TREE-RING DATING IN THE AMERICAN ARCTIC

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The coniferous forests of the world tend to disappear with regularity toward two very different boundaries that are, nevertheless, determined by aspects of climate. These timberlines are the dry one beyond which moisture does not sufficiently nourish the tree and the cold one that does not give the tree enough time to grow. Too little work has been done at the high mountain timberlines of southerly latitudes to allow us to say much about the possibilities there, but in the arctic regions, where the upper line of tree growth sprawls out laterally to sea level and forms the "tree line," tree-ring dating has a rich potential field of research and application. As regards this latter, we can say now with great assurance that dendrochronology can be useful all around the northern rim of the continents. This is because of the detailed studies of Scandinavian botanists and foresters, which show that the northernmost forest in their area is limited by the temperature of the growing season, and by the climatic aspects of tree-ring work in Alaska and northern Canada, which show precisely the same thing. Thus far, the Europeans seem to restrict their studies of growth rings very largely to botanic and climatic matters. This author lacks knowledge as to whether or not tree-ring research has been applied in any way to the forests of Siberia.

The aims of arctic dendrochronology are only in a very small part identical with those of other investigations of tree growth. For this reason we shall summarize the uses to which tree-ring collections have been put in the American Arctic, and point up some of the positive results and difficulties met with during two decades of this areal research.

Climatic meaning. The rings of spruce trees in northern Alaska and along the lower Mackenzie River have been shown to reflect the temperature of the period of most intensive growth of the trees. This period is somewhat earlier along the sheltered rivers south of the Brooks Range than near the shore of the Arctic Sea in Canada. Thus a correlation of spruce growth in northern Alaska is strongest with mean June-July temperatures, while the July mean corresponds most nearly to tree growth at the Mackenzie River delta, as is the case with conifers at the limit of tree growth in Scandinavia. Although northern spruce trees continue to grow during the late summer, their sealing cells seem to record no appreciable further effect of climate.

The student who expects all trees near the tree line to record temperature accurately is sure to be disappointed, however. As is the case elsewhere, careful selection of the samples to be used is the first essential of dendrochronology. Circuit uniformity must be present (not to be confused with the fact that most arctic trees exhibit a cross section which is "off center") or there can be no crossdating even in the trees of one stand. Trees growing in peaty muskeg are often impossible of use because of a variety of ring distortions, including even spiralling of ring thicknesses

as seen in cross section. This phenomenon is not an aspect of the spiralling of "grain" which is always present in the best wood for crossdating. Needless to say, one could traverse Alaska negatively selecting trees that through distortions or strong local effects gave no climatic indications at all. On the other hand, it seems certain that if the averaged ring widths of groups of trees spaced dozens or hundreds of miles apart show a strong identity they are reflecting widely manifested departures in summer temperature.

One of the most fascinating possibilities in the broader climatic record in arctic trees may be just now coming to light. This is seen in the presence of crossdating qualities between spruce trees collected last summer near Churchill, on the western shore of Hudson Bay, and timberline spruce more than two thousand miles away in western Alaska. Surprisingly enough, a stand of trees near Churchill reaching back 350 years seems to bypass the Mackenzie trees for a better correlation with the more westerly trees responding to June-July temperature. We had not expected crossdating between these two areas because of a failure to find even a faint linkage between Alaskan and Scandinavian ring-widths. Yet it seems quite possible that the further study of tree growth about the tree line between Hudson Bay and Alaska will reveal further continuities of a single great climatic zone.

The climatic meaning of certain local belts or blocks of strong crossdating has not yet been solved. The most striking such area is that of the Yukon Flats region of the middle Yukon River, where the sensitive tree-ring record at river bottom differs considerably from the widespread temperature record of the timberline on neighboring mountains. These locally stamped chronologies can be either helpful or discouraging in archaeological or driftwood dating, but they do not alter the fact that the widespread temperature record exists pristine at the nearest extreme timberline. We do not yet know what happens as one approaches forested areas to the south where even the timberlines may result from a combination of factors other than arctic cold. Tree samples recently collected from south of the Alaska Range and from the forest border in southwestern Alaska may cast light on this subject.

Archaeological applications. The discovery of crossdating in the archaeological driftwood from St. Lawrence Island in the late 1930's led to overenthusiasm about the dating of many sites along the treeless shores of the Arctic. The St. Lawrence Island wood provided thousands of samples mainly from recent levels, and two chronologies were extended back to about 1550 A.D. One of these was later lengthened to 978 in wood excavated along the Kobuk. Other hundreds of promising samples of driftwood from earlier levels of the same sites and other sites of Alaska that are now on record but undated will undoubtedly be useful in time, but as yet we have added little to the chronologies first worked out from wood that we know originated either along western Alaska rivers or in the region of the Yukon Flats. More collections should be made along the big Arctic rivers. When that is done and chronological patterns are established for each river, then even more ancient driftwood villages can be dated. On hand just now for complete analysis are collections of wood from the Birnirk and other excavations at Point Barrow, from islands near the Colville River mouth, from points along the eastern shores of Bering Sea, and a

few other localities all visited by achaeologists other than the author.* Also to be completely studied are the collections of wood from excavations by the author in the Norton Bay region of Bering Sea. Cooperative effort in collection offers promise of eventual success in extending chronologies in driftwood of unknown origin, even though results are painfully slow to accumulate.

The archaeological use of river drift from a short river is an entirely different matter. We have been most successful in dating the sites of the Kobuk River, and now have a chronology nearly 1,000 years long (and quite parallel in its latest years with available records of June-July temperature) that can be used in the field and without much difficulty of interpretation. If the need should arise, local stands of timber would offer the means of dating almost any wooden structure built recently of local wood within the broader belt of known crossdating in the Arctic. Archaeological sites, unfortunately, seldom fall within this range of dating.

The dating of sea currents. Our ability to trace many selected logs of driftwood or objects made of driftwood back to their general source of origin along the Yukon and Mackenzie rivers offers many possibilities of following paths of driftwood that scatters itself all along the shores of the Chukchi Sea and the Bering Sea, and, to a limited extent, eastward around the shores of the Arctic Sea. Some conclusions as to sea currents have been published, including evidence of a northward current through Bering Strait and a meeting of this current with a west-flowing one near Point Barrow. Many lines of research can be seen in this direction. The broadest applicability of sea current dating would be realized, of course, only if the tree-ring sequences of all the major rivers flowing into the Arctic Sea were known.

Several other lines of research in tree-rings about the arctic tree line have been suggested or partly explored. One of these concerns crossdating in buried wood of the silt deposits in the regions of permafrost preservation. The first extensive sequence of prehistoric arctic crossdating was worked out in wood from such a deposit near Fairbanks, and the geological application of the results of this work seem promising.

One may well ask why so much of the dendrochronological work begun or suggested for the far north since the middle 1930's is still unfinished. The answer is partly that tree-ring dating in this region has applications that need never be concluded, but we must realize as well that this work is very demanding in energy and meticulousness. The researcher has to explore and collect in many almost inaccessible places, and then to sit endless hours measuring, plotting, and cross-comparing. As a primary discipline, arctic dendrochonology will progress as students learn the fascination of its precision as a research tool, but it cannot be expected to serve at all if it is not given long hours and proper care.

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*A very interesting and important collection has just come in (September, 1954) from Banks Island, a most inaccessible part of the Canadian archipelago, east of the mouth of the Mackenzie River.