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$\delta^{13}C$ MEASUREMENTS FROM THE IRISH OAK CHRONOLOGY

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ABSTRACT. Measurements of the stable isotope ratio $^{13}C/^{12}C$, relative to PDB, were made for fractionation correction purposes on all oak samples used in the Irish oak ^{14}C calibration curve. Stable isotope data have not been published previously. We have collated the stable isotope data from the calibration work, carried out some further measurements to investigate anomalies in the original results, and generated tables of data that include site and tree information pertaining to both stable isotopes and source material for ^{14}C calibration measurements. The data suggest that land-grown trees tend to be isotopically lighter than bog-grown wood, and that the Irish trees used in the calibration exercise tend to be isotopically heavier than those from Scotland and England. Preliminary analysis of the data is given.

INTRODUCTION

Measurements of the ^{14}C content of Irish oak have been used to create a radiocarbon calibration curve (Stuiver and Pearson 1986, 1993; Pearson and Stuiver 1986, 1993; Pearson *et al.* 1986). Each ^{14}C measurement was corrected for fractionation by measuring the stable isotope ratio, $^{13}C/^{12}C$, relative to that of PDB. However, the published calibration data did not include the stable isotope measurements. Because the stable isotope measurements are potentially a valuable data resource, we have collated the data set, made some repeat measurements and present the results below. We made repeat measurements on wood for the interval, 3250–1650 BC, because the original data showed a step-like discontinuity in the results spanning this period. The mean difference between the repeat measurements and the original data, by which the ^{14}C results were corrected, was 1.66‰; the new values were isotopically lighter than the old. When we apply this offset to the data that show the step-like discontinuity, the step is removed, and the data set appears more uniform. We believe that the offset for the 3250–1650 BC material is due to the use of an incorrectly calibrated mass spectrometer before 1980 (samples after 1980 were measured on a new, properly calibrated, instrument). Thus, we have adjusted all $\delta^{13}C$ measurements made prior to 1980 by 1.66‰.

METHODS

The stable isotope measurements used to correct the ^{14}C calibration dates for fractionation were made on decadal and bidecadal wood samples. The dendrochronological date quoted was the center date of the 10- or 20-yr block, respectively. The species were either *Quercus robur* or *Q. petraea.* The pieces of wood were hand-planed into thin shavings and then chemically treated to cellulose using the following method. *Ca.* 200 g of shavings were placed in a 5-liter beaker containing 3 liters of H_2O, 55 ml of 1N HCl and 40 g of $NaClO_2$. The contents were heated to 70°C and stirred regularly until outgassing ceased. Additional HCl and $NaClO_2$ were added and the process repeated until the wood was completely bleached (usually requiring 24 h). The samples were drained and treated with 55 ml of 1N HCl in 3 liters of water and heated to remove any remaining $NaClO_2$ before being thoroughly washed in hot, deionized, low ^{222}Rn water, and left to drain overnight. Samples were then dried in an oven at 110°C and, when dry, were charred at 500°C to release the more volatile components and produce a carbon-rich residue of *ca.* 30 g. Samples were combusted to CO_2 in a flow-through system (McCormac, Kalin and Long 1993). *Ca.* 40 ml of CO_2 at STP were sub-sampled after the gas had been allowed to equilibrate in 4 × 10-liter glass bulbs.

Measured $^{13}C/^{12}C$ ratios after 1980 were made on a VG Micromass 602E mass spectrometer. Because this instrument has reliably reproduced the accepted NIST values for NIST-18, ANU Sucrose and Oxalic Acid II, we have normalized the pre-1980 results to values obtained from this instrument. Currently, we use NIST 19 ($\delta^{13}C$ +1.95‰ rel. PDB) as our primary standard, with a secondary, working standard of pine wood.

RESULTS

Figure 1A shows the results from the original Irish chronology extracted directly from laboratory records. These measurements were used to correct the ^{14}C data in Pearson *et al.* (1986) and Pearson and Qua (1993). A step-like discontinuity in the results is evident and becomes even more apparent if an 11-yr running mean is applied to the data (Fig. 1B). Fifteen recent measurements on the identical wood material used by Pearson for the calibration data differ by 1.66‰ (σ = 0.54‰) from the original measurements. When this correction is applied to all pre-1980 data, the discontinuity no longer exists (Fig. 1C,D). Thus, we have adjusted all the measurements in the intervals, 3250–1650 BC and AD 1190–1810 inclusive, by 1.66‰. Other measurements made before 1980 were also adjusted; these include the values for 1050–970 BC. (The results reported in Table 2 are corrected data. The original data can be recreated by adding 1.66 to the values in the intervals specified above.)

