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TREE RINGS IN THE WESTERN GREAT BASIN

by

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PREFACE

This summary was presented by C. W. Ferguson at the 1962 Great Basin Anthropological Conference, Carson City, Nevada, September 7, 1962. As a status report, it has been updated for the present publication with the assistance of R. A. Wright. Various aspects have been aided in part by financial assistance from the National Science Foundation (Research Grants NSF-G 5568 and NSF-G 19949). Continued studies have been conducted in the Department of Watershed Management and the Laboratory of Tree-Ring Research at the University of Arizona, Tucson. Collections of specimens have been made in cooperation with the Death Valley National Monument, the Lava Beds National Monument, the U. S. Forest Service, the Eastern California Museum, the Nevada State Museum, and the Department of Water and Power of the City of Los Angeles. All specimens mentioned in this report are on deposit at the Laboratory of Tree-Ring Research. Dr. Ferguson is a Research Associate and Mr. Wright is a Graduate Associate in Research at the Laboratory.

INTRODUCTION

The success of tree-ring dating in the Southwest has not been duplicated in the Great Basin area. Studies of modern tree-ring material in the western Great Basin have been relatively limited, but substantial work has been done by Douglass (1928), Hardman and Reil (1936), Keen (1937), Antevs (1938), Schulman (1956), Schulman and Ferguson (1956), Ferguson and Wright (1962), and Ferguson (1963).

In terms of tree-ring dating in the Great Basin, as elsewhere, there are two major aspects: the modern, dealing with both chronology building and interpretation in terms of environment, and the archaeological. Archaeological dating is dependent upon the finding of tree-ring material of suitable sensitivity and length preserved in archaeological context. There has been no dating of archaeological tree-ring material in the Great Basin due to a combination of the paucity of excavated wood and charcoal and to the difficulty in dating any such material. Conditions for the dating of both modern and archaeological material, however, are met in the western Great Basin, and it remains for time and the

active participation of research workers to establish the framework for more extensive dating in the area.

MODERN MATERIAL

Renewal of the study of bristlecone pine, Pinus aristata, in the White Mountains of California was made possible by a National Science Foundation grant to the University of Arizona. Staff members of the Laboratory of Tree-Ring Research have developed a chronology for bristlecone pine in the White Mountains of California and have carried out associated environmental and growth studies and have made statistical comparisons between various factors.

The inventory of specimens left by Edmund Schulman has been completed, and his dating has been found to be correct back to 780 B.C., the limit he had reached by the time of his death. Schulman's collections were made to find chronologies of the greatest possible length. As a result, the average ring width on many of his cores was so narrow and the frequency of locally absent and missing rings was so high that dating was difficult. Subsequent studies have shown that commonly up to five percent of the annual rings may be missing on a single radius of the older trees. Field collections are now largely aimed toward finding more usable chronologies in difficult and early time periods. These usually cover shorter, more specific periods, but can be incorporated into the master chronology by cross-dating.

As of May 1, 1963, a usable master chronology had been established for a total period of 3850 years. This has been cross - checked with other chronologies as far back as they were available -- 1900 years for limber pine, Pinus flexilis; 2000 years for the Southwest master chronology; and 3200 years for sequoia , Sequoia gigantea. The master chronology represents a combination of chronologies of individual trees and is based upon a decreasingly smaller number of trees in the earlier time periods.

The methodology of chronology building and tree-ring analysis and interpretation has been refined by the use of programs, written in Fortran for use on an IBM 7072 computer system (Fritts 1963). Computer programs developed for rapid processing and computing of data from measured tree-ring series, include standardization of ring widths and calculation of averages, first order serial correlation, standard deviation, and mean sensitivity. Correlation studies can then be used to establish the similarities among any groups of series. An additional program is used to plot either absolute or standardized ring measurements.

The present White Mountain bristlecone pine chronology still is in the process of being refined and extended. At this writing, the earliest date reached by a well established mean is 1550 B.C. A detailed study of four full cross sections of a tree permitted an extension to a pith at approximately 1900 B. C.

