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UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES XII

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This list is a continuation of Univ. of Pennsylvania Dates VII (Radiocarbon, 1965, v. 7, p. 179-186). It includes results for samples of *Sequoia gigantea* and for *Pinus aristata*, most of which were tree-ring dated at the Lab. of Tree-Ring Research, Univ. of Arizona.

All sequoia and bristlecone pine samples have been corrected for deviations in C^{13}/C^{12} ratios. The δC^{13} values listed represent the deviations (multiplied by 2) of the samples measured from the δC^{13} value of our 100-yr old standard oak sample which is also the reference value (adjusted for zero age) for the calculation of δC^{14}. In our previous publication (Radiocarbon, 1965, v. 7, p. 179-186), δC^{13} values were erroneously reported as negative deviations from our oak standard. For the calculation of the Δ's, however, they were used in the correct sense. This mistake has been corrected in this list and one notes that the sequoias and bristlecone pines tend to be enriched slightly in C^{13} as compared with the oak standard.

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We express our appreciation to C. Wesley Ferguson and to Bryant Bannister of the Laboratory of Tree-Ring Research for their invaluable collaboration. The National Science Foundation has provided grants GP-3778 and GA-993 for financial support of this known-age dating program. We thank also Robert Stuckenrath, Jr. and Barbara Lawn for processing these samples in our Radiocarbon Laboratory.

Sequoias and Bristlecone Pines

The C^{14} results for dendrochronologically dated samples which we have processed in this laboratory—both those published in Dates VII and those in this list—are plotted in Fig. 1. The most pronounced fluctuation starts in the 1st millennium B.C. and continues back in time to the 6th millennium B.C.—our present limit of dated samples. The most significant observation based on these new data is the fact that this large divergence continues back to 5100 B.C. (Ralph and Michael, 1967, p. 3-11). Therefore, if we believe the C^{14} data and those for remanent magnetization, it is evident that changes in the magnetic field of the earth in past times are not the sole cause of the discrepancy between radiocarbon and true ages. Based on recent archaeomagnetic studies by Bucha in Czechoslovakia (Bucha, 1967) the magnetic intensity was at least 50 per cent greater in Roman times than today. It has followed a more or less cyclic pattern, and had a value similar to the present ca. 3600 B.C. (in terms of radiocarbon years). Even allowing for the variability in radiocarbon years, Fig. 1 shows that the C^{14} data do not fit this cyclic pattern. Also, if one assumes that magnetic changes are worldwide, and if one selects

