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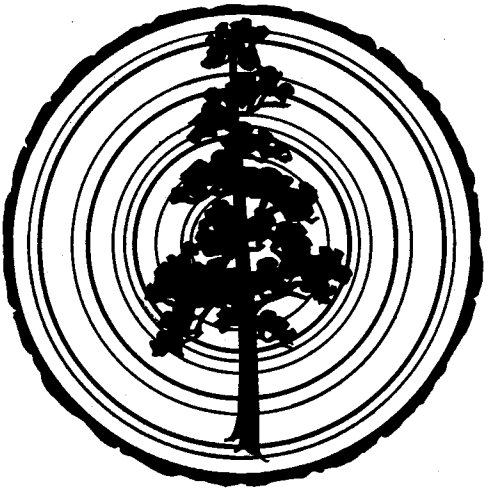

CONTENTS

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TABULATION OF DATES FOR BLUFF RUIN, FORESTDALE, ARIZONA

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Introduction. A general discussion of the age of Bluff Ruin was given in a previous article: "Checking the Date of Bluff Ruin, Forestdale; A Study of Technique," *Tree-Ring Bulletin,* vol. 9, no. 2, October, 1942. Herewith are (1) a list of the dated specimens from this site, (2) data which bear upon the accuracy of the dating, and (3) items that will assist in future attempts to make this dating more complete. The table follows the plan used in this Bulletin except for the estimated bark dates which are discussed in the text.

Wherever possible, specimens are identified by the FST numbers in Emil W. Haury's record, with the addition of Ralph T. Patton's numbers in a separate column under the group letter B (the latter were assigned, on opening the packaged collections in the laboratory, before full identity was obtained). The next columns give the first or inside dated ring, the last or outside dated ring, and the overall distance in millimeters from one to the other. Listed also are the number of locally-absent rings within the series, the species, the ring type, and by footnotes the evidence of nearness of the outside ring on the specimen to the true outside or bark date.

We use here the same sequences described in 1942 with the addition of Sequence F and a slight modification in C and D.

The significance of center and bark dates. The dates of center are obtained directly, and enable one to estimate the number of trees. If specimen centers show very different dates then there are two or more trees depending upon the number of such separated dates. The importance of the number of trees is related, of course, to the general interpretation of ring sequences that crossdate, for such crossdating between different trees is the intrinsic evidence of climatic effect. In this instance, it implies a record of seasonal rainfall.

The bark date, on the other hand, has to be estimated as a rule, and is primarily of archaeological importance, since it is commonly the date at which the Indians cut a living tree for use in house building or for firewood.

Evidence of bark date may be found in several ways. The best of all is the presence of bark, but this is very rare. The next is the presence on the specimen of an outside surface that obviously follows the contour of some one ring. Sometimes the outside does not follow a ring perfectly and then its probable date has to be approximated from rings that are themselves dated with precision. Hence, though we give the dates of rings with utmost care, we cannot give cutting dates always with the same exactness.

Another evidence of bark date is the sharply decreasing average size of rings which normally occurs near the outside when the food supply of the tree becomes too small. These rings may be called "converging" or "starvation" rings, and usually occur at some distance from the tree center. Very shallow or very limited soil such as gathers in small cracks in rocks cannot maintain a large tree. Hence, the tree grows rapidly while very small and then its rings begin to diminish sharply in average size and may finally become much too faint for the investigator to distinguish even under the microscope. Such rings are excellent internal evidence of nearness to the cutting date of the tree.

