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Ancient Monuments Laboratory
Report 10/94

THE DATING OF OAK TIMBERS FROM THE WOOTTON QUARR SURVEY, ISLE OF WIGHT

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Summary

The tree-ring analysis and dating of 32 wood samples are described. All but two of the samples were from fallen oak trees. A group of 20 timbers crossmatched to produce a 770-year chronology which spans a period 3463-2694 BC. The trees fell at intervals between 3230 BC and 2694/3 BC. A 268-year floating chronology was produced from three other ring sequences. Radiocarbon dating indicates that this undated chronology is slightly older than the 770-year chronology, whilst other undated ring sequences are younger.

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Introduction

The Wootton Quarr Survey project is the second phase of the Wootton Creek project. Phase 1, the field evaluation project, was carried in 1990 by the County Archaeological Unit. It produced six oak timbers for tree-ring analysis from along the eroding beach. Two of these were dated by dendrochronology to the Neolithic period whilst radiocarbon dating indicated that three others dated to between 2195 and 1750 Cal BC (UB-3271, 3528±37; UB-3272, 3640±38; and UB-3274, 3681±38 (see Table 7 and Hillam 1991).

Phase 2 produced 26 samples for analysis (Table 1). Sample 1000005 is a post from one of several post alignments on Quarr beach (site 2027, NGR SZ574932). It was the only post which appeared to have sufficient rings for dating purposes. All but one of the remaining samples are from fallen trees. Samples 1000013-22, 1001835, 1002153, 1002347, 1002368-9, and 1002382-3 are also from Quarr beach. Samples 1000023-1000028 are from Fishbourne beach, which produced the 1990 tree-ring samples (site 1526, NGR SZ559932). The final site is Newton East Spit (site 2175, NGR418921). This is in the western Solent, about 16km west of the other two sites, and is being used as a control site to test for continuity in marine advance in the Solent valley. It produced two samples: 1002312 is from a fallen tree, and 1002386 is from one of the timbers in a trackway or platform. A piece of *Corylus* from the structure had already been radiocarbon dated to 2920-2505 Cal BC (GU-5341, 4160±70 BP)[1].

Tree-ring analysis was undertaken in 1993 and early 1994 with the following aims:

1. to provide absolute or relative dates for the timbers,
2. if absolute dates were not obtained, to provide information which would enable the most efficient use to be made of radiocarbon dating,
3. to provide information about the prehistoric woodland which had produced the fallen trees,
4. to consolidate and extend the 331-year tree-ring chronology obtained from the Phase 1 study, which spans the period 3059-2729 BC. This final aim coincides with a larger research project being undertaken at the Sheffield Dendrochronology Laboratory, which is to produce a well-replicated tree-ring chronology covering the prehistoric period. Since research at the Belfast Tree-Ring Laboratory has produced chronologies for north-west England and East Anglia (Baillie and Brown 1988; Brown and Baillie 1992), the Sheffield research is concentrating on samples from southern England (eg Hillam *et al* 1990).

This report describes the results of the 1993/4 Phase 2 analysis and also incorporates the results from the Phase 1 field evaluation project. For ease of computation, all the samples numbers have been abbreviated; for example, 1000005 becomes 5 and 6050001 becomes 605 (Table 1).

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[1]All calibrated date ranges cited in the text are quoted at two standard deviations. All radiocarbon results are calibrated using the datasets published by Pearson and Stuiver 1986 (500-2500 BC) and Pearson *et al* 1986 (2500-5210 BC).

Methods

The larger samples were spilt radially into segments for ease of handling. The samples were prepared by freezing them for at least 48 hours and then cleaning their cross-sections with a surform plane. The ring widths were measured to an accuracy of 0.01mm on a travelling stage which is connected to an Atari microcomputer. The Atari uses a suite of dendrochronology programs written by Ian Tyers (pers comm 1992). The measured ring sequences were plotted as graphs using an Epson HI-80 plotter, also connected to the Atari. Crossmatching was carried out first visually by comparing the graphs on a light box, and then using a computer program to measure the amount of correlation between two ring sequences. The crossmatching routines are based on the Belfast CROS program (Baillie and Pilcher 1973; Munro 1984), and all the t values quoted in this report are identical to those produced by the first CROS program (Baillie and Pilcher 1973). Generally *t* values of 3.5 or above indicate a match provided that the visual match between the tree-ring graphs is acceptable (Baillie 1982, 82-5).

Dating is achieved by averaging the data from the matching sequences to produce a site master curve, and then testing that master for similarity against dated reference chronologies. A site master is used for dating whenever possible because it enhances the general climatic signal at the expense of the background noise from the growth characteristics of the individual samples. Any unmatched sequences are tested individually against the reference chronologies. All potential tree-ring dates are then checked by examining the quality of the visual match between the graphs.

If a sample has bark or bark edge, the date of the last measured ring is the date in which the tree died or was felled. A complete outer ring indicates that the tree was felled during its period of dormancy between late autumn and early spring (referred to as "winter felled"). A partially formed ring indicates that the tree was felled in late spring or summer (known as "summer felled"), although it is not always possible to distinguish between an incomplete ring and a complete narrow ring. In the absence of bark edge, felling dates are calculated using the sapwood estimate of 10-55 rings. This is the range of the 95% confidence limits for the number of sapwood rings in British oak trees over 30 years old (Hillam *et al* 1987). Where sapwood is absent, felling dates are given as *termini post quem* by adding 10 years, the minimum number of missing sapwood rings, to the date of the last measured heartwood ring. The actual felling date could be much later depending on how many heartwood rings have been removed or eroded.