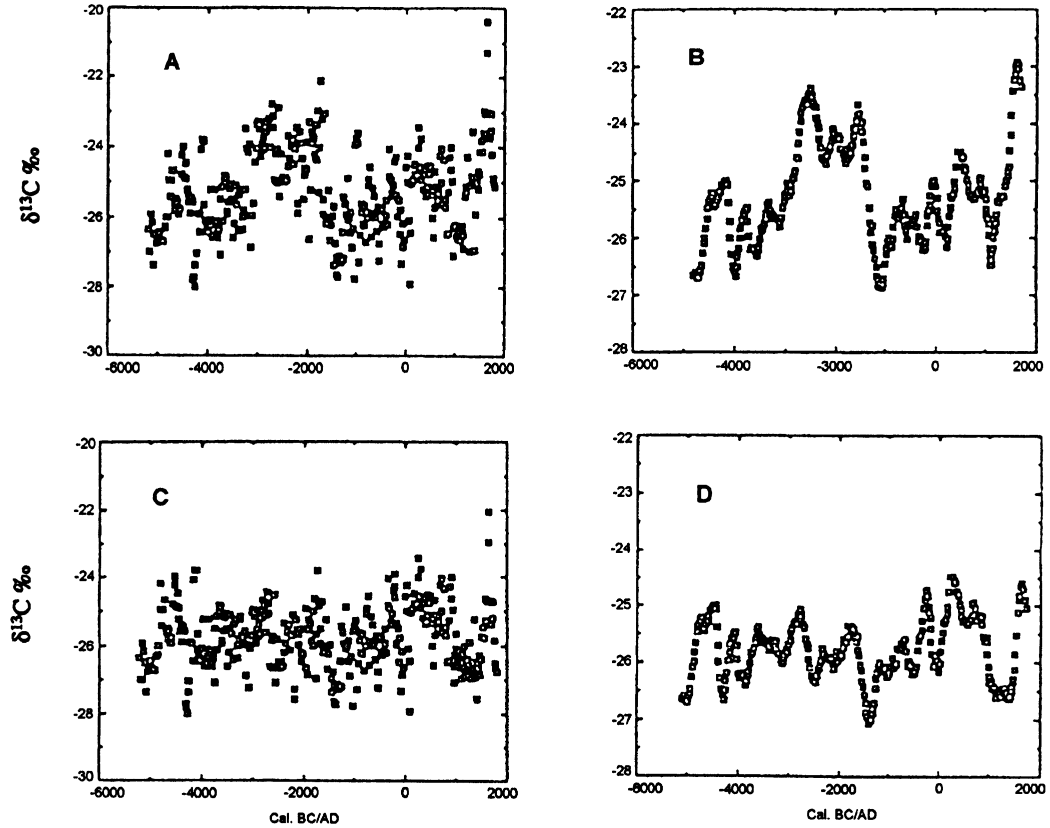

Fig. 1. A. $\delta^{13}C$ measurements used to correct the ^{14}C calibration measurements on the Irish oak; B. 11-yr running mean of data in A; C. $\delta^{13}C$ measurements pre-1980 data have been corrected (see text for details); D. 11-yr running mean of data in C.

Bog oak constituted 75% of the wood used in the Irish chronology. The site of growth of the remainder of the wood is often uncertain because the timbers were taken from historical buildings and archaeological structures and may not have grown near the site from which they were recovered. For the most part, this wood was probably "land-grown" because it had wide rings. We sought wide-ringed samples for ^{14}C dating, so that the 150 g of material required for high-precision dating could be readily obtained. Thus, all the samples measured for the Belfast portion of the calibration have an inherent bias toward wide-ringed wood. Table 1 identifies the source of the wood samples. The 269 measurements on bog oaks show a mean $\delta^{13}C$ of –25.87‰ and σ of 0.846 (Fig. 2A). The standard error on the mean is 0.05‰. The land-grown oaks (Fig. 2B) have a bimodal distribution with peaks near –26.6‰ and –25.4‰. The mean of the set is –25.52‰ (σ = 0.99) and the standard error on the mean is 0.1‰. The smaller ring areas, which are typical of bog oaks that grow in a stressed environment, should result in ^{13}C enrichment as found by Stuiver, Burk and Quay (1984). They found that >50% of the trees they measured had a significant correlation between ring area and $\delta^{13}C$. They also showed that as ring area increased, ^{13}C decreased.

