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AN 800-YEAR DOUGLAS FIR AT MESA VERDE*

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An extraordinarily old Douglas fir, recently dated at Mesa Verde National Park, has now closed the break[1] in the climatic history of that locality in the late 1200's and has provided a most striking example of the survival and longevity of trees growing under adverse conditions. Increment borings show that it began growth in A.D. 1150±5.

Location. This tree grows some 100 feet below the mesa top on a steep, sandstone slope, facing northwest, in a spur of Navajo Canyon, about 1¼ miles airline northwest of the park headquarters. On the topographic map of the park, scale 1:31250, 1936 edition, its coordinates are 37°11′48″ N, 108° 30′6″ W, elevation 6,900 feet.

Form. Above the twisted lower stem, two feet in average diameter, the trunk tapers to a snag top, at about 35 feet. The distorted form of this fir, illustrated in Figure 1, seems to be the result of two major events in its career. After a slow start under suppression and after assuming in its first century the common L-shaped form of Douglas firs growing on steep slopes, this tree, sometime near A.D. 1250, was apparently bent some 30°-40° to one side, perhaps by the fall of a rock or nearby tree or by the displacement of a supporting rock (see below). Following this came an interval of undisturbed growth, lasting at least 300 years, which gave the tree a straight vertical stem above the 10-foot level. A second violent change in axis occurred after the tree had reached the over-age, snag-top stage; again the entire stem was bent, at an angle of almost exactly 45°, apparently as a result of the decay and movement of the sandstone block, shown in Figure 1, which acts as its buttress.

Present condition. Growth in recent decades has been relatively vigorous, the tree at present supporting many active branches and bearing a number of green cones. Borings in the lower stem and in the roots show the presence, especially in the latter, of numerous cracks filled with resin; indeed, the resin saturation was found to be more extensive than in any other tree of this species sampled by the writer.

Since further erosion of the sandstone buttress may, if allowed to continue unchecked, result in the fall of this tree long before its surrender to its natural enemies, artificial support will, it is hoped, be provided.

* Grateful acknowledgement is made of the cordial co-operation of the National Park personnel at Mesa Verde — in particular, Chief Ranger Jack J. Wade, whose enthusiastic participation in the field work was very helpful.

[1] Schulman, Tree-Ring Bull. 12 (3), 1946. In that paper, the Pueblo beam sequence of ring widths ended at A.D. 1274. The ring sequence based on living trees began at A.D. 1288, the data preceding 1304 being based on an incomplete core of one tree of a group sampled in August, 1945. That tree was visited again on July 9, 1947, in the hope that a few early rings might be added by a core striking the pith. The remarkable character of this tree was then realized; 125 rings were added to the inner part of its known record!

Photo by Robert L. Starks.

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Figure 1. Stem form of the 800-year Douglas fir.

Left: The main stem is inclined at an angle of about 45° to the line of sight.

Center: The distorted lower stem lies in a nearly horizontal position. Two cores striking very close to the center were obtained at *a* and *b*, some twenty inches apart, with pith dates near A.D. 1150 and 1170; the excentricity of the stem at these levels is indicated by the broken line showing the probable location of the pith. The root-stem c at the radius marked shows a pith date near A.D. 1197. The exposed root *d* is better shown in the view, at right, from below the tree.

Right: The stratified sandstone block, which acts as a buttress for the tree, is seen to be partly eroded away; it is now oriented at an angle of about 45° to the horizontal bedrock strata.

Age class. The 800-year Mesa Verde fir is remarkably long-lived even for this region of many over-age trees. During four visits to this area, in 1939 and later, in search of long records of climate in trees, some 100 Douglas firs, 10 ponderosa pines, and 15 pinyon pines were sampled. Of these, 36 firs and 2 pinyon pines proved to be 500 years or more in age, distributed according to the following table:

Began Growth, A.D.*	No. of Trees	
1401-1450	19	
1351-1400	12	(2 pinyon)
1341-1350	1	
1331-1340	1	
1321-1330	1	
1311-1320	0	
1301-1310	3	
-1150	1	

The great discontinuity in age between the oldest and the second oldest tree at Mesa Verde may perhaps be eliminated on further sampling. At present, however, the former is the only recorded tree which was living in the late 1200's when Mesa Verde was apparently abandoned. (At this time it was almost certainly older than any member of the departing tribes!)

Elsewhere in the Rocky Mountains, apart from occasional junipers and upper timberline conifers for which great ages have been suggested, few trees are known which approach or exceed in age that of the fir here reported.[2] The maximum age seems to be a function of latitude (locality?) for at least one species: Douglas firs over 600 years of age are fairly common in certain areas of the Colorado River Basin near 39°-40° N latitude, yet are to the writer's knowledge nowhere found south of 35°.

