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EDITORIAL

As most readers of this journal already know, the *Tree-Ring Bulletin* has appeared at irregular intervals over the past few years. The reason for this irregularity has been the increased difficulty in obtaining suitable manuscripts for publication. So serious had the situation become, that the *Bulletin's* former editor, the late Edmund Schulman, was considering discontinuance of the journal altogether. Following Schulman's untimely death, and as reported in our last issue, the Tree-Ring Society met in Tucson, Arizona, on October 11, 1958, to consider the problem. In the minds of those attending this meeting, and in the opinions expressed in letters solicited from the Society at large, there was overwhelming agreement that the *Bulletin* should continue to be published in spite of delayed deadlines. As evidenced by the date of this issue, however, the same vital problem still remains, although, in part, the fault is ours for we have purposely incurred additional delay in an earnest effort to bring you a balanced coverage of all phases of tree-ring research. As new workers enter the field of dendrochronology our position is bound to improve. In the meantime we urge our readers to exercise patience, and we sincerely encourage you and your colleagues to submit manuscripts to us.

B. B.

THE GROWING SEASON OF ALASKAN SPRUCE

W. H. OSWALT

Tree-ring studies over the past twenty years have focused upon either the relative time placement of wood from archaeological sites or upon the climatic significance of ring patterns in trees. The geographical areas of interest have been largely the southwestern United States, sub-arctic North America and Scandinavia. There has been undeniable progress in "dating" wood, but the relationship between climatic factors and variations in tree-ring widths is not well understood. The subject matter for this study is the growing season of trees and more particularly the relationship between the duration of yearly growth in Alaskan conifers and temperatures during the period of cell multiplication.

A great deal of study has been devoted to isolating the climatic factor that best correlates with the amount of annual growth in datable species. However, there has not been any previous systematic sampling of trees during the time of cell multiplication to establish precisely the period of growth in datable trees of North America. It is true that ring samples have been taken during the growing season, and some estimates of the duration of the growth period can be made from such specimens. For example, it has been pointed out repeatedly that in sub-arctic Alaska there is a positive correlation between a year with low summer temperatures and a narrow radial growth increment, whereas a large ring tends to reflect a summer with relatively high mean temperatures. It seems a much more sound approach to establish first the period during which the trees with datable ring sequences grow and then consider the possible relationship beween the amount of growth and climatic correlates. This technique has been attempted by sampling white spruce *(Picea glauca)* during most of one summer (1949) in two ecologically contrasting stands. Supplementary data were derived from observing trees in scattered stands during various growing seasons (1948, 1953, 1954).* From the analyzed material it has been possible to suggest limited generalizations regarding the growing season of white spruce in northern Alaska. These generalities have been considered further in light of previous statements on the radial growth of North American conifers.

The samples for this study were all Swedish increment cores taken in an area extending from interior Alaska westward to the limit of spruce approaching the Bering Sea coast. The interior Alaskan and Bering Sea coast trees were sampled primarily to determine the seasonal growth period, while the collections to the west were made in order to establish local tree-ring chronologies to be used for dating wood from recently abandoned Eskimo structures. Growth observations made on individual trees in the latter stands are for one date only during 1948, 1953, or 1954, but the beginning of cell reproduction is adequately indicated in the samples.

The consistent sampling method throughout this study was to collect cores (at 6- to 13-day intervals) at a uniform height around the trees in June, July, and early August. In each case twelve trees were sampled during most of the growing season, and of this number seven of the Fairbanks group from interior Alaska and eight of the Cape Denbigh group

*The author is very grateful to Walter Aaron for collecting the Fairbanks specimens and also acknowledges that the collection from Cape Denbigh was made at the suggestion of J. L. Giddings, Jr. while the writer was a member of an archaeological field party under his direction. This paper was read in manuscript form by Terah Smiley and James Van Stone, whose helpful comments are appreciated; however, the writer alone is responsible for the treatment of the data.

from the Bering Sea coast were selected on the basis of clarity and were graphically illustrated (Figs. 1, 2). The trends and span of growth in the remaining trees agreed with the illustrated specimens.

It is realized that the boring method for determining growth increments has serious limitations. When a tree is sampled in this manner, the first few cells of the season may be squeezed beyond recognition. Slight variations in the amount of the growth increment may result from boring different points on the same circumference, since varying exposure and slope factors affect radial uniformity. Sampling the trees at intervals of from 6 to 13 days also gives a more erratic representation of the growth curve than would actually occur. In spite of these difficulties it is felt that the trends and span of seasonal growth have been realized in these data.

The white spruce of northern Alaska grow in diversified geographical areas. A brief description of the sampled localities is included, but for a detailed description of spruce growing conditions in northern Alaska see Giddings (1941). The sampled stand near Fairbanks (approximately six miles down the Chena River from Fairbanks and one-half mile north of

