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ROOT GROWTH-RINGS AND CHRONOLOGY

EDMUND SCHULMAN

The ring chronologies in roots have been studied only to a very limited extent. The existing literature is in agreement, however, that outstanding among the characteristics of root growth is irregularity. With some surprise, therefore, it was noted that the chronology in the roots of dry-site Douglas firs of the Southwest almost equalled in quality that of the stem growth. Only two root chronologies, which represent Douglas firs on sites over 500 miles apart, have been analysed.

Chiricahua Mountains, southern Arizona. Growing 30 feet above a steep bank in Lower Pinary Canyon, just across from the camp grounds and at an elevation of about 5500 feet, is a Douglas fir, of stem diameter about 28 inches, whose root system has been partially exposed, though nowhere is it completely undermined. The largest exposed root, running horizontally for some distance from the tree, was bored at 10 and 20 feet from the stem, in the middle of the exposed circuit. Samples of the trunk obtained at the same time showed the tree to be about 250 years old. Some sections of the root were relatively straight, others badly twisted. The sample at 10 feet indicated a pith-ring date of about A.D. 1740; the core was datable only in part of its rather erratic ring record and so was not further used. The core at 20 feet proved datable throughout and indicated a pith-ring date near A.D. 1775; the ring-width measures are plotted in Figure 1 together with the growth curve for the stem (the root core was somewhat off center, and a few inner rings are omitted). Diametral growth in the root averaged only one-third to one-fourth that of the stem radius measured; and, since both root and stem appeared quite symmetric, this can probably be taken to apply to the trunk as a whole in the portion below the branches. The surge in the diametral growth of the root in the 1850's is of interest, but the phenomenon of greater annual increase for 1854 in the root as compared with the stem appears to have only local significance. No rings were found locally missing in the stem; but in the root the cambium was locally dormant, in the sense of no new complete cells being added, during two years 1902 and 1925, both of which had exceedingly dry winters. False rings are present in the root chronology and show the usual identification criterion for false rings in Douglas fir stems—the characteristic continuation of relatively dark color between the two latewood bands.

Of special interest is the general agreement in chronology between root and stem; both records are consistent with the general chronology for southern Arizona.

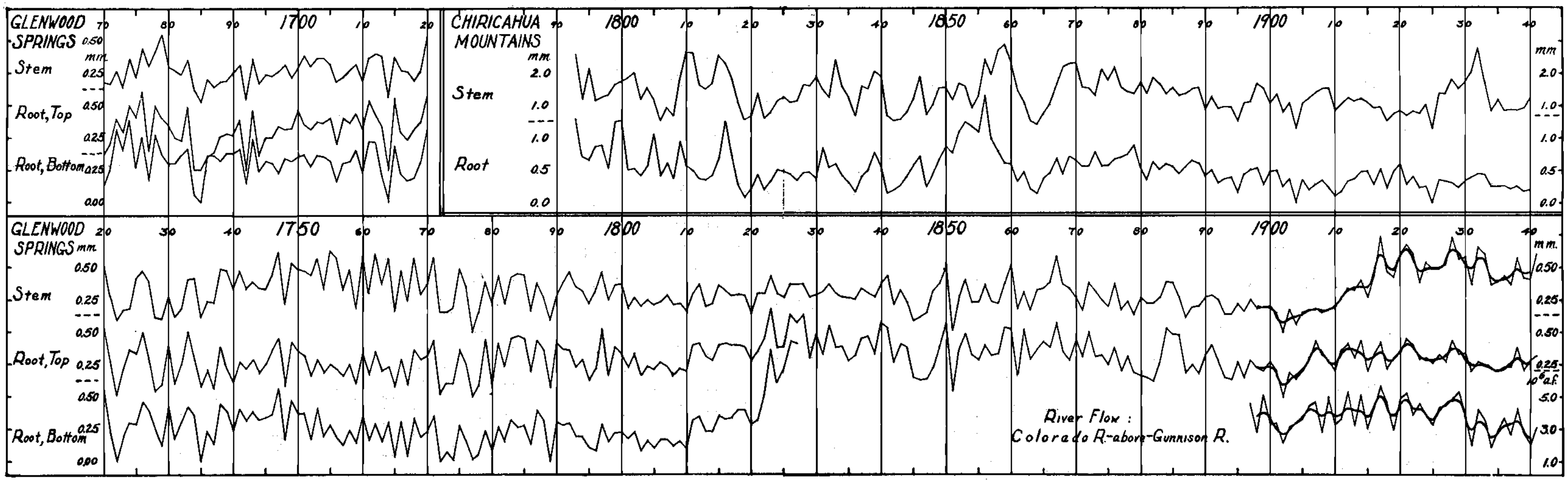

Figure 1. Crossdating between root and stem in drought-sensitive Douglas fir.