Full cross sections greatly simplify the search for locally absent rings in that the complete circuits can be checked, thus reducing the probability of omitting the ring for a year of minimum growth. Sufficient material is on hand to provide a usable and relatively reliable 4000-year chronology by the 1963 summer field season. This master chronology will permit a rapid and extensive search for additional old trees of desirable chronology characteristics by the extraction of pith area cores, thus not initially requiring a complete radius. In this manner a single core containing a series of hundreds of years can be dated against the master chronology and its tree-ring characteristics can be evaluated. Then, if age and sensitivity are shown to be desirable, a more complete sampling can be made during the same field season.

Utilizing unpublished data of Schulman for the bristlecone pines in the White Mountains of California, Fritts (1963) has correlated the bristlecone pine tree-ring indices for 1650 to 1920 with series of other species from 19 stations (Schulman 1956) at varying distances from the White Mountains. These chronologies, 271 years in length, show significant correlations, and hence, significant dating with the bristlecone pine chronology, up to approximately 1000 miles eastward and southward, 700 miles to the northeast, and 300 miles to the north. The development of a 4000-year bristlecone pine chronology should lead to eventual dating, if not by visual inspection, by means of cross-correlating at all possible dates with early archaeological samples throughout Nevada, Utah, southern Idaho, the Rocky Mountains of Wyoming and Colorado, New Mexico, Arizona, and as far as northern Mexico. As a corollary to dating based upon the bristlecone pine master chronology, other chronologies could be established throughout eastern California and Nevada.

Growth-ring studies were made on material from single-leaf pinyon, Pinus monophylla, stumps cut in the late 1800's near Charcoal Kilns, Panamint Mountains, Death Valley National Monument, California (Ferguson and Wright 1962). Increment borings from adjacent pinyons, limber pines, and bristlecone pines, and cross sections from two recently cut pinyon stumps and from numerous stems of big sagebrush, Artemisia tridentata, provided a basis for the development of a master chronology for the Panamint Mountains and the subsequent dating of the historic Charcoal Kilns material. Cutting in the period 1876-1879 was indicated by tree-ring dates from 25 stumps and one piece of road cribbing. Identification of individual years in the growth-ring sequence was progressively more difficult in trees toward the lower elevational limits of the pinyon, due to the high frequency of locally absent and missing rings. In many specimens, five to ten percent of the years in intervals of one hundred years or more were not represented on a single radius by growth for a given year. Dating of all increment borings and cross sections was made possible by the selection and use of specimens from upper elevations that had a larger average ring width and few or no missing rings. Following the proper identification of the critical intervals in both the modern specimens and the stumps, standardized values were derived for the mean from 1700 to 1954 of absolute ring widths of four pinyon pines, comprising the Panamint Mountains master chronology,

and the mean from 1760 to 1868 of eight measured stump specimens, comprising the comparison chronology. Plotted values were used to illustrate the visual dating. Standardized values for the mean of the eight stump specimens were incorporated into the Panamint Mountain master chronology.

Utilizing computer techniques, correlation routines can measure all possible matches between two series of indices. Dating of either modern specimens or archaeological material is achieved by visual inspection (sliding coincidence or memory methods) by the use of skeleton plots, or by the use of plotted ring measurements (Douglass 1946; Roughton 1962; McGinnies 1963). In instances where ring series cannot conclusively be dated by visual or plot techniques, the computer-programmed correlation routine can be used to cross-date indices. To illustrate and further verify the relationship between the master chronology and that of the stump material, the data from the Charcoal Kilns study were punched on cards and processed on computer programs. Linear correlation coefficients for 147 succeeding years were derived with the end dates of the interval of comparison ranging from 1808 to 1954. With the exception of the matched date, the correlation coefficients ranged from +0.20 to -0.27. The match point had a value of +0.77 at an end date of 1868. Hence, a significant difference occurs between the high match point correlation and all other values, and the correlation coefficients for the other 146 correlations behave normally in that 99 out of 100 cases appear to fall within the expected limits of $\pm$ 0.25.