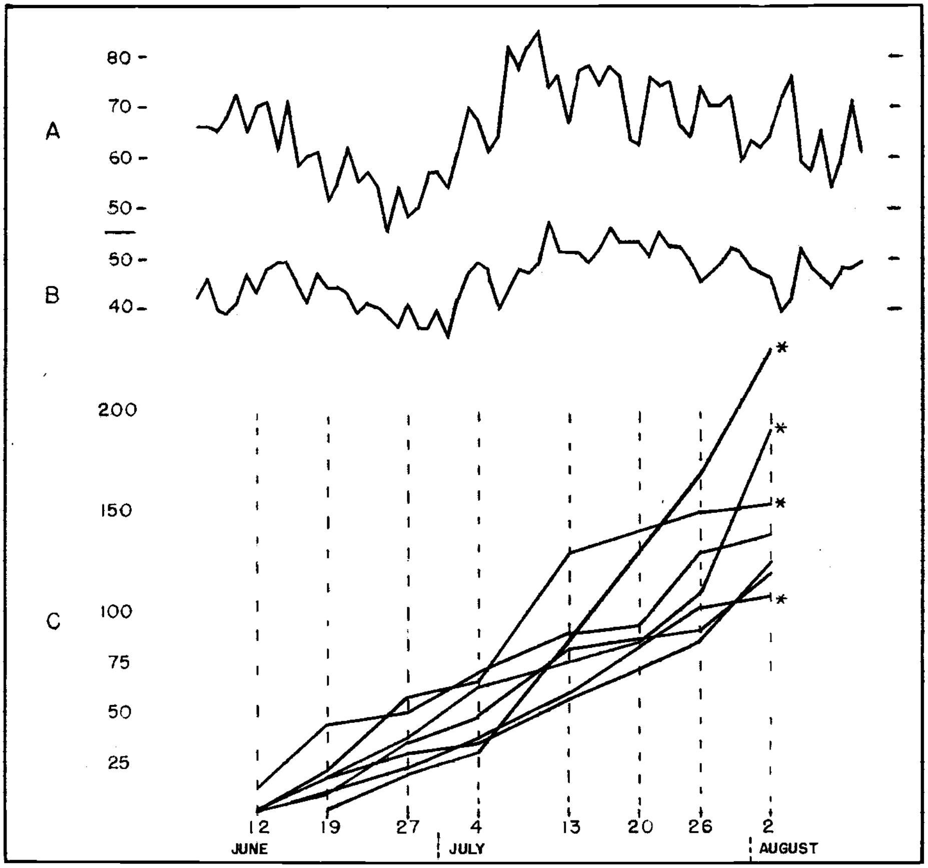

FIG. 1. 1949 growth and temperatures for the sampled white spruce near Fairbanks, Alaska. A represents maximum temperatures for the period of sampled growth; B, minimum temperatures; and C, the amount of annual growth in hundredths of a mm. for the individual trees. The scale used for the Fairbanks stand is one-half that for the Cape Denbigh stand. Dotted lines indicate sampling dates, while the asterisk indicates that an individual tree was still growing at the last sampling date.

the north bank of the river) is scattered along an open valley bottom at an elevation of approximately 450 feet where the primary ground cover consists of underbrush and scattered patches of moss. The soil is a very fine silt, and there are lenses of permafrost beneath the ground surface. With approximately 12 inches of precipitation annually, this area is relatively dry and is free from standing water except during a few weeks in April and/or May when there is melted snow in many depressions. The trees are all fast growing with from 40 to 60 rings, and the individual variation in annual ring width is slight. The relative uniformity in ring widths indicates that these trees do not grow under extreme marginal conditions. Nor were the rings sensitive enough to crossdate.

The 1949 growth samples from near Fairbanks are represented in Figure 1. These seven trees initiated cell multiplication during approximately the 15-day period from June 8 to June 23. Three of the seven trees had completed or virtually completed their growth by the first of August, while the other four were still adding large cells at this date with no indications of sealing off for the year. The only visually discernible correlation between temperature records and the growth of Fairbanks trees (Fig. 1 A, B) is that during the period of relatively low temperatures from June 25 through July 2 there was comparatively little growth. The temperature records for the growing season are from the United States Weather Bureau station at Fairbanks at nearly the same elevation as that of the stand five miles away.

Spruce on Cape Denbigh grow near the limit of the species which borders the tundra zone of western Alaska. The sampled stand, including approximately 30 trees, is nearly 100 feet above the beach on a hillside at the southeastern section of the cape. The ground cover is moss, and a few scattered willows and alders grow among the spruce; at the upper end of the stand willows dominate and then give away to a grassy tundra. Scattered outcrops indicate that eroded bedrock lies beneath a thin soil layer. All the trees are relatively young, having somewhat fewer than 200 rings, and there is good evidence that the tree-line is advancing in this area. Cape Denbigh spruce have a uniformity in ring pattern from tree to tree, with year-to-year variations in ring width readily observable.

The 1949 growing season for the eight illustrated white spruce from Cape Denbigh begins during a period of at least 18 days, from approximately June 23 to July 11; unfortunately this span cannot be isolated precisely because of the nature of the sampling interval. Six trees added cells until shortly before the last sampling date, August 19, at which time they were beginning to seal off. The two others were still adding large cells at this time and gave no indication of adding the darker late cells common to many Alaska spruce. In Figure 2C the amount of radial growth for individual spruce is plotted. It appears that a relatively slow growth at the beginning of the season was followed by a leveling off and a final period of rapid growth before the production of small late cells. While all the trees correspond in a general way in their yearly growth patterns, there was one specimen, a particularly fast growing tree, which added cells slowly at first and then increased much more rapidly than the others. This tree and one other gave no indication of sealing off at the final sampling date.

Figure 2A and B represent the maximum and minimum temperatures for the approximate growth period of the Cape Denbigh samples. The temperatures are from the United States Weather Bureau station at Unalakleet, approximately 40 miles to the south of Cape Denbigh along the same coast and isotherm but at a lower elevation. A visual comparison between growth for the 1949 season and temperatures for the same period indicates that when the prevailing high minimum temperatures dropped, as from July 24 through August 4, the production of cells was curtailed, but it increased

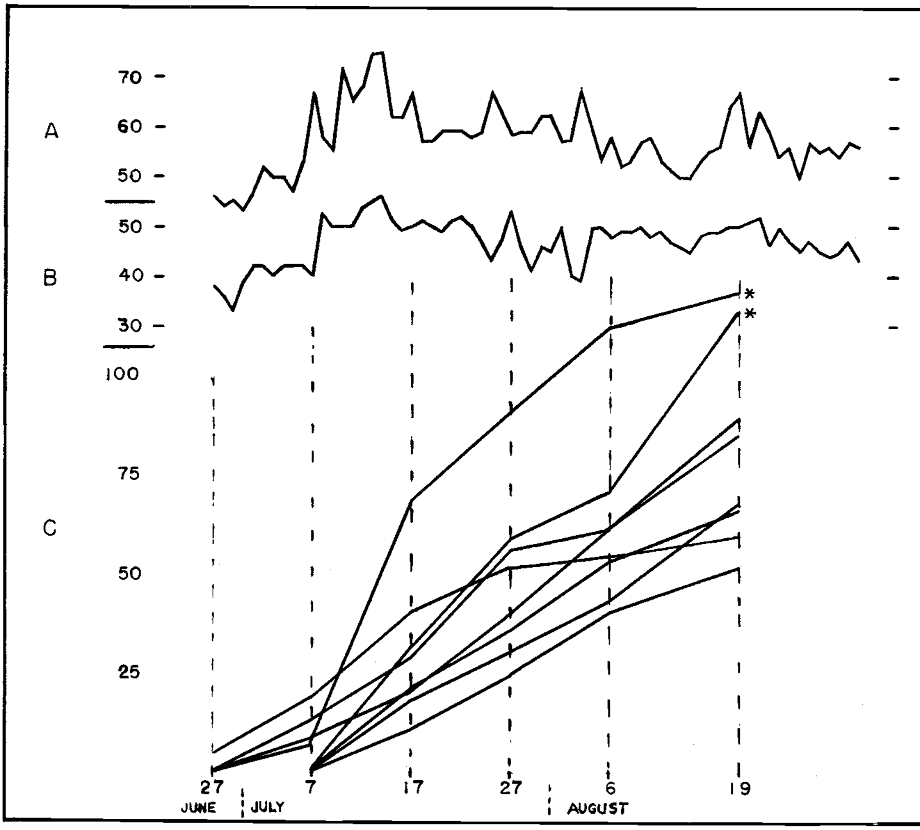

FIG. 2. 1949 growth and temperatures for the sampled white spruce from Cape Denbigh, Alaska. A represents maximum temperatures for the period of sampled growth; B represents minimum temperatures; and C, the amount of annual growth in hundredths of a mm. for the individual trees. Dotted lines indicate sampling dates, while the asterisk indicates that an individual tree was still growing at the last sampling date.

again soon after the temperature rose. There was also an apparent rise in minimum temperatures after July 7, and it was shortly following this date that four of the eight trees began adding cells.

