DISPERSAL POTENTIAL OF *ANOPLOPHORA GLABRIPENNIS* MOTSCH.

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INTRODUCTION

The Asian longhorned beetle (ALB) (*Anoplophora glabripennis* Motsch.) is native to China and Korea. As a recent invader, ALB is a candidate for eradication because infestations are currently thought to be limited in size and scope. The aim of eradication is the elimination of all reproductively viable ALB from North America. Intensive survey for infested trees, followed by felling, removal, and chipping, is currently the only available method of population suppression. Effective surveys require establishment of boundaries around infestations (referred to as eradication survey and delimitation survey boundaries), inside of which surveys are conducted. Current guidelines for the eradication surveys, as per USDA Animal Plant Health Inspection Service (APHIS), are 1/2 mile from the closest known infested tree. These guidelines are based upon rate of detection of infested trees. However, delineation of boundaries should be based upon the dispersal potential of ALB, likely the most important factor for invasion by exotic species (Higgins et al. 1996). Therefore, the objective of these studies was to determine the dispersal potential of adult ALB, thereby providing a basis for the delineation of the quarantine boundaries and the concentration of survey and detection efforts. In turn, this should lower the detection threshold for incipient populations, vastly improve the operational cost:benefit ratio of APHIS's eradication program, and greatly enhance the potential for successful eradication.

Because the release of ALB is justifiably prohibited in North America, mass mark recapture (MMR) field experiments were conducted in Gansu Province, China, in order to estimate ALB dispersal characteristics. In the event that ALB becomes uncontainable in the U.S., this research, when coupled with other current investigations (i.e., colonization behavior, host preference, natural enemies), will provide estimates of ALB dispersal parameters that are applicable in other landscapes at risk (i.e., urban and forests) in North America. In so doing, therefore, this proactive approach will form the basis for development of adaptive management strategies for this and other invasive species.

MATERIALS AND METHODS

These studies were conducted 1 km west of the town of Liu Hua, bordering the Yellow River in Gansu Province, north central China. This field site was selected because it possessed landscape characteristics similar to those of the urban infestations in the U.S., particularly site-specific factors that are thought to most likely influence dispersal distance. The general landscape is composed of both host (72.3%) and non-host (27.7%) tree species of mixed age classes. Known ALB hosts are dominated by *Populus nigra* L. var. *thevestina* (Dode) Bean, comprising ca. 87% of the ALB hosts, followed by *Salix* sp. and *Ulmus* sp., at 9% and 4%, respectively. The study site was composed of isolated trees and trees planted along paths amid dwellings, such as homes and greenhouses, as well as trees planted as wind-rows (generally 2 m spacing within rows and 50 m spacing among rows) bordering agricultural fields. Greenhouses and small dwellings were also commonly found within or adjoining agricultural fields.

ALB used in these studies were marked and released from the center of the study areas. Of these ALB, those that had emerged from logs were released daily, while those that were collected outside the study areas were released weekly. Transects radiated from the center release site in 8 directions: north, northeast, east, southeast, south, southwest, west and northwest. Recapture locations lay along each transect at 50-, 100-, 150-, 200-, 250-, 300-, 400-, 500-, and 600-m intervals in the 1999 study, and at 100-m intervals from 100-1,000m in the 2000 study. However, landscape heterogeneity (presence of obstacles) sometimes required that recapture positions be modified accordingly. Each recapture location was composed of a fixed group of poplar trees (average of 12 trees per location). Trees at each recapture location were sampled weekly for adult *A. glabripennis* by shaking. This passive recapture method was preferred since it did not influence the dispersal behavior of ALB (as is common where pheromone traps are used to recapture insects in MMR studies). In addition to recapturing beetles along the transects mentioned above, beetles were also sampled weekly at random positions beyond the 600-m and 1,000-m radius in the 1999 and 2000 studies, respectively. Each marked ALB recaptured was preserved, and the location, release date, and body length and width recorded. In addition, marked female ALB were dissected and the number of mature eggs recorded. Unmarked adult ALB collected were recorded and released.

RESULTS AND DISCUSSION

Distances at which marked beetles were recaptured during 1999 and 2000 are shown in Figures 1 and 2, respectively. In 1999, the average distance that ALB dispersed was 266 m, while the maximum distance was 1,450 m. Analysis showed that the 98% recapture radius was 560 m (n=188 recaptured beetles). In 2000, the average distance that ALB dispersed was 498.02 m, while the maximum distance was 2,664 m (n=401 recaptured beetles). Among these recaptured ALB, 20 (10.6% of the recaptured ALB in 1999) and 76 (19.0% of the recaptured ALB in 2000) were recaptured beyond 600 m and 1,000 m in 1999 and 2000, respectively.

