The annual rings on the buried wood from these localities indicate a period of over 30 years with deficient moisture. Apparently this drought period contributed very largely to the death of these trees.

The correlation coefficient between ring width and the annual rainfall for 63 years at North Platte is 0.63±0.05. An occasional lag effect is observed.

The recorded droughts of 1856 to 1860, 1869 to 1873, 1893 to 1894, and the one culminating in 1910 are all reflected in tree growth very faithfully. The periods of 1676-84, 1765-70, 1795-1800, 1820-24, and 1839-43 were also apparently deficient in precipitation. The period from 1820 to 1824 is of special interest because of the apparently extreme severity of the drought and the fact that it was extraordinarily widespread, being a matter of record in the diaries of several persons in the New England States and showing in the growth of trees studied by Douglass at Flagstaff, Arizona.

The above study has been in progress for about five years; a complete report on it is in preparation.

PROBLEMS IN DATING RINGS OF CALIFORNIA COAST REDWOOD

EMANUEL FRITZ*

In this brief note are described several anomalies in growth rings of California redwood (*Sequoia sempervirens*) which the tree-ring analyst must consider when working on redwood as a possible means of dating past climatic events.

Discontinuous growth rings.—In leaning redwoods all growth rings will not completely encircle the tree. On the side toward the lean, they take an abnormal width and their anatomy is that of compression wood. On the opposite side, diameter growth is dormant for most of the period of the lean, with occasional years producing very narrow rings. One tree example may be cited. This tree stood on a slope that had slipped apparently 161 years before cutting. When felled, it showed a long diameter of 102 inches and a short one of 45. The radius of the side toward the lean was 82 inches but only 20 inches on the opposite side. There were 472 rings on the 82-inch radius and 363 on the 20-inch radius. There were 161 rings of the new type, but of these only 109 appeared also on the 20-inch radius. Thus 52 rings failed to be formed completely around the trunk. Since the time of the slide that slanted the tree, diameter growth on the long radius was 58 inches but only 4 inches on the short radius opposite. A tree-ring analyst would hardly spend much time on a leaning tree, but the observation is nevertheless of interest.

Discontinuous rings are very common in vertical and apparently normal old-growth redwood trees. At this time no reliable explanation can be offered. It is almost certain that in large and very old trees the ring count on any one radius fails to add up to the age of the tree. Several radii must be counted and then, for greater accuracy, the area between the radii must be studied intensively for evidences of "lost" rings. For example, tree section no. 1596, measuring 37 inches in diameter one way and 43 inches at right angles, gave the following ring counts on five separate radii: 268, 290, 348, 363, and 397. In this case it was possible to make a single count to obtain 397 by counting on the 268-year radius until discontinuity was noted and then moving circumferentially to other radii and continuing the count to the outer edge. Another section, no. 1546, with a diameter of about 10 feet, and cut about 20 feet above the ground, gave the following radial counts: 1755, 1809, 1901, 1911, 1941, 1984, 1995, 2015, and 2079. Later, the area between the "oldest" radius and the neighboring radii was examined and an additional 98 rings were picked up.

Discontinuous rings are found also in young trees and in the accelerated-growth portions of trees that have been released from long suppression[1]

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Spiralled compression wood.—Frequently associated with discontinuous rings in coast redwood is compression wood. In the case of leaning trees the rings formed after the lean began are largely compression wood in the area toward the lean, while on the opposite side the wood is the normal type. Compression wood is an old story in leaning trees. But in apparently plumb old-growth trees there often also appear areas of compression wood. A group of rings, collectively, will form a crescent-shaped body of compression wood, some of the rings often being discontinuous some distance from the crescent. More interesting, however, is the formation of compression wood in a continuous spiral. Each new growth ring develops compression wood for several inches along the circumference, but each year this strip of compression wood begins and ends a fraction of an inch farther to one side. Collectively, this series of compression wood strips, therefore, appears to spiral around the tree. Fig. 1a is a reproduction of a pen-and-ink sketch of the cross section of tree no. 1596. Only such part of each growth ring as exhibits compression wood is reproduced. Within the zone of compression wood there is no discontinuity of rings, and the rings are wide and easily

[1]E. Fritz and J. L. Averell, Discontinuous growth rings in California redwood, Jour. Forestry, 22, 31-38, 1924.