The growing conditions of the trees along the lower and upper Kuskokwim River and the lower-middle Yukon River are quite similar. These collections were made during 1953 and 1948, respectively. For a more detailed statement on the ring records of these regions see Oswalt (1950, 1954). The sampled trees are in valley bottom stands usually flooded during periods of high water in the spring or fall but free from standing water most of the summer. The ground cover varies locally but usually includes underbrush, a moss layer, and/or scattered alders and willows among the spruce. The soil is silt, and often permafrost is present just beneath the ground surface. The trees under consideration from the Kuskokwim and Yukon rivers are near the tundra zone of western Alaska and represent either tree-line spruce or those near the biological limit of the species.

Considering the Kuskokwim and Yukon samples in general, the 1948 and the 1953 growing season for some trees began from June 12 through June 20 (17 trees beginning to grow and 58 more in the same stands not growing as yet between these dates), and there are indications that other trees, especially along the lower-middle Kuskokwim River, began growing during the first week in July. The time at which growth was initiated is the only observation which may be derived from this sample; the starting dates all fall within the range of the control collections from Fairbanks and Cape Denbigh.

Summary. The white spruce of northern Alaska growing at either of two ecological extremes, valley bottom in the interior or tree-line on the Bering Sea coast, add cells over a period of from 50 to 60 days, and samples from the intermediate areas add their first cells at approximately the same time. Growth begins as early as the middle of June and extends as late as the latter part of August, with most growth centering in the month from July 5 to August 5. It is also apparent that the growing season is, on the whole, later for tree-line spruce of western Alaska than for those of the valley bottom in interior Alaska. The data also suggest that there is a direct and positive correlation between low temperatures during the growing season and a decrease in cell multiplication.

Comparisons. Fortunately there are other studies of seasonal growth in marginal trees which may serve as comparative material for this study. Marr (1948) made a study of seasonal growth in spruce (mainly white spruce) sampled near the tundra zone on the east coast of Hudson Bay and seemingly in somewhat the same ecological position as the Cape Denbigh stand. It was found that in 1939 ring formation began in early July and extended through the month of August, showing a growing season which averaged nearly two months. The only other systematic analysis of seasonal growth in northern trees of North America, known to the writer, was made by Belyea, Fraser, and Rose (1951) for trees from two localities in Ontario. In summary, it was found that white spruce in one stand, at Chalk River, began growing May 11, and at the other stand, Cedar Lake, growth began May 29 or 18 days later. The period of growth lasted 100 days in both cases.

Giddings (1941) concluded, after a series of observations of cellular multiplication in spruce during the late 1930's, that valley bottom trees of interior Alaska complete most of their growth during June with the final cells being added in early July and that tree-line spruce of interior Alaska add their annual ring from approximately mid-June to mid-July, both growing seasons being approximately 30 days. It was also noted that in the White Mountain tree-line stand in 1938 the first cells of some trees were not added until June 24. It is evident that the span of spruce growth noted by Giddings for the trees of northern Alaska is on the whole earlier and of much shorter duration than that noted by the writer.

The work of Giddings indicates that the time of growth initiation in the same species of spruce varies in different geographical regions. A similar conclusion was reached by Pearson (1931) in a growth analysis of trees in the southwestern United States.

Analysis of ring widths in extremely marginal spruce and selected temperature data for the same region and period demonstrates a positive direct correlation, particularly between a year of low temperature and a small ring. Giddings (1943:32) observed that

> Curves of timberline tree growth closely approximate the curve of mean June-July temperatures for the same general area. Available daily records for the last ten years indicate an even closer relationship of temperatures for a month beginning the middle of June and continuing to the middle of July.

This correlation between June and/or July temperatures and the proportion of radial growth in conifers is significant and has been illustrated by Hustich (1948) for specific stands in Finland. Schove's analysis (1950) of historical temperature records and tree-ring growth in Scandinavia and an unpublished analysis of Alaskan materials by the writer further substantiate the correlation. The two periods, that of significant temperatures and that of annual growth, are not identical, however. The influential temperature period is June and July, whereas most annual growth takes place in July and August. This observation does not negate the fact that the actual beginning of cell multiplication is influenced by a local immediate rise in temperature nor that any extreme temperature fluctuations during the span of growth would have an effect upon growth. There is apparently a significant lag effect influencing the dominant growth factor in southwestern United States conifers for certain years (T. L. Smiley, personal communication). If such a lag hypothesis is validated by further inquiry, knowledge of marginal conifer physiology will be increased greatly, but at the same time the difficulties in interpreting the actual growth periods and their significance will be compounded.

APPENDIX I

During the 1954 growing season, spruce samples were collected from widely scattered areas in Alaska; from them additional insight may be gained into the approximate growing season and particularly the time of growth initiation. The samples from Eureka on the Glenn Highway and those from the Anchorage-Seward Highway were collected by James Van Stone; the remaining samples were collected by the writer while a member of the Katmai Project in the Katmai National Monument and through the courtesy of the National Park Service.

Locality	*Date*	*Growth*
Anchorage-Seward Highway (10 miles north of Homer Cutoff)	June 13, 1954	All ten sampled trees were beginning to add their first cells; growth averaged approximately .05 mm. (all growth increments are approximate).
Naknek Road (Bristol Bay area)	June 22, 1954	Four trees had as much as .15 mm. growth, while one other had no growth.
Eureka (Glenn Highway)	July 9, 1954	Seven trees were adding their first cells; no growth was over .25 mm. One tree had not begun to grow.
Kuliak Bay (Katmai National Monument)	July 11, 1954	Four trees had begun to grow; growth was as much as .30 mm. (the surrounding rings were extremely large). One tree had not started to grow.
Hallo Bay (Katmai National Monument)	July 11, 1954	Three trees had as much as .07 mm. growth, but two others had not begun to add cells.
Aniak (Kuskokwim River)	August 11, 1954	Three trees sealed off for 1954 by this time, but one other had not.

