

TREE-RING BULLETIN

Vol. 5

JULY, 1938

No. 1

A Quarterly



CONTENTS

- Dendrochronology in Two Mississippi Drainage Tree-Ring Areas.....FLORENCE HAWLEY SENTER
Southwestern Dated Ruins: IV.....FLORENCE HAWLEY SENTER
On Photographing the Rings of Oak Specimens.....DAVID B. EISENDRATH, JR.
Estimated Tree-Ring Chronology: 300-450 A. D.....A. E. DOUGLASS

PUBLISHED BY THE TREE-RING SOCIETY

Emil W. Haury, Managing Editor
Department of Anthropology
University of Arizona
Tucson, Arizona

\$1.50 Per Year

50 Cents a Copy

THE TREE-RING SOCIETY

President.....Dr. A. E. Douglass
Secretary.....Mr. H. T. Getty
Treasurer.....Dr. Emil W. Haury

Tree-Ring Laboratory
University of Arizona
Tucson, Arizona

THE TREE-RING BULLETIN

Editor-in-chief.....Dr. A. E. Douglass
Managing Editor.....Dr. Emil W. Haury
Associate Editors:
Archaeology.....Mr. W. S. Stallings, Jr.
Botany.....Dr. Waldo S. Glock
Cycles.....Mr. Edward Schulman

AUTHORS

The Tree-Ring Bulletin will publish papers resulting from original research in tree-rings in their relation to climatology, archaeology, and other subjects. Manuscripts should be typewritten in double spacing. The Editor reserves the privilege of returning to the author for revision approved manuscripts and illustrations which are not in the proper form for the printer.

In reporting tree-ring data authors are requested to use a tabular form such as appears on the back of Vol. 1, No. 1. Until funds are available authors will be requested to pay the cost of illustration.

Each contributor will be given, free of charge, twenty-five copies of the Bulletin in which his article appears. Reprints may be procured at cost with or without covers if ordered at the time the galley proof is submitted. Manuscripts and illustrations should be sent express prepaid or by registered mail to the Editor-in-chief.

SUBSCRIBERS

All correspondence having to do with subscriptions should be addressed to Dr. Emil W. Haury, Department of Anthropology, University of Arizona, Tucson, Arizona.