Glenwood Springs area, central Colorado. A root core was obtained from a bushy, 20-inch Douglas fir growing on a steep, sandstone ledge, elevation about 7000 feet, several hundred yards north of the Crystal River entrance to the White River National Forest. The tree has a number of roots exposed either by soil erosion or by growth along soil-filled cracks too small to completely contain them. The largest root, running horizontally, was bored at a distance of seven feet from its junction with the stem and in the center of the exposed half-circuit. With a nearly horizontal lower stem, this fir represents a rather extreme example of the characteristic downhill bulge at the base of such stunted conifers on very steep slopes. Examination of the stem core showed the ring record to be extremely sensitive, as one would expect at a site of such great moisture stress. This tree proved to be about 530 years old.

A portion of the root core extended past the center and thus gave the ring chronology in part of the bottom radius, 180° from the nearly complete top radius. The innermost ring of the latter just by-passed the pith and dated at A.D. 1653; thus the maximum age of the root (at its junction with the stem) is about 300 years.

All of the root core could be dated, and it proved to have as sensitive a ring record as that in the stem. In the top radius locally-absent rings were noted at A.D. 1684, 1685, 1714, 1777, and 1902; for the bottom radius missing rings were found at 1685, 1714, 1722, 1772, and 1789. Rings which were missing on one radius were when present on the other extremely narrow. In at least two of these cases of rings which were analysed to be locally-missing there was some indication that the ring was actually present, in the form of a single line of radially compressed latewood cells, of lighter color and somewhat more open than the final cells of the preceding year's growth. It is also possible that during the "missing" growing seasons there was some cambial activity, represented by a thickening or deposition on the outside cell-wall of the previous year's growth.

No false rings were found, in contrast to the record in the Chiricahua root discussed above. The very small average annual growth of the Glenwood Springs tree may account in part for the difference. Climatic differences are, no doubt, also responsible in part: false rings are common in fir in southern Arizona but quite rare in the colder climate of the Glenwood Springs area of Colorado.

Circuit uniformity in the root is very high, as indicated by the very close agreement in growth fluctuations in the top and bottom radii shown in Figure 1. This appears to hold true even within a few years of, and perhaps right to, the pith. (17 inner rings on the root core were not measured because the sample was progressively more tangential than perpendicular to the rings, and ring limits were thus difficult to determine). Even in this fine record one erratic surge in growth may be noted on the bottom radius, however, in the 1820's.

The remarkably parallel fluctuations of stem and root are also shown in Figure 1. There is, thus, strong evidence that root chronologies in Douglas fir are of excellent indicator value, if the tree is on a good chronology site with respect to stem growth. The straighter sections of the root, no doubt, are the most favorable in this respect. Although half of the root circuit was exposed, there does not seem to be any substantial difference in growth characteristics between the top and the bottom radii; however, the latter is not represented by any data in the critical outside century of growth.

It is notable that the upsurge in the stem growth in recent decades, shown also on a supplementary core 90° from the complete one, is much less pronounced, if present at all, in the root growth. This surge seems to be merely a release from suppression.

The root core gives a surprisingly fine record of runoff of the upper Colorado River. The winter precipitation records of the area also show good agreement with the root chronology. (The record at the nearest station, at Glenwood Springs, appears to be defective because of an apparently artificial trend!) That available moisture is the dominating factor in controlling year-to-year fluctuations in root growth of this dry-site Douglas fir thus seems reasonably clear.

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THE RANGE OF RING SENSITIVITY

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In the April, 1942 BULLETIN examples of the extremes in ring sensitivity in the Rocky Mountains were discussed. Illustrations supplementing that paper are given here.

In the presence of valid crossdating, the degree of ring sensitivity appears to be directly translatable into climatic quality, and thus the most sensitive specimens are the prizes in the field collections.

Figure 2, illustrating the identification of missing rings, shows also the profound effects of environment and exposure on the ring chronology in Douglas firs.

The upper panel gives the ring records in two very old, shrub-like trees near Salida, Colorado, on a steep southeast slope facing the Arkansas River valley. The gravel surface, underlain by sandstone, limestone, and shale, is spotted with a sparse vegetation: largely dwarfed firs about a foot in diameter at the base, tapering steadily to snag tops 10-12 feet above the base, and usually showing strong spiral growth in stem and branches. The average annual radial increment of 0.15 to 0.35 mm indicates that the site is one of so-called bound growth, as does also the damped character of the growth fluctuations from year to year. Crossdating is, however, very good for these relatively complacent trees, and in spite of the extremely small average ring-width there are no locally-absent rings on the cores. The gravel surface may permit some conservation of moisture in finer material beneath it.