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SWAMP-GROWN EASTERN WHITE PINE AND HEMLOCK IN CONNECTICUT AS DENDROCHRONOLOGICAL MATERIAL

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In August, 1943, while engaged in an investigation of compression wood, the writer examined a number of white pine (*Pinus strobus L.*) and hemlock (*Tsuga canadensis* (L) Carr.) stumps in a swamp in the Yale forest situated in Tolland and Windham counties, Connecticut. The stand in this swamp had been cut in the winter of 1937-1938. Field inspection revealed marked variations in the width of the growth rings along a given radius; so sections of 14 white pine and 4 hemlock stumps were collected and brought to New Haven for more careful examination. With one exception (number 5) all stumps sectioned were sound; in fact, soundness was the sole criterion employed in deciding which stumps to section.

Although rainfall during the summer of 1943 was considerably below normal the water table was very close to the ground surface; in fact, pools of water were frequently encountered. The wet character of the habitat was further evidenced by the common occurrence of species such as *Alnus incana* (L.) Moench., *Benzoin aestivale* (L.) Nees., *Betula lutea* Michx. f., *Nemopanthus mucronata* (L.) Trel., and *Rhus vernix* L.

Stump diameters ranged from 13 to 28 inches and ages varied from 120 to 219 years in pine and from 188 to 357 in hemlock. The average age of the pines was about 185 years; trees of this species were essentially evenaged. After smoothing the stump sections, growth rings were measured using a 14X hand lens and a scale graduated to 0.02 of an inch (0.508 mm). Only one radius was employed in stumps 1 to 6, but in all others two radii were used. No features which could be interpreted as doubling or deletion of growth rings were encountered.

From a plot of the ring widths of each stump, years of maxima and minima became evident. With this general plotting as a basis, years of maxima and minima appearing in more than half of the stumps of either species were listed (Table 1.). One year, 1895, which showed minima in only half of the pine stumps was also included because minima appeared in the hemlock stumps for this same date. Maxima and minima for the dates listed in Table 1 were then classified on the basis of their distinctness. Weak peaks or depressions were assigned a value of 1, if moderately pro-

nounced they were given a value of 2, and if very pronounced a value of 3. Using this admittedly arbitrary classification the data were plotted to produce Figure 1. The wide lines represent years of maxima and the narrow ones years of minima. The heights of the lines indicate the relative distinctness of either maxima or minima, the highest denoting those most pronounced.

TABLE 1. YEARS OF MAXIMUM AND MINIMUM GROWTH IN WHITE PINE AND HEMLOCK FROM A SWAMP IN THE YALE FOREST, UNION, CONN.

White Pine		Hemlock	
Maximum	Minimum	Maximum	Minimum
1921x	1909xx	1886x†††	1895x†
1894x	1895x	1858x†††	1883x†
1886xxx	1856x	1851x†	1843x†
1881x	1849x		1798††
1822x	1843xx		1784†††
1764			

x Full agreement with dates of Lyon.

xx Not mentioned by Lyon.

xxx Reported by Lyon as a year of both maximum and minimum.

† Full agreement with data of Avery, et al.

†† Fair agreement with data for trees on ledges; disagreement with data of Avery, et al for trees along brook.

††† Disagreement with data of Avery, et al.