Reasons for survival. To what then may the remarkable longevity of this tree be attributed? Perhaps in large part it is the product of many generations of survival of the fit in an extremely difficult environment. It seems probable, too, that the repeated shock and continuing strain on its root system have helped this tree, perhaps through the agency of excess resin production, to ward off both pest and decay.

Ring characters. The fine sensitivity of the ring record in the 800-year fir is illustrated in Figure 2.

Perhaps related to the disturbed growing conditions of its youth are the rather emphatic false or non-annual rings, visible in Figure 2 and easily identifiable on the wood, which were laid down in the lower stem of this tree in A.D. 1224, 1251, 1258, 1293, 1308, and 1311. Such rings are unusual at Mesa Verde, though quite common in southern Arizona and New Mexico. Such doubling seems to fade out, even within twenty inches of the lowest level *a*, as shown in part by the comparative record from level *b* in Figure 2; the recent centuries in both records are free of emphatic false rings.

Variations in ring chronology in the distorted lower stem are somewhat greater than is usual in the highly sensitive trees of this locality. To reduce this effect to a minimum, a mean of seven radii was taken during the interval 1240-1400 (see Figure 3); this is believed to provide a fairly reliable series joining the archaeological chronology to the record from the main body of living trees at Mesa Verde.

* Five to ten years were allowed for height growth to the sampling level, plus, in some cases, allowance for off-center cores.

[2] Schulman, Journal of Forestry 43: 422-427, 1943. An 860-year pinyon pine near Dolores in southwestern Colorado and an equally old Douglas fir, of the cold climate, complacent type, near Redcliff in central Colorado, are there reported; the normal life span of Rocky Mountain conifers seems to be about 500 years.