TABLE 1. Irish Oak Chronology Site Details and Mean $\delta^{13}C$ Values

Site	Location	$\delta^{13}C$	1 σ	N*	Lat (N)	Long (W)	Grid Ref.
1–B**	Allistragh, N. Ireland	–24.44	0.53	10	54°22′	6°40′	H 864 484
2–L	Athlone, Ireland	–24.29	0.31	3	53°25′	8°56′	N 04 42
3–B	Balloo Cottage, N. Ireland	–25.16	0.31	5	54°28′	5°43′	J 486 607
4–B	Ballymacombs N. Ireland	–26.59	0.78	20	54°50′	6°31′	H 95 99
5–B	Blackwater, N. Ireland	–25.87	1.01	21	54°29′	6°38′	H 880 616
6–L	Bordesley Abbey, England	–24.94		1	52°21′	1°57′	SP 045 699
7–L	Brabstown, Ireland	–25.61	0.74	7	52°40′	7°24′	S 41 56
8–L	Cadzow, Scotland	–25.00	1.57	11	55°45′	4°00′	NS 74 53
9–L	Caerlaverock, Scotland	–26.47	0.27	15	55°01′	3°31′	NY 025 656
10–L	Carlisle, England	–25.00		1	54°54′	2°56′	NY 399 559
11–B	Charlemont, N. Ireland	–25.68	0.91	6	54°26′	6°41′	H 857 557
12–B	Derrymacfall, N. Ireland	–26.09	0.65	16	54°28′	6°29′	H 998 598
13–L	Dorsey, N. Ireland	–25.10	0.66	13	54°07′	6°34′	H 941 194
14–L	Drumard, N. Ireland	–25.20	0.74	11	54°55′	6°36′	C 904 082
15–B	Garry Bog, N. Ireland	–25.92	0.82	101	55°06′	6°32′	C 945 300
16–B	Lisnisk, N. Ireland	–26.08	0.49	5	54°15′	6°7′	J 235 350
17–L	Little Island, Ireland	–24.90	0.20	4	51°54′	8°21′	W 76 72
18–L	London, England	–26.04	1.18	7	51°30′	0°05′	TQ 33 80
19–B	Lough Magarry, N. Ireland	–25.85	0.96	14	54°54′	6°18′	D 094 077
20–B	Mill Lough, N. Ireland	–26.82	0.98	3	54°14′	7°17′	H 465 315
21–B	Motorway, N. Ireland	–25.37	0.58	27	54°28′	6°26′	J 015 594
22–B	Randalstown, N. Ireland	–26.11	0.52	18	54°45′	6°18′	J 095 898
23–L	Shaw's Bridge, N. Ireland	–26.21	0.83	11	54°33′	5°57′	J 325 691
24–B	Swan Carr, England	–25.92	0.66	9	54°38′	1°31′	NZ 315 264
25–L	Teeshan, N. Ireland	–25.02	0.37	8	54°54′	6°19′	D 085 066
26–B	Toomebridge, N. Ireland	–26.42	0.44	9	54°45′	6°29′	H 983 903
27–B	Tullyroan, N. Ireland	–26.11	0.34	5	54°26′	6°37′	H 891 568

*N = total number of measurements contributing to the $\delta^{13}C$ value
**Tree origin: B= bog oak; L = land-grown

Because the samples selected for the Belfast calibration project were biased toward the widest-ringed trees, differences between land-grown and bog oaks, in this case, would be expected to be small. The mean ring widths for the entire set of bog and land-grown oaks used for calibration were identical (1.35 mm). The rather strange bimodal distribution in the land-grown oaks can be explained by separating English and Scottish wood from Irish wood (Fig. 2C). In the samples used in the calibration work, it appears that the trees from Britain are isotopically lighter than Irish trees,