TREE-RING BULLETIN

INDEX TO VOLUME IV

Abiquiu: church	No. 2, 5	Loloma Ki	No. 4, 6
Abo: Mission church	No. 2, 5	Los Aguajes	No. 2, 4
Acoma: Mission church	No. 2, 5	Lowry Ruin	No. 2, 3; No. 3, 3
Alamo	No. 2, 4	Medicine Cave	No. 4, 6
Alkali Ridge	No. 2, 3	Mocho	No. 2, 4
Amoxiumgua	No. 2, 5	Mogollon Village	No. 3, 3
Arroyo Negro	No. 2, 4	Nalakihu	No. 4, 6
Awatovi	No. 3, 3	Obelisk Cave	No. 3, 3
Baker Ranch	No. 4, 6	Pecos	No. 2, 4
Basket-Maker III	No. 1, 7	Pena Negra	No. 2, 4
Basket-Maker III	No. 2, 3	Piedra Ruin	No. 3, 3
Basket-Maker III	No. 3, 3	Pindi	No. 2, 4
Bat Woman	No. 4, 6	Pine River Ruin	No. 3, 3
Betatakin	No. 4, 6	Posi	No. 2, 5
Bones, Pleistocene	No. 4, 3, 5	Pueblo Largo	No. 2, 4
Bonito Terrace	No. 4, 6	Puye	No. 2, 5
Broken Flute Cave	No. 3, 3	Riana Ruin	No. 2, 4
Buried wood	No. 4, 3	Rowe	No. 2, 4
Calamity Cave	No. 4, 6	San Christobal	No. 2, 4
Canyon Creek Ruin	No. 3, 3	Seshukwa	No. 2, 5
Canyon de Chelly	No. 4, 6	Spanish Colonial Buildings	No. 2, 5
Cebolleta: Church	No. 2, 5	Starkweather Ruin	No. 3, 3
Cedro	No. 2, 4	Swallows Nest	No. 4, 6
Central Georgia		Tecalote	No. 2, 4
Dendrochronology	No. 2, 6	Te'ewi	No. 2, 5
Chamisalocita	No. 2, 4	Tonto National Monument	No. 3, 3
Climatology	No. 1, 5	Tshirege	No. 2, 5
Cochiti: Mission church	No. 2, 5	Tsiping	No. 2, 4
Cundiyo	No. 2, 4	Tunque	No. 2, 4
Cycles	No. 1, 6	Turkey House	No. 4, 6
Dates from:		Tusayan Ruin	No. 3, 3
Alamo	No. 2, 4	Twin Cave	No. 3, 3; No. 4, 6
Alkali Ridge	No. 2, 3	Tyuonyi	No. 2, 5
Amoxiumgua	No. 2, 5	Unshagi	No. 2, 5
Arroyo Negro	No. 2, 4	Vandal Cave	No. 3, 3
Awatovi	No. 3, 3	White House	No. 4, 6
Bat Woman	No. 4, 6	White Mound	No. 3, 3
Betatakin	No. 4, 6	Winona Village	No. 4, 6
Broken Flute Cave	No. 3, 3	Wupatki	No. 4, 6
Calamity Cave	No. 4, 6	Deadman's Flat	No. 4, 6
Canyon Creek Ruin	No. 3, 3	Dogozshibito	No. 4, 6
Cedro	No. 2, 4	Douglass, A. E.	No. 1, 3; No. 3, 8
Chamisalocita	No. 2, 4	Elden Pithouse	No. 4, 6
Cundiyo	No. 2, 4	Fairbanks, Alaska	No. 4, 3
Elden Pithouse	No. 4, 6	False rings in Monterey Pine	No. 3, 4
Five Kiva House	No. 2, 3	Five Kiva House	No. 2, 3
Frijolito	No. 2, 4	Flagstaff	No. 4, 6
Gila Pueblo	No. 3, 3	Flora, I. F.	No. 1, 7
Howiri	No. 2, 5	Frijolito	No. 2, 4
Hupobi	No. 2, 5	Giddings, J. L.	No. 4, 3
Ken-a Ki	No. 4, 6	Gila Pueblo	No. 3, 3
Kiatsukwa	No. 2, 5	Glock, W. S.	No. 4, 7
Kiet Siel	No. 4, 6	Gran Quivira: Large church	No. 2, 5
Ladder House	No. 4, 6	Gyusiwa: Mission church	No. 2, 5
Llano	No. 2, 4	Haury, E. W.	No. 1, 7; No. 3, 3
		Howiri	No. 2, 5
		Hupobi	No. 2, 5
		Ken-a Ki	No. 4, 6

Kiatsukwa	No. 2, 5
Kiet Siel	No. 4, 6
Ladder House	No. 4, 6
Laguna Mission church	No. 2, 5
Las Trampas: Church	No. 2, 5
La Vita: Church	No. 2, 5
Lino Black-on-grey	No. 1, 7
Lino Grey	No. 1, 7
Llano	No. 2, 4
Loloma Ki	No. 4, 6
Long Canyon	No. 4, 6
Los Aguajes	No. 2, 4
Lowry Ruin.....	No. 2, 3; No. 3, 3
McGregor, J. C.	No. 4, 7
Medicine Cave	No. 4, 6
Medicine Valley	No. 4, 6
Mochó	No. 2, 4
Mogollon Village	No. 3, 3
Monterey Pine	No. 3, 4
Nalakihu	No. 4, 6
Nambe: Mission church	No. 2, 5
Nokai Canyon	No. 4, 6
Obelisk Cave	No. 3, 3
Pecos: Mission church	No. 2, 5
Pecos Ruin	No. 2, 4
Pena Negra	No. 2, 4
Piedra Ruin	No. 3, 3
Pindi	No. 2, 4
Pine River Ruin	No. 3, 3
Poshu	No. 2, 5
Posi	No. 2, 5
Pueblo I.....	No. 2, 3; No. 3, 3; No. 4, 6
Pueblo II.....	No.2,3;No.2,4;No.3,3;No.4,6
Pueblo III.....	No.2,3;No.2,4;No.3,3;No.4,6
Pueblo IV.....	No.2,3;No.2,4;No.2,5;No.3,3
Pueblo V	No. 2, 3
Pueblo Largo	No. 2, 4
Puye	No. 2, 5
Quarai: Mission church	No. 2, 5
Ranchos de Taos: Church	No. 2, 5
Riana Ruin	No. 2, 4
Rio Gallina complex	No. 2, 3
Rowe	No. 2, 4
San Cristobal	No. 2, 4
San Francisco Phase	No. 3, 3
San Ildefonso: Mission church	No. 2, 5