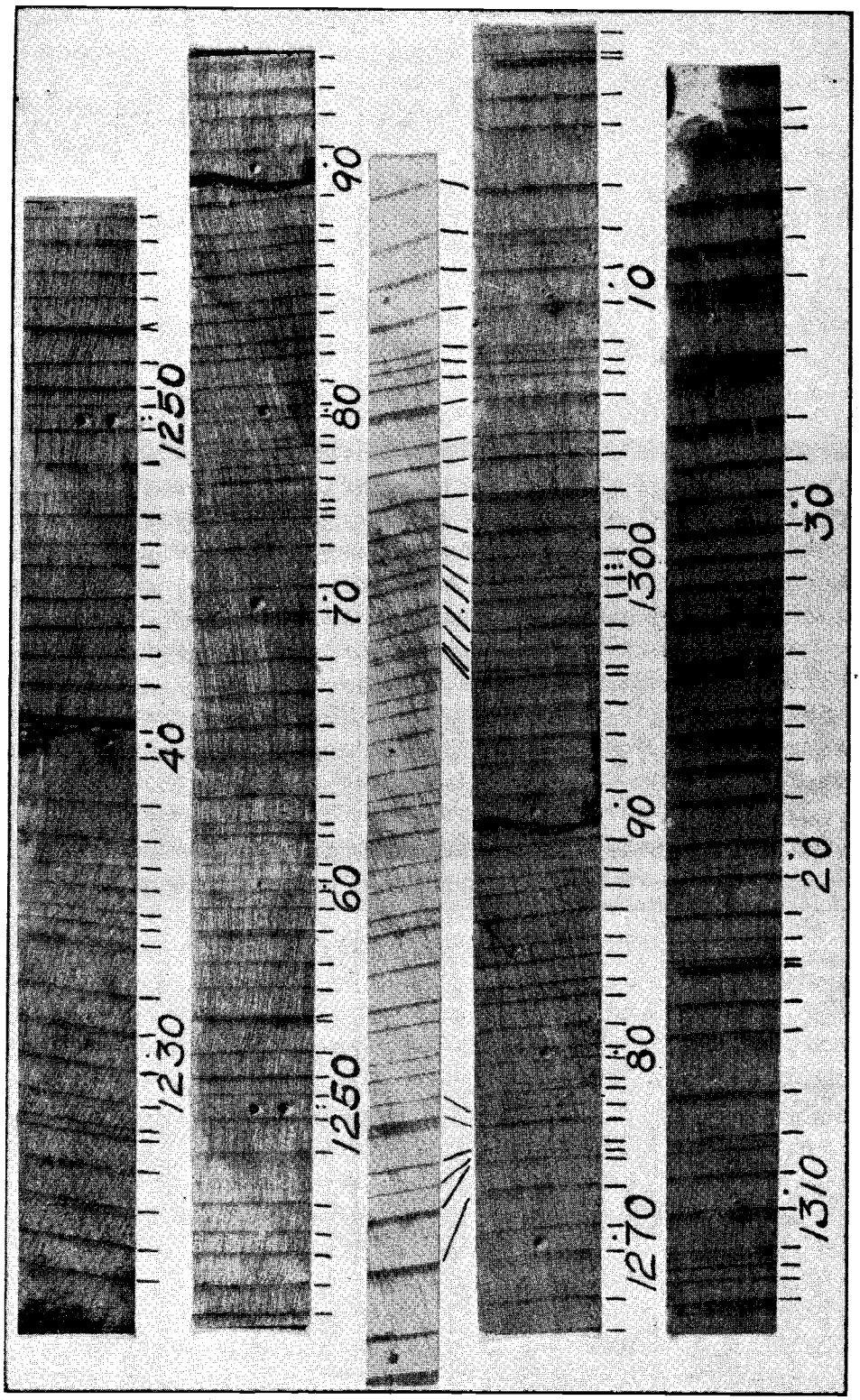

Figure 2. A photographic record of an interval including the "Great Drouth" at Mesa Verde, representing part of the core at *a* in Figure 1. The central strip represents part of the core at *b* and provides a crossdating check on the record.

Table 1. Tree-Ring Indices for Mesa Verde: Ring Widths in Per Cent of the Growth Trend*

A.D.	0	1	2	3	4	5	6	7	8	9
460	.....	.....	.....	.....	.....	120	101	109	101	80
470	73	83	88	61	76	117	94	144	149	91
480	128	65	114	91	126	79	49	87	65	79
490	114	75	69	49	131	138	126	107	101	114
500	62	79	111	96	110	134	85	118	84	116
510	160	94	55	39	69	49	48	47	49	33
520	40	37	72	148	64	64	00	91	104	86
530	196	106	111	127	156	112	50	115	118	83
540	83	96	58	64	115	60	103	79	112	121
550	104	115	168	144	92	119	109	96	103	124
560	152	38	104	00	67	14	52	67	19	29
570	57	57	95	81	100	128	181	105	57	71
580	48	124	152	90	67	76	110	176	110	190
590	43	100	162	162	143	114	143	29	148	71
600	143	110	90	38	76	119	81	90	105	90
610	67	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
730	.....	.....	.....	78	118	114	110	117	27	75
740	131	132	87	146	97	96	106	91	66	140
750	114	41	132	154	120	93	48	20	104	130
760	60	128	68	64	78	142	146	38	126	87
770	65	58	116	75	48	53	100	73	53	46
780	142	52	37	83	67	156	162	156	60	144
790	108	108	135	59	179	44	103	15	129	102
800	161	51	155	227	115	77	92	80	55	05
810	125	68	90	120	201	163	149	77	55	25
820	143	159	179	38	56	68	106	51	123	29
830	40	81	112	91	66	51	133	80	125	62
840	14	103	46	136	51	111	75	40	79	58
850	93	85	197	167	214	156	206	47	149	113
860	132	154	188	38	140	115	80	23	48	160
870	80	99	113	91	91	105	129	34	46	88
880	45	108	86	66	18	120	97	118	97	118
890	118	100	57	114	28	49	218	141	132	196
900	173	48	129	53	58	148	09	03	96	116
910	147	169	159	143	144	123	82	144	144	157
920	117	129	55	23	35	96	91	78	135	146
930	53	111	110	90	107	101	110	42	106	75
940	95	120	142	108	135	109	151	136	153	131
950	141	95	152	87	69	58	190	64	54	113
960	171	103	155	115	118	73	190	115	92	72
970	110	154	16	209	180	78	85	151	71	95
980	08	07	107	49	52	99	95	182	181	246
990	133	31	97	81	99	111	137	73	107	83
1000	122	61	63	103	91	07	128	129	144	20
1010	86	100	139	52	96	128	136	174	88	10
1020	127	123	120	148	153	169	110	131	122	117
1030	56	81	50	51	99	37	36	134	79	92
1040	119	41	126	84	61	82	43	121	53	122
1050	131	95	167	82	153	57	141	133	150	121
1060	110	152	57	259	224	251	181	99	105	139
1070	124	94	150	136	148	157	175	166	130	170
1080	259	99	90	97	128	24	85	134	158	116
1090	20	44	82	32	58	64	71	61	81	37
1100	93	56	114	113	85	113	62	112	88	89
1110	110	81	152	75	145	161	169	216	146	148
1120	150	73	161	61	170	130	53	140	126	130
1130	112	30	125	48	89	68	101	65	84	128
1140	42	134	132	107	104	147	75	76	71	110
1150	18	34	161	94	66	130	29	97	16	142
1160	111	33	165	174	107	156	46	125	88	59
1170	104	96	125	124	124	53	101	88	130	69
1180	114	125	41	53	109	82	29	75	110	105
1190	130	40	55	86	157	143	121	129	68	62
1200	170	147	64	113	105	67	77	80	75	117
1210	124	157	137	126	101	53	55	18	54	111
1220	86	63	92	127	113	89	111	46	104	112
1230	116	99	120	89	83	103	68	105	173	161
1240	86	132	110	88	82	77	59	74	131	123
1250	104	70	86	128	16	114	102	119	60	110
1260	82	90	121	47	97	133	85	113	104	141
1270	94	141	119	54	50	111	50	67	41	80
1280	55	96	104	55	83	65	105	85	49	94
1290	132	95	72	101	100	22	69	82	110	56
1300	79	108	127	126	72	139	83	56	52	125

