If, in Figure 1, the 49 years of recorded Durango precipitation are compared with the Ft. Lewis tree growth for the same interval, it is found that approximately 32 years show positive agreement; 10, negative agreement; and the remaining years, no correlation. The correlation coefficient, +.59, is hightly significant. A correlation of +.44 was found between ring-widths of the young trees at Dolores and precipitation at Durango. As with the comparison of curves above, the correlation is much better during certain periods than in others. From 1906 to the 1930's radial growth was excessive as compared with the apparent moisture supply. Other factors controlling growth have not yet been studied.

If the flow of the Animas River at Durango is compared with ring-widths, a significant correlation of +.45 is shown for the Ft. Lewis trees, and +.66 for the Dolores trees.

For the Ft. Lewis trees, the average period of continuous subnormal growth, and its standard deviation, is 2.6 ± 0.3 years, and of above-average growth, 2.8 ± 0.3. The maximum length of a continuous period of subnormal growth is 11 years, and of above-average growth, 9 years, as determined from the average of 10 trees. These means are based on a 200-year series.

That young trees are growing approximately as well today as in earlier centuries seems to be indicated by the comparisons of several groups of trees. Ten young Dolores trees, none of which was over 30 years of age, have an average ring-width of 3.52 mm, whereas the average ring-width for the same period in the lives of 14 old Ft. Lewis trees, which for the most part began their growth in the 1600's, is 2.68 mm. For 4 Falls Creek logs, all of which were seedlings in the years between 1430 and 1594, the average ring-width for their first 25 years is 2.14 mm. Two groups of young trees in northern Colorado, studied earlier, grew at the rates of 2.53 mm and 3.06 mm respectively. Old trees in the same group had grown at the rates of 2.74 mm and 2.40 mm during similar youth periods.

To correct growth curves for the "age" effect, the records of measurements for 18 trees were averaged and a composite growth curve obtained (Figure 1, bottom). Such a curve would need correction when applied as a standardizing line to the individual tree curve but would be preferable to lines with abrupt and arbitrary changes in direction.

Although it is impossible to derive the details of climate from even the more intricate tree-ring studies, one may conclude from the data presented herewith that the climate of the San Juan Basin has not differed greatly during the last four or five hundred years from that covered by our weather records. Some of the weather fluctuations have no doubt been greater than those shown in gage records.

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NOTES ON DENDROCHRONOLOGIES AT THE ARNOLD ARBORETUM

EDMUND SCHULMAN

The Arnold Arboretum of Harvard University, at Jamaica Plain south of Boston, Massachusetts, contains several species of particular interest to dendrochronologists. In general, mesophytic forest types prevail, as a con-

sequence of the evenly distributed precipitation of some 40 inches annually and the moderate temperatures of the mid-latitudes in coastal regions. However, tree sites may be found on knolls at elevations of 200-300 feet where is exposed the underlying bedrock—Roxbury Conglomerate associated with the Permian glaciation; the characteristic openness of stand on such sites would appear to be related at least in part to limited soil moisture. The ring records on several upland areas were examined early in 1944; the following notes are limited to some general features of the chronologies, since insufficient material was obtained to justify quantitative analysis.

CEDAR OF LEBANON, *Cedrus libani*

This large conifer of the Taurus, Lebanon, and other ranges and its related species of the Atlas Mountains (*C. atlantica*) and the Himalaya Mountains (*C. deodara*) represent a most promising potential source of drought chronologies in the eastern hemisphere. Interest in this species is enhanced by the well-known, extensive use of *C. libani* in Biblical times.

Seeds of the Lebanon cedar were successfully planted at the Arboretum in 1902; the dozen or more trees now average well over a foot in stem diameter. The site of the stand, although near a hilltop, is gently sloping and with fairly deep soil.

Core samples showed the rings to be very well defined. The youth of the trees, the average ring-width of about 4.5 mm, and the fairly complacent growth precluded the presence of any missing rings. Little may be said about ring sensitivity or crossdating in such young, favorably-located trees; the narrowness of the 1936 and 1934 rings seems promising (see the chronology below in hemlock). False rings are present but are very diffuse, of the form normal in ponderosa pine of the Southwest, and easily recognized. A curious feature is the presence of extremely faint bands, five to twelve or so within each ring, which might be called embryo false rings.

