

FIELD EVIDENCE FOR INTRASPECIFIC COMPETITION BETWEEN SUGAR-MAPLE TREES (*ACER SACCHARUM*)

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ABSTRACT

I investigated patterns in the spatial and size distribution of sugar-maple (*Acer saccharum* Marsh) trees at the Juniata College Raystown Field Station (Entriken, PA). Three indicators of intra-specific competition were assessed in this population. No evidence for intra-specific competition was found.

INTRODUCTION

One of the oldest ideas in ecology is that individuals using the same resource will compete if that resource is in short supply. For many years, ecologists assumed that the sizes of small populations within a given community were ultimately limited by resources. Hence, competition was believed to be an inevitable consequence of making a living and the major determinant of community structure (i.e., the number of species and the size of each population). However, constant combat for resources is not necessarily implied. Over many generations, species may evolve ways to avoid competition (i.e., resource partitioning). Nevertheless, the community is ultimately structured by competition, be it ongoing or the "ghost of competition past."

Competition is a particularly important process in plant ecology and plant ecosystems, because plants are sedentary (i.e., they stay in one place). The size, proximity, and density of plants will have a large effect on the intensity of competition.

The predominant definition of competition in most text books describes inter-specific competition, i.e., competition that occurs between two species. The term intra-specific competition refers to competition between members of a single species. In this case, the activities of some individuals of a species make resources unavailable for other members of the same population. Consider a thicket of young trees competing in this way. For a time, there is enough sunlight or water for all of them to survive, although they do not grow as fast as they would if they were less crowded. Later, some begin to lose out; they die, and the density drops.

The object of this investigation was to determine whether intra-specific competition is occurring in a population of sugar maples trees (*Acer saccharum*). I attempted to estimate the effects of intra-specific competition by examining the size, proximity, and density of sugar maples at the Juniata College Raystown Field Station (Entriken, PA).

METHODS AND MATERIALS

A grove of sugar maples at the Raystown Field Station was selected for study because it appears to be a natural monoculture, and there is much interest in these trees because of the maple syrup they provide. A monoculture ensures that competition is between trees of the same species rather than of different species that may differ in growth rate and growth form. It is also preferable to study a stand of trees of similar age.

Within the field site, a tree surrounded by others of the same species was selected. The circumference of the tree was measured at standard height, i.e., usually breast height (approximately 1.3 m). If some trees had divided stems, the circumference measure was made at a standard height nearer the ground for all the trees. Following Warrington (1994), the distances to all neighboring trees were measured within a circle of 'standard radius' about the central tree (i.e., 5 m), which was large enough that at least one neighbor could be measured for all central trees. This procedure was repeated for several central trees, trying to avoid overlap between circles. It was not essential that the survey of trees was truly random. It was more important to ensure minimal overlap between sampled circles and the maximum range of sizes of the central trees.

Measurements of tree girth were converted to values of cross-sectional area for each tree. Tree biomass would be the ideal measure of tree size, but it is not possible to estimate this easily for most tree species. However, the cross-sectional area is a reasonable compromise and preferable to a linear size measurement, such as circumference or radius. It can be estimated as follows:

$$\text{Tree circumference (girth)} = 2\pi r$$

$$\text{Therefore, } r = \text{tree circumference}/2\pi$$

$$\text{Cross-sectional area} = \pi r^2$$

$$\text{Therefore, cross-sectional area} = (\text{tree circumference})^2/4\pi$$

RESULTS

Table 1 shows the mean density of trees, the mean cross-sectional area and the mean distance to the nearest neighbor (d). The mean density of trees was calculated from the total number of trees in each sample circle. If the distribution of trees was random, then the expected mean distance (Exp. d) to nearest neighbors would be:

$$\text{Exp. } d = 1/(2(\star D)),$$

where D is mean tree density. From this one can calculate the ratio R :

$$R = d/\text{Exp. } d$$

If $R = 1$, the tree distribution is random. If $R > 1$, the tree distribution is more uniform. If $R = 2.15$ maximum possible spacing (hexagonal pattern) is reached. If $R < 1$, the tree distribution is aggregated (clumped). If $R = 0$, complete aggregation (all individuals being at the same point) exists. The mean observed distance to the nearest neighbor is R times as great as would be expected if the population was randomly distributed.