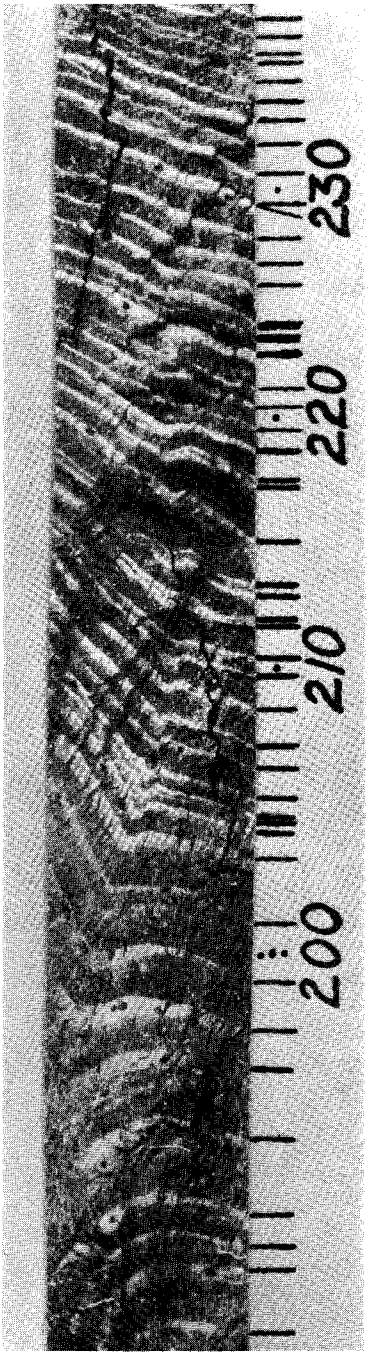
We have used another indicator of nearness to the cutting date, the "sap-heart contact." It is the date at which the tree's heartwood changes to sapwood. There is a tendency to a characteristic number of rings in the sapwood of Douglas fir and ponderosa pine. This number may be added to the sap-heart date to get an approximate cutting date.

Finally, evidence may be obtained from a large group of charcoal pieces by plotting them individually, after dating, in progressive order of their outside dates, which may thus be found to approach a definite date without going beyond it. This method has been used to secure approximate dates in large collections of charcoal pieces, to which it is specially applicable, since charcoal beams are frequently found broken into numerous pieces.

Sequence A. All charcoal. This is the original sequence dated by Patton in the early months of 1942. A recent study by microscope showed the cells in all specimens to be mostly under 0.03 mm in width and the rings to have many resin ducts and narrow latewood, hence the species is taken to be pinyon (*Pinus edulis*), common in the vicinity of Forestdate. There are over 20 specimens belonging in this sequence. However, they probably came from only two or three trees which were burned into charcoal and badly broken. All of them are from the Great Kiva.

These specimens give a beginning date for the ring series about 234 A.D. and indicate probable bark or cutting dates near A.D. 315 ± 10.

Sequence B. Charcoal and wood. Sequence B, also based on Great Kiva specimens, was recognized by Patton as different from Sequence A. It is pinyon as identified under the microscope. The series has about 120 rings in it and represents two or more trees as indicated by different average ring-size and general appearance. This group is specially valuable because a number of specimens show the outside curvature of the tree. In the previous mention of this sequence (October, 1942) a provisional dating was assigned which has been verified in the present review. Some of these specimens carry a ring series of more than 100 years with not more than three or four absences. As presumed, the three small rings 210, 212, and 214 A.D. agree with similar rings in MLK-153 which came from Red Rock Valley in the northeastern corner of Arizona. By this dating we secure the real use of the excellent outside curvature of some of these pieces. In FST-234 the curvature is continuous around some 80° of the circumference and rings can be seen following this curvature through most of that distance. Since the outside ring is now dated at 318 A.D. the cutting date, estimated at 320 ± 2, becomes a very good date for the ruin and supports the age previously obtained.



Early Ring Record at Bluff Ruin.
FST-233, pinyon, magnification ×6. Ring 229 A.D. absent.
Compare the chronology with that in MLK-153, January 1939 *Bulletin*, p. 21.