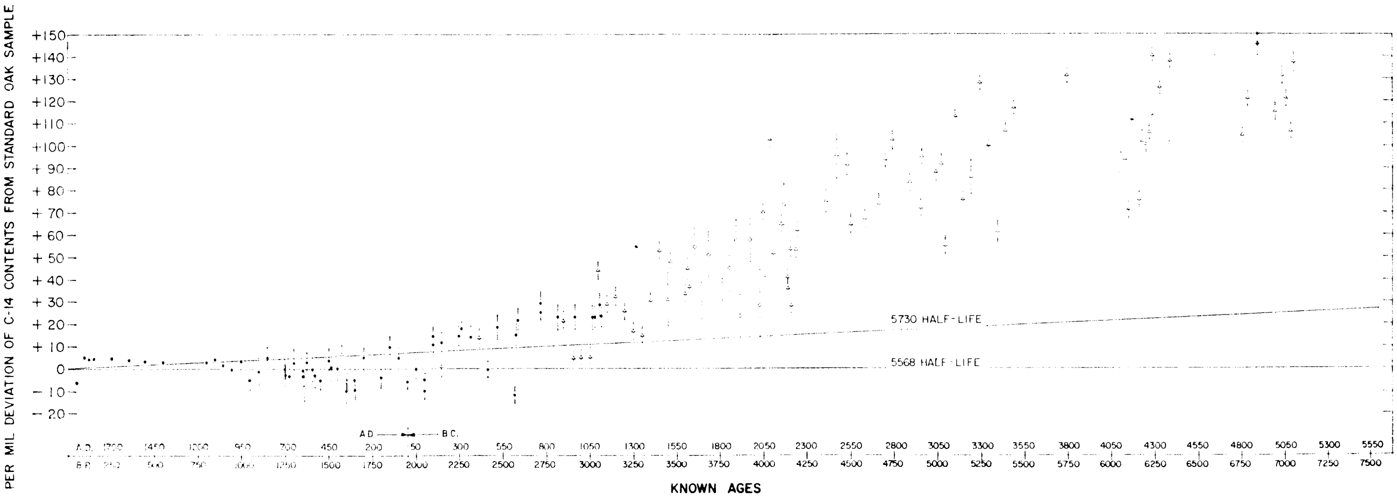

Fig. 1. Per mil deviations from 100-yr-old oak standard of dendrochronologically dated sequoia and bristlecone pine samples. All have been corrected for C^{13}/C^{12} variations. Sequoias are designated by solid circles; bristlecone pines, by open triangles except for those with circles which were counted by Isotopes, Inc.

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boundary conditions for an equation relating the C^{14} and magnetic changes based upon Bucha's data, the solution for a cyclic relationship between magnetic and C^{14} inventories should now be found. A preliminary calculation indicates, however, that the effect would produce a difference of only 265 yr with a time lag of 150 yr. Therefore, both the magnitude and duration are too small to fit the C^{14} evidence.

As for major causes, we are left with the constancy of the cosmic-ray intensity and the equilibrium balance between atmosphere and oceans. Studies of the decay series of other nuclides in meteorites indicate that there have been no major changes in cosmic-ray intensity during the past 300,000 yr (Heymann and Schaeffer, 1962) nor even during the past 5 million yr (Crevecoeur, 1966). The precision attainable in these studies, however, is not quite sufficient to eliminate this possibility from C^{14} considerations.

It now seems probable that a large part of the deviation of radiocarbon dates was caused by a major change such as an "Ice Age" which occurred several millennia earlier than the limit of our dated samples. In turn, this may have been prompted by changes in solar activity or solar wind patterns. Confirmation must wait, however, until a chronology of known ages is extended beyond 8000 B.C.

Irrespective of fundamental causes, enough data are now available to estimate corrections for radiocarbon years. In order to apply these results in some meaningful way to radiocarbon dates obtained from archaeologic samples, we have constructed a table which indicates the amount of deviation of C^{14} dates and dendro-dates for each sequential 500 yr period based on the 5730 half-life (see Table 1). It can be seen that the amount of deviation increases at an increasing rate during the 3500 yr B.C. for which we have processed enough closely spaced, precisely dated tree-ring samples. While the 2nd half of the 1st millennium B.C. shows a deviation of + 50 yr (that is, the radiocarbon dates are on the average 50 yr younger than the precisely dated tree-ring samples), in the 2nd half of the 4th millennium B.C. this deviation increases to + 550 yr.

Two additional groups of tree-ring samples cover the periods 4395 to 4135 B.C. and 5110 to 4810 B.C., respectively. The 1st group (which spans 260 yr only) shows an average deviation of + 600 yr, the 2nd (which spans 300 yr) a deviation of + 750 yr.

From the C^{14} deviations shown in Column 2 of Table 1, we have adjusted the chronologic positions of the radiocarbon dates and (in our work sheets) placed them opposite the spans of dendro-dated samples with which they should be correlated in order to obtain a "true" date. Since deviations increase at an increasing rate over the approx. 3500 B.C. yr under discussion, adjustments of the positions of radiocarbon dates sometimes result in "overlaps" in the chronologic sequence. For example, the average deviation for the 1st half of the 1st millennium B.C. is + 50 yr, for the 2nd half of the 2nd millennium B.C. it is + 100 yr.