Table 1. Density, cross-sectional area, and distance to nearest neighbor of sugar-maple trees at the Juniata College Raystown Field Station ($N = 34$).

	Mean	Standard deviation	Coefficient of variation %
Sugar Maple:			
Tree density (trees/m ²)	.0289	N/A	N/A
Cross-sectional area (m ²)	.059	.044	75
Nearest neighbor (m)	2.294	.912 (SE .266)	N/A

Table 2: Calculated values for the sugar-maple grove at Raystown Field Station.

Variable description	Variable	Value
Tree Density	D	.0289trees/m ²
Expected Distance	Exp.d	2.94 m
Ratio R	R	.78
Standard Error of distance to neighbor	SE _d	.2660

Based on data in Table 1, the distance between sugar-maples trees would be 2.94 m if their distribution were random (see Table 2). The observed mean distance to nearest neighbors was 2.294 m. The ratio R was 0.78. The nearest neighbor distances for the trees was significantly less than the value expected if the trees were randomly distributed, thus indicating that the trees were showing a clumped (aggregated) distribution. The observed distance (d) is more than 1.96 standard errors away from the expected distance (Exp. d) ($P < 0.05$).

The size distribution (cross-sectional areas) of all the sugar-maple trees is shown in Fig. 1. The mean cross-sectional area of the 34 sugar maple trees in the survey was 0.059 m² (approximately indicated by arrow in Fig. 1). The size distribution of the sugar maples was not skewed either to the left or to the right.

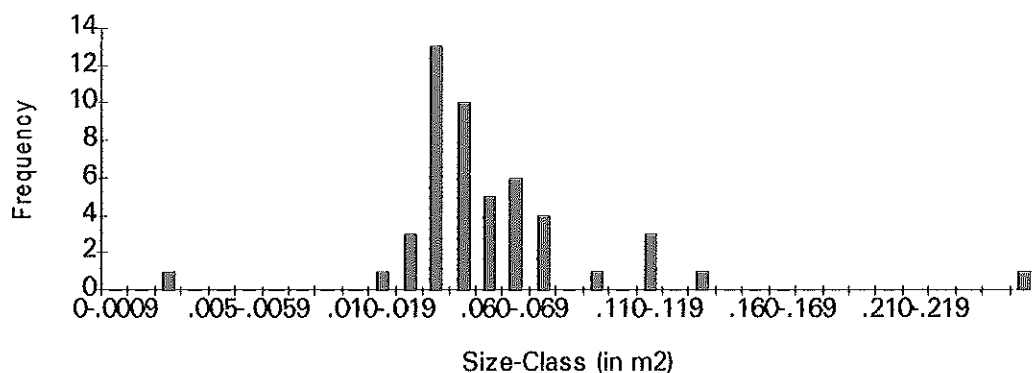


Figure 1. Size-class distribution of cross-sectional areas (m²) of sugar maple trees ($n=34$).

thinning of the population). So the suppressed individuals close to larger plants die, leaving a more widely and regularly spaced population of plants.”

None of these patterns were observed in the sugar-maples at the Raystown Field Station, thus suggesting that intra-specific competition has not been important in this population. The plant-size distribution of the sugar maples is not skewed in either direction (see Fig. 1). There was no clear relationship or evidence found of large individuals being surrounded by smaller ones (see Fig. 2). And the spatial distribution of the sugar maples was aggregated or clumped, rather than uniform. The absence of significant evidence for intra-specific competition in this population may be because the study plot was not a true monoculture, i.e. there were several other tree species present. Perhaps better evidence for intra-specific competition would have been found in another more homogenous grove of trees, as found by Warrington (1994).

Unfortunately there are no other published studies on the sugar maples at the Raystown Field Station with which to compare my results.

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