San Juan: Mission church	No. 2, 5
Santa Ana: Mission church	No. 2, 5
Santa Cruz de la Canada: Church.....	No. 2, 5
Santa Fe:	
Guadalupe Church	No. 2, 5
"Oldest House"	No. 2, 5
Palace of the Governors	No. 2, 5
Parroquia	No. 2, 5
San Miguel Chapel	No. 2, 5
Santa Rosa de Lima: Church	No. 2, 5
Schulman, Edmund	No. 3, 5
Seshukwa	No. 2, 5
Spanish Colonial Buildings	No. 2, 5
Stallings, W. S.	No. 2, 3
Starkweather Ruin	No. 3, 3
Swallows Nest	No. 4, 6
Talpa: Chapel	No. 2, 5
Taos: Mission church (old)	No. 2, 5
Tecalote	No. 2, 4
Te'ewi	No. 2, 5
Three Circle Phase	No. 3, 3
Tonto National Monument	No. 3, 3
Trees, Buried	No. 4, 3
Tree-Ring Applications	No. 1, 5
Tree-Ring Chronology, Estimated.....	No. 3, 8
Tree-Ring Conference	No. 1, 2
Tree-Ring Dating: Accuracy.....	No. 4, 6
Tree-Ring Identification	No. 1, 3
Tree-Ring Interpretation	No. 1, 4
Tree-Ring Laboratory	No. 3, 2
Tree-Ring Work, 1937.....	No. 1, 3
Tsegi Canyon	No. 4, 6
Tshirege	No. 2, 5
Tsiping	No. 2, 4
Tunque	No. 2, 4
Turkey House	No. 4, 6
Tusayan Ruin	No. 3, 3
Twin Caves	No. 3, 3
Twin Caves	No. 4, 6
Tyuonyi	No. 2, 5
Unshagi	No. 2, 5
Vandal Cave	No. 3, 3
Walnut Canyon	No. 4, 6
White House	No. 4, 6
White Mound	No. 3, 3
Willey, G. R.	No. 2, 7
Winona Village	No. 4, 6
Wupatki	No. 4, 6

DENDROCHRONOLOGY IN TWO MISSISSIPPI DRAINAGE TREE-RING AREAS

FLORENCE HAWLEY SENTER

In 1934 the University of Chicago inaugurated work on tree-ring studies in the Mississippi Drainage with the object of eventually being able to date the Indian mounds of that area. The work was suspended from 1935 to the summer of 1937, when a tree-ring laboratory was established and full time work was resumed at Chicago under auspices of the Indiana Historical Society. During the summer, collections of approximately a thousand oaks, cedars, pines, hemlocks, ash, and poplars were made in Wisconsin, Minnesota, Illinois, Missouri, Kentucky, Tennessee, Indiana, and Iowa. These specimens were shipped to the tree-ring laboratory in Chicago, where boxes of specimens taken from the Indian mounds were already collected.

The result of the winter's work on the modern specimens has been improved technique in working with modern oak rings, the tree on which most of the work has been done, development of cross-dating of ash and of poplar in dating in that area, and the compilation of master charts extending back into the 1500's A.D. representing two distinct areas, a northern and a central. The northern area is known to include northern and central Wisconsin, eastern Minnesota, and the edge of Canada. The central area takes in Illinois, Indiana, Kentucky, southeastern Missouri, and Tennessee even to its eastern borders. The exact limits of either area are not yet known, but that problem will be pursued in future collections. The central area is already known to be larger than the southwestern tree-ring area, a fortunate situation when one considers that much of the middlewest has long since lost its virgin timber and good specimens are only available from scattered sections.