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RESEARCH COMPLETED ON POWER-DRIVEN TOOLS FOR TAKING LONG CORE-BORINGS

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Cores up to six feet long and approximately one-half inch in diameter can now be taken from the trunks of either hard or soft wood trees by power-driven coring tools recently developed expressly for this purpose in Atherton, California. The new tools differ from other corers in one important respect, namely, the cutting heads are detachable. This desirable feature is accomplished by a joint that cannot accidentally unscrew or loosen and thus leave the cutting head in the tree.

The problem of designing such a joint and other features for which there was no precedent so delayed progress that the development period extended over several years. The joint had to be able to transmit high torque, or twisting effect, in both directions (which eliminated most types of screwed joints) and it had to be as slim as possible to minimize friction. How great an improvement was made in decreasing joint diameter, even

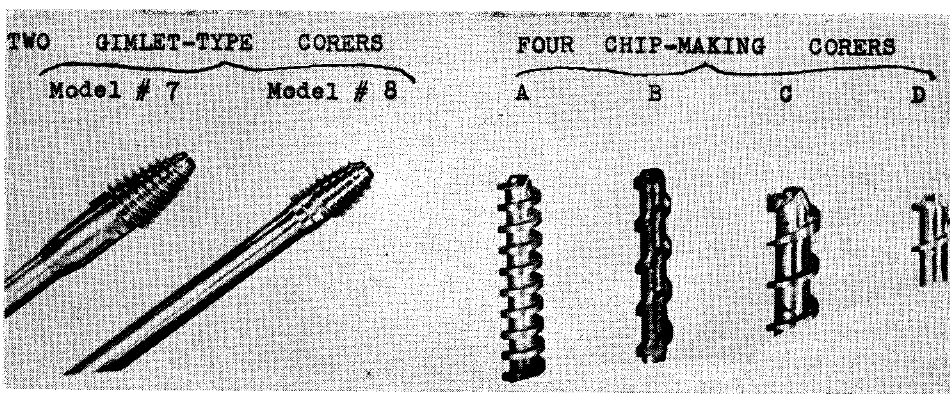

FIG. 1. Cutter-heads of original design. Two at left for cutting soft wood; four at right for cutting and removing chips in hard wood.

after the basic principle was developed, can be seen in Figure 1 which shows model 7 beside the much more efficient model 8. On both these models the diameter of the tube is the same.

Heretofore, in the manufacture of coring tools of shorter lengths, the difficult joint problem has been solved by eliminating the joint altogether, that is, constructing the tool by the "gun-barrel method" which drills the central hole out of a solid steel cylinder and thus produces the finished tool from a single piece of metal. But in corers six feet long this is impractical even if the same metal were equally suited to both tube and coring head.

By having a joint between these two parts it is possible to use a very high-strength steel in the cutting head tempered to meet exacting requirements, while still retaining in the long shaft the advantages of modern tube manufacture, which includes ready availability at a price low enough so that, at least for the gimlet-type corers, several extras can be kept on hand for emergency replacements.

The steel selected for the cutting-head is a carbon-manganese-silicon-molybdenum alloy with a breaking strength of 323,000 lb. per square inch and a hardness (Rockwell) of 59, despite which it will bend before it will break. After being worked to the exact form desired it is hardened by a process which subjects the metal to a temperature of 1600 deg. F. in an atmosphere of 1½% to 4% of oxygen; it is then quenched in oil and drawn at 290 deg. F. It is believed that these cutting heads will withstand any stresses to which they will be subjected in tree-cutting procedure.

The tubes, similarly, are of a material precisely suited to their special requirements. The alloy selected is a cold-drawn chrome-molybdenum, with normalized stress, which allows heat application to near critical temperatures and subsequent cooling in air without change in physical properties. This permits brazing or silver-soldering without loss of temper—an invaluable advantage where a re-heat treatment after finishing would be impractical.

With the joint problem solved, it is believed that this same type of joint can be used for one and perhaps two more 6 ft. tube lengths to be added as extensions. If this is successful the equipment then should be able to core to depths three times the present 6 ft. limit or about 18 ft. This would be enough to reach the center of even the largest *Sequoia gigantea* whose maximum diameter is 32 ft. Thus far, however, no extensions have been attempted and actual coring operations have been limited to the initial 6 ft. tube lengths.

With the present 6 ft. coring tools, cores can be brought to the laboratory for studying ring characteristics in continuous sequence from bark to central point in trees up to 12 ft. in diameter. Trunks in this size range comprise a large percentage of the trees important to the dendrochronologist.

In addition to the joint problem, another phase of this project which delayed progress was the absence of precedent or any reference literature whatsoever. Each advance had to be a cut-and-try process. A search in the patent office produced none of the hoped-for information about earlier designs of wood-coring tools. Apparently, none have been patented in this country. The years of slow progress can be dismissed here with the comment that the results are shown in the accompanying illustrations.

In the model 7 cutter-head the joint consists of a machined, tapered jaw-clutch in which separation of the two jaws during operation is prevented by an overlying, threaded sleeve which is advanced from the rear over threads cut in the jaws. The sleeve is advanced until it abuts against a shoulder at the forward end of the threads and then a snap-ring (an idea borrowed from the gasoline-engine piston) is fitted into a groove behind the sleeve. Such a joint cannot come unscrewed accidentally and has maximum strength for resisting torque in either direction.

Though model 7 was ideal in other respects, the sleeve construction made it considerably thicker than the tube. The cutting head, of course, had to be large enough to squeeze back the wood fibers so that the thick joint could pass. Despite the relatively large diameter, it did this successfully in soft woods, as coring in redwood proved. But friction was excessive and operating experience showed that a design with less difference between tube diameter and the overall diameter was necessary if frictional resistance was to be kept down. Based on experience in operating the model 7 head, modifications in joint design were worked out which resulted in production of model 8.

Model 8 has met all requirements for coring soft woods. The relatively small diameter of the cutting head exceeds the core diameter by no more than the necessary minimum to provide adequate strength. In striking contrast to its predecessor, this later model produces a 0.450 in. core with a cutting head diameter, at thread base, of only 0.889 in.

