INFESTATION DYNAMICS OF THE ASIAN LONGHORNED BEETLE IN THE UNITED STATES

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ABSTRACT

The Asian longhorned beetle (ALB), *Anoplophora glabripennis* (Coleoptera: Cerambycidae), is an exotic pest of Asian origin, first discovered in North America (Brooklyn, NY) in 1996. That infestation has now spread to Queens, Manhattan and Long Island, NY and Jersey City, NJ. Based on DNA profiles (Carter et al. 2005) and other evidence, independent introductions have occurred in the Chicago area (discovered in 1998), Toronto, Ontario (2003) and Carteret, NJ (2004). The introductions at each site have displayed similar characteristics: a colonization event occurring near an importer of goods from Asia, several years of undetected increase and localized spread, the appearance of satellite infestations at distances ranging from a few hundred meters to 40 km from the point of establishment, and a spatial distribution that is patchy (clumped or aggregated) and self-similar on all spatial scales.

With regard to the ALB, I define "infestation dynamics" to be a sequence of events and component elements comprising (1) introduction from a point of origin in Asia; (2) distribution via shipping to a point of entry in NA; (3) redistribution by air, road, rail or ship from the point of entry to a colonization locale; (4) escape into the environment and initial colonization of one or more host trees; (5) establishment (successful production of a second generation) at the colonization site; (6) within-tree dynamics (increase and spread over time); (7) local dynamics involving natural dispersal to neighboring trees, often of several species; (8) medium-scale dispersal (up to a few km) by flight or with human assistance (in or on vehicles); and (9) large-scale distribution with human assistance (on the order of many km). Infestation dynamics is concerned with population increase or decrease at specific locations, dispersal of individuals, and the changing spatial distribution of the population, resulting in what could be viewed as "behavior" of the infestation, as a whole, in space and time. An infestation exhibits a sequence of characteristics that can be observed, studied, measured and modeled in pursuit of understanding, prediction of future events, and the development of management techniques and strategies.

This paper focuses on within-tree, local and medium-scale dynamics, drawing on data from the U.S. infestations. Techniques have been developed to age egg sites, tunnels and exit holes by examining the tree's growth response to injury. The within-tree dynamics of the ALB has been studied in detail at the Jersey City and Carteret infestations. In Jersey City the locations of all egg sites and the locations and ages of all exit holes were recorded on 102 infested trees. Here the damage was concentrated in the middle and upper portions of infested trees, primarily on or near the bole and major limbs. In contrast, nearly half the damage to 67 infested trees examined in Carteret was found in the lower third of the trees. One red maple in Carteret having over 800 exit holes was dissected carefully, with the locations and ages of all injury sites recorded in each 30 cm section of the entire tree. These data, not yet fully analyzed, will produce a detailed history of population increase and spread within a single

tree. The oldest damage on another red maple in Carteret, one having 215 exit holes (66% in the lower third of the tree), dates back to 1998 (> 6 years). Dating all of the exit holes in the lower third (2.4 m) of this tree, it was found that the number of beetles emerging each year were: 1999 (1); 2000 (6); 2001 (14); 2002 (29); 2003 (52); and 2004 (40). The tree, still living but in very bad condition, was removed in December 2004. These data show that the number of beetles emerging approximately doubled each year from 2000 to 2003, but then fell 23 percent in 2004. It appears that following years of exponential increase of the population in the tree, the declining quality or quantity of the resource caused an increase in mortality or emigration from the tree, or both, in 2004. Applying a 2X annual rate of increase to the observed numbers of exit holes in 54 maple trees from Carteret (bearing 1,979 exit holes in all), the numerical and spatial development of the infestation can be inferred. Of the trees examined, the number becoming infested each year and their mean distance from the apparent point of introduction are estimated to have been: 1996: (1 tree, 0 m); 1997: (no trees infested); 1998: (3 trees, 99 m); 1999: (2 trees, 46 m); 2000: (1 tree, 124 m); 2001 (5 trees, 123 m); 2002 (2 trees, 172 m); 2003 (14 trees, 572 m); 2004 (26 trees, 674 m). The exact ages of all of these exit holes must still be determined. The scenario that appears is one of localized population increase and only slow spread for several years, followed by a sudden increase in the number of trees infested and their distance from the presumed point of first colonization. The data from the Jersey City infestation presents a very similar picture. Data being accumulated from several localized infestations in New York will be analyzed in a similar way. These dispersal distances agree very well with data collected from nearly 1300 infested trees in Chicago, which indicate that the median distance from trees bearing only eggs sites to the nearest tree bearing an older exit hole was less than 20 m, while the 95th and 99th percentiles of the spatial distribution were approximately 125 m and 400 m, respectively.

These results suggest that in areas with abundant host trees, at least, ALB infestations do not spread rapidly. Rather, the population appears to multiply steadily in a limited number of trees for a number of years, then expands suddenly as the condition of the earliest-infested trees deteriorates. If true, this behavior of ALB infestations presents challenges for detecting new introductions, but offers an opportunity to confine and control infestations while they still cover a relatively small area, if detected early. The results gathered to date lend insight into the within-tree distribution of damage and the response of host trees to injury that will help refine survey techniques and permit estimation of probabilities of detection and the date of first infestation. This research has also produced other data on local and medium-scale dynamics that have already helped to define survey, treatment and regulatory strategies.