Small studies of oak rings in the middlewest have been carried on in limited areas previous to 1934. In going into the study of oak rings on a large scale, it was necessary to develop a technique of bringing the rings into easy visibility and of becoming familiar enough with the growth habits of oaks to be able to interpret the rings. Experiments were made in staining the rings with acids, with dyes, with inks, and with chalk rubbed into the pores of spring growth. None of these proved as satisfactory as cleaning off the surface with a sharp draw knife while the wood was held firmly in a vise. In oaks, as in conifers prepared with a razor blade, the cut should be at about a 45 degree angle from the horizontal. Oak wood is so hard that it cuts cleanly with the draw knife if a slicing movement is used. Punky spots or areas in which the rings are so small that the multiplicity of large pores makes the wood soft must be trimmed later with the razor blade knife.

The cut is oiled with kerosene, and the amount used should be more than that used on softer woods. If the surface is viewed through a thin film of oil, as on an oil immersion slide under a microscope, the visibility of ring structure is greatly improved. Because of the large pores the oil sinks in rapidly and must be replenished frequently. For this a small atomizer has been found efficient. Heavy shawl or bank pins are used for marking the rings, and the prick is put into the porous spring wood. The hard wood of its later growth bends pins before they penetrate.

The oak ring is outlined by a thin growth of summer wood just under the heavy spring pores of the succeeding year. To see this thin outline,

the specimen must be held horizontally, as a pine specimen, and tipped back and forth until the rays of the light behind it bring the narrow dark line into the most distinct view. The light should be directly behind the portion of the specimen being examined; even a slight angle between the light and the specimen greatly cuts down the visibility. Most of the oak specimens taken are wedges, and it has been found convenient to cut a small triangle from each end of a shoe box and to set the wedge into the cradle thus provided. The thickness of this exterior line varies in proportion to summer rains, as in certain pines.

Tree-ring studies in oaks are certainly more difficult than in pines, but they offer several advantages. Oak records are apt to be longer than pine records in the middlewest and in the south, providing one finds the right spots from which to collect old oaks. Moreover, oaks rarely, if ever, grow double rings. What appears to be a double ring is sometimes seen as a slightly marked, irregular, indefinite line beneath the obvious exterior line of the ring, but no cases have been found of the oak growing a second set of the large pores that mark the beginning of the spring wood. Hence identification of doubles presents no real problems. Identification of actual rings, however, may present a problem if one counts the rings down one side of a heavy medullary ray and then moves at some point to the other sides. These rays often mark a break in the ring similar to a geological slip; on one side of the ray the edges of the ring are lower than on the other by half or even by the whole width of the ring. Many of the early mistakes made in work on oak rings have been traced to the confusion thus arising. However, if one will get the light red on a well oiled specimen, he can trace the heavy edge of the ring across the hard wood of the medullary ray and onto the other side. In places where identification of rings is difficult, as in areas of very small rings, tracing the outlines on the medullary rays is often of considerable aid. And always it must be stressed that one cannot count oak rings by the large pores that at first glance appear to mark easily read rings; in areas of small rings the count can be made correctly only by identification of the exterior lines. Application of the Eisendrath photographic technique⁽¹⁾ of bringing rings into visibility by fluorescence offers new possibilities for facilitating study and measurement of small difficult rings, either directly or from enlarged photographs.

The white oak has been found to show longer records and greater sensitivity than any other oak examined, the longest record extending from 1937 back to 1569 A.D. The ash, another ring porous tree, closely checks the record of white oak rings where tested. Although work on ash has just been begun, this tree appears to offer even more than the oak, for it seems not to be as subject to the sets of small rings common in the centers of oaks. These small rings are the result of the oak seedling usually being protected by a nurse tree, and the rings remain small until the young tree grows enough to escape into the sunshine. It is true that these areas of small rings are often sensitive even in their smallness. In fact, the oak is much more sensitive in its youth than in its old age, and this fact enables the dendrochronologist to utilize young modern trees for the best modern records and yet to expect good records of ancient periods from the youth rings of old trees.