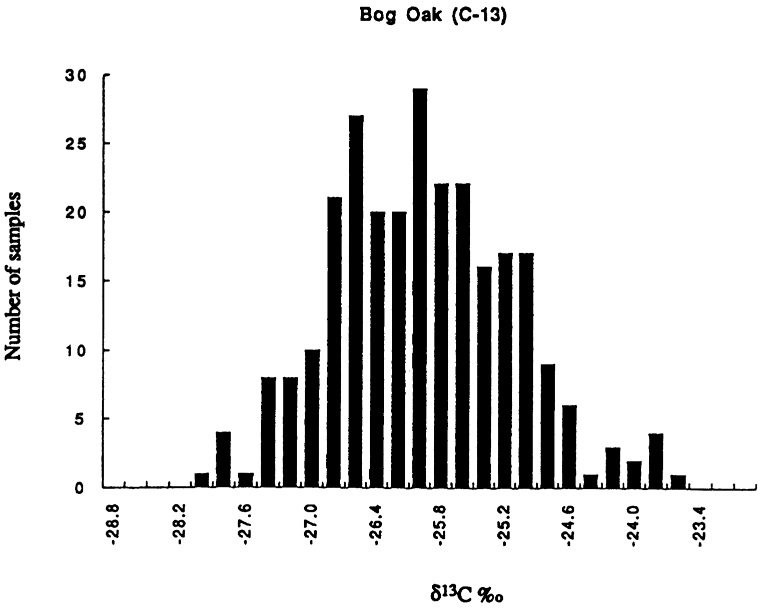

Fig. 2A. $\delta^{13}C$ data binned every 0.2‰ for bog oaks

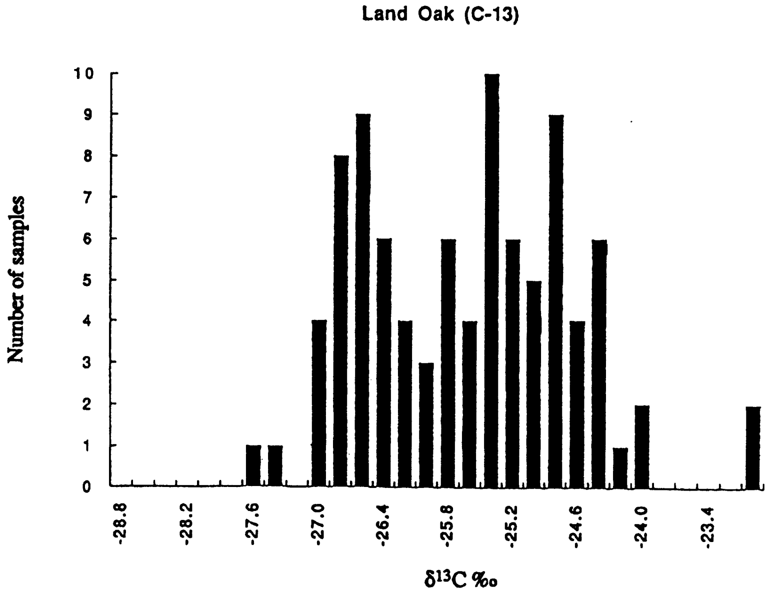

Fig. 2B. $\delta^{13}C$ data binned every 0.2‰ for land-grown oaks

resulting in the two peaks in Figure 2B and C. One reason for this may be that we erroneously included bog oaks in the land-grown category from Ireland. This could occur because we do not know the origin of timbers from historical structures. Other reasons may be that subtle climate differences may have caused fractionation of the ^{13}C in the cellulose of the wood from the two locations, or that species variation as a function of geographic location may have caused the difference.

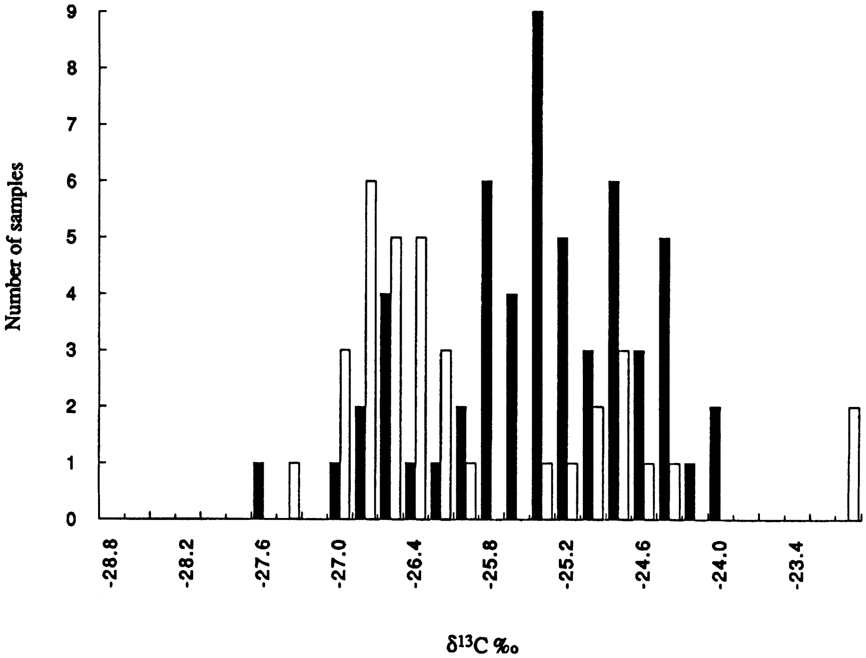

Fig. 2C. Land-grown oaks separated into categories of Irish oak (■) and Scottish and English oak (□).