Distances at which marked female ALB dispersed with eggs during 1999 and 2000 are shown in Figures 3 and 4, respectively. Surprisingly, there was no significant correlation in eggs remaining in females as distance increased. One explanation is that ALB emerge from trees with their full complement of eggs, disperse, settle, and then begin to oviposit. However, female ALB held no more than 25 eggs at recapture, but are capable of producing as many as 80 eggs (Gao, per. comm.; Smith, unpublished data). Therefore, this may indicate that female ALB develop eggs continuously or in batches. Thus, mated females may disperse great distances (1,442 m and 2,664 m in 1999 and 2000, respectively) and then deposit eggs. We suspect that the distribution in Figure 4 shows evidence for serial oogenesis.

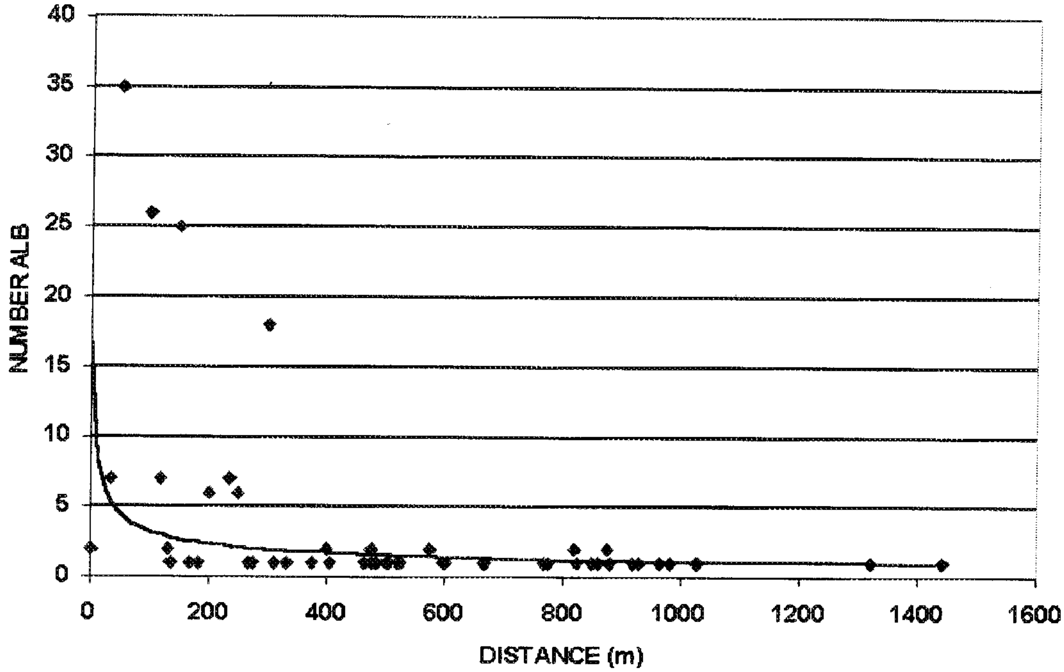

Figure 1. Dispersal distance of adult ALB (1999).

