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THE RELEVANCE OF DENDROGRAPHIC STUDIES TO TREE-RING RESEARCH*

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ABSTRACT

The annual increment growth measured by dendrographs on three different species is essentially a linear function of tree-ring width. The bark increment remains more or less constant. Records from dendrographs can therefore be employed in studying the environmental and physiological determinants of ring width.

During the past several years the author has been engaged in studies of daily tree growth. Dendrographs (Fritts and Fritts 1955) which were mounted on individual trees were used to record the daily range in size of each tree at a single radius. The dendrograph records were converted to daily growth by employing the equation $G = m_i - m_{pi}$ where G is growth, only when positive, m_i the maximum size for day i, and m_{pi} the maximum size obtained during any day preceding i. Changes occurring when the radial measurement is less than the previous maximum size are recorded as zero growth, so that all values represent only "new" increment and thus can be summed to provide a measure of the total increment. Such a definition is based upon the principle that new cell enlargement occurs only when the tissues are full of water and turgor pressure is high. Thus a series of positive daily growth increments is obtained which can be analyzed in terms of current environmental factors (Fritts 1958, 1960a) or summed up to provide the total annual increment.

However, the dendrograph measures changes in both the bark and xylem areas. This study is an attempt to determine what portion of the year's radial increment as measured by dendrographs can be ascribed to the xylem increment represented by the annual ring width.

Methods and results. The opportunity for this study was afforded by the termination of growth studies on six dominant forest trees near Charleston, Illinois, at the end of the 1960 growing season (Fritts 1959, 1960b). The dendrographs had been on two white oaks *(Quercus alba L.)* and a sugar maple *(Acer saccharum Marsh.)* for four years and on a second sugar maple and two red oaks *(Q. ruba L.)* for three years. A seventh dendrograph

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had been mounted for the last growing season on a second radius of one of the white oaks.

When dendrographs were removed from each tree, increment cores were extracted from the measured radius and immediately glued into grooved boards. Several months later, each mounted core was soaked in distilled water for several days until there was no measurable imbibitional swelling during a 24 hour period. Each ring was measured three times and the measurements averaged. The annual ring widths and the corresponding season's increment, as determined from the dendrograph records, are included in Table 1.

TABLE 1. Ring widths in inches and the total year's increment measured with a dendrograph.

Source of Measure	*Year*				
	1957	*1958*	*1959*	*1960*	
White Oak					
1 Ring Width	.074	.107	.068	.086	
Dendrograph Measure	.082	.124	.073	.113	
2 Ring Width	.146	.147	.082	.166	.116
Dendrograph Measure	.150	.141	.083	.172	.121
Red Oak					
1 Ring Width	......	.062	.066	.066	
Dendrograph Measure	......	.071	.076	.071	
2 Ring Width	......	.086	.124	.141	
Dendrograph Measure	......	.099	.131	.153	
Sugar Maple					
1 Ring Width	......	.102	.055	.068	
Dendrograph Measure	......	.108	.051	.075	
2 Ring Width	.043	.083	.048	.045	
Dendrograph Measure	.077	.103	.057	.053	

An analysis of covariance (Snedecor 1956: 394-9) was undertaken to determine the differences existing in the relationships between radial growth and ring width for the three species (Table 2). No significant differences were apparent in either the regression coefficients or the adjusted means, but the deviation from regression was significantly higher for the white oaks and sugar maples (p. = .05). The sugar maple data exhibited the lowest regression coefficient and the highest mean deviation from regression. The common regression line (Table 2) is plotted with the data in Figure 1. The regression equation for the total sample (Table 2) is $Y = 1.005x - 0.0097$ inch, and the correlation coefficient is 0.968.

TABLE 2. Analysis of covariance for ring width as a function of increment measured with dendrograph.

Source of Variation	*b*	*df*	*Deviation from Regression*	*Mean Square*
White Oak	1.025	7	716	102.3
Red Oak	0.969	4	40	10.0
Sugar Maple	0.817	5	773	154.6
Within		16	1529	95.6
Regression Coefficient		2	105	52.5
Common	0.970	18	1634	90.8
Adjusted Means		2	75	37.5
Total	1.005	20	1709	

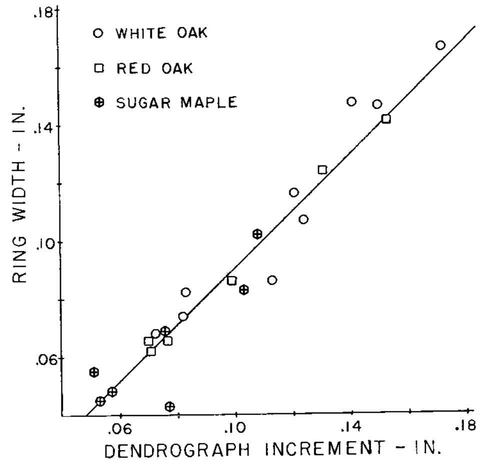

FIG. 1. A plot of the data and the common regression line for ring width as a function of increment measured with dendrograph.

Discussion. These data demonstrate that the dendrograph measure can essentially account for the variation in ring width. The square of the correlation coefficient indicates that only six percent of the variance is unaccounted for. There is approximately a 1:1 ratio, plus a constant of 0.010 inch, in the relationship between ring width and the radial increment in the two species of oak. This indicates that essentially all of the year to year variation is due to xylem growth. The sugar maples exhibit a 4:5 ratio; their deviation from regression is greater, but the variation in ring width from year to year is less. Thus in the sugar maples it may be that both the bark and the ring increment vary. The greater deviation from regression for this species may be due partly to error in ring measurement, as the ring borders were somewhat irregular and indistinct.

Though further study is needed on the relative growth of the xylem and bark elements within the season, the small amount of bark which is formed and the approximate one to one relationship between ring width and the dendrograph record, indicate that the measured daily growth may largely represent the daily xylem increment. Thus, by studying the factors controlling daily radial growth by means of the dendrograph, one should be better able to understand the environmental and physiological determinants of ring width.

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