# INFLUENCE OF STAND COMPOSITION ON LOCUST BORER (COLEOPTERA: CERAMBYCIDAE) ATTACK RATES

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(Accepted for publication May 21, 1985)

## ABSTRACT

Locust borer attack rates were studied in relation to stand mixtures in Appalachian Maryland. Current (active) attacks, as opposed to past attacks, were utilized to evaluate present stand composition. Current attack density increased with increased percent black locust on the plots. The trend was significant in 2 of 3 study areas ($P < 0.05$). Current and past attack density were not correlated with each other, nor was current attack correlated with indices of tree thrift or size.

Key Words: *Robinia pseudoacacia, Megacyllene robiniae,* attack density.

J. Entomol. Sci. 20(2): 207-211 (April 1985)

## INTRODUCTION

Several workers have suggested that reduced damage by the locust borer, *Megacyllene robiniae* (Forster), occured when black locust was growing in mixtures with other tree species, particularly hardwoods. However, the observations were not quanitified. Hall (1942) suggested that reduced attack may be associated with denser shading and greater amounts of soil litter in mixed than in pure stands, and recommended mulching with hardwood leaves in pure locust stands. Craighead (1919) observed less injury by locust borers in stands with dense undergrowth than in those with sparse growth. Garman (1916) observed that stands with few black locusts had less borer attack, suggesting the effect of stand mixture. Berry (1945) included stand mixture in a list of important factors regarding locust borer attack. However, he did not achieve reduced borer attack in mixtures of black locust and loblolly pine in North Carolina, and suggested mixtures with other hardwood species instead.

A goal of this study was to extend and test the early observations. Our objectives were to compare locust borer attack density in predominantly black locust stands with those in stands with decreasing representation of black locust, and with stands of locust mixed with pine. The hypothesis to be tested was that stand mixture influenced locust borer attack density; and further, that increasingly purer locust stands incurred progressively high levels of attack.

## METHODS AND MATERIALS

In 1977 and 1978, three study areas were selected, each of which contained stands with the following mixtures: (A) low percentage of black locust stems (2 - 30%) with mixed hardwoods, (B) medium percentage of black locust stems (33 - 40%)

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with mixed hardwoods, (C) high percentage of black locust stems (82 - 100%) with mixed hardwoods, and (D) black locust (43 - 60%) with red pine *(Pinus resinosa* Ait). Study areas were mapped and gridded at 30 m intervals. Four 30 $\times$ 15 m study plots were randomly selected at each site, one plot in each of the mixed stands described above. The species composition within plots was derived by basal area measurement ($m^2$/ha), total stem count (stems/ha) and "overstory" stem count (stems/ha). Basal area was measured using a wedge prism with a metric basal area factor of 10. Three separate measurements were averaged per plot. Measurement locations within the study plot were placed at 7.62 m intervals along the center line. The basal area for black locust was obtained by converting diameter at breast height (dbh) to basal area, utilizing a conversion table, and totalling for each plot. Woody plants in the study plot which exceeded 1.8 m in height were considered "overstory," whereas the total stem count included all woody stems regardless of height. An average stand height was established from a randomly selected sample of 10 dominant or co-dominant black locusts within each plot.

Current, or active, attacks were counted on all 582 locust trees in all plots to a height of 2.13 m on the stems by external observation of holes, boring dust, and sap. Accumulated past attacks were counted on a randomly selected sample of trees, requiring the felling, sectioning, and dissection of entire stems, from ground level to a top diameter of 2.54 cm. Trees to be dissected were randomly chosen from 2.54 cm diameter classes — two trees per plot in each diameter class. A total of 79 trees (37 in study area 1, and 42 in area 2) were dissected. Past attack data were not obtained from area 3 because no cutting of trees was permitted. Growth rate and sapwood width were measured using increment borings on standing study trees and by averaging the widest and narrowest ring and sapwood portions on dissected trees.

Numbers of current attacks, and annual past attacks were tested for correlation with stand composition and tree thrift indices. Annual past attacks were calculated as the total number of attacks divided by tree age.

A Pearson correlation test incorporating 24 variables was used in analysis. The test evaluated trends and correlation levels between attack intensity and stand composition, and tree age and dimension.

## RESULTS

A summary of data on tree dimension and attack intensity is presented in Table 1. As shown, the increasing representation of black locust in plots A through C was accompanied by progressively higher occurrences of current borer attacks per tree. The trend was statistically significant in areas 2 and 3 ($r = 0.99$ and 0.98, respectively; $P < 0.05$), and was present in area 1, though not significant. With one exception (plot 1, area 2), the lowest current attack intensities for each area occurred in the locust-pine mixtures.

The relationship between accumulated past attack and percent black locust was less clear than for current attacks. Also, the Pearson correlation test indicated that past and current attack intensities were not correlated with each other. Their trends were not consistent in relation to all parameters tested.

