

Report on the Chronology Phase of the
Bristlecone Pine Study

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This report summarizes the work done on the chronology phase of the bristlecone pine study, "Continuation of Studies on the Dendrochronology of Bristlecone Pine (Pinus aristata Engelm.)" and the earlier "Dendrochronology of Bristlecone Pine (Pinus aristata Engelm.) as a Basis for the Extension of Dendroclimatic Indices," which were supported by National Science Foundation Research Grants GP-2171 and G-19949, respectively. This research continued studies initiated by Edmund Schulman under NSF Grant G-2274, but terminated by his untimely death in 1958.

The proposal (1961) was "to make an analysis of growth rings of bristlecone pine, to construct a tree-ring chronology covering more than four millennia," and (1963) "to complete studies underway in the establishment of a 4600-year tree-ring chronology for bristlecone pine in the White Mountains of California, ...to extend the study of bristlecone pine to major sites throughout the range of the species, and to cooperate with The University of Arizona Radiocarbon Laboratory in the establishment of a joint control for the long-term dendroclimatic calendar."

A status report was presented January 10, 1965, in the proposal "Dendrochronology of Bristlecone Pine Prior to 4000 B.C." The title of this study (supported by Research Grant GP-4892) expresses a degree of confidence in the strength and extent of the bristlecone pine chronology. At that time, the limit of the chronology was 3878 B.C.

The present master chronology for the White Mountain area has a computer-derived standardized mean that terminates at 2400 B.C. The growth-ring chronology from living trees that have a maximum age of nearly 5000 years has been extended

with records from long-dead trees. Various measured ring sequences from remnants dating to about 4650 B.C. have been submitted for computer processing. This early record is still in the process of development, but the quality of the crossdating is good and the confidence in the dating is high. There are, for example, four specimens represented by ten measured radii at 3200 B.C.

Studies of bristlecone pine throughout its geographical extent have been deferred because of the pressing need for intensely developing the White Mountain chronology for maximum length. In various stages of development, however, are bristlecone pine chronologies for the Inyo Mountains that adjoin the White Mountains on the south, the Panamint Mountains that lie west of Death Valley, and the Spring Mountains near Las Vegas, Nevada. These areas all show value for climatic analysis and probably will be developed in conjunction with the "Dendroclimatic Series" project at the Laboratory. Other more isolated areas are also being studied: near Cedar Breaks and Bryce Canyon in Utah and in some of the high mountain areas in Nevada. The Wheeler Peak area has produced a 4900-year-old bristlecone pine (D. R. Currey, "An Ancient Bristlecone Pine Stand in Eastern Nevada." *Ecology* 46(4):564-6. Early summer, 1965).

Cooperative dendrochronological and radiocarbon analysis of this millennia-old wood has proved to be mutually beneficial. Carbon-14 dates, used initially as a guide to the precise tree-ring dating of remnants of unknown age, were in turn interpreted in terms of the actual tree-ring age of the specimen. The resultant series of dual dates, extending to 4200 B.C., indicates that radiocarbon determinations on specimens 2000-years-old and older result in derived dates that are increasingly too recent. The discrepancy between the C-14 dates and the calendar dates may reflect a long-term change in the relative amount of radiocarbon in the atmosphere, a change that may be associated with the warming

period following the last glaciation. The bulk specimens of bristlecone pine are providing precisely-dated wood for detailed radiocarbon analysis that is aimed toward defining the discrepancy between radiocarbon and actual dates.

Associated studies in the dendrophysiology and dendroclimatology of bristlecone pine and other coniferous species are providing a basis for the interpretation of paleoclimate.

Many aspects of the bristlecone pine chronology study will be continued under the current NSF Grant GP-4892 under the title "Dendrochronology of Bristlecone Pine Prior to 4000 B.C." The initial projects provided a basis for the extension of the tree-ring chronology into earlier periods. Recent additions give, for the above title, a chronology of 600 years (to 4600 B.C.); and thus provide a continuous chronology of over 6600 years.

The relation of the past projects to radiocarbon analysis has been very favorable. The emphasis in cooperative studies which originally provided a C-14 date as a guide to the tree-ring dating of remnants of unknown age is now reversed and we are supplying precisely-dated wood as a calibrated control for C-14 analysis. In anticipation of increased requests for dated wood in the B.C. time-range, we are collecting bulk wood so that the Laboratory can serve as the distribution point for such material.

Dr. LaMarche of the U.S. Geological Survey is continuing his study of short-term geologic erosion based upon the ages of the bristlecone pine. He currently is interested in the relict timberline and has submitted for radiocarbon analysis wood found from 400 to 600 feet above the present timberline. The tree-ring dating of these remnants will depend upon our development of a long-term upper timberline chronology (our primary emphasis has been upon the drought-controlled chronology of the lower limit of the species).

Four papers are in preparation:

Dendrochronology of bristlecone pine, Pinus aristata, to 780 B.C.

(with Edmund Schulman) Accepted for publication in the Tree-Ring Bulletin.

Relation of radiocarbon dates to dendrochronologically dated bristlecone pine, Pinus aristata. (with Paul Damon) Suggested for Science.

Determination of the age of the Thayngan settlement of Swiss Lake Dwellers as an example of dendrochronologically calibrated radiocarbon dating.

(with B. Huber and H. E. Suess)

Pollen analysis of dendrochronologically dated bark traps.

(with V. C. LeMarche, Jr. and D. Adam)

The increasing scope of the study has moved back the publication date of a definitive monograph covering all aspects of the development and presentation of the tree-ring chronology for bristlecone pine. This will be done near the end of the present project, probably with a contribution by Dr. Fritts on the climatic interpretation.

Tangential to the main body of research are an ever-enlarging number of smaller projects that will be published separately. Among these are:

A report on archaeological dates based upon the bristlecone pine chronology. Two sites have already provided such dates. One, Crooked Creek Cave, is at an elevation of 10,000 feet in the Ancient Bristlecone Pine Forest. A second is the so-called antelope trap site south of Hawthorne in west-central Nevada. Computer correlation studies with material from Navajo Mountain in south-central Utah are now in progress.

A continuous series of reports on radiocarbon dates based upon dated wood of the bristlecone pine. We now are providing wood for four radiocarbon laboratories. Their publications will cite both our Laboratory and the National Science Foundation support.