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TABLE 1

Suggested method of adjustment of radiocarbon dates to calendric dates based on the determination of average deviations for 500-yr periods in A.D. and B.C. eras as calculated with 5730 half-life

Time period represented by radiocarbon dates	Average deviation of C^{14} dates (+ = younger, − = older)	Calendric period represented by precisely dated tree-ring samples	Number of samples
A.D. 1525-2000	+ 50	A.D. 1500 to 1950	13
A.D. 975-1524	0	A.D. 1000 to 1499	10
A.D. 450-974	− 50	A.D. 500 to 999	13
A.D. 1-449	− 50	A.D. 1 to 499	13
449- 1 B.C.	+ 50	499 to 1 B.C.	8
924- 450 B.C.	+ 50	999 to 500 B.C.	9
1324- 925 B.C.	+100	1499 to 1000 B.C.	14
1699-1325 B.C.	+250	1999 to 1500 B.C.	13
2099-1700 B.C.	+350	2499 to 2000 B.C.	14
2499-2100 B.C.	+450	2999 to 2500 B.C.	7
2949-2500 B.C.	+550	3499 to 3000 B.C.	12
[3999-2950 B.C.]	+600	4395 to 4135 B.C. (260 yr)	9
[4499-4000 B.C.]	+750	5110 to 4810 B.C. (300 yr)	8
		Total	143

This results in a 50-yr overlap of these 2 half-millennia. Overlaps from 50 to 150 yr occur between half-millennia throughout the B.C. era with the exception of the 1st and 2nd halves of the 1st millennium B.C. which do not overlap because their average deviation is the same (+ 50 yr).

Because of overlaps, further adjustments must be made in positioning radiocarbon dates in relation to "true" dates of tree-ring samples. Distortion of the overlap will be minimized if the span of the overlap is equally divided and the halves assigned to adjacent (contiguous) half-millennia. This final adjustment is indicated in Column 1 of Table 1. Thus, to determine an adjustment of a C^{14} date for a sample of unknown age, one should select the range in Column 1 (of Table 1) and apply the correction factor given in Column 2.

Those who use Table 1 to "correct" any radiocarbon date should be aware of its arbitrary basis. New data, perhaps based on quite different assumptions (e.g., Stuiver, 1967), might significantly change the values computed here. New discoveries in the field of paleomagnetism (e.g., Bonhommet and Babkine, 1967) may provide a better theoretical basis for the causes of the fluctuations than the one we have tentatively accepted, and thereby lead us to weigh some of our empirical values differently. In any case, our statistical treatment is an approximate one,

TABLE 2

Lab. no.	Dendrochronologically determined age A.D.-B.C.	B.P. (1950)	δ14 (deviation from oak st'd mils)	2xδC^{13} (deviation from oak st'd mils)	Δ (δ14 corrected for 2xδC^{13} mils)
		P-SW-SEQ-1	*Sequoia gigantea*		
P-1114	A.D. 1450 ± 15	500	+28.3 ± 4.6	(+7.8)*	+20.2 ± 4.6
		P-SW-SEQ-2	*Sequoia gigantea*		
P-651	A.D. 1900 ± 10	50	− 4.5 ± 3.9	+1.8	− 6.3 ± 3.9
P-650	A.D. 1800 ± 10	150	+ 7.2 ± 3.9	+2.8	+ 4.4 ± 3.9
P-649	A.D. 1750 ± 10	200	− 4.4 ± 4.3	0	− 4.4 ± 4.3
P-648	A.D. 1650 ± 10	300	+30.4 ± 4.4	+1.8	+28.5 ± 4.4
P-880	A.D. 1596 ± 7	354	+23.2 ± 3.9	+2.7	+20.4 ± 3.9
P-881	A.D. 1550 ± 8	400	+31.6 ± 4.3	+5.4	+26.0 ± 4.3
P-631A	A.D. 1505 ± 12	445	+ 7.1 ± 4.3	+3.6	+ 3.3 ± 4.3
P-882	A.D. 1350 ± 7	600	− 0.4 ± 4.6	+7.8	− 8.2 ± 4.6
P-883	A.D. 1150 ± 7	800	+12.0 ± 4.0	+9.1	+ 2.8 ± 4.0
P-884	100 + 6 B.C.	2050	− 4.4 ± 3.9	+5.5	− 9.9 ± 3.9
		P-SW-ENT-1	*Sequoia gigantea*		
P-1113	A.D. 1450 ± 20	500	+29.7 ± 4.5	+5.5	+24.0 ± 4.5
P-885	150 ± 8 B.C.	2100	+20.3 ± 4.4	+5.5	+14.7 ± 4.4
P-886	300 ± 8 B.C.	2250	+20.5 ± 4.3	+5.9	+14.5 ± 4.3
P-655	318 ± 5 B.C.	2268	+20.1 ± 3.2	+2.3	+17.8 ± 3.2
P-658	468 ± 5 B.C.	2418	+ 0.8 ± 4.0	+0.6	+ 0.2 ± 4.0
P-660	618 ± 8 B.C.	2568	− 3.3 ± 4.0	+5.1	− 8.4 ± 4.0
P-661A	768 ± 5 B.C.	2718	+30.5 ± 3.4	+5.1	+25.2 ± 3.4