A.D.	0	1	2	3	4	5	6	7	8	9
1310	129	127	151	193	109	108	14	66	85	128
1320	135	147	101	83	65	152	128	114	91	73
1330	127	129	150	176	175	80	155	156	50	135
1340	61	76	83	81	78	105	85	57	86	104
1350	45	39	68	156	130	84	108	105	138	144
1360	79	59	65	66	54	76	111	87	115	67
1370	154	90	101	99	139	69	60	68	105	89
1380	205	138	179	213	142	122	156	130	136	73
1390	21	80	108	90	108	114	69	76	60	67
1400	38	61	41	40	95	96	131	111	102	148
1410	141	34	151	22	124	59	74	95	65	75
1420	84	59	77	58	85	74	131	121	138	118
1430	129	127	154	131	92	70	115	92	37	94
1440	120	158	84	102	95	66	63	85	78	57
1450	52	140	111	111	100	14	81	22	152	95
1460	76	44	124	90	23	40	110	131	97	111
1470	111	39	76	48	99	61	118	139	119	68
1480	55	87	105	102	186	152	139	96	132	132
1490	149	237	137	126	135	11	83	99	177	101
1500	10	66	115	111	120	50	17	84	101	145
1510	51	132	147	154	164	91	32	88	50	124
1520	142	89	26	88	87	104	163	158	91	108
1530	135	105	16	90	102	91	120	120	59	90
1540	140	105	23	118	69	70	91	66	100	94
1550	164	88	96	140	70	96	146	137	125	127
1560	116	66	73	102	104	114	74	42	124	88
1570	156	136	141	63	60	84	94	98	87	17
1580	38	51	45	32	13	09	65	44	95	65
1590	31	120	75	64	129	105	98	102	61	109
1600	34	109	93	60	84	134	124	91	157	140
1610	180	120	86	146	108	154	163	170	165	83
1620	156	141	136	64	56	76	47	89	71	113
1630	108	105	47	116	118	140	79	89	103	97
1640	162	134	89	108	87	89	152	134	73	129
1650	158	184	73	160	45	168	144	92	89	102
1660	134	81	79	79	66	145	55	53	60	60
1670	84	90	105	150	140	124	53	76	121	84
1680	110	113	128	113	53	05	92	76	84	105
1690	116	97	132	124	79	95	60	95	128	140
1700	106	155	84	110	58	116	140	53	97	108
1710	179	134	136	105	79	100	71	84	108	126
1720	181	116	110	166	76	160	147	150	92	16
1730	82	89	103	76	139	45	105	55	79	74
1740	55	74	68	110	92	132	165	189	42	147
1750	105	110	87	92	95	73	71	42	71	116
1760	71	89	95	89	100	60	139	61	121	108
1770	95	152	102	18	82	60	84	97	58	71
1780	50	79	39	110	105	113	81	100	76	68
1790	42	113	132	129	87	87	74	100	89	97
1800	105	84	140	89	118	79	71	124	63	74
1810	74	87	108	63	71	126	165	142	47	42
1820	39	142	79	45	55	97	105	89	116	100
1830	95	95	142	145	97	134	111	108	152	150
1840	174	160	84	150	145	58	121	21	121	137
1850	148	39	134	142	113	126	142	95	129	97
1860	92	08	147	97	50	105	110	152	121	160
1870	53	63	42	87	89	71	42	140	68	97
1880	79	76	76	66	108	113	100	63	153	126
1890	129	129	113	53	50	82	24	118	103	18
1900	58	108	16	121	16	97	95	132	105	129
1910	111	108	145	71	137	171	147	171	63	124
1920	198	126	140	74	113	79	142	100	116	82
1930	87	84	118	79	34	95	63	97	108	79
1940	76	150	134	95	99	92	50	106		