After proving the success of model 8 by trial, and believing there was no prospect for any further reduction of head diameter, it was realized that it would be impracticable if not impossible to force such a tool 6 ft. or more into a hard, close-grained wood. In other words, for long cores in the very hard woods, what is needed is some type of chip-making tool. Thus was born the decision to develop another and entirely different type of cutter-head that could bore its way into woods of any degree of hardness, friction being reduced by cutting out and removing chips as the cutting edge is advanced.

The series of experiments then begun was aimed at combining the screw-conveyor principle with a cutter design that would slowly advance a circular cutting-edge around a core while the encircling wood was cut away in chips which would be moved back out of the hole. This type, obviously, would require an overall diameter larger, in proportion to the core, than in the gimlet type, but with proper screw-conveyor design the friction developed should be very much less.

Development of this chip-making tool involved nothing unique as was the case with the novel-type joint. Rather, the process was a matter of cut-and-try in order to find (a) what modifications of standard wood-boring tools (notably the ship augur) would best suit this purpose and then (b) how such a design could be adapted to economical manufacture. Eventually both these requirements were met in a chip-making tool which, when tried out in the improved form shown in Figure 1, was an unqualified success.

Undoubtedly this success was, to a considerable extent, dependent upon a power plant, the development of which had been carried on concurrently with work on the coring tool design. The power required was much greater than had been anticipated because of the unexpectedly large amount of friction encountered in the long holes. Of the power plant as originally assembled only the two and three-quarter horsepower prime-mover remained when the final assembly was photographed (Figs. 2, 3).

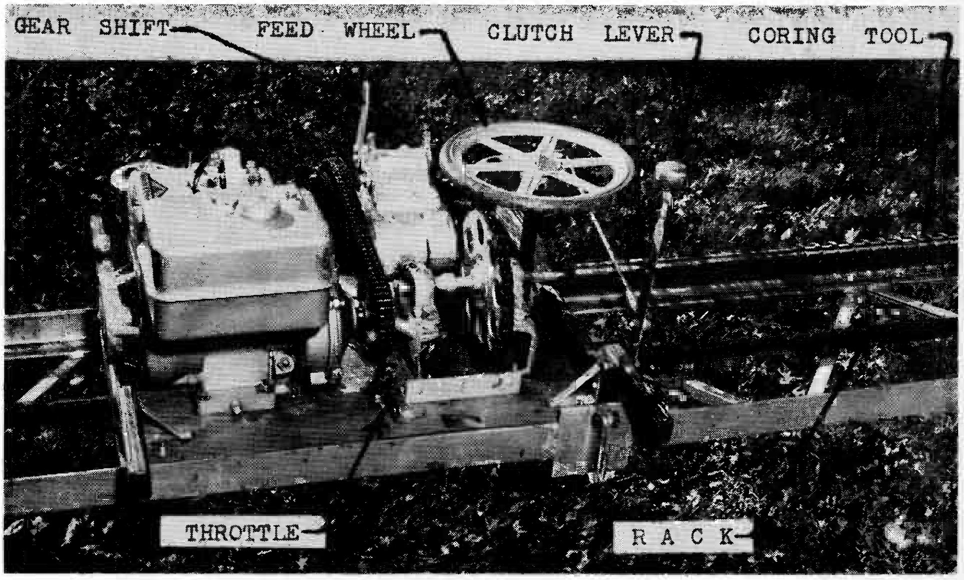

FIG. 2. Close-up of power unit from operator's side. Vertical shaft of feed-wheel has a pinion on lower end which engages a mid-track rack.

Some of the parts had been rebuilt several times to meet unexpected requirements. Because of the heat developed by friction, it was found best not to attempt a driving-rate faster than a safe maximum which an experienced operator can determine by the "feel" of the feed wheel. However,

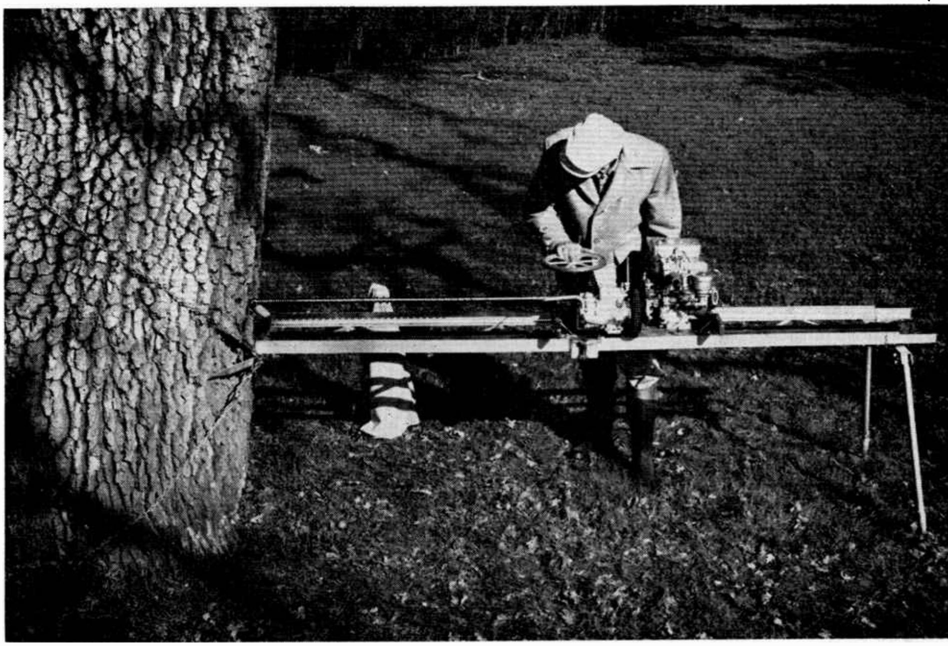

FIG. 3. Power-unit rides an 8 ft. steel track braced against the tree with chains and turnbuckles. Central joint makes shipping length 4 ft. Telescoping legs at track end adjust for sloping ground.

for speedy withdrawal motion the gear ratio in the transmission was stepped up to about 165 r.p.m. The clutch is a necessity in careful control of speed, especially in starting a new hole. Operation will be understood from the control labels on the several parts shown in Figure 2. General appearance of the outfit, assembled and in operation, is shown in Figure 3.