Because uncorrected stable isotope measurements were used to correct the ^{14}C calibration dates, we checked for differences in ^{14}C dates between the published Irish oak and the University of Washington chronologies in the offset interval (*i.e.,* Irish oak results that are affected by more positive $\delta^{13}C$ measurements should be older than the Washington dates). There is no evidence, in the ^{14}C results, of a systematic difference between Belfast and Washington data due to the discontinuity in the ^{13}C measurements. This is presumably because the $\delta^{13}C$ values of both the samples and the oxalic acid standards were measured on the same instrument and both were offset by approximately the same amount. Unfortunately, detailed records of these early measurements are no longer available in the Belfast laboratory.

TABLE 2. $\delta^{13}C$ Relative to PDB Over the Time Period, AD 1810–5140 BC

Cal AD/BC	$\delta^{13}C$	Tree	Site	Cal AD/BC	$\delta^{13}C$	Tree	Site
1810 AD	–26.77	2825	8	1570 AD	–24.62	1987	24
1790 AD	–26.65	2825	8	1550 AD	–25.77	1987	24
1770 AD	–26.52	2825	8	1530 AD	–25.44	1987	24
1750 AD	–25.86	2652	8	1510 AD	–25.75	1987	24
1730 AD	–25.17	2652	8	1490 AD	–26.42	2054	24
1710 AD	–24.70	2652	8	1470 AD	–26.31	2054	24
1690 AD	–25.37	2652	8	1460 AD	–26.85	2054	24
1670 AD	–24.66	2652	8	1450 AD	–26.66	2054	24
1650 AD	–22.04	2652	8	1430 AD	–26.66	2054	24
1630 AD	–22.93	2652	8	1410 AD	–27.57	2054	24
1610 AD	–24.69	2652	8	1390 AD	–26.92	1941	5
1590 AD	–25.25	1992	24	1370 AD	–25.22	1941	5

TABLE 2. (Continued)