Two indices of tree thrift, radial growth rate and sapwood width, were tested against stand mixture and borer attack density. Radial growth rate and sapwood

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Table 1. Black locust tree and stand measurements as related to density of locust borer attacks.

| Study area | Plot* | Percent black locust: Basal area | Percent black locust: In overstory | No. of trees: In plot | No. of trees: Trees sampled | Size-related factors: Age (yrs) | Size-related factors: Ht (m) | Size-related factors: Diam (cm) | Thrift indices: Avg. sapwood width (cm) | Thrift indices: Avg. growth rate (mm/yr) | Locust borer attack: Avg. current attack† | Locust borer attack: Avg. past attack‡ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | A | 12.2 | 17.3 | 13 | 8 | 20.2 | 9.5 | 14.1 | 10.1 | 5.2 | 0.31 | 1.56 |
| | B | 42.3 | 39.7 | 27 | 11 | 16.7 | 9.1 | 9.8 | 13.0 | 6.0 | 0.33 | 1.10 |
| | C | 92.6 | 92.7 | 76 | 8 | 14.9 | 7.3 | 8.8 | 14.0 | 6.1 | 0.45 | 1.18 |
| | D | 55.9 | 59.5 | 113 | 10 | 13.9 | 8.1 | 8.7 | 16.7 | 6.7 | 0.14 | 0.77 |
| 2 | A | 25.8 | 2.2 | 19 | 8 | 33.2 | 13.0 | 15.3 | 9.6 | 3.8 | 0.05 | 2.15 |
| | B | 43.9 | 33.3 | 32 | 13 | 19.6 | 9.7 | 11.9 | 11.2 | 5.5 | 0.25 | 2.70 |
| | C | 100.0 | 100.0 | 68 | 11 | 13.2 | 12.1 | 10.0 | 12.1 | 7.4 | 0.96 | 2.74 |
| | D | 32.5 | 43.3 | 23 | 10 | 9.5 | 7.2 | 7.1 | 14.9 | 8.2 | 0.22 | 0.46 |
| 3 | A | 60.0 | 30.3 | 31 | 0 | – | 12.0 | 13.8 | – | – | 0.19 | – |
| | B | 37.1 | 33.0 | 29 | 0 | – | 10.5 | 10.3 | – | – | 0.03 | – |
| | C | 84.0 | 81.7 | 58 | 0 | – | 8.9 | 8.8 | – | – | 0.34 | – |
| | D | 21.0 | 48.9 | 93 | 0 | – | 5.7 | 3.6 | – | – | 0.02 | – |

* Black locust composition categories used in the study: (A) low percentage black locust stems (2 - 30%) with mixed hardwoods, (B) medium percentage black locust stems (33 - 40%) with mixed hardwoods, (C) high percentage black locust stems (82 - 100%) with mixed hardwoods, (D) black locust (43 - 60%) with red pine.

† Current attacks/year/tree, bottom 2.13 m.

‡ Past attacks/year/tree, entire stems.

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width were inter-correlated ($P = 0.006$) and were positively correlated with percent black locust in the plots ($P = 0.048$). However, they were not correlated with current attack density. They were negatively correlated with past attacks/year/tree ($P = 0.010$), indicating less annual past attack with increased tree thrift.

The tree size-related features of age, height, and diameter were inter-correlated ($P = 0.008$). Their averages decreased with increasing percent locust in the plots, but the trend was not significant. As with the thrift indices, no correlation was obtained between these features and current attack density, but they were positively correlated with past attack/year/tree ($P < 0.010$).

## DISCUSSION

The data supported the suggestion of past workers that black locust growing in mixtures received fewer borer attacks. This assertion is supported statistically, although stronger correlation would have been desirable. We therefore do not claim conclusive proof of a relationship, but offer substantiating evidence. Increased damage by insects in pure stands of some trees, including black locust, has been presented in the literature as a silvicultural principal (Toumey and Korstian 1947). However, in the absence of a data base, the observations remain to be tested under a variety of forest conditions. The suggestion of a relationship in this study implied some benefit to growing black locust in mixtures with other hardwoods and with pine.

Although current and past attacks were not correlated with each other, their divergence was not extreme, and the statistical values were near that necessary for significance. Nonetheless, the data demonstrated that the two must be considered separately, since they are not necessarily accurate indicators of each other. A correlation between the two would have been desirable, as it could have improved the capability of estimating past borer damage within a tree without the need for dissection. Although both current and past attacks were counted, only current attacks were used for comparison against present-day stand mixtures.

The changing successional features of locust stands may help explain variations in the accumulated past attack density. Black locust stands typically progress from a relatively pure to a mixed state with age, originating in clumps of root sprouts in clearings or old fields. It is considered an early pioneer species, giving way to more competitive hardwoods (Allard 1943; Auten 1945). The pine-locust mixtures used in this study were atypical associations for black locust growth in that they were plantations, single-species, and of red pine south of its normal range.

Past workers have reported that increased tree thrift and vigor are associated with higher growth rates (Meteer and Linjala 1973; Kotska and Sherald 1982; Khatamian and Hilton 1977) and greater radial widths of sapwood on the stems (Waring 1980). Current attack rates were not correlated with the above thrift indices in this study, in contrast to the common observation that vigorous trees incur reduced borer damage. The lack of correlation might have been due to the over-riding effect of other factors, such as stand mixture, whose trends in the study plots were opposite those of tree thrift.

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## ACKNOWLEDGMENTS

We are indebted to the Maryland Agricultural Experiment Station for partial funding of this study. In particular we thank Drs. Lamaar Harris and Filmore Bender. This paper is Scientific Article 3820 and Contribution No. 6798 of the Maryland Agricultural Experiment Station, and Contribution No. 1622-AEL of the University of Maryland, Center for Environmental and Estuarine Studies.

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