* A C^{13}/C^{12} measurement was not made for this sample. This value is average for Sec. P-SW-SEQ-2 (Ralph *et al.*, 1965, Table 1, p. 181), processed at about same time.

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TABLE 3

P-SW-INY-19 *Pinus aristata*

Lab. no.	Dendrochronologically determined age A.D.-B.C.	B.P. (1950)	$\delta 14$ (deviation from oak st'd mils)	$2x\delta C^{13}$ (deviation from oak st'd mils)	Δ ($\delta 14$ corrected for $2x\delta C^{13}$ mils)
P-1255	1515 ± 5 B.C.	3465	+ 49.8 ± 3.7	+ 1.8	+ 48.0 ± 3.7
P-1260	1615 ± 5 B.C.	3565	+ 62.7 ± 5.8	+16.6	+ 45.1 ± 5.8
P-1262, I-2992*	1655 ± 5 B.C.	3605	+ 61.9 ± 8.0	+ 7.2	+ 54.3 ± 8.0
P-1264, I-2983*	1695 ± 5 B.C.	3645	+ 37.6 ± 10.0	+ 8.3	+ 29.0 ± 10.0
P-1266, I-2989*	1735 ± 5 B.C.	3685	+ 60.2 ± 10.5	+ 8.7	+ 50.5 ± 10.5
P-1269	1795 ± 5 B.C.	3745	+ 36.9 ± 3.8	+ 1.8	+ 35.0 ± 3.8
P-1270, I-2984*	1815 ± 5 B.C.	3765	+ 41.1 ± 13.4	+ 5.6	+ 36.3 ± 13.4
P-1272, I-2988*	1855 ± 5 B.C.	3805	+ 48.6 ± 10.0	+ 3.6	+ 44.8 ± 10.0
P-1274, I-2987*	1895 ± 5 B.C.	3845	+ 65.1 ± 9.6	+ 7.6	+ 57.0 ± 9.6
P-1275, I-2986*	1915 ± 5 B.C.	3865	+ 34.1 ± 10.0	+13.0	+ 20.7 ± 10.0
P-1350, I-2991*	1975 ± 5 B.C.	3925	+ 67.9 ± 10.0	+ 9.8	+ 57.4 ± 10.0
P-1135, I-2990	2030 ± 10 B.C.	3980	+ 39.4 ± 18.2	+11.0	+ 28.0 ± 18.2
P-1136	2050 ± 10 B.C.	4000	+ 77.8 ± 3.9	+ 7.5	+ 69.7 ± 3.9
P-1138	2090 ± 10 B.C.	4040	+109.6 ± 4.2	+ 6.5	+102.3 ± 4.2
P-1139	2110 ± 10 B.C.	4060	+ 59.0 ± 4.0	+ 7.0	+ 51.6 ± 4.0
P-1142, I-2985*	2170 ± 10 B.C.	4120	+ 84.9 ± 10.0	+11.0	+ 73.0 ± 10.0
P-1143	2190 ± 10 B.C.	4140	+ 45.2 ± 3.5	+ 4.1	+ 40.9 ± 3.5
P-1144	2210 ± 10 B.C.	4160	+ 34.6 ± 4.0	+ 6.4	+ 27.9 ± 4.0
P-1146	2250 ± 10 B.C.	4200	+ 67.6 ± 3.8	+ 5.4	+ 61.9 ± 3.8
P-1159	2415 ± 5 B.C.	4365	+ 78.3 ± 5.5	+ 3.5	+ 74.5 ± 5.5