Cal AD/BC	$\delta^{13}C$	Tree	Site	Cal AD/BC	$\delta^{13}C$	Tree	Site
1350 AD	–26.66	1941	5	550 AD	–26.59	2151	14
1330 AD	–26.48	1941	5	530 AD	–26.01	2151	14
1310 AD	–26.73	1941	5	510 AD	–25.35	2970	26
1290 AD	–26.98	3236	27	490 AD	–24.53	2970	26
1265 AD	–25.91	1944	5	470 AD	–24.74	2970	26
1255 AD	–25.88	1944	5	450 AD	–25.08	2970	26
1235 AD	–26.90	1944	5	430 AD	–24.51	2970	26
1225 AD	–26.43	1944	5	410 AD	–25.31	2970	26
1215 AD	–26.74	1944	5	390 AD	–25.39	2970	26
1195 AD	–26.90	1944	5	370 AD	–24.74	3676	18
1175 AD	–26.89	4348	9	350 AD	–24.76	3676	18
1165 AD	–26.66	4348	9	330 AD	–25.17	3676	18
1155 AD	–26.03	4348	9	310 AD	–24.91	3676	18
1145 AD	–26.48	4348	9	290 AD	–23.75	451	1
1135 AD	–26.58	4348	9	270 AD	–24.56	451	1
1125 AD	–26.24	4348	9	250 AD	–23.97	451	1
1115 AD	–26.98	4348	9	230 AD	–23.44	451	1
1105 AD	–26.67	4348	9	210 AD	–24.78	455	1
1095 AD	–26.45	4348	9	190 AD	–24.76	449/450	1
1085 AD	–26.37	4348	9	170 AD	–24.46	455	1
1075 AD	–26.17	4348	9	150 AD	–24.75	455	1
1065 AD	–26.39	4348	9	130 AD	–24.89	455	1
1055 AD	–26.21	4348	9	110 AD	–25.01	455	1
1045 AD	–26.62	4348	9	90 AD	–27.93	218	21
1035 AD	–26.24	4348	9	70 AD	–26.46	218	21
1025 AD	–26.55	2877	27	50 AD	–26.08	218	21
1015 AD	–26.22	2877	27	30 AD	–25.00	5041	10
1005 AD	–26.10	2877	27	10 AD	–24.24	sh1508	19
995 AD	–26.31	2877	27	10 BC	–24.55	sh1508	19
985 AD	–25.67	2877	27	30 BC	–26.65	sh345n	19
975 AD	–26.28	2877	27	50 BC	–26.19	sh345n	19
965 AD	–26.63	2877	27	70 BC	–26.87	sh345n	19
955 AD	–27.08	2877	27	90 BC	–27.32	sh345n	19
940 AD	–24.94	4495	6	110 BC	–26.48	sh388n	19
920 AD	–24.61	1984	2	130 BC	–25.78	2979	13
900 AD	–23.99	1984	2	150 BC	–25.50	2979/2888	13
880 AD	–24.26	1984	2	165 BC	–25.96	2979/2888	13
860 AD	–25.25	3691	7	175 BC	–25.95	2965/2888	13
850 AD	–26.44	3691	7	185 BC	–25.34	2965	13
830 AD	–26.49	3691	7	195 BC	–24.57	2965	13
810 AD	–25.70	3691	7	205 BC	–24.26	2965	13
790 AD	–25.44	3691	7	215 BC	–23.92	2965	13
770 AD	–24.34	3691	7	230 BC	–24.39	2965	13
750 AD	–25.63	3691	7	250 BC	–25.05	2965	13
730 AD	–25.00	2164	14	270 BC	–25.39	2965	13
710 AD	–24.04	2164	14	290 BC	–25.28	2965/2978	13
690 AD	–24.24	2164	14	310 BC	–24.91	2965/2978	13
670 AD	–25.10	2164	14	330 BC	–24.02	1995	15
650 AD	–25.29	2164	14	350 BC	–24.84	1995	15
630 AD	–25.49	2164	14	370 BC	–26.23	1856	15
610 AD	–25.11	2164	14	390 BC	–25.48	1856	15
590 AD	–24.65	2151	14	410 BC	–25.95	1856	15
570 AD	–25.70	2151	14	430 BC	–26.16	1856	15

TABLE 2. (Continued)