FST Spec. Number	(B) Number	Species	Inside Dated Ring	Outside Dated Ring	Length, mm.	Number of Absent Rings	Ring Type
			SEQUENCE A				
.....	1	PNN	231	274	36	0	B
.....	2	"	224	280	39	0	AB
.....	2a	"	242	267	22	0	AB
.....	3	"	231	274	42	0	AB[4]
.....	4	"	248	285	27	0	AB
.....	5	"	235	274	38	0	AB
.....	6	"	243	294	37	0	A
.....	7	"	261	304	9	1	A
.....	8	"	252	295	30	0	A[1,4]
.....	9	"	249	279	39	0	AB
.....	11	"	259	293	21	0	B
260	17	"	267	305	32	1	B[2]
264	....	"	275	305	28	0	B
266	20	"	260	301	40	0	B[2]
268	12	"	262	302	30	0	B[2]
271	16	"	260	304	40	0	AB[2]
278	15	"	262	312	40	0	AB[2]
279	....	"	280	316	21	0	B[2,4]
280	....	"	268	299	40	0	AB
282	19	"	274	309	20	0	B[2]
283	....	"	272	305	25	0	B
284	18	"	258	300	41	0	B[2]
287	....	"	277	317	26	0	AB[1]
288	13	"	255	305	41	0	B[2]
			SEQUENCE B				
232	....	"	218	281	14	5-6	
233	21	"	191	314	37	4±	AB[2]
234	....	"	191	318	29	4-6	[2]
235	....	"	284	318	9	0?	
236	....	"	232	320	23	6±	[2]
237	....	"	224	280	11	6	BC
238	....	"	205	312	26	4±	[1]
272	14	"	192	307	40	6±	
			SEQUENCE C				
199		PP	244	288	29	0	AA
200		"	220	262	40	1	A[1,3,4]
201		"	219	270	45	0	A
202		"	231	286	28	5	A
245		"	262	293	36	2	A
247		"	285	302	27	0	A[3]
257		"	272	306	36	1	A
			SEQUENCE D				
160		PNN	190	265	23	0	B[1]
163		"	200	285	30	0	B[1]
164		"	257	296	37	0	B
			SEQUENCE F				
F 14-15		PP	173	302	65	0	AB[1,2]

[1]Converging rings in outer part; also called starvation rings.
[2]Shows outside curvature, probably somewhat worn.
[3]Shows predicted rings.
[4]Photograph published October, 1942.

Sequence C. Wood, with some charcoal surfaces. This is the highly sensitive ponderosa pine sequence. In some cases, a ring may be twenty times as large as the next following ring. A diminution much less than this ratio may appear in other trees that crossdate perfectly well so that most doubtful cases encountered have been solved satisfactorily by the use of other specimens. Careful comparisons between these specimens indicates that FST-199 from House 3 is a different tree from FST nos. 200, 201, and 202 from House 1. No. 202 shows very high sensitivity with one or two depressed rings a small fraction of a millimeter in thickness. This possibly is not from the same tree as the other two. Nos. 245, 247, and 257 all look alike and are doubtless out of one tree coming from House 2. No. 247 comes very close to the original outside as judged by its curvature. 302 A.D. may be the true outside ring. From the straightness of the rings in some cases the diameter of the tree could be 12 inches or so. However, where the tree is part wood and part charcoal, as in all these specimens, there may be substantial distortion of the curvature of the rings.

The dated sequence extends from 220 A.D. to 305 with center at 191 or 192 and one absence at 229 A.D. Rings 285-286 A.D. are sometimes microscopic and one possibly absent; 291 is sometimes doubtful as the ring representing it could be taken as a double of the preceding year; 294 is sometimes absent. Specimen FST-247 gives the series from 285 to 302, and shows all these absent rings. They are, therefore, classed as predicted rings and have established the correctness of the dating. FST-199 performs an important service because it overlaps FST nos. 245, 247, and 257 from House 2 in its outer parts and FST nos. 200, 201, and 202 from House 1 in its inner parts, thus producing one continuous sequence from 224 to 306 A.D. with only 229 A.D. persistently absent.

FST-200, FST-201 and FST-202 are highly sensitive ponderosa pines from House 1. These show strong compression in the rings at the outside and therefore give a close approach to the cutting date of the trees. The rings may be traced toward the center to about 224 A.D. with accurate dating; then come more difficult rings to the center near or before 200 A.D. with doubles which make date identification uncertain. The later rings can be identified into the 270's but probably extend ten years beyond that. The diminishing size of these starvation rings indicates a small loss on the outside. Part of this series has been published (1942) in a photo group. The bark date of this sequence is A.D. 306+×.

Sequence D. Wood. Sequence D from House 6 was known in the first discussion of this dating as the "long stick" from its principal specimen FST-163. It has some 85 rings in it. This sequence also includes FST-160 and FST-164. This series is characterized by long intervals of complacent rings separated by brief sets of very small rings. FST-164, pinyon, shows a strong dating at 296 A.D. with probably a small loss on the outside.

