COMPARISON OF THE REPRODUCTIVE POTENTIAL OF *ANOPLOPHORA GLABRIPENNIS* (MOTSCH.) AMONG HOST TREE SPECIES

Michael T. Smith, Jay S. Bancroft and Joseph Tropp

USDA Agricultural Research Service, Beneficial Insects Introduction Research Lab
501 S. Chapel Street, Newark, DE 19713

Introduction

Potential spread of the Asian longhorned beetle *(Anoplophora glabripennis* Motschulsky) (Coleoptera: Cerambycidae: Lamiinae: Lamiini) (ALB) in the United States is dependent upon its rates of reproduction and dispersal, particularly among host tree species that it encounters within suitable climatic regions. Therefore, the goal of this study was to measure the reproductive potential of ALB on three host tree species. More specifically, investigations of the age-specific fecundity and survivorship, and the intrinsic rate of increase of ALB were undertaken.

This study of the individual performance of adult female ALB, which is under optimal conditions of the abiotic and biotic environment, represents the first of the three basic steps in the research approach in nutritional ecology outlined by Price (1997). The species of host-tree colonized obviously plays an important role in the reproductive success and population dynamics of ALB. Therefore, from among the tree species thus far reported attacked by ALB in the U.S., Norway maple (*Acer platanoides* L.), red maple (*Acer rubrum* L.) and black willow (*Salix nigra* Marsh.) were used. Norway maple is widely planted as an ornamental in urban landscapes, while red maple is prevalent among maple species in many northeastern U.S. forests. Willow is planted as an ornamental and is among the three most commonly attacked tree genera in China.

Materials and Methods

ALB-Infested Logs. ALB-infested logs were obtained from Chicago, Illinois, February 1999, and transported to the USDA-ARS BIIR quarantine facility (Newark, Delaware). Both ends of the logs were sealed with melted paraffin wax and then placed into 189.2 l metal trash-cans. Cans were vented and held under quarantine conditions at 22°-25°C, 50-60% RH and a photoperiod of 16:8 (L:D) h. Newly emerged ALB were collected daily.

Experimental Cages and Oviposition Logs. Experimental cages were 24 cm wide, 45 cm deep and 41 cm high with a removable plexiglass front door. Cage sides and top were screened with saran. Cages, open on the bottom, were placed atop metal trays (35 cm x 50 cm and 2 cm high) filled with fine, sterilized sand. Sand was kept moist daily and cages were held at 22°-25°C, 50-60% RH and a photoperiod of 16:8 (L:D) h.

Logs of *A. platanoides, A. rubrum* and *S. nigra* were cut from live healthy trees and returned to BIIR. Tops of logs were sealed with paraffin wax and then assigned at random (unsealed end down into the moist sterilized sand) to experimental cages. Freshly cut twigs and foliage bouquets in distilled water-filled flasks of each tree species were also placed into their respective cages in order to provide food for adult ALB, and were changed daily or as needed.

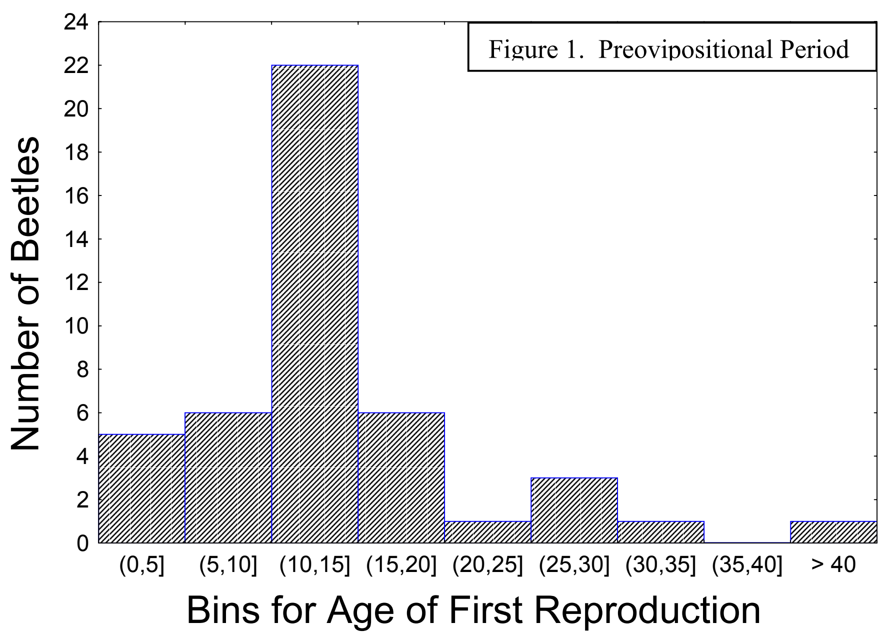
Newly emerged ALB (0-24 h old), obtained from the ALB-infested logs, were randomly assigned to cages (one pair per cage), and a total of 15 pairs evaluated for each tree species. Because female ALB are normally longer lived than males, replacement males (1-3d old) were provided so as to maintain mate availability.