See p. 7 herein.

Oak dating, at least at present, should be done principally by groups, as one dates difficult groups of southwestern pinons. Specimens from Indian mounds have been set aside until the ground work for the area was well covered, but to test the actual possibilities of dating with oak rings the material from an old log cabin of unknown building date was cut. The logs were found to cross date with themselves, and to check against the master chart and against the actual wood of the modern specimens. The log cabin specimens dated themselves with no more difficulty than ordinary difficult specimens of southwestern pine. The dates were checked by Douglass. In this central area, the pine record has been found to check that of the oaks, which means that the two species can be used in recognizing and studying the idiosyncrasies of each other. They can each be used to extend the master chart and a specimen of either species can be dated on one chart.

Hemlock and pines have both been examined in the northern studies; the two trees do not check each other in growth records. Hemlock is difficult to cut clearly because it is so soft, but the records are long and sensitive, and cross-date well. The hemlock masterchart is completed back to 1550. The oldest hemlock record so far examined goes back to 1490. A good collection of hemlock sections was obtained from a paper mill at Wisconsin Rapids. Pine and hemlock borings are carried in hollow bamboo tubes to the laboratory. Stave mills in the South were found to be most cooperative for collecting oak specimens.

Field work in the summer of 1938 will be planned to more definitely locate broader lines of the two new tree-ring areas, to check some of the least investigated spots in these areas, to increase modern ash and poplar collections, and to find more very old modern ash, oak, and hemlocks to be used in extension of the two master charts. Small but distinct regional variation in records within the large areas must be distinguished and comparisons with precipitation and temperature records made statistically. A self-plotting measuring machine of new design has been built by Dr. J. Workman in the physics department of the University of New Mexico for measuring the rings of specimens reaching to two and a half feet in radius, and a new tubular borer for taking cores from living oaks up to the same radius is under construction in Chicago.

Until May, 1938, laboratory work was concentrated upon modern trees. At that time Dr. A. E. Douglass came to the Chicago laboratory, checked the mastercharts, and returned to Tucson with some sample specimens of wood for the Arizona laboratory. With his approval, cross-dating of pine and oak specimens from the mound collections of Tennessee, Kentucky, Illinois, and Wisconsin is being carried on, the better specimens carrying approximately one hundred rings of such sensitivity as to insure eventual dating. The usual technique of chipping the surfaces of charred specimens preserved with gasoline and paraffin was found to work fairly well for oak, but pine posts buried for some hundreds of years in damp soil broke apart, ring from ring when chipping was attempted. Even preservation of these water logged specimens was relatively unsuccessful until, with the aid of T. M. N. Lewis of the University of Tennessee, it was found that if the wood was first very securely wrapped around the circumference and covered over at the ends with bands of cheesecloth and then immersed in a solution of warm gasoline saturated with paraffin, the wrapped wood took on some firmness.

Days or weeks later, as the water still remaining in the wood slowly dries out, the specimen should be re-immersed in the solution, the soaking varying as experiment proves necessary.

When the specimen is to be studied, the heavy paraffined cheesecloth wrapping is cut from one end but left covering the rest of the surface for protection. If the wood is still damp it should be left to dry for two or three days, after which the surface may be carefully cut with a razor blade.

Our photographer, Mr. Eisendrath, experimented with hardening this surface with bakelite dissolved in acetone. The solution, scarcely thicker than water, is poured onto the surface, into which it quickly sinks, especially if the wood is well compressed horizontally by tight wrappings or by rubber bands over the wrappings. After two or three applications of the bakelite the wood is set aside to dry for several hours. The bakelite penetrates one half inch or more without difficulty, provides such body to the wood that it can be cut as cleanly as fresh wood, and holds a surface that may be photographed. Heating the bakelite to crystalize it impairs the surface for cutting and for observation. Experiments with other substances that might be used on wet wood in the field are being made, but the combination of firm wrapping, adequate field preparation in warm gasoline saturated with paraffin, and laboratory preparation with bakelite in acetone has proved so successful that we do not hesitate to recommend it to others working with wet or with dry charcoal.