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TABLE 3 (Continued)

Lab. no.	Dendrochronologically determined age A.D.-B.C.	B.P. (1950)	$\delta 14$ (deviation from oak st'd mils)	$2x\delta C^{13}$ (deviation from oak st'd mils)	Δ ($\delta 14$ corrected for $2x\delta C^{13}$ mils)
P-1156	2475 ± 5 B.C.	4425	+103.7 ± 10.7	+ 7.4	+ 95.5 ± 10.7
P-1153	2535 ± 5 B.C.	4485	+ 94.7 ± 4.8	+ 5.9	+ 88.3 ± 4.8
P-1148	2555 ± 5 B.C.	4505	+ 70.7 ± 4.6	+ 5.6	+ 64.7 ± 4.6
P-1152	2635 ± 5 B.C.	4585	+ 70.9 ± 4.1	+ 3.8	+ 66.8 ± 4.1
P-1313	2715 ± 5 B.C.	4665	+ 73.3 ± 4.6	0	+ 73.3 ± 4.6
P-1315	2755 ± 5 B.C.	4705	+ 97.6 ± 3.9	+ 3.8	+ 93.4 ± 3.9
P-1317	2795 ± 5 B.C.	4745	+116.5 ± 4.4	+13.0	+102.0 ± 4.4
P-1303	2895 ± 5 B.C.	4845	+ 87.1 ± 3.9	+11.2	+ 74.9 ± 3.9
P-1306	2955 ± 5 B.C.	4905	+ 75.5 ± 3.9	+ 3.8	+ 71.4 ± 3.9
P-1308	3015 ± 5 B.C.	4965	+ 94.5 ± 3.7	0	+ 94.5 ± 3.7
P-1310	3075 ± 5 B.C.	5025	+ 91.4 ± 4.0	0	+ 91.4 ± 4.0
P-910	3802 ± 47 B.C.	5752	+131.0 ± 3.5	0	+131.0 ± 3.5

* Ten samples in this list were converted to CO_2 in this lab, but due to difficulties in obtaining anti-coincidence geiger counters, were counted for us by Isotopes, Inc. Because they were not counted for 2 or more full 1000 min intervals and because short-interval duplicate counts for most were not statistically consistent, standard deviations quoted for these 10 samples are large.

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not insensitive to the choice of limits between groups of measurements. Table 1 is intended as a provisional attempt to generalize and reduce what is (in some contexts) a major discrepancy in radiocarbon dating.

Descriptions of the sections of sequoias and bristlecone pines and lists of dates follow. In these lists C^{14} dates and deviations have been calculated with the 5568 half-life, and B.P. dates are based on A.D. 1950. The uncertainties quoted for the dendrochronologically determined ages represent the age spans of the samples cut out for processing. Since true dates are close to median values listed, no allowance for these small spans has been made in the calculations.

Tolerances quoted for the C^{14} values include the combined standard statistical uncertainty of the sample and of the oak standard. In this publication no allowance has been made in Columns 5 and 6 (Tables 2-6, inclusive) for possible errors in the C^{13}/C^{12} measurements.

Sequoia series (P-SW-SEQ-1)

Radial sec. from stump of *Sequoia gigantea,* felled between 1897 and 1902. Located at Loop Rd., off Hoist Ridge in Converse Basin (36° 48′ N Lat, 118° 57′ W Long), Sequoia Natl. Forest, California. Coll. 1959 and subm. by H. N. Michael, Univ. Mus., Univ. Pennsylvania. *Comment*: Sec. P-SW-SEQ-1 was dated on basis of sec. from same stump removed earlier (1955) and dated by Lab. of Tree-Ring Research, Univ. Arizona, Tucson. Age range is 291 B.C. to A.D. 1786. Outer rings had been consumed by forest fire. One sample is listed in Table 2.