* The number of specimens on which these data are based, for any date, is that given in Tree-Ring Bull. 12(3), 1946, Fig. 2 except for dates A.D. 1176 to 1287 inclusive, for which the numbers given there should be increased by one. Appropriate weight should be given to the fact that the mean of seven radii from the 800-year fir, A.D. 1240-1400, has been used in constructing the table. The innermost portion of the ring record in this fir, preceding A.D. 1176, was compressed and uncertain and was thus omitted in this revision. Seven cores collected on September 5, 1947, when the growth-ring for the current year was complete, served to extend the 1945 series.

The ring record. No direct ring data in the late 1200's for Mesa Verde itself have heretofore been available. Thus the suggestion[3] that one of the

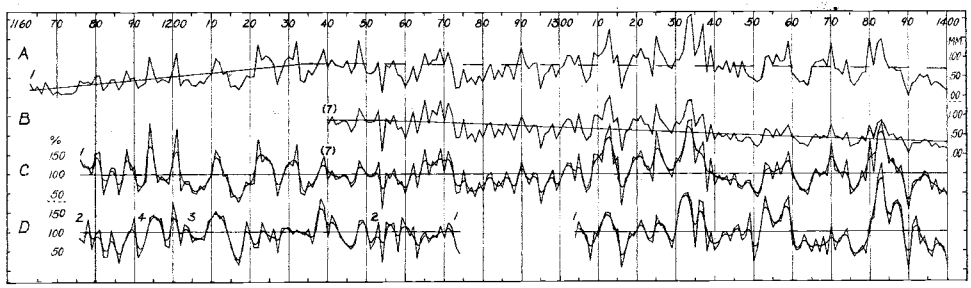

Figure 3. Comparison of the ring records in the 800-year fir with those in other trees. A. The inner portion, A.D. 1163-1400, of core *a* from the lowest sampled level in the trunk; estimated growth trend superposed. Compare with Figure 2. B. The mean record in seven cores from this tree; estimated growth trend superposed. C. The mean growth record standardized. D. Left comparison curve: the standardized growth index based on archaeological beams (Tree-Ring Bull. 12 (3), 1946). Right comparison curve: the standardized growth index of the second oldest living tree at Mesa Verde thus far known.

important factors in the abandonment of Mesa Verde by the Cliff Dwellers has been protracted drouth was based on archaeological beams from neighboring areas—the climatically comparable Oraibi and Showlow districts 100 or more miles to the south-southwest.

But the growth of the 800-year tree now confirms, somewhat tentatively until supported by other tree records, that the "Great Drouth" was present at Mesa Verde in force. As shown in the ring photographs[4] and in Figure 3, specially difficult growth conditions seem to have set in with the winter of A.D. 1272-73 and lasted, with minor interruptions, for some 28 years. The well established dependence of sensitive ring growth on winter rainfall in this region and the relative importance of the latter as compared with the spotty summer rains lead to the probability that water supply was at a catastrophic low during almost all the last quarter of the 1200's.

Data based on the 800-year tree for the interval A.D. 1176-1400 have been merged with the previous master chart for Douglas fir at Mesa Verde.[1] The revised growth index for this species, given in the table, represents 1,361 years of fairly homogeneous tree-gage records of winter rainfall in one locality and is now continuous for the last 1,215 years. The complete analysis of these data in terms of climatic and hydrologic significance awaits the development of a sufficient number of such series.

The contribution of the 800-year fir to climatic history and its remarkable longevity under adversity mark it as worthy of venerable consideration among the Park monuments.

Tucson, September 27, 1947.

[3] A. E. Douglass, Dating Pueblo Bonito, Nat. Geog. Soc. Tech. Papers 1, 1935 (see also, Professional Engineer, June-July, 1931, p. 12).

[4] Published photographs of this drouth period in other areas may be found for Oraibi (Douglass, Nat. Geog. Soc. Tech. Papers 1, 1935, p. 64), Kinishba (G. C. Baldwin, Tree-Ring Bull. 2:12, 1935), and Sierra Ancha (E. W. Haury, Medallion Papers 14, 1934, Plate 12). All of these, and other records from the Hopi villages and from Showlow, have been published by Douglass on microfilm (Amer. Documentation Inst. Doc. 1298, Washington, 1939).