Protocol. Scars made by adult *A. glabripennis* on the surface of oviposition logs were differentially marked and recorded daily. Oviposition logs were replaced every 7 d with freshly cut logs until death of the adult female beetle. Once replaced, the removed oviposition logs were held (with their base in moist sand and under identical environmental conditions) for 21-28 d after which each scar was dissected and categorized as nicks, aborted oviposition sites (interface of inner bark and phloem with a roughly circular area which is discolored or stained, and slightly sunken or depressed), nonviable eggs (unhatched) and viable eggs (presence of larvae and/or frass). Upon death, female body width and length were measured, and body size was calculated as a cylinder ($\pi r^2 L$). Length and circumference of each oviposition log was also measured in order to calculate log surface area.

The data were used to test whether reproduction or mortality varied among ALB provided the three tree species. Analysis of variance (ANOVA) was used to test for an effect of tree species. Means of oviposition sites produced by ALB on each of the three tree species were then used to normalize the data and compared using Tukey's HSD test. A general linearized model was used to test for effects of log area, beetle size and beetle age on female oviposition site production. A Kaplan-Meier analysis was performed to test for effects of tree species on survival. Finally, a life table was calculated with age-specific survival (l_x) and age-specific egg viability (m_x) of females. Because rearing techniques have not been fully developed for this univoltine species, number of viable eggs were used as a proxy for reproductive success. The net reproductive rate (R_o) and the intrinsic rate of increase (r) were estimated for ALB on each of the three host-tree species.

Results

Data analysis of the daily fecundity of *A. glabripennis* showed that *A. glabripennis* performs differently among three host tree species. Preovipositional period (Fig. 1) averaged



10.6d, 16.7d, and 15.8d on Norway maple, red maple and black willow, respectively. Collectively however, preovipositional period was generally between 10 - 15 days of age.

Longevity of adults averaged 103.9d (44-131d), 97.2d (30-137d) and 83.0d (58-107d) on Norway maple, red maple and black willow, respectively (Fig 2).

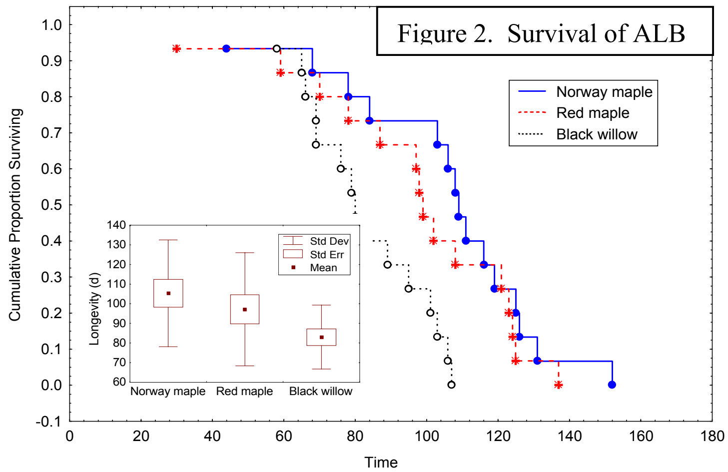


Figure 2. Survival of ALB

Daily and lifetime oviposition were significantly higher on Norway maple (1.80eggs/day; 193.3 eggs/lifetime), than on Red maple (0.99eggs/day; 98.5 eggs/lifetime), which was in turn significantly higher than that on black willow (0.54eggs/day; 45.9 eggs/lifetime) (Fig. 3 and 4). Approximately 90.3% of all oviposition sites contained an egg.

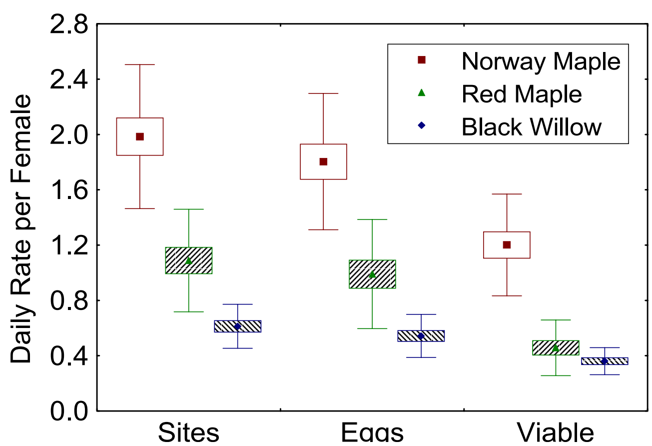


Figure 3.