Cal AD/BC	$\delta^{13}C$	Tree	Site	Cal AD/BC	$\delta^{13}C$	Tree	Site
450 BC	−26.31	1841	15	1490 BC	−25.98	1933	15
470 BC	−26.21	1841	15	1510 BC	−26.27	1933	15
490 BC	−25.72	1841	15	1530 BC	−26.02	1933	15
510 BC	−25.80	1841	15	1550 BC	−26.71	2254	28
530 BC	−26.76	2209	4	1570 BC	−25.23	1933	15
550 BC	−27.27	2209	4	1590 BC	−26.03	1933	15
570 BC	−25.69	1841	15	1610 BC	−26.20	1933	15
590 BC	−26.42	2199	15	1630 BC	−26.07	1933	15
610 BC	−26.01	2209	4	1650 BC	−24.69	1933	15
630 BC	−25.93	2209	4	1670 BC	−25.94	1933	15
650 BC	−25.39	2209	4	1690 BC	−25.51	1933	15
670 BC	−25.14	2209	4	1710 BC	−24.84	1933	15
690 BC	−25.84	2209	4	1730 BC	−23.78	2027	15
710 BC	−26.56	2209	4	1750 BC	−26.97	2027	15
730 BC	−24.55	2214	11	1770 BC	−25.66	2027	15
750 BC	−25.05	2214	11	1790 BC	−24.61	2027	15
770 BC	−24.92	1895	15	1810 BC	−24.99	2027	15
790 BC	−26.01	1895	15	1830 BC	−26.01	1915	15
810 BC	−26.73	2018	15	1850 BC	−25.85	1915	15
830 BC	−26.26	2018	15	1870 BC	−25.35	1869	15
850 BC	−25.66	2018	15	1890 BC	−25.21	1869	15
870 BC	−26.20	4403	25	1910 BC	−25.52	1869	15
890 BC	−25.87	4403	25	1930 BC	−26.86	1869	15
910 BC	−25.60	4403	25	1950 BC	−24.91	1869	15
930 BC	−26.55	4403	25	1970 BC	−26.64	312	4
950 BC	−27.30	4403	25	1990 BC	−25.50	312	4
970 BC	−25.25	4410/4403	25	2010 BC	−26.27	312	4
990 BC	−25.52	4410/4403	25	2030 BC	−26.46	312	4
1010 BC	−25.42	4410/4403	25	2050 BC	−26.23	312	4
1030 BC	−25.56	4410/4403	25	2070 BC	−25.51	2117	15
1050 BC	−27.77	2203	4	2090 BC	−25.97	518	23
1070 BC	−26.35	2203	4	2110 BC	−25.66	518	23
1090 BC	−26.89	2208	4	2130 BC	−25.53	518	23
1110 BC	−26.44	2208	4	2150 BC	−25.21	518	23
1120 BC	−25.87	2248	28	2170 BC	−27.29	341	4
1130 BC	−26.00	2248	28	2190 BC	−27.55	341	4
1150 BC	−25.95	2258	28	2210 BC	−25.08	1857	15
1170 BC	−24.85	2208	4	2230 BC	−25.70	1857	15
1190 BC	−26.09	2248	28	2250 BC	−25.66	509	23
1210 BC	−25.94	2248	28	2270 BC	−26.14	509	23
1230 BC	−25.62	2246	11	2290 BC	−25.39	2140	15
1250 BC	−27.23	2246	11	2310 BC	−25.57	510	23
1270 BC	−25.41	2033	15	2330 BC	−25.61	510	23
1290 BC	−26.47	2033	15	2350 BC	−25.95	510	23
1310 BC	−27.19	2033	15	2370 BC	−25.34	2140	15
1330 BC	−27.28	2033	15	2390 BC	−26.22	1546	23
1350 BC	−27.12	2033	15	2410 BC	−26.61	1546	23
1370 BC	−27.72	2033	15	2430 BC	−26.51	1546	23
1390 BC	−27.65	2033	15	2450 BC	−26.53	1546	23
1410 BC	−27.18	2114	15	2470 BC	−26.66	1546	23
1430 BC	−26.77	2114	15	2490 BC	−26.51	1546	23
1450 BC	−26.96	2114	15	2510 BC	−25.83	1546	23
1470 BC	−27.36	2114	15	2530 BC	−26.66	1546	23

TABLE 2. (Continued)