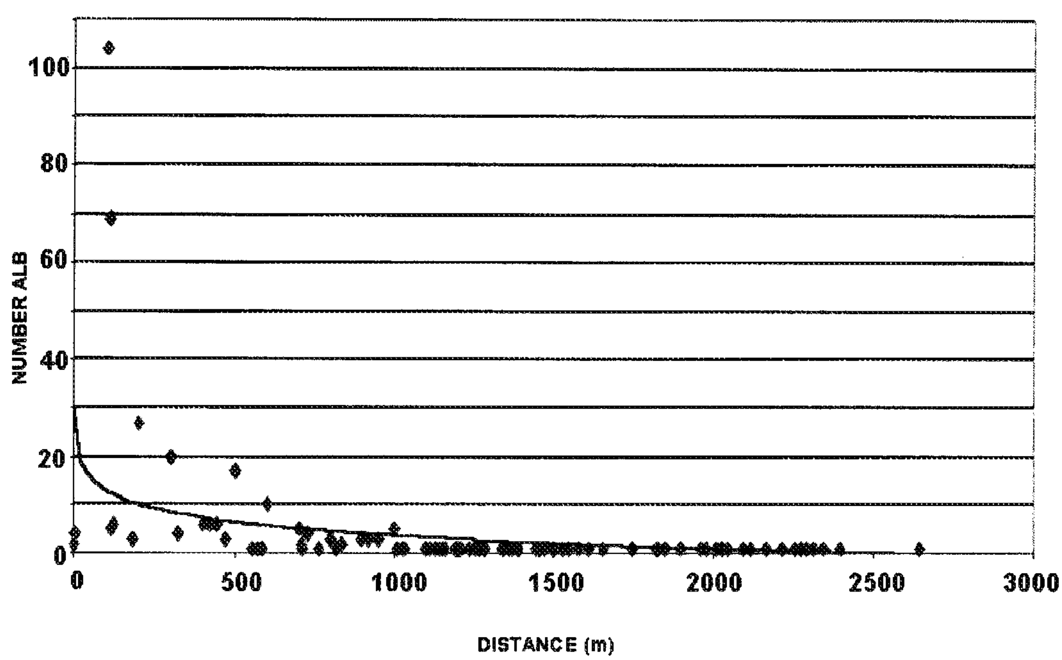

Figure 2. Dispersal distance of adult ALB (2000).

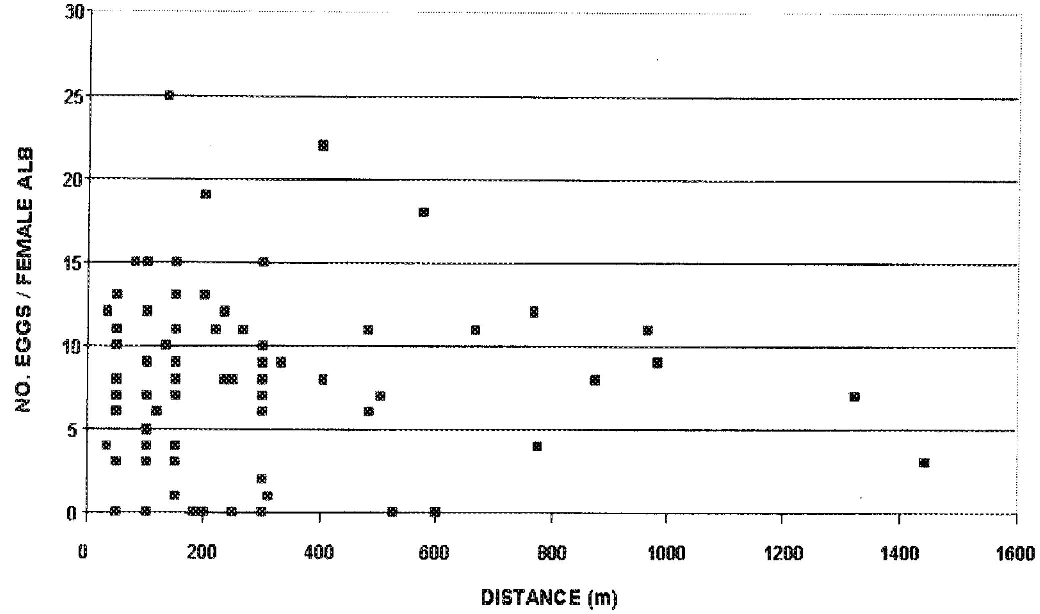

Figure 3. Distance ALB disperse eggs (1999).

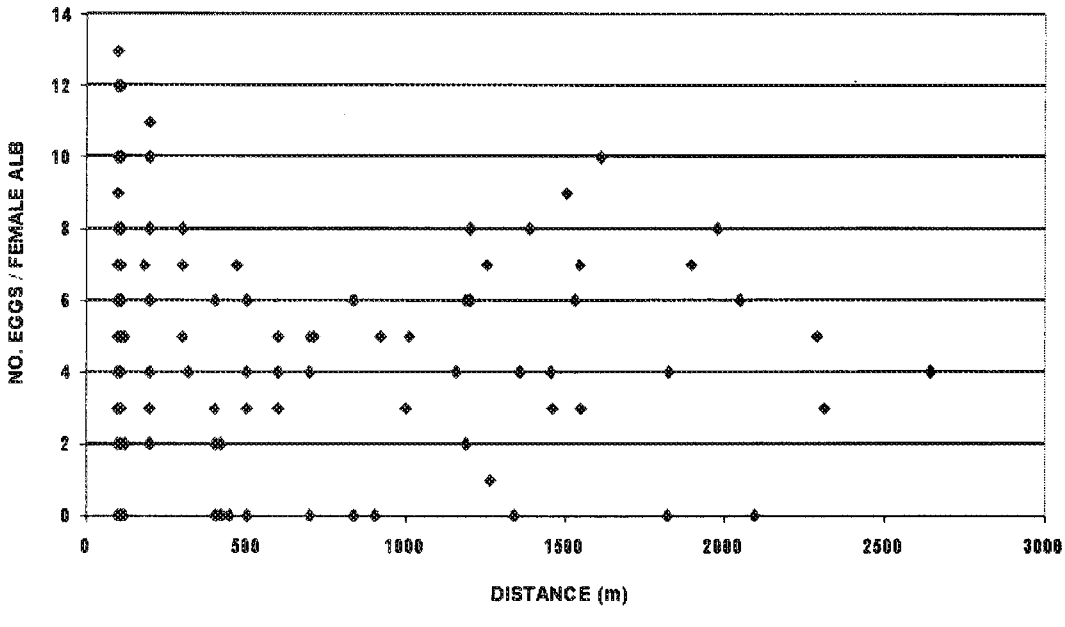

Figure 4. Distance ALB disperse eggs (2000).