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TREE-RING DATING IN THE MISSOURI BASIN CHRONOLOGY PROGRAM*

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A little more than a year ago the Missouri Basin Project of the Smithsonian Institution formulated a program aimed at producing a detailed chronological framework for the archaeological horizons of the Central Plains and the Middle reaches of the Missouri River. The program was begun as a cooperative effort, enlisting the aid and resources of a large number of individuals and institutions with interests in the prehistory and geoclimatology of the Plains. The initial organization and planning was carried out in Lincoln by personnel of the Missouri Basin Project, the Laboratory of Anthropology of the University of Nebraska, and the Nebraska State Historical Society. The original plan, specifying a concurrent and complimentary series of investigations exploiting the radiocarbon method, dendrochronology, geoclimatology, and related techniques, was intended, as a first step, to date pivotal sites—sites of key importance in delimiting cultural horizons as they are now understood.

The institution of such a program should not be construed as implying a current lack of synthesis and systematization in Plains prehistory. On the contrary, the past decade has shown a rapid advance in our understanding of cultural sequence and process within the Missouri Basin—an advance stimulated in large part by the salvage program. The problem, as the Missouri Basin Project saw it, was summarized as follows:

> The whole subject of chronology and dating problems has been approached in a random way in the past. Each archaeologist, with a problem in chronology, has handled it in his own way. Dates and chronologies, derived by various techniques, have been established with primary focal points centered in specific sites and work, done by specific individuals, at specific localities. This is in no way a criticism of past work. It has been largely a necessity for obvious reasons, and the approach has not been unfruitful. In fact, some of these chronologies . . . might be thought of as pilot studies illuminating the further fruitfulness of a broad, coordinated, systematic program of chronology . . . (Stephenson 1958:2).

The archaeological situation in the Plains is a complex one. Preceramic remains from the High Plains have been a matter of continuing concern, but early sites have also been recently found along the mainstream of the Missouri. Even at this preliminary stage of investigation, it is apparent that several such preceramic horizons are present. The Woodland occupation is somewhat better known, but as yet the patently complex pattern of interrelationship has not been worked out in detail. The succeeding semi-sedentary village occupation brought a great proliferation of related cultural entities, characterized by substantial communities, many of which were protected by elaborate stockades and dry moats. Several major manifestations are recognized, based upon house type, village plan, and ceramics. In the Middle Missouri, and this, of course, is much simplified, a basic distinction has been made between an early horizon, distinguished by cord-roughened pottery and by long rectangular houses sometimes arranged in street blocks, and a late horizon with irregularly placed circular houses and simple-stamped pottery. Abrupt change is not present; rather, transitional sites and potteries have been noted, as well as strong influences emanating from the Central Plains (see Lehmer 1954).

The radiocarbon method would seem to be particularly applicable to the dating of the preceramic sites. There was some concern initially that the rectangular house occupation might be too recent for dependable dating,

*Manuscript submitted September, 1959, with permission of the Secretary of the Smithsonian Institution.

but nonetheless, radiocarbon samples were submitted as an experiment. We felt that any clustering of dates for such early foci would be significant, regardless of the margin of error. In addition, it was hoped that tree-ring plots might be ultimately pushed backward to overlap and cross-check the radiocarbon dates, particularly the recent ones where the range of error is expected to be greater. The circular house horizon is known to have persisted well into the historic period; thus it should be particularly amenable to a dendrochronological attack.

At this time, ten radiocarbon dates have been produced. They bracket the early village and Woodland sites, and while in some cases they are somewhat earlier than expected, they have done no real violence to the established scheme. Concurrently, geochronological investigations have been carried out at preceramic sites, and in one instance, the recently developed proportional counter was given confirmation to the predicted sequence in the early levels of the Medicine Crow site. These aspects of the chronology program will be reported in greater detail elsewhere.

The dendrochronological phase of investigation has shown less immediate results. This is to be expected since in the initial stages efforts have been directed toward the accumulation of specimens useful in the construction of master plots. It seems worthwhile, nonetheless, to offer a detailed progress report and a statement of future expectations, partly in the hope of eliciting comments or criticisms.

Interest in dendrochronology is not new to the Plains. Tree-ring data already exist for three discontinuous areas. Harry E. Weakly has plotted sequences in western Nebraska, pushing the chronology back first to A.D. 1480 (Weakly 1943, 1950) and more recently to about A.D. 1280 (Weakly, personal communication). Weakly utilized both red cedar and ponderosa pine in his plots; hardwoods were found to have little value. Weakly's master charts were used successfully in dating charcoal from the Ash Hollow cave (Champe 1946), and more recently, he has developed another ring sequence for a small area in northeastern Nebraska which provided a very reasonable date for the late (Oneota) occupation of the Lynch site.

Some years ago George F. Will presented a ring sequence based upon a "Master Burr Oak Stump" from the Bismarck, North Dakota area (Will 1946). A number of house timbers from archaeological sites in the Middle Missouri (Will 1948) were dated, but the results seem to place the relevant occupations too early in time (Lehmer 1954:137-8). Both Will (1948:70) and Lehmer (1954) have pointed out the dangers of projecting a master chart too far afield.

This points up a major problem in the development of master charts for areas along the mainstream of the Missouri River. Over much of the area, and this is particularly true in the Big Bend and Oahe Reservoirs of South Dakota, there is a substantial variation in rainfall between adjacent locales in any given year and between adjacent locales from year to year. This sort of unpredictability is brought forcefully to the attention of anyone who has worked in the region. Heavy rains make roads impassable in limited parts of the river bottoms; yet across the first ridge, no rain has fallen. The next year the situation might be reversed. It is hoped that a regional trend can be isolated from these linked environmental enclaves, but at the moment the data for more specific comment are not available.

In addition to such variation, based on local rainshadows and shifting stormpaths, the factor of elevation is also of obvious importance, particularly in regard to surface cover. Lehmer (1954:114-5) distinguishes three physiographic zones for the Oahe area which apply with equal validity to the Big Bend and Fort Randall Reservoirs, extending downstream to the Nebraska-South Dakota borders. The first zone, and the highest in terms of relative elevation, is the "upland, the rolling plain into which the river valley is incised. The second consists of a series of eroded slopes ["breaks"] and level terraces which lie between the abrupt edge of the upland and the present flood plain, and which are above all but the highest flood crests . . . . The third physiographic zone is the flood plain itself, a constantly shifting area bordering the meandering channel of the river, and including a number of islands. . . ." (Lehmer 1954:114-5).