SOUTHWESTERN DATED RUINS: IV

Chaco Canyon, New Mexico

By FLORENCE HAWLEY SENTER

Site	Period	Type of Masonry	No. of Specimens	Range of Dates
Chetro Ketl*	Pueblo III	Inferior wide banded with core	33	931-1102
		Narrow banded with core	81	925-1066
		Spalled blocks with core	11	1060-1116
		Fine unbanded with core and spalled blocks with core	19	911-1103
Talus Rock Shelter	Pueblo III		2	1101
East Dump of Chetro Ketl	Pueblo III	Stratum 4 (1)	10	921-1054
		Stratum 3	44	929-1119 (2)
		Stratum 2	1	1090 (2)
		Talus Site I of Chetro Ketl	Pueblo III	Narrow banded with core
Hungo Pavi*	Pueblo III	Inferior wide banded with core	2	1066-1076
		Fine wide banded with core	5	1048-1064
		Spalled blocks with core	1	1004
Kinklizin	Pueblo III	Spalled blocks with core	1	1084
Kinya-a	Pueblo III	Spalled blocks with core	6	1097-1106
Kinbiniola*	Pueblo II	Spalled blocks with core	2	1119-1124
		Unfaced slab	4	941- 943
Penasco Blanco*	Pueblo III	Unfaced slab	7	898-1055
		Fine wide banded with core	6	1051-1062
		?	1	996
Pueblo Pintado	Pueblo III	Fine wide banded with core	2	1060
Tsinklitzin	Pueblo III	Spalled blocks with core	2	1111
Una Vida	Pueblo III	Spalled blocks with core	1	987
		Fine wide banded with core	1	1048
		Unfaced slab	6	847- 950
		Fine wide banded with core	1	1027
Wijiji	Pueblo III		1	1027
Leyit Kin	Pueblo III		18	1011-1045

Tseh Tso	Pueblo II	Small spalled blocks without core	1	922
Kinchindi (3)	Pueblo III		2	1019-1042
Mound No. 20(4)	Pueblo III		4	1039-1045
Kinishba (Ft. Apache)	Pueblo IV	Spalled blocks with core (?)	3	1307

* See also other installments of this series.

- (1) See Hawley, F. M., 1934, "The Significance of the Dated Prehistory of Chetro Ketl", Univ. of New Mex., Mon. Series, Vol. 1, No. 1, for explanation of peculiar range of dates and strata composition.
- (2) Corrected for burned-off exteriors.
- (3) Also known as Small House Unit No. 26 (according to Fisher's Chaco Survey).
- (4) Also known as Mound No. 21 (according to Fisher's Chaco Survey), and as Mound No. 27 (according to Wilson's Survey).

ON PHOTOGRAPHING THE RINGS OF OAK SPECIMENS

By DAVID B. EISENDRATH, JR.

In photographing the rings of oak specimens, it was found in many cases, particularly where small rings were encountered, that color differentiation between spring and summer wood was so slight as to make distinct photographic record difficult or impossible.

The investigator tried both daylight and Mazda (artificial) illumination with a great many film and filter combinations in an attempt to obtain contrast and sharply defined edges in ring patterns, but with little success. Although photography with infra-red materials and techniques gave somewhat better results, the method was uncertain, and expensive. An attempt was then made to photograph with light from the blue end of the spectrum, and also with invisible ultra-violet rays. It was found that kerosene, used in ring counting, fluoresced slightly, giving a dull glow to the specimen under ultra-violet light; since Pennsylvania oils fluoresce more brightly than other oils, Pennsylvania kerosene with a few drops of motor oil added was used, and produced even better fluorescence. Photographs of these specimens were surprisingly easy to study and were well defined, indicating further research into the field.

Since photography by ultra-violet light is impossible with ordinary cameras and (glass) lenses, a study was made of materials which, under ultra-violet light, would fluoresce visibly, and thus could be photographed more easily. Although several such materials were tried, best results were obtained by the following method:

A small amount of refined Anthracene (powdered), C_6H_4 : (CH) 2: C_6H_4 , is dissolved in a few c.c.'s of ether, in which it is slightly soluble, and after the ether has almost completely evaporated, an equal amount of alcohol is added. This material is mixed thoroughly by shaking in a test-tube, until a thinnish paste remains. This paste is then rubbed over and into the surface of the cut specimen with a piece of cotton; it must be rubbed vigorously and carefully in order to make the rings absorb it uniformly. After the entire section has been treated in this manner, it is allowed to dry, forming a white surface over the cut edge. After drying, the cut edge is then rubbed gently with a piece of cotton soaked in alcohol in order to remove the surplus surface crystals.