FST-163 finally yielded a satisfactory date of 285 A.D. for its last ring. This was accomplished by the aid of the previous successful dating of the B sequence and a good skeleton plot of it. This dating was of course verified by the comparison of the ring sequence in the wood and charcoal with the minutely memorized picture of practically all other known specimens covering the same period of time. The actual appearance of the rings them-

selves in comparison with all other presentations is of course the final arbiter of the genuine quality of a dating. Certain other features will be referred to below. The bark date of this sequence may be taken as A.D. 285+×.

Sequence E. No completely satisfactory dates were found in Sequence E from a stratigraphic location called E-5. Three ponderosa pine specimens, FST-124, FST-125, and FST-127, probably came from the same tree. Dating was prevented by too many double rings. FST-140, a ponderosa, also has double rings. FST-144 and FST-146 are pinyon; FST-144 has a provisional dating of its last ring at 257 A.D., the inner ring being at 209. Further study may give more weight to this date. FST-146 shows strong outside curvature on a radius of about 50 mm and a fairly definite outer ring, but the dating is not satisfactory.

Sequence F. The following notes represent a preliminary study only. The 1944 collections at Bluff Ruin were contained in 15 packages. These were numbered 1 to 15 as opened, under the group letter F. The specimens were distributed as follows:

House	6	F-1	House	15	F-2
		F-9*			F-8
"	14	F-4*			F-10
		F-5*			F-12*
		F-13*	"	19	F-6*
"	11	F-3			F-7
		F-11	"	21	F-14
					F-15

Six specimens, starred above, are juniper and their study was postponed. Five of the others were found to have difficult ring series probably impossible to date. Thus there were left F-1 in House 6, F-3 near House 11, and F-14 and F-15, parts of one tree, in House 21. Each of these shows a significant relation to the tree's outside. F-1, probably pinyon, is a half section with a smooth unmarred outside. It gives a suggestion of dating in the 260's but has one or two disagreements that have kept it out of the dating tables for the present. F-3, ponderosa pine, seems to have a trace of bark, so its date could become valuable. Dr. Haury thought it might be many years later than the Kiva specimens dating near 320 A.D. Many of the narrow rings are hard to distinguish on account of spots of gum, both in charcoal and wood. It will need careful preparation before a reliable reading can be made.

F-14 and F-15, two parts of the same tree with nearly the same central date, are large fragments of ponderosa pine, each about 14 inches long, together giving a ring record from 173 to 302 A.D. The records from 173 to 236 and from about 256 to 302 A.D. are exceedingly good but the intermediate interval from 236 to 256 is badly distorted from injury and the repair work of the tree. The ring type is excellent and the details resemble Durango specimens particularly. Thus this is a valuable contribution to the dendrochronology of the second and third centuries. The bark date of these two specimens is 304+×.

Ring 229 A.D. Practically up to the time of this writing (October, 1944) the complete absence was assumed of any ring for 229 A.D. Sequence A did not extend that far back. Sequence B simply omitted one ring in that vicinity. Sequence C showed 231 A.D. as a microscopic ring while 229 was absent. Sequence D has only just been dated. The easier sequence on the large end of FST-163 had 229 A.D. absent but the supposedly more difficult sequence at the small end showed 229-31 as two microscopic rings separated by a larger one, which is exactly the form these rings take in the Durango and Red Rock Valley sequences.

The group near 212 A.D. Sequence B has this group very prominent—210 A.D. very small, 212 and 214 micro, and 217 micro and locally absent. The small rings 210, 212, and 214 A.D. resemble a similar series in MLK-153 from the Red Rock Valley. The same sequence in FST-163 has 212 A.D. normal instead of small and in this resembles the Durango record. This resemblance to Durango specimens is carried only partially to the center. The rings 199 and 201 A.D. are only slightly smaller in the C sequence but the small rings at 194-195 are small as in Durango and Red Rock Valley.

Possible extra ring in the 240's. FST-200, FST-201, and FST-202 show the series of small rings beginning at 243 A.D.—three rings almost exactly alike followed by larger rings 246-7-8. There is an annual-like extra ring between 244 and 248 A.D., which, however, in one instance at least looks like a part of the preceding ring. This extra ring does not appear in any other ring record we have which presents that decade. This fact together with the strong tendency to false rings in the Forestdale area leads us to the present opinion that it does not indicate an extra year. However, more specimens are needed to completely disprove its annual character in view of the relatively limited number on which the early centuries of the Central Pueblo Master Chronology is based.