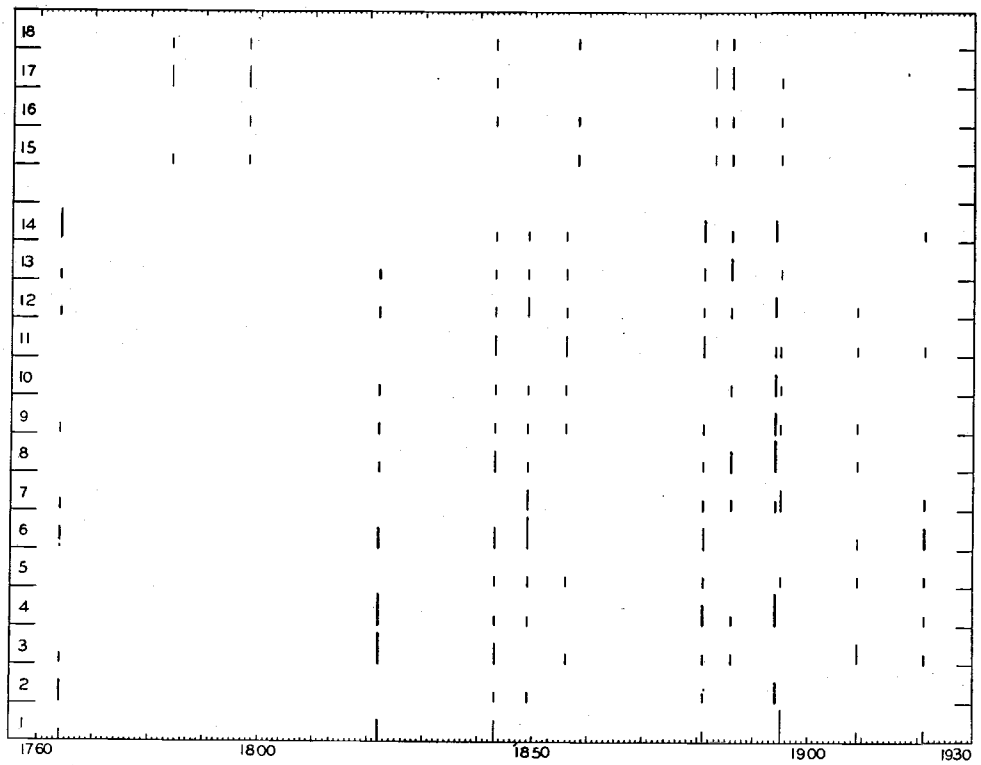

Figure 1. Years of growth maxima and minima in white pine and hemlock from a swamp in the Yale Forest, Union, Conn. Tree numbers along left side (1-14 white pine, 15-18 hemlock). Wide lines indicate maxima; narrow lines indicate minima. Heights of lines indicate the relative distinctness of either maxima or minima, the highest denoting those most pronounced.

Comparison of the dates given in Table 1 with results obtained by Lyon[1] in Massachusetts and New Hampshire for the same species reveals a surprising agreement. Bearing in mind that the earliest date given in Lyon's tables is 1799, it may be noted that the agreement in hemlock dates is perfect and in white pine nearly so. The exceptions in white pine are (1) 1886, a year of maximum growth reported by Lyon as showing a maximum at Carlisle and a minimum at Douglas, Mass., and (2) 1909 and 1843, years of minimum growth not mentioned by Lyon.

The close agreement of years of maxima and minima reported by the present writer and by Lyon was earlier characterized as surprising. When Lyon's work was first consulted it was anticipated that if any relationship existed it would be negative. That is, it was presumed that in unusually dry years swamp-grown trees would show a maximum of growth whereas in unusually wet years a minimum would be shown. At present there appears to be no satisfactory explanation for the similarity in growth fluctuations of white pine and eastern hemlock in the Connecticut swamp and on the upland situations in Massachusetts and New Hampshire. Attempts to associate the growth fluctuations of the Connecticut material with climatic conditions such as temperature or precipitation have been unavailing although many such were made.

Following comparison of the years in Table 1 with those of Lyon a similar comparison of the hemlock dates was made with the data presented by Avery, Creighton and Hock[2]. These authors investigated the growth of two groups of hemlock trees growing near New London, Connecticut. Trees in one of the groups were growing on a dry ledge and those in the other group were located along a brook in a ravine. Growth indications for the years 1851, 1895, 1883, and 1843 in Table 1 are in full agreement with the data presented by Avery, et al., for both of their groups of trees. Fair agreement in 1798 is noted only for trees growing on ledges. Disagreement is noted in 1784, 1858 and 1886.

It was realized from the outset that the material investigated was theoretically poor for dendrochronological purposes. Not only did the trees grow in a swamp but also they had developed considerable compression wood because of the inclined position of many, if not most, of the stems. Further, the selection of stumps for examination was essentially random. These facts make even moderate agreement with results of other investigators quite unexpected. However, a serious effort was made to avoid any possible personal bias and it is the belief of the writer that this objective was obtained.

About the only conclusions which seem warranted are that even trees developed in a swamp habitat may have dendrochronological value and that in addition to precipitation and temperature there may be other factors or factor complexes having a widespread occurrence which influence tree growth in rather diverse habitats. The possibility of discovering general, regionally operating controls of tree growth other than those regularly recognized should be borne in mind by investigators of tree-rings.

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[1] C. J. Lyon, Ecology 24, 329-344, 1943.

[2] Avery, Creighton and Hock, American Jour. Botany 27, 825-831, 1940.