Cal AD/BC	δ^{13}C	Tree	Site
2550 BC	–27.08	1546	23
2570 BC	–24.51	1330	22
2590 BC	–25.74	1355	22
2610 BC	–26.67	1355	22
2630 BC	–25.85	1355	22
2650 BC	–26.60	1355	22
2670 BC	–24.75	1323	22
2690 BC	–25.07	1323	22
2710 BC	–24.41	1323	22
2730 BC	–25.08	1323	22
2750 BC	–25.63	1323	22
2770 BC	–24.84	1349	22
2790 BC	–24.66	1349	22
2810 BC	–24.93	1349	22
2830 BC	–25.19	1349	22
2850 BC	–25.66	1349	22
2870 BC	–25.36	1349	22
2890 BC	–25.73	1349	22
2910 BC	–25.55	1334	22
2930 BC	–25.93	1334	22
2950 BC	–25.01	1087	3
2970 BC	–25.13	1087	3
2990 BC	–24.94	1087	3
3010 BC	–25.02	1087	3
3030 BC	–25.70	1082	3
3050 BC	–26.10	2191	15
3070 BC	–27.27	2397	15
3090 BC	–25.99	1073	17
3110 BC	–25.96	1073	17
3130 BC	–26.91	1073	17
3150 BC	–25.58	1066	17
3170 BC	–25.96	1066	17
3190 BC	–25.79	2314	15
3210 BC	–25.68	2314	15
3230 BC	–25.13	2314/2291	15
3250 BC	–25.23	2291	15
3270 BC	–25.80	2291	15
3290 BC	–26.37	2291	15
3310 BC	–26.00	2291	15
3330 BC	–25.20	2291	15
3350 BC	–25.33	2291	15
3370 BC	–26.43	2579	5
3390 BC	–25.39	2579	5
3410 BC	–25.67	2579	5
3430 BC	–25.11	2579	5
3450 BC	–25.49	2579	5
3470 BC	–26.22	2579	5
3490 BC	–26.60	2579	5
3510 BC	–25.06	1532	22
3530 BC	–25.48	1532	22
3550 BC	–25.16	1542	22
3570 BC	–25.58	1542	22
3590 BC	–25.87	1542	22
3610 BC	–25.93	1542	22
3630 BC	–24.88	1542	22
3650 BC	–24.84	1542	22
3670 BC	–25.00	2731	12
3690 BC	–26.15	2731	12
3710 BC	–25.15	2731	12
3730 BC	–25.48	2731	12
3750 BC	–27.08	2736	12
3770 BC	–26.39	2736	12
3790 BC	–26.51	2736	12
3810 BC	–26.60	2736	12
3830 BC	–26.12	2745/2738	12
3850 BC	–25.23	2745	12
3870 BC	–26.52	2870	12
3890 BC	–26.57	2870	12
3910 BC	–26.51	2870	12
3930 BC	–26.61	2870	12
3950 BC	–26.27	2870	12
3970 BC	–25.20	2870	12
3990 BC	–26.09	2174	15
4010 BC	–26.47	2174	15
4030 BC	–26.41	2174	15
4050 BC	–26.33	2174	15
4070 BC	–26.15	2174	15
4090 BC	–25.64	2174	15
4110 BC	–23.79	2595	5
4130 BC	–23.80	2595	5
4150 BC	–24.05	2595	5
4170 BC	–26.47	2495	20
4190 BC	–25.95	2495	20
4210 BC	–25.90	2495	20
4230 BC	–27.04	2495	20
4250 BC	–27.38	2495/2785	20,15
4270 BC	–28.02	2495/2785	20,15
4290 BC	–27.74	2495/2785	20,15
4310 BC	–27.79	2495	20
4330 BC	–25.58	2785	15
4350 BC	–25.44	2785	15
4370 BC	–25.91	2178/2184 1899	15
4390 BC	–25.39	2785	15
4410 BC	–25.59	2785	15
4430 BC	–25.21	2785	15
4450 BC	–24.89	2785	15
4470 BC	–24.48	2785	15
4490 BC	–24.86	2785	15
4510 BC	–24.00	2785	15
4530 BC	–24.21	2785	15
4550 BC	–24.79	2785	15
4570 BC	–25.78	2215	11
4590 BC	–25.95	2815/2804 2514/2215	15,11,20
4610 BC	–25.93	2815/2215 2804/2514	15,11,20

TABLE 2. (Continued)

Cal AD/BC	$\delta^{13}C$	Tree	Site
4630 BC	–25.58	2815/2804 2514/2215	15,11,20
4650 BC	–25.51	2815/2215 2804/2514	15,11,20
4670 BC	–25.82	2215	11
4690 BC	–25.61	2815/2517	15,20
4710 BC	–24.67	2815/2517	15,20
4730 BC	–24.65	2517	20
4750 BC	–24.94	2517	20
4770 BC	–25.42	2517	20
4790 BC	–24.95	2517	20
4810 BC	–24.18	2517	20
4830 BC	–26.01	2502	20
4850 BC	–26.01	2502	20
4870 BC	–26.28	2502	20
4890 BC	–26.32	2502	20
4910 BC	–26.72	2179	15
4930 BC	–26.68	2179	15
4950 BC	–26.70	2179	15
4970 BC	–26.73	2179	15
4990 BC	–26.45	2179	15
5010 BC	–26.66	2179	15
5030 BC	–26.71	2175/2179	15
5050 BC	–26.78	2175/2179	15
5070 BC	–26.51	2175/2179	15
5090 BC	–27.38	2175/2179	15
5110 BC	–26.55	2179	15
5130 BC	–26.16	2179	15
5150 BC	–25.95	2179	15
5170 BC	–27.03	2175	15
5190 BC	–27.00	2175	15
5210 BC	–26.37	2175	15

CONCLUSIONS

We have presented the $\delta^{13}C$ measurements used to correct the ^{14}C calibration data of Pearson *et al.* (1986) and Pearson and Qua (1993). These data were taken from laboratory records that contain all the mass spectrometric measurements made since 1970. We have shown that, for periods covering almost two millennia, the $\delta^{13}C$ results were in error by 1.66‰. This is coincident with the time when an old mass spectrometer was used. Recent measurements on wood from which the calibration samples were taken have enabled us to correct this offset. Table 2 shows the results of the corrected data. The mean $\delta^{13}C$ value for all 360 oak samples from the chronology is –25.78‰ relative to PDB. Oaks from Britain are isotopically lighter than Irish oaks. We suggest that this may be due to uncertainty in the origin of timbers from historical structures in Ireland or to subtle climate or species differences.

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