The flood plain or "bottom" flora is dense and varied. Cedar, ash, oak, cottonwood, willow, hackberry, and many others are present. Actually, it forms an extension of the Oak-Hickory division of the Southern Hardwood Forest. It seems highly probable that in this environment annual growth increments would show a relative complacency. However, in the climatic extremes of this region, seasonal air temperature and solar radiation might be crucial factors. Trees are not abundant in the second zone, but "breaks" standing high above bottom areas contain localized stands of cedars *(J. virginianus, scopulorum)*. Here the problem of a consistently high-water table is not of importance and humidity is characteristically less extreme. With these factors in mind, an effort was made during the 1958 field season to collect samples from standing trees of all prevalent types and from the two significant physiographic zones. An additional effort was made to secure specimens from such early white structures as might exist in the area, but, unfortunately, few e arly buildings were found.

The collecting was done systematically, sampling the bottoms and slopes in a broad band on both sides of the Missouri River. Two areas received major attention:

1) Fort Thompson-Lower Brule-Medicine Creek, extending east to west through the lower portion of the Big Bend and the upper portion of the Fort Randall Reservoirs.
2) Fort Sully-Fort Bennett-Cheyenne River, extending east to west through the lower portion of the Oahe Reservoir.

Area 1 lies a short distance upriver from Chamberlain, South Dakota, and Area 2 above Pierre, South Dakota, about 75 miles to the north. It was originally planned that specimens would be gathered along the entire length of the Fort Randall, Big Bend, and the Oahe Reservoirs, but it was soon discovered that suitable timber was quite limited in distribution. This was particularly true of the varieties of cedar.

In total, 70 specimens were collected. Fifty-seven percent took the form of transverse sections cut just above the root buttress, 41% were 4.0 mm. diameter cores from living trees or old buildings, and the remainder were wedge cuts or other sections of root, stump, or trunk. In terms of a further breakdown, 53 specimens were of cedar, with a small representation of oak, ash, cottonwood, elm, pine, and hackberry, the latter having been collected despite its tendency to produce multiple rings.

The material is unanalyzed as yet, but the results of a superficial examination are encouraging. As expected, the bottom-growing specimens do not appear to be markedly sensitive, but the "breaks" cedar is especially good. Although the annual rings are compressed, they are distinguishable and sensitive, presumably reflecting rainfall as the drought years of the 1930's and 1940's are very evident. It should also be pointed out that several very old living cedars were sampled; one from the highland in the bight of the Big Bend contains more than 250 rings. This, fortunately, brackets the entire historic period in the area.

At this time no ring plots have been made, for the simple reason that no specialist has been available to the program. It is hoped that Mr. Harry

E. Weakly will be able to examine the material in detail during the coming year with a view toward beginning the construction of a group of master plots.

So far as the dating of specific archaeological sites is concerned, there is ample material now in hand for a substantial beginning. The typical circular earth lodge, as it was known historically, contained an abundance of large timbers. The earlier rectangular structures, some of which may or may not have been earth lodges, also utilized many timbers for wall supports. Late houses often contain posts of cottonwood, which seldom preserves well, or worse, no posts at all. Bone or stone wedges may be present in the post mould but the timber is frequently absent. This suggests a pattern of salvage and reuse of major support members which will complicate the dating problem. The long rectangular structures frequently contain well preserved cedar timbers which are excellent for tree-ring dating. A large proportion of those examined appear to have sensitive ring patterns.

In addition to the numerous house posts now in the collections of institutions, there are also large quantities of charcoal from intramural hearths that may be suitable for dating.

The preceding statement has been in the nature of a progress report of the Chronology Program in general, and in a more detailed way, of the current status of dendrochronology in the Middle Missouri. It is self-evident that dendrochronological problems in the Plains are not unique. At this time, however, we cannot state them in detail; rather we are in the reconnaissance stage, collecting data and assessing our resources. There is still much ground to be covered before we can even begin to see a regional pattern.

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INTERNATIONAL CONFERENCE ON FOREST TREE GROWTH

TERAH L. SMILEY

An International Conference on Forest Tree Growth was held on the University of Arizona campus April 10-14, 1960. Forty specialists in the field were invited to present papers at the meeting; eight from Sweden, Finland, Denmark, and Canada, and the remaining 32 from 24 universities, colleges, and other research organizations in 17 of the United States.

The conference was first proposed in order to bring together people to discuss tree-ring studies. It became apparent, however, that before such a conference could be successful, it would be necessary to have one on the general status of knowledge concerning tree growth as an entity. The conference which emerged was one wherein specialists were invited to discuss six major fields involved in tree growth.

The first session, on Physiology, was organized and moderated by T. T. Kozlowski of the University of Wisconsin. In this session photo-periodic control, photosynthetic problems, auxin gradients, and the role of water were discussed in relationship to the physiology of the forest trees.

The second session, organized and moderated by R. Zahner, University of Michigan, was concerned with Soils and their importance to growth. Besides the nutrition of the soil itself, aeration and moisture were discussed, as were mycorrhizae and its importance to growth, and intraspecific root grafting which occurs in close stands.

Climate was the topic of the third session, which was organized and moderated by A. L. McComb, University of Arizona. The major climatic facets under discussion centered around temperature, moisture, and wind.

The fourth session, on Genetics, was organized and moderated by H. A. Fowells, U.S. Department of Agriculture, Washington, D.C. The discussions were on variation and taxonomy, ecotypes of forest trees, elite trees, and the hybrid vigor of forest trees.

G. S. Allen, University of British Columbia, organized and moderated the fifth session on the topic of Dendrochronology. The major discussion was on the ontogeny and physiology of ring development, and one paper was presented on the application of dendrochronology to archaeology and dating.

The sixth session, on Mensuration, was organized and moderated by G. M. Furnival, Yale University. The end product of growth—the actual increase in board feet—was discussed in regard to even-aged and all-aged stands. The method of measuring individual trees and of determining the amount of growth from samples was brought into the discussion.

Of special concern to readers of this *Bulletin* is the fact that emphasis was placed on the growth of the tree (as expressed in tree-rings) as the culminating response of the tree to all of its controlling factors. In spite of all that is known regarding tree growth, we do not yet begin to understand the total phenomena involved in forest tree development and regeneration. Many basic problems of growth still remain to be solved before a full understanding of tree-ring development can be reached.

T. T. Kozlowski is presently editing the series of papers which will be published in the near future. Any inquiries on this publication should be addressed to the Secretary of the Tree-Ring Society or to the Laboratory of Tree-Ring Research, University of Arizona.

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SOUTHWESTERN DATED RUINS. VII.

