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"Effect of periodical cicadas on radial increment growth in sugar maples of the forest edge and forest interior in Griffy Preserve"

INTRODUCTION

Periodical cicadas can affect trees in a number of ways. In emergence years females oviposit on tree branches, commonly causing branch mortality in host trees. After nymphs hatch from egg nests and drop to the ground to burrow in the soil below, they feed on tree root xylem fluids throughout the course of their 13- or 17- year development. More secondary effects resulting from the presence of cicadas can include nutrient loads into forest ecosystems in outbreak years and the possibility of pathogen entry into trees due to cuts made by oviposition and root-feeding. Root-feeding by periodical cicada nymphs was found to reduce radial tree-ring growth in host scrub oaks by up to 30% in the four years following an emergence event, but to have no significant effect on tree growth in the four years leading up to cicada emergence (Karban 1980). Another study found a 4% reduction of radial increment growth evident in oak trees during cicada emergence years; effects in other years were variable or not present, suggesting that oviposition has a greater impact than nymphal root-feeding on tree growth (Koenig and Liebhold 2003).

In outbreak years, cicadas initially emerge in greater numbers from forest interiors than forest edges, yet a trend toward greater colonization of forest edges has been noted (Rodenhouse *et al.* 1997). Cicadas burrowing in edge areas tend to time their emergence slightly earlier than cicadas in interior forest, likely due to cues of sunlight and soil temperature that affect edge areas first. Interior forest cicadas may emerge soon after edge cicadas and be drawn to male chorus centers that have already formed on forest edges. Females also prefer to oviposit in sunlit areas, which forest edge can provide. Thus forest edge trees may experience more oviposition than interior forest trees, leading to greater densities of burrowing nymphs below edge trees compared to interior host trees. Nymph mortality, however, may be higher where population densities are greater and offset the initially higher density of feeding nymphs (Williams and Simon 1995). This study sets out to evaluate the effect of Brood X periodical cicadas on radial tree-ring growth of sugar maples in Griffy Preserve, and to consider whether a more pronounced effect is evident within trees of the forest edge compared to trees of the forest interior.

METHODS

A site was chosen in Griffy Preserve that borders the IU Golf Course. Both interior and edge trees were sampled to obtain cores that were prepared and analyzed according to methods of dendrochronology (Stokes and Smiley 1968). A master chronology was developed for each set of trees by charting and averaging relative growth patterns among each series of tree cores.

RESULTS

The series intercorrelation within each tree ring series was significant. Average ring growth as it varied between edge and interior trees can be seen in Figure 1, including the onset of highly variable growth beginning with the 1987 emergence year. Climate variables that significantly affected tree growth were identified with multiple regression analysis and removed from the core data. Superposed epoch analysis compared the means of increment growth associated with the

17 years before and 17 years after each outbreak year of 1953, 1970, and 1987. Averaging the data in this way could reveal signals in tree rings caused by cicada periodicity. Applied to the interior chronology, a waveform emerged in the graphical output that roughly follows a 17- year cycle. It can be seen in Figure 2. Time series analysis picked up no 17- year response, however.

DISCUSSION

The climate signal in the chronologies was not strong, probably due to watering and fertilization employed upslope of the Preserve to manage the golf course. No clear reductions in growth emerged in outbreak years or in years directly following emergence, as other studies have uncovered. The 17-year signal suggested by superposed epoch analysis remains of interest, and spectral analysis could elucidate a cicada signal where time series analysis could not. The edge trees constituted a more variable and less intercorrelated chronology than that of the interior, and reanalysis of more problematic cores may assist in developing more definitive results.

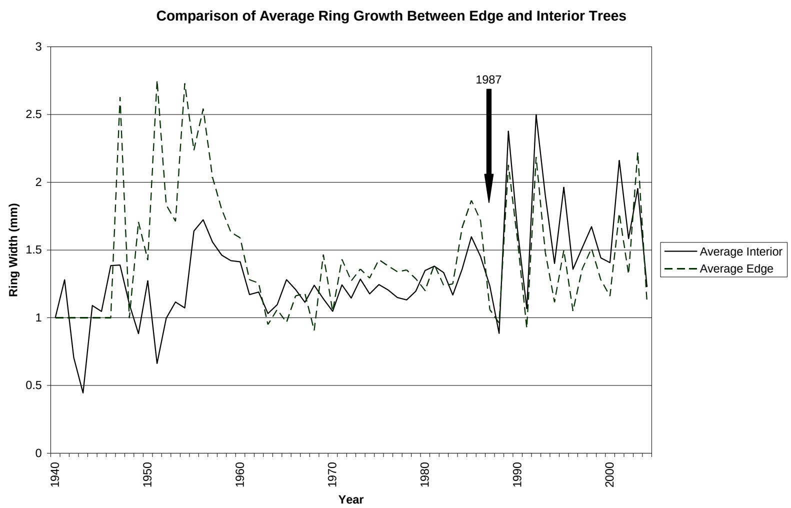

Figure 1: Comparison of ring growth between edge and interior cores.

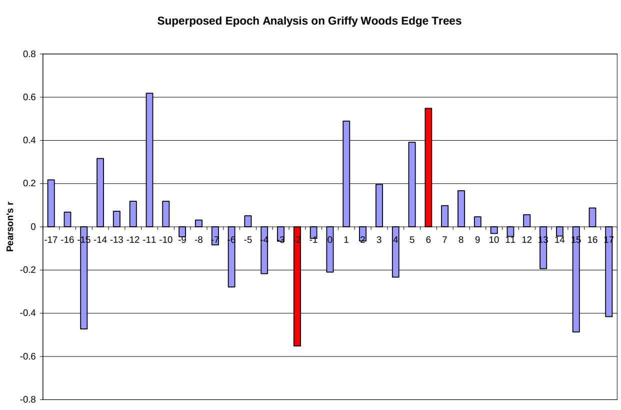

Figure 2: Superposed epoch analysis with suggestion of 17-year cycle. Lag year zero marks outbreak year. Red bars indicate statistically significant years of

growth