EASTERN RED CEDAR, *Juniperus virginiana*

Although seldom found in extensive stands, this conifer can survive on difficult sites and is widely scattered throughout the eastern United States. The closely-related species of the Southwest, *J. scopulorum*, is the only juniper commonly useful for chronology study in that region.

Two trees, of 6-inch stem diameter, 12-15 feet high, and growing with roots in cracks along the top of an almost bare rock knoll, proved to be about 130 years old. The outer century of growth measured 39 mm on one core and 58 mm on the other. Although the variability in chronology appeared to be much greater than in the hemlocks noted below, a recognizable crossdating existed, for diagnostic rings such as 1924 and 1899 were unmistakable.

The great difficulty in correctly "reading" the chronology in junipers of the Southwest, even in those trees which show good circuit uniformity, is the presence of annual-like false rings. The Arboretum junipers are no exception. Numerous sharply-bounded false rings were noted; a few can be recognized as such only under the best conditions of illumination of the razor-cut 40° surface (Tree-Ring Bulletin, vol. 7, no. 4).

It seems probable that at least part of the pronounced intraseasonal fluctuation in ring growth of the eastern red cedar is related to weather changes within the growth season. This species may thus prove very useful in relevant ecological studies, particularly when the specially-sensitive relation of chronology to site, observed in other junipers, is studied.

EASTERN HEMLOCK, *Tsuga canadensis*

A fine stand of this species on Hemlock Hill was destroyed by the hurricane of September, 1938. Only a shallow soil is found on this gently-sloping dome. Hemlock is of special interest in New England dendrochronology, for, as Lyon has shown, it is one of the best sources of chronology.

Preliminary examination of a number of stumps showed that, as in the Southwest, relatively narrow rings tended to remain narrow about the circuit, whereas wide rings were likely to vary greatly along different radii. A skeleton plot was therefore made of the narrow rings in each of the oldest trees, seven ranging from 130 to 170 years in age being found. The count was made inward from the bark ring at 1938, which had been completed at the time the trees were blown down.

A fair degree of crossdating existed between all trees. Although there were perhaps one-third as many diagnostic rings as in the more sensitive Douglas firs and pines of the Southwest, it was soon possible to "pick up the dating" in the middle of the sequence and date the series to the outside ring at 1938. The early decades of growth showed characteristically complacent rings. Surges in growth following release from suppression occurred at various times, there being some indication of a general release in 1874 (though this may be related to the poor growth just preceding this date).

No locally-absent rings were found (even the oldest trees were hardly over-mature), and no emphatic false rings were recognized. Since even the narrowest rings were of the order of one mm in width and since the entire circuit of each stump was examined, it appears unlikely that any microscopic rings exist and were omitted from the count; this is checked by the crossdating. However, this very rapid but crude stump-top analysis would be a very dangerous procedure on difficult ring series, such as in the drought conifers of the Southwest.

The chronology of narrow rings is given below, weighted in direct proportion to the relative narrowness.

1936— 1	1899—10	1872— 3	1841— 4	1811— 7
1934— 2	1896— 3	1871— 5	1840— 1	1806— 2
1924— 8	1895— 3	1866— 3	1838— 3	
1918— 6	1890— 1	1864— 8	1829— 2	
1914— 2	1883— 4	1861— 2	1826— 3	
1911— 3	1880— 1	1853— 3	1823— 1	
1900— 2	1873— 5	1843— 5	1820— 4	

At the foot of Hemlock Hill several stumps of *Tsuga*, larger than any on the crest, were examined. All showed fast growth. The ring records were extremely complacent and the chronology was obscure.

A 130-year oak on a flat outside the South Street Gate, 40 inches in diameter at 6 feet, showed a very complacent, faint chronology in which the diagnostic thin rings 1924 and 1899 were tentatively identified. No chronology could be recognized on the core of a 125-year old beech, growing on a favorable site in the Arboretum.