BRYANT BANNISTER

A long established policy of the *Bulletin* has been the publication of tree-ring dates obtained from archaeological specimens. A special series of articles designed to present dates from Southwestern ruins was inaugurated in 1937, a series which was continued intermittently through 1951. Since that time, however, only one paper on dated Southwestern archaeological samples has appeared in these pages (Schulman 1952), although two summaries of dates have been published elsewhere. These are: a list of all Southwestern dates either checked or derived by the staff of the Laboratory of Tree-Ring Research (Smiley 1951) and a compilation of dates from the Rio Grande area of New Mexico (Smiley, Stubbs, and Bannister 1953). In order to complete the record of work accomplished since the release of the two summaries, the *Bulletin* resumes and plans to continue the Southwestern Dated Ruins series.

CHACO CANYON, NEW MEXICO*

Site	*Catalogue Series*	*No. of Specimens*	*Range of Dates, A.D.*
Bc 59	Bc $\frac{59}{4}$–1, –3	3	1110
Casa Chiquita	CCh–1	1	1060+
Chetro Ketl	CK–700, –959	201	989–1067
Hungo Pavi	HP–10, –13	4	942, 943, 987, 1064
Kin Kletso	CKK–2, –27	17	1059–1178
Pueblo Bonito	JPB–206	1	1049
Ackerly House (Pueblo Bonito)	JPB–207, –209	3	1030+, 1031, 1077+
Tri-Wall Unit (Pueblo del Arroyo)	JPB–205	1	1109

COMMENTS

Bc 59. A small masonry pueblo on the south side of Chaco Canyon within one-half mile of Pueblo Bonito, this excavated ruin contains at least 16 rooms and five kivas representing a long, but not necessarily continuous, period of occupation. The dated specimens, all of which yielded cutting dates, were originally used in the construction of the subfloor ventilator shaft of the upper distinct level of Kiva 2 (see Vivian 1959:69). No report of the excavation is presently available.

Casa Chiquita. One of the relatively small, multi-storied pueblos strung along the north side of the Chaco River, Casa Chiquita is located about one mile downstream from Pueblo Bonito. Although the ruin is still unexcavated, the dated sample was collected from a first story viga. The "+" symbol used with this date (a cutting date) indicates that the outer rings on the specimen are very crowded and that possibly some rings are absent.

Chetro Ketl. This ruin, along with neighboring Pueblo Bonito which is one-half mile further downstream, is one of the largest and most famous of all Chaco Canyon structures. It has been the scene of numerous excavations (see Brand, Hawley, Hibben, et al. 1937:25-7), and has been the subject of a comprehensive archaeological-dendrochronological analysis (Hawley 1934). In 1947 a flash flood did considerable damage to the rear (north) wall of the ruin, and in the salvage work that followed, the

*The dates reported in this article have been extracted from *Tree-Ring Dating of Archaeological Sites in the Chaco Canyon Region, New Mexico* (Bannister 1959) where more detailed information on sites, proveniences, and individual dates is to be found. Unless otherwise noted, all specimens were submitted by Gordon Vivian of the National Park Service. The dating work was carried out by the author and all dates were checked by members of the Laboratory of Tree-Ring Research staff.

National Park Service collected the specimens reported herein. Hitherto unpublished, the 201 dates represent construction timbers from the block of rooms numbered 43 through 65, and all but five of the dates are believed to be cutting dates.

The given range of dates does not do justice to the actual concentrations involved. There are, for example, 89 dates in the 1036-40 interval and 48 dates in the 1043-47 interval. Minor clusters occur at 1020-21, 1028-29, and 1050-51. Only 12 dates precede 1020 and only one date falls after 1051. In the overwhelming majority of cases, the pre-1036 beams were found associated with greater numbers of pieces that dated later and, consequently, the earlier specimens probably represent reused timbers.

Hungo Pavi. Generally classed as a medium-sized Chaco Canyon pueblo, Hungo Pavi is situated about two miles upstream from Pueblo Bonito on the north side of the canyon. There has been no reported excavation undertaken at the ruin, although a number of tree-ring samples have been collected from exposed beams. Of the four dates listed, the two earliest ones are derived from logs which may have been worked on by A. E. Douglass and previously reported by Douglass (1935:51) and Peterson (1935:24). All four dates are cutting dates of construction beams; the first three listed are from first story vigas and the last from a second story timber.

Kin Kletso. Another small multi-storied pueblo containing at least 55 ground floor rooms and five circular kivas, Kin Kletso (Yellow House) lies roughly half-way between Pueblo Bonito and Casa Chiquita. The site has been thoroughly excavated and a complete report by Gordon Vivian and Tom W. Mathews is currently in preparation. Four specimens originally collected and dated by Florence M. Hawley—one date published in Hawley (1934, Plate I)—have been incorporated into the CKK series.

Nine of the Kin Kletso dates are from construction timbers. Only seven of these, however, are identified by provenience. Of these seven, four are from three first-story rooms with the cutting dates 1059, 1076, 1076, and 1076, and three are from three second-story rooms with the cutting dates 1123, 1124, and 1124. The two construction specimens of unknown provenience date 1063 (not a cutting date) and 1124. In addition there are eight non-construction dates obtained from charcoal found in fill, firepits, and ash lenses in four different rooms. Six of these dates range from 1088 to 1128, and two other specimens date at 1171 and 1178. Since the latter two are the latest ones from any of the Chaco Canyon pueblos and therefore of special significance (see Vivian 1959:26,69), they were doubly checked by A. E. Douglass and T. L. Smiley. A detailed account of the 17 Kin Kletso dates is presented in Bannister (1953).

Pueblo Bonito. Pueblo Bonito, the major attraction in the Chaco Canyon National Monument, has been amply described in both popular and scientific literature (see Judd 1954 for bibliography). The lone specimen cited here was found as float material, although it probably came from the north wall of the ruin at the third story level. The date is not a cutting date.

Ackerly House (Pueblo Bonito). The three dated specimens from Ackerly House are an excellent example of reused timbers. Although the logs were believed to have first been incorporated into Pueblo Bonito, the actual collection site was the original Richard Wetherill residence and trading post constructed in the late 1890's a few feet west of the southwest corner of Pueblo Bonito. The structure eventually became known as Ackerly House and was recently demolished by the National Park Service. All three dates are cutting dates.

Tri-Wall Unit (Pueblo del Arroyo). Attached to the west and south sides of Pueblo del Arroyo, a large Chaco Canyon pueblo located one-fourth mile west of Pueblo Bonito, is a small cluster of rooms and kivas dominated by an unusual three-walled circular building. This excavated complex has been well documented by Judd (1959:96-119) and Vivian (1959:61-70). The single cutting date comes from a pole stub embedded in the east wall of Room 1 (Pueblo del Arroyo room numbering series) and has been previously published by Vivian (1959:68).

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