Daily Reproductive Rate

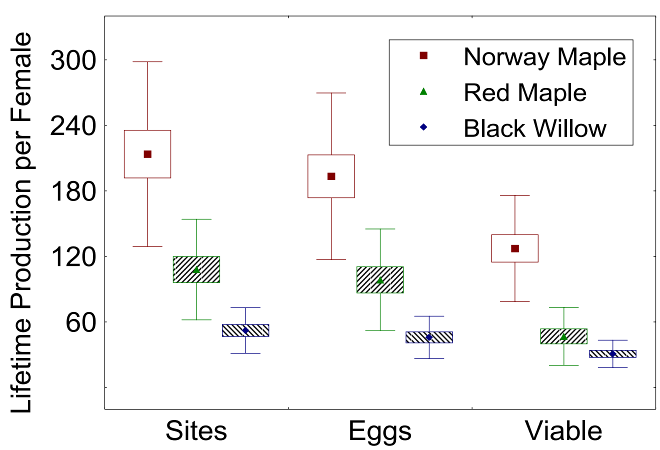
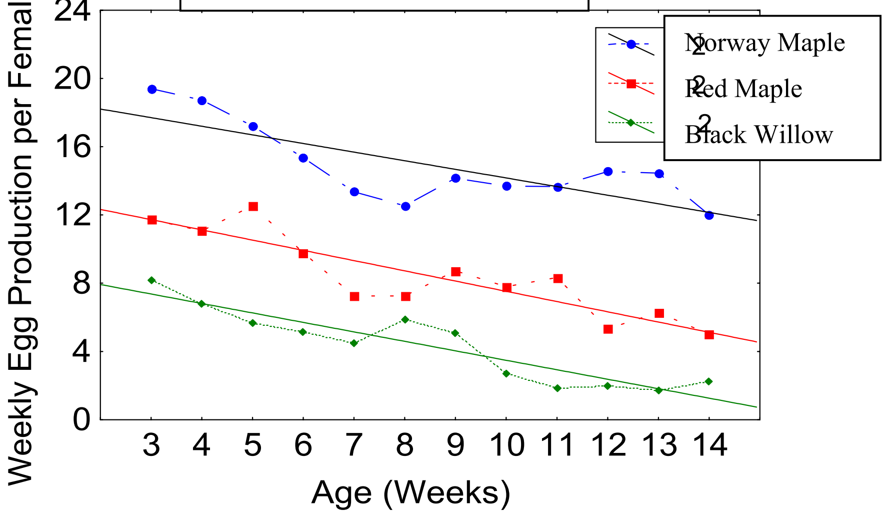


Figure 4.

Lifetime Reproductive Rate

Ov [illegible] g. 5).

Figure 5. Age Specific Fecundity



Percent egg viability was 60.4% on Norway maple, 60.5% on black willow, and 42.5% on red maple, which translates into an average lifetime production of 127.3, 46.8 and 30.7 viable eggs on Norway maple, red maple and black willow, respectively. The annual intrinsic rate of increase on Norway maple, red maple, and black willow was 4.1, 3.1, and 2.7, respectively. These likely over estimate intrinsic rate of increase since larval, pupal and adult mortality are not included. However, these results show that, in terms of adult ALB survival and reproductive capacity, the maples were more suitable than willow, with Norway maple somewhat more suitable than red maple. We hypothesize that woody-tissue characteristics (i.e. nutritional substances, secondary substances, structural features) caused the observed differences in *A. glabripennis* survival and reproduction.

Discussion

The differences among the three host-trees reported here represents the initial assessment of the impact of ALB after its invasion and establishment, and is among the studies suggested by Hanks (1999). This new information provides insights into the reproductive strategies of ALB, and by discriminating the potential effects of available trees on reproduction, one aspect of ALB impact on various ecosystems in the U.S. is measured. We are incorporated these data into an individual based simulation model of ALB spread. We suggest studies of dispersal with respect to mating and food preference will further this assessment of invasion. Future studies should also include the evaluation of host suitability of various tree species in terms of development from egg to adult, with particular attention to host stress. Collectively, these studies will contribute to the development of management guidelines (eradication and otherwise) that are sensitive to insect-host interactions under various landscapes at risk in the U.S.

LITERATURE CITED

Hanks, L. M. 1999. Influence of the larval host plant on reproductive strategies of cerambycid beetles. Annu. Rev. Entomol. 44: 483-505.

Price, P. W. 1997. Insect Ecology. John Wiley & Sons, Inc., New York.

Acknowledgments

We thank USDA, APHIS, State of Illinois and City of Chicago officials, including Winn McLane (USDA, APHIS, PPQ, Otis Plant Protection Center, Otis ANGB, MA), Joseph J. McCarthy, Ken Kruse and Joe Schaffer, for assistance in the acquisition of *A. glabripennis*-infested logs from Chicago, IL. We also thank James Dobson (Forester for the Blackbird State Forest, DE) and Ken Swan (USDA, ARS, BIIR) for their assistance in acquiring trees used in this study.