Sequoia series (P-SW-SEQ-2)

Radial sec. of *Sequoia gigantea,* felled in 1950, from Giant Forest (36° 35′ N Lat, 118° 48′ W Long), Sequoia Natl. Park, California. Sec. from part of trunk ca. 20 to 25 ft above forest floor while tree was standing. Coll. 1959 and subm by H. N. Michael. *Comment*: Sec. P-SW-SEQ-2 was tree-ring-dated at Lab. of Tree-Ring Research. Its age range is 212 B.C. to A.D. 1946. Adjacent sec. was dated by Arizona Radiocarbon Lab. (see Damon *et al.*, 1963). Samples appear in Table 2.

Sequoia series (P-SW-ENT-1)

Radial sec. of *Sequoia gigantea* from Enterprise Mill area of Balch Park (36° 13′ N Lat, 118° 41′ W Long), Mountain Home State Forest, California. Tree probably felled in 1874. Radial sec. came from "butt log" of tree, part of trunk ca. 20 ft above forest floor while tree was standing. Butt log labeled D-22A by Douglass (1919, 1945). Coll. 1960 and subm. by H. N. Michael. *Comment*: sec. was cross-dated with other Sequoia samples held by Radiocarbon Lab. (samples dated previously by Lab. of Tree-Ring Research, Tucson). Cross-dating was further checked with publ. data of various tree-ring records (Douglass, 1936, 1949). Rings of the sec. cover ages 1121 B.C. to A.D. 1691. Samples listed in Table 2.

TABLE 4

Lab. no.	Dendrochronologically determined age A.D.-B.C.	B.P. (1950)	δ14 (deviation from oak st'd mils)	$2x\delta C^{13}$ (deviation from oak st'd mils)	Δ (δ14 corrected for $2x\delta C^{13}$ mils)
			P-SW-INY-20 *Pinus aristata*		
P-1023	900 ± 39 B.C.	2850	+31.6 ± 3.7	+ 6.0	+25.4 ± 3.7
P-1022	958 ± 18 B.C.	2908	+10.8 ± 3.1	+ 6.1	+ 4.6 ± 3.1
P-1021	1001 ± 23 B.C.	2951	+12.0 ± 3.4	+ 6.7	+ 5.2 ± 3.4
P-1020	1052 ± 27 B.C.	3002	+11.9 ± 4.3	+ 6.3	+ 5.5 ± 4.3
P-1019	1100 ± 20 B.C.	3050	+49.4 ± 4.0	+ 5.5	+43.6 ± 4.0
P-1018	1150 ± 29 B.C.	3100	+33.7 ± 3.7	+ 4.8	+28.7 ± 3.7
P-1017	1200 ± 19 B.C.	3150	+40.1 ± 4.0	+ 7.6	+32.2 ± 4.0
P-1015	1249 ± 14 B.C.	3199	+28.9 ± 3.8	+ 3.0	+25.8 ± 3.8
P-1013	1300 ± 15 B.C.	3250	+24.6 ± 3.7	+ 7.8	+16.6 ± 3.7
P-1011	1350 ± 14 B.C.	3300	+18.9 ± 4.1	+ 4.2	+14.6 ± 4.1
P-1009	1400 ± 14 B.C.	3350	+35.8 ± 3.7	+ 5.5	+30.1 ± 3.7
P-1007	1453 ± 18 B.C.	3403	+54.1 ± 4.1	+ 1.4	+52.6 ± 4.1
P-1005	1500 ± 15 B.C.	3450	+33.4 ± 12.2	+ 2.7	+30.5 ± 12.2
P-1001	1600 ± 10 B.C.	3550	+42.9 ± 3.8	+ 9.0	+33.5 ± 3.8
P-1000	1625 ± 25 B.C.	3575	+38.3 ± 3.5	+ 1.8	+36.5 ± 3.5
			P-SW-INY-24 *Pinus aristata*		
P-1345	2155 ± 5 B.C.	4105	+66.3 ± 4.1	+ 1.8	+64.4 ± 4.1
P-1346	2190 ± 5 B.C.	4140	+46.5 ± 4.2	+10.2	+35.8 ± 4.2
P-1347	2208 ± 2 B.C.	4158	+64.9 ± 3.8	+11.0	+53.2 ± 3.8
P-1348	2238 ± 3 B.C.	4188	+64.5 ± 3.9	+11.0	+52.8 ± 3.9

Bristlecone Pine series (P-SW-INY-19)

Large fragment (*Pinus aristata*) from White Mts., California-Nevada, from forest floor near head of drainage of main valley (Methuselah Walk), at + 9300 ft (37° 23′ N Lat, 118° 10′ W Long). Coll. 1963 and subm. by C. W. Ferguson, Univ. of Arizona. Another specimen (P-SW-INY-19a), part of the same tree coll. 1964. All samples were dendro-dated at Lab. of Tree-Ring Research, Univ. Arizona. Samples listed in Table 3.

