xu[2], R. Mack[1], V. Mastro[1], and Y. Luo[2]

[1]USDA-APHIS-PPQ-PSDEL, Bldg. 1398, Otis ANGB, MA 02542

[2]College of Natural Resources and Environmental Sciences, Beijing Forestry University, Beijing, PRC

Abstract

Breeding populations of Asian longhorned beetles (ALB), *Anoplophora glabripennis* (Motschulsky), were first discovered in the U.S. in 1996 in Brooklyn, NY. Initially, survey consisted of ground-based visual examination of trees for beetles and their damage, and the only proven control method was the total destruction of infested trees. As part of an overall research effort on the insect, studies on behavior and ecology of adult beetles were initiated in hopes of finding traits that could be exploited to develop improved management methods such as attractant-baited traps, tactics that targeted insecticide applications to the pest (e.g., "attract-and-kill"), trap-tree systems, biologically-based control agents, or improved strategies for employing available methods. Here, we review a group of studies on localized and host-selections behaviors of ALB adults, focusing primarily on work done by USDA-APHIS personnel from the CPHST facility at Otis ANGB, MA. Because ALB populations in the U.S. are typically very sparse and under active eradication, most field work described here was conducted in Ningxia, PRC, in cooperation with researchers at Beijing Forestry University (BFU). Studies that have been conducted in several related areas (e.g., host plant range, longer-range dispersal, sonic detection of insects, evaluation of fungal pathogens) are beyond the scope of this presentation.

In 1999 and 2001, B. Wang and D. Lance ran observational studies to describe patterns of daily activity and localized movement of adult ALB. The 1999, we primarily conducted repeated observations on marked, field-collected beetles that were released into a shelterbelt of poplar hybrids. In 2001, ALB were observed *in situ*, 4 X daily for 3 weeks, in a shelterbelt of poplar and willow. During these studies, we observed quantifiable (significant) trends in daily activity patterns, but we found at least some beetles engaged in all activities and on all portions of trees at all times of day. One exception was the tendency of beetles to remain in shaded areas during hot, sunny periods. Repeated observations of marked beetles on the same tree were common, suggesting limited appetitive movement by these insects. At the same time, though, 10% to 36% of beetles, depending on time and sex, were walking when observed. Observations of flight were rare (unless unduly disturbed, no beetles flew or took flight while being observed), although beetles in general appeared to take flight fairly readily when deprived of requisites such as food, moisture, or shade. Typically, over 50% of beetles were observed on stems larger than those upon which they would normally feed (i.e., > ~7 mm diameter).

Mechanisms of host location and host-plant selection were the subject of several types of studies. In 2000, B. Wang and D. Lance initiated a series of flight-orientation tests in which beetles were released at the center of 7.5-m-diameter ring of eight potted poplar trees. Beetles that left the release point landed on the trees much more often that would have been predicted by chance (based on the proportion of the circle subtended by the trees) and tended to approach the downwind sides of trees (i.e., flying upwind). In addition, when alternating trees were replaced with artificial trees, ALB oriented much more readily to the real trees than to the artificial ones. All of this suggested possible involvement of volatile semiochemicals in orientation of beetles to trees, but results of subsequent trials with cloth-covered real and artificial trees indicated that this orientation was based primarily on visual cues. B. Wang has followed this work with more extensive evaluations of how size, shape, and color affect orientation of ALB to objects. In addition, J. Francese, using a similar technique, was not able to demonstrate that ALB orient preferentially to highly preferred hosts (e.g., *Acer platanoides* of *A. mono*) over more marginal but suitable hosts (e.g., *Populus nigra*) or even comparably-sized artificial trees.

Since 2001, J. Francese has headed a series of complementary studies to determine the possible role of tenure on host plants as a determinant of ALB host utilization patterns. Field-collected beetles were released onto potted hosts of different species, or onto potted artificial trees, and numbers of beetles remaining were counted and specified intervals thereafter. Perhaps surprisingly, there was relatively little difference in beetles remaining on trees over time among *Populus nigra* (considered a good host in Ningxia), *P. alba* (marginal host), and an artificial tree, with low numbers (~10-25%) remaining on trees as little as 8 h after release. Significantly greater proportions of beetles (~50% on average) remained on *Acer* throughout the 8-h period, regardless of whether the trees were hosts that the insect utilizes in N. America or *A. mono*, a species native to Asia. Host selection in this insect appears to occur in large part by visual orientation to a tree followed by the decision to either remain on that tree or move to another.