Comparable correlations also were run using the logarithmic transformation of the index values. The match point had a correlation coefficient of +0.85 at the same end date, 1868. The higher value of the logarithmic transformation is due to the weight that this routine places on the small rings. The emphasis in dating that is placed on small rings (Douglass 1946) is reaffirmed by the high value of the logarithmic transformation.

The accumulated evidence of dated specimens, plots of measured ring series, and standardized means - - not to mention the personal familiarity of the dendrochronologist with the material - - provides a base upon which to date additonal specimens and other species in the area and to extend this dating to nearby regions that at present are unrepresented by tree-ring chronologies.

A preliminary basis exists for the establishment of a 350-year tree-ring chronology for the Truman Meadows area, Nevada, north of U. S. Highway 6 near the California line. Increment borings were taken from 13 single-leaf pinyon pines in June, 1962. The length of ring series on single cores from individual trees ranged from 140 to 362 years. Portions of all specimens were dated, but because of the extremely small and missing rings, the cores have not yet been completely analyzed. Additional specimens, especially one or two cross sections, would be required for the identification of all critically small rings and the establishment of a master chronology. Complete dating of

pinyons in this area would be aided by the use of the well established chronology for bristlecone pines only a short distance south in the White Mountains of California. And, once dated, the Truman Meadows pinyons may be of use in archaeological dating, both in the Truman Meadows area and at the antelope trap site south of Hawthorne, Nevada.

A manuscript dealing with growth rings in Mormon tea, Ephedra viridis, in the White Mountains of California is in preparation. It has been found that this species reaches ages of over one hundred years, and that the chronology is basically the same as that for nearby specimens of bristlecone pine, limber pine, single-leaf pinyon, and big sagebrush.

ARCHAEOLOGICAL MATERIAL

A pinyon stump mortar from the Hunter Mountain area, north of Death Valley, California, was examined and found to have about 162 rings. The quality of the ring series was similar to that of the Charcoal Kilns stumps and, while it apparently dated, it was deemed necessary to have more modern material from the nearby area before the date and its substantiating evidence could be released.

An extensive collection of pinyon and juniper wood has been made from the remains of a stone and log wall of a supposed antelope trap south of Hawthorne, Nevada. Increment borings have been made from pinyon trees on the site and from nearby areas, but time has not permitted their study. Ultimately, the White Mountain chronologies and comparable data from Truman Meadows, the Charleston Mountains, and other areas in Nevada will provide for the establishment of a modern chronology for the antelope trap site. The pinyon was considered to offer the best possibilities for dating and innumerable cross sections have been measured and plotted. Eight of these have been cross-dated, in part, and indicate a floating chronology of about four hundred years. Again, more time and effort will need to be expended to work out the details of cross-dating, both of the modern and of the prehistoric specimens, before a local master chronology can be established and the site dated.

Test excavations in the Truman Meadows area were made in June, 1962, under the direction of Ruth D. Simpson of the Southwest Museum. Charcoal fragments, one to two centimeters in diameter, were found near the surface. These were mostly pinyon and had only 20 to 30 annual rings. There was much variation in average ring width and in sensitivity of ring pattern. Some specimens had ages up to 52 years and apparently datable chronology characteristics. More complete excavation undoubtedly would disclose larger specimens and longer ring series which could be cross-dated and grouped into a floating chronology. Strengthening and lengthening such a chronology would eventually provide sufficient data to identify it with a master chronology.

A second test excavation was made in July, 1962, at a cave site near Crowley Lake, California. Burned fragments of big sagebrush were found on the surface. These contained 13, 14, 18, and 34 annual rings, but were so complacent that they would not date even if longer series were present.

During the summer of 1962, excavations were made of pithouse structures in the Lava Beds National Monument in northern California. Archaeological and modern tree-ring material, including both juniper and pine, was analyzed by Marion L. Parker at the University of Arizona. Some cross-dating was found within the site and with modern material, but the dating is only tentative. Modern material from the immediate area was available, but published modern chronologies for nearby areas provided a basis for comparison.

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