Bristlecone Pine series (P-SW-INY-20)

Slab, 11 in. long, 2.5 in. wide, part of sec. of *Pinus aristata* from White Mts., California-Nevada. Coll. 1964 about mid-way between Schulman Grove and Methuselah Walk (37° 23′ N Lat, 118° 10′ W Long) and subm. by C. W. Ferguson and M. L. Parker. Dendro-dated at Lab. of Tree-Ring Research. Age-span of specimen is 1640 B.C. to 797 B.C. Samples listed in Table 4.

Bristlecone Pine series (P-SW-INY-21)

Samples removed from large remnant of *Pinus aristata* found on Methuselah Walk (37° 23′ 40″ N Lat, 118° 09′ 30″ W Long), White Mts., California-Nevada. Coll. 1963 and subm. by C. W. Ferguson. Samples dendro-dated in Lab. of Tree-Ring Research and listed in Table 5.

Bristlecone Pine series (P-SW-INY-22)

Samples from remnant of *Pinus aristata* found near Schulman Grove (ca. 37° 22′ 50″ N Lat, 118° 09′ 45″ W Long), White Mts., California-Nevada, at ca. + 9600 ft. Coll. 1966 and subm. by C. W. Ferguson. *Comment*: originally, samples P-1290 and P-1291 were submitted as "floaters," *i.e.*, undated pieces of wood. Subsequently, this series and P-SW-INY-23 (*vide infra*) were correlated and precisely dated by Lab. of Tree-Ring Research. Samples listed in Table 5.

Bristlecone Pine series (P-SW-INY-23)

Samples from fragment of *Pinus aristata* found near Schulman Grove (ca. 37° 22′ 50″ N Lat, 118° 09′ 45″ W Long), White Mts., California-Nevada, at ca. + 9600 ft. Coll. 1963 and subm. by C. W. Ferguson. *Comment*: same as for P-SW-INY-22, above. Samples listed in Table 6.

Bristlecone Pine series (P-SW-INY-2)

Cross sec. from stump (*Pinus aristata*) from White Mts., California-Nevada. Tree felled in 1956, Tree-Ring Research Lab. No. WHT_{B_2} 5547, according to C. W. Ferguson of that lab. Tree grew in Methuselah Walk area (37° 23′ 40″ N Lat, 118° 09′ 30″ W Long), ca. 2.2 mi by trail from Schulman Grove. Coll. 1960 and subm. by H. N. Michael. One sample is listed in Table 6.

Bristlecone Pine series (P-SW-INY-24)

Samples from fragment of *Pinus aristata* found near Schulman Grove (ca. 37° 22′ 45″ N Lat, 118° 10′ 00″ W Long), White Mts., Cali-