Previous studies have generally reported lower ALB dispersal distances than were found in the study reported here. These differences may be based upon a variety of factors. First, recapture sampling at high frequency over an extensive area may trap out dispersing individuals (Turchin 1997). This may have contributed, in part, to the lower average dispersal distance of 106 m reported from the mark recapture study by Wen et al. (1998), in which they recaptured ALB daily or every other day. Weekly recapture sampling was used in the study reported here. Secondly, recapture sampling duration, both in terms of the entire life-span of an insect, as well as across an entire season, provides a more accurate measure of population dispersal. Wen et al. (1998) used unknown-aged ALB and extrapolated dispersal distance from the first 28 days of recapture. As many insects are known to decrease movement behavior with age, this may account, in part, for their shorter dispersal distance. Both life-time (use of newly emerged ALB) and season-long (recaptured for ca. 100 d) ALB dispersal potential were ascertained in the study reported here. Finally, landscape heterogeneity, especially variation in size and arrangement of tree species, is likely to have strong effects on ALB dispersal. This, too, may account (at least in part) for the lower ALB dispersal distance (generally within 200 m, but not more than 300 m) reported by Huang (1991), where they conducted their experiment in a homogeneous young poplar plantation (3- by 5-m tree spacing). ALB dispersal distance may tend to be relatively low in plantations where preferred host trees are proximal, but greater where preferred host trees are more widely spaced. Our field site (described above) contained heterogeneity in key features that are likely to be important to ALB dispersal. Our future studies will strengthen the understanding of host tree interaction and dispersal in response to landscape elements.

The most important implication for eradication of ALB is that the maximum dispersal distance recorded was 2,664 m (1.5 miles) by a female ALB carrying mature eggs. It must be assumed that ALB can disperse at least 2,664 m in the U.S.. Therefore, surveying or treatment of trees should extend to this distance so that incipient colonies do not prevent eradication. Current APHIS detection and survey guidelines are as follows: (1) each year, all host trees within 0.5 miles from an infested tree are inspected; (2) each year, 50% of all host trees that are between 0.5 miles to 1.5 miles from an infested host tree are inspected; and (3) over a 3-year period, 18 host trees/square mile (two host trees at each of nine inspection points, within each 1- by 1-mile grid) that are between 1.5 miles and 25 miles from each infested host tree are inspected.

The data reported here show that 89.4% and 81.0% of ALB dispersed less than 600 m (0.37 miles) and 1,000 m (0.62 miles) in 1999 and 2000, respectively, suggesting that most beetles occur close to previously infested trees. On the other hand, the data also show that 10.6% and 19.0% of ALB dispersed beyond 600 m (0.37 miles) and 1,000 m (0.62 miles), and that 0.53% and 0.25% of ALB dispersed 1,450 m (0.9 miles) and 2,664 m (1.6 miles) in 1999 and 2000, respectively. Collectively, these beetles represent long dispersers that may initiate new infestations. For eradication to be successful, ALB near previous infestations must obviously be killed. However, one must also detect and kill rare, newly founded infestations resulting from the long dispersers as well. Therefore, one of the greatest challenges facing eradication will be to effectively partition finite resources between efforts to kill all beetles in local infestations and efforts to detect and kill the more rare, distant infestations that represent foci for potential future breeding populations. Spatially explicit models being developed here at

BIIR, using data from a number of complementary studies, will provide a detailed understanding and prediction of ALB spread within landscapes at risk in the U.S..

LITERATURE CITED

Higgins, S.I.; Richardson, D.M.; Cowling, R.M. 1996. **Modeling invasive plant spread: the role of plant-environment interactions and model structure**. Ecol. 77: 2043-2054.

Huang, J. 1991. **Current status and problems in the control of poplar wood-boring insect pests**. J. For. Dis. Ins. Pests. 1: 52-56.

Turchin, P. 1997. **Quantitative analysis of movement: measuring and modeling population redistribution in animals and plants**. New York, NY: Sinauer Associates.

Wen, J.; Li, Y.; Xia, N.; Luo, Y. 1998. **Study on dispersal pattern of *Anoplophora glabripennis* adults in poplars**. ACTA Ecol. Sin. 18: 269- 277.