It will be found that under sunlight, or the light from a white-flame arc light, the section will glow brightly because of the ultra-violet light in the source striking the crystals of anthracene which have been absorbed by the cells of the rings. It has been found that better crystals will form if the surface of the specimen is dry before this solution is applied.

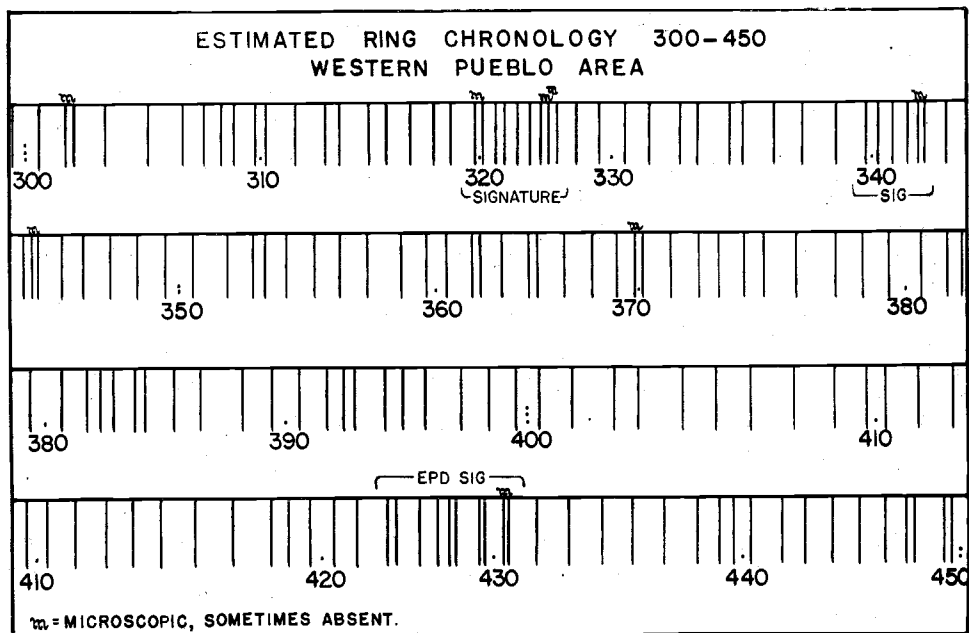
In order to photograph the wood treated in this manner, it is neces-

sary to eliminate much of the additional light coming from the source. An ordinary Wratten C5 filter or other blue transmission filter will transmit the fluorescent blue light; best results have been obtained with Panchromatic Process films, or, for extreme contrast, Kodalith. For Leica (miniature camera) photography, 35mm Positive, Microfile, or Reprolith films are excellent.

It may be necessary to suggest that no light coming through glass be used, as this would filter out the ultra-violet light appreciably.

ESTIMATED TREE-RING CHRONOLOGY: 300-450 A. D.

A. E. DOUGLASS



302	microscopic; sometimes absent	370	very small to microscopic
308	small	363-370	very small group
310	very small	373	smallish
313	small	375	smallish
320	microscopic and usually absent	377	smallish
320-7	very small or microscopic group (signature)	382	small
324	very small	383	smallish
326	very small and sometimes absent	385	very small
327	very small	392--3&5	small group
333	small amidst large rings	399-401	small group
335	small amidst large rings	410	small
340	smallish	418	small
340-4	small (signature)	423	very small to microscopic, EPD signature 423-431
343	very small	425	very small
344	very small, sometimes microscopic	426	small
353	small	427	very small
360	sometimes small	429	microscopic, rarely absent
362	very small and sometimes absent	431	microscopic, frequently absent
365	very small and occasionally absent	439	smallish
		447	small
		449	very small