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TABLE 5

Lab. no.	Dendrochronologically determined age A.D.-B.C.	B.P. (1950)	δ14 (deviation from oak st'd mils)	$2x\delta C^{13}$ (deviation from oak st'd mils)	Δ (δ14 corrected for $2x\delta C^{13}$ mils)
			P-SW-INY-21 *Pinus aristata*		
P-1160	3045 ± 5 B.C.	4995	+ 96.7 ± 4.4	+ 8.3	+ 87.7 ± 4.4
P-1161	3095 ± 5 B.C.	5045	+ 59.5 ± 4.1	+ 4.3	+ 54.7 ± 4.1
P-1294	3155 ± 5 B.C.	5105	+114.9 ± 3.5	+ 1.8	+112.9 ± 3.5
P-1163	3195 ± 5 B.C.	5145	+ 80.8 ± 3.6	(+ 5.1)*	+ 75.3 ± 3.6
P-1164	3245 ± 5 B.C.	5195	+ 90.3 ± 8.0	+ 4.5	+ 85.4 ± 8.0
P-1165	3295 ± 5 B.C.	5245	+131.0 ± 3.4	+ 3.0	+127.6 ± 3.4
P-1169	3345 ± 5 B.C.	5295	+109.8 ± 3.4	+ 4.5	+ 99.3 ± 3.4
P-1168	3395 ± 5 B.C.	5345	+ 66.5 ± 4.7	(+ 5.1)*	+ 61.1 ± 4.7
P-1167	3445 ± 5 B.C.	5395	+112.2 ± 3.4	+ 5.6	+106.0 ± 3.4
P-1166	3495 ± 5 B.C.	5445	+122.1 ± 3.1	(+ 5.1)*	+116.4 ± 3.1
			P-SW-INY-22 *Pinus aristata*		
P-1420	4810 ± 5 B.C.	6760	+127.1 ± 3.7	+20.6	+103.9 ± 3.7
P-1419	4840 ± 5 B.C.	6790	+126.3 ± 3.8	+ 5.6	+120.0 ± 3.8
P-1422	4900 ± 5 B.C.	6850	+141.6 ± 5.7	+ 1.8	+139.5 ± 5.7
P-1418	5000 ± 5 B.C.	6950	+120.5 ± 4.2	+ 5.6	+114.2 ± 4.2
P-1417	5040 ± 5 B.C.	6990	+139.2 ± 3.7	+ 7.4	+130.8 ± 3.7
P-1416	5060 ± 5 B.C.	7010	+122.4 ± 3.7	+ 1.8	+120.4 ± 3.7
P-1291	5090 ± 5 B.C.	7040	+112.4 ± 3.8	+ 5.9	+105.8 ± 3.8
P-1290	5110 ± 5 B.C.	7060	+143.2 ± 4.5	+ 5.4	+137.0 ± 4.5

* The $2x\delta C^{13}$ values in parentheses are average values for other samples of P-SW-INY-21, processed about same time.

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TABLE 6

Lab. no.	Dendrochronologically determined age A.D.-B.C.	B.P. (1950)	δ14 (deviation from oak st'd mils)	$2x\delta C^{13}$ (deviation from oak st'd mils)	Δ (δ14 corrected for $2x\delta C^{13}$ mils
			P-SW-INY-23 *Pinus aristata*		
P-1318	4135 ± 5 B.C.	6085	+103.3 ± 4.5	+9.2	+ 93.1 ± 4.5
P-1319	4155 ± 5 B.C.	6105	+ 78.3 ± 4.1	+7.2	+ 70.6 ± 4.1
P-1295	4215 ± 5 B.C.	6165	+ 81.9 ± 3.8	+6.2	+ 75.1 ± 3.8
P-1296	4235 ± 5 B.C.	6185	+105.3 ± 4.1	+3.6	+101.3 ± 4.1
P-1297	4255 ± 5 B.C.	6205	+109.9 ± 3.9	+9.2	+ 99.7 ± 3.9
P-1298	4275 ± 5 B.C.	6225	+107.3 ± 3.7	+1.8	+105.2 ± 3.7
P-1299	4295 ± 5 B.C.	6245	+146.2 ± 3.9	+5.7	+139.7 ± 3.9
P-1301	4335 ± 5 B.C.	6285	+135.8 ± 3.5	+9.2	+125.4 ± 3.5
P-1302	4395 ± 5 B.C.	6345	+143.5 ± 3.8	+5.6	+137.1 ± 3.8
			P-SW-INY-2 *Pinus aristata*		
P-428	A.D. 345 ± 2	1605	−0.2 ± 4.0	(+5.4)*	−5.6 ± 4.0

* The $2x\delta C^{13}$ value is average for samples of other P-SW-INY trees processed at about same time.

fornia-Nevada, at ca. + 9650 ft. Coll. 1963 and subm. by C. W. Ferguson. *Comment*: 4 samples were used in comparative study with samples of same age from P-SW-INY-19. No difference in C^{14} contents found. Samples listed in Table 4.

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