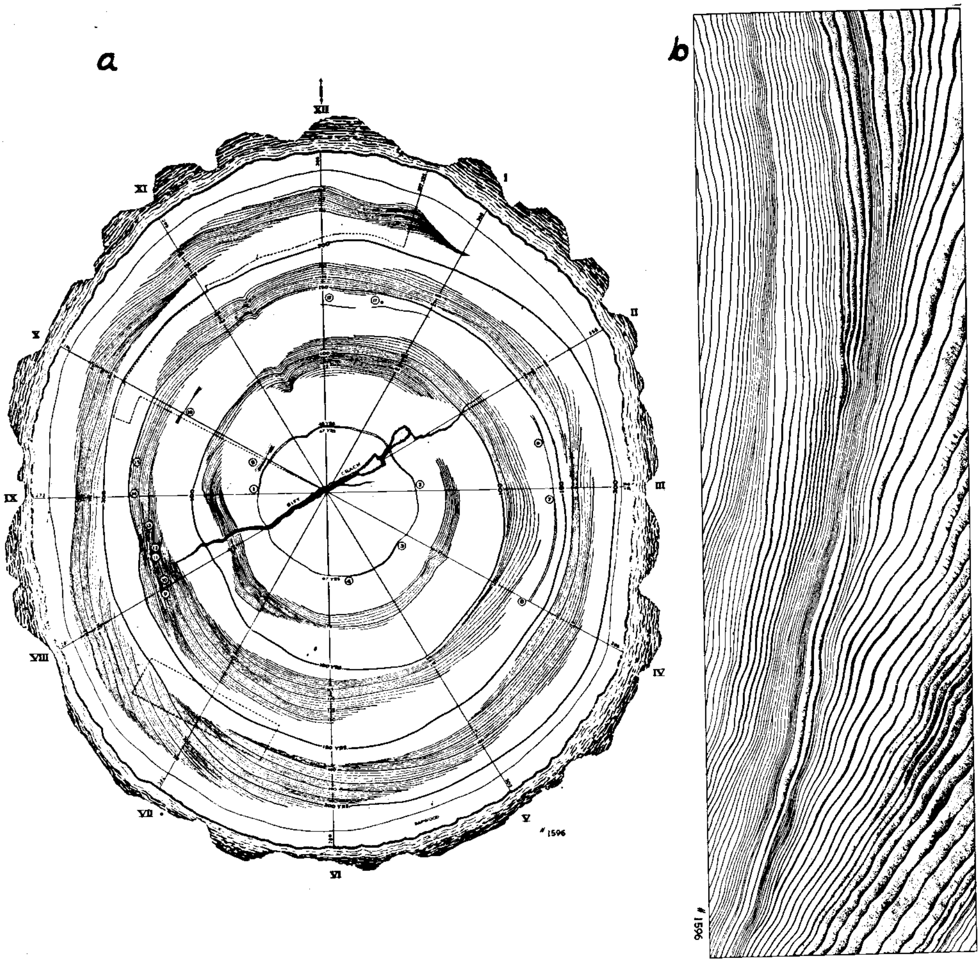


Fig. 1a. Spiral compression wood in California coast redwood.
Fig. 1b. An enlargement of the area enclosed in the rectangle in 1a.

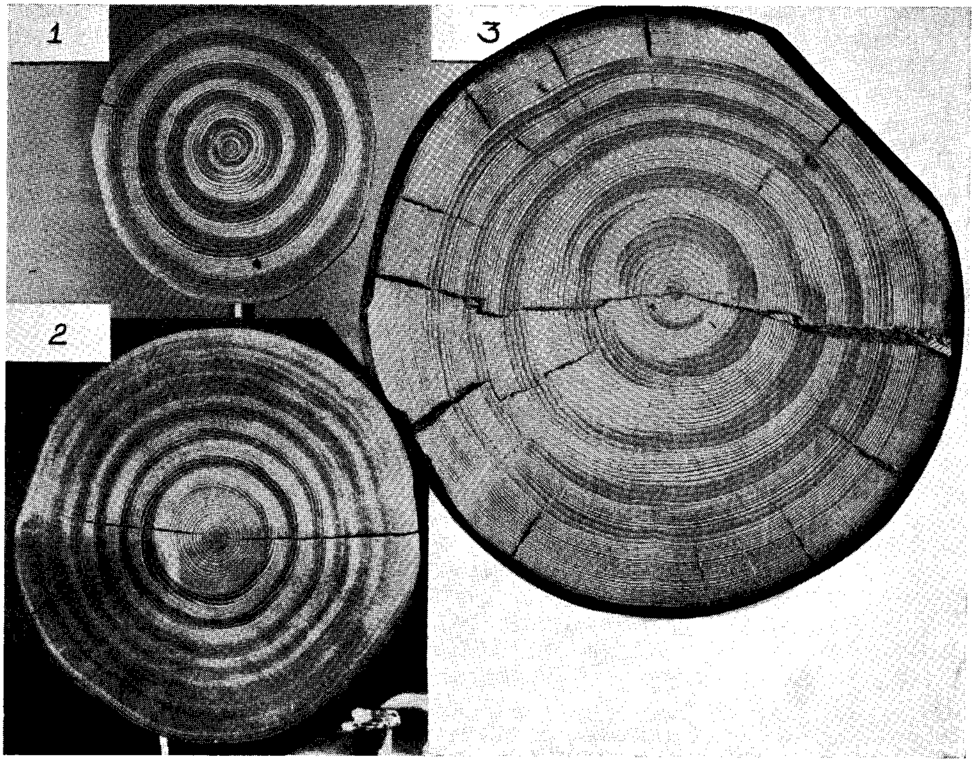
followed. Immediately outside the zone the rings may continue as wide as within the zone but lack compression wood characteristics. Soon, however, the reverse of wide-ringed zones is encountered, when the rings become narrow and abruptly converge while some disappear. In fig. 1a the spiral makes three circuits of the trunk. In another specimen recently studied eight full circuits are made. Obviously, the abnormal thickness of the growth rings in the compression wood area is not related to climatic factors, and borings into such spiralled trees are worse than worthless to a student attempting to determine a relationship between rings and climate. Fig. 1b is a pen-and-ink sketch of the area, denoted by the rectangle in fig. 1a. With a low-power hand lens the discontinuity is easily noted. Typical compression wood portions are stippled to distinguish them from non-compression wood portions.

Redwood's two-millenium span of life makes it an especially valuable tree, but obviously specimens must be selected with great care and studied with due attention to the anomalies mentioned before they can be regarded as reliable recorders of past climatic conditions.

EXAMPLES OF SPIRAL COMPRESSION WOOD

A. E. Douglass

The photographs in fig. 2 show three very interesting cases of spiral compression wood. Numbers 1 and 2 show two sections in the Skogshögskolans Botaniska Avdelning, Stockholm, Sweden. Picture no. 1 was forwarded by Dr. Carl Malmström at the request of Professor T. Lagerberg;



Scale: Nos. 1 and 3 are ½ actual size, no. 2 is ¼ actual size.

Fig. 2. Photographs of cross-sections showing spiral growth of compression wood.