The role of semiochemicals in the ecology of ALB remains, for the most part, poorly defined, despite ongoing research in this area since the insect's discovery in the U.S. This work has been conducted primarily by scientists at SUNY-ESF in Syracuse, NY, USDA-ARS in Beltsville, MD (and more recently Newark, DE), Beijing Forestry University, and, more peripherally, the APHIS lab at Otis. GC-EAD studies have been run by several of these groups and resulted in the identification of numerous antennally active compounds both from the beetles and from their host plants. Unfortunately, results of laboratory and field bioassays of these materials have yet to demonstrate the existence of a volatile attractant that is sufficiently effective for program use, but components of a contact pheromone for mate recognition have been identified (see Zhang et al., *Naturwissenschaften* 90: 410 [2003]) and more recently tested host-plant blends continue to show some promise in tests being run by USDA-ARS scientists.

Although we still lack an effective method to attract beetles to traps, tests since 2002 have worked toward developing a trap that exploits the beetles' relatively frequent walking on larger stems. Commercially available traps such as the IPM Tech Intercept Panel trap (used as a standard) and Great Lakes IPM plum curculio trap (modified for the larger ALB) have been tested, along several experimental traps designed by Otis or BFU personnel. Of traps tested to date, the Great Lakes IPM trap appears most useful, as it is commercially available, relatively simple to use, and at least comparable to others in trapping power (captures several-fold more than the IPM Tech trap, for example). In 2004 mark-recapture studies, though, we found that the Great Lakes IPM trap captured only ~10% of beetles that were placed on the same tree as the trap, and that the proportion dropped to ~2% for trees as little as 4 m from the trap. Of the 600 beetles in this study, two were captured on trees that were 100 to 150 m from their release sites.

We also attempted to exploit beetle movement on trunks of trees for control by applying insecticides to limited portions of trees (specifically, bands around larger stems). We initially chose test compounds based on results of previous insecticide trials of B. Wang and co-workers. In some cases, burlap was soaked in label-rate aqueous mixtures of commercially available formulations (e.g., "Tempo"; a.i. = cyfluthrin), allowed to air-dry, and stapled (30-cm bands) around trees. In other cases, cooperators provided experimental formulations (e.g., IPM Tech, Hercon Environmental, Isca Tech). In general, effective a.i.'s (cyfluthrin, lambda-cyhalothrin, and, to a lesser extent, permethrin), produced significantly greater numbers of dead beetles around treated versus untreated trees. Unfortunately, we have not been able to show that this translates into significantly fewer live beetles on the trees, even in 2004 testing where larger plots (e.g., 20 trees long in a shelter belt) were used in an attempt to reduce effects of beetle movement on populations in individual trees. Bioassays (2004) of treated burlap (using the surrogate species *Plectrodera scalator*) indicated that the required exposure time for cyfluthrin (the compound we have evaluated most intensively in these tests) may be longer than desirable for effective control. Exposure to cyfluthrin-treated burlap for 5 min produced mortality that was roughly comparable to a 1-min exposure to lambda-cyhalothrin, so a switching to this "hotter" insecticide may prove helpful (tests need to be repeated with *A. glabripennis*).

Finally, R. Mack and co-workers demonstrated trapping and insecticide-banding methods in Brooklyn, NY and Carteret, NJ in 2004. No beetles were recorded as trapped or killed at the two Brooklyn sites, but this was not unexpected as one of the sites (Evergreens Cemetery) had no known infestation, and materials at the other (a courtyard behind row-houses on Grand Avenue) were in place for only a week, relatively late in the season, before the trees were removed. By contrast, in Carteret, NJ, nine dead beetles were found in conjunction with insecticide-banded trees (either Demand [lambda-cyhalothrin] on burlap or cypermethrin in "Splat", an Isca Tech product; 5 trees treated with each). One of the nine was found in a hanging device designed to trap falling beetles; the others were found on the ground. Also, five beetles were captured in modified Great Lakes IPM traps that were installed above fungus-treated bands on 10 trees. Four of those were send to A. Hayek (Cornell Univ.), but she was unable to confirm the presence of fungal infections in those insects.

In conclusion, attempts to develop alternative management tactics based on behavior of adult ALB have not, to date, produced any "magic bullets" for the eradication programs. However, trapping methods and, especially following optimization, insecticide-banding methods may prove useful for specific management goals.

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