Results

1. The timbers.

All the samples were oak (*Quercus* spp.). Sample 5 from a stake alignment was roughly a quarter segment from a tree measuring about 280-300mm in diameter (Table 1). It would have been approximately 95-100 years old when it was felled. It contained 91 rings including 22 sapwood rings and possible bark edge, but it was estimated that 5-10 rings were missing from the inside of the tree. 2386 from the Newtown East Spit platform had 116 rings but no sapwood or pith. The tree could have been well over 200 years old

when it was felled. It is impossible to determine how the timber was worked because of erosion of the wood, but it probably utilises no more than one quarter of the tree trunk.

The samples from the fallen trees were generally from much older and larger trees which had been badly eroded by the tides. Samples 17, 2153, and 2369 from the Quarr beach; 28, 182, 263, 603, and 604 from Fishbourne beach, and 2312 from Newtown East Spit still had their piths (the centre of the trunk). All that was left of the remainder was the eroded bottom half of the fallen tree. It is therefore not possible to determine the exact size and age of the trees. Many were probably older than 200 years when they fell and some may have been over 300 (eg 15, 24, and 602). Sample 603, which had bark and pith, was about 330 years old when it died. The slight uncertainty about the number of rings is due to the narrowness of the outer sapwood rings which made accurate measurement impossible. The outer few rings were therefore counted rather than measured so as not to distort the ring width data. Tree 2153 was of a similar age when it fell.

The tree diamters probably varied from 400-500mm (eg 17) up more than 1m (eg 602). The average ring widths were generally narrow (Table 1). Many of the trees grew at a rate of around 1mm per year. Sample 28 at 1.97mm was the fastest grown tree, whilst 263 at 0.43mm was the slowest. These rates of growth suggest that the trees were from dense woodland, possibly also stressed by exposure to sea winds.

2. Tree-ring dating.

The samples were measured in groups of six or seven in no particular order, and the first group tested for crossmatching before proceeding to the second group and so on. For simplicity, however, the results will not be described step-by-step but will be summarised for the group as a whole.

The samples from the fallen trees had 97-317 rings (Table 1). Sapwood and bark were present on several samples but the outer rings were often badly compressed or very narrow. It was possible to measure out to the bark surface on only ten samples (21, 23, 24, 263, 602, 2153, 2312, 2347, 2369, and 2383). On five other samples (15, 18, 182, 603, and 1835), it was possible to count the unmeasured rings up to the bark edge.

When the ring sequences were compared with each other, two groups of matching sequences were formed. The first group matched the 602/604 chronology from Phase 1 which spanned the period 3059-2729 BC (Hillam 1991). The second group contained five samples but was floating in time. A radiocarbon sample from tree-ring sample 20 indicated that this group was older than the first group (see below). As more samples were analysed, the two groups were eventually linked together to form a 770-year sequence covering the period 3463-2694 BC (Fig 1). The twenty matching ring sequences included in the new master chronology correlated well together (Table 2), whilst the chronology itself (Table 3) was similar to other British tree-ring chronologies (Table 4).

A second group of three sequences was crossmatched to give a chronology of 268 years (Tables 5, 6). Although this was tested against the 770-year Isle of Wight chronology, plus other prehistoric reference chronologies (see Appendix), no reliable dating was obtained. A section from sample 21 was therefore submitted for radiocarbon analysis. The radiocarbon result dates years 23-43 of sample 21 to 3675-3360 Cal BC (GU-5299, 4730±60 BP), which suggests that this 268-year sequence probably lies off the older end of the main 770-year sequence.

The unmatched samples were also tested against the reference chronologies. A tentative date in the 26th century BC was obtained for sample 28 but at present this cannot be confirmed. No dating was obtained for samples 5, 182, 263, 603, 605, 2347, 2383, or 2386. Most of these have under 100 rings and may possibly never be dated by dendrochronology. However, 603, with 317 rings, may eventually date as more timbers are analysed.

3. Radiocarbon dating.

The radiocarbon results from, or associated with, the timbers are summarised in Table 7. The radiocarbon samples were submitted at intervals throughout the project, mostly from the Sheffield Dendrochronology Laboratory as an aid to the tree-ring analysis. The radiocarbon result from timber 20, for example, indicated that this ring sequence, one of an undated group of five, was older than those in the original Isle of Wight master sequence. As more samples were analysed dendrochronologically, this proved to be true. Other timbers with radiocarbon dates, for example 603, have not yet been dated by dendrochronology. However, if the radiocarbon results are combined with those from dendrochronology (Table 8), an indication of the chronological coverage of the ring sequences is obtained.

Chronological coverage of the timbers

The oldest known timbers are the group of three (16, 21, and 1835) which make up the 268-year master chronology. Although undated by dendrochronology, the radiocarbon results indicate that years 23-43 fall within the 2σ range of 3675-3360 Cal BC (GU-5299, 4730±60 BP; Table 7).

After this, dendrochronology provides a precise dating framework for the twenty trees which make up the Isle of Wight chronology (Fig 1, Table 8). The oldest group dated by dendrochronology come from Quarr Beach (Fig 2). Timber 18 fell in about 3230 BC, the slight uncertainty being caused by a few narrow rings near the bark surface. 15 fell in 3140-3137 BC. Timbers 14, 19, 20, and 2382 may also have died around this time, but lack of sapwood makes it impossible to determine the exact year of death. 2368 died after 3146 BC, and 2153 in 3072/1 BC. Then there are two dated trees from Fishbourne Beach: 27 fell after 3088 BC, and 23 in 3011/0 BC, possibly in the summer of 3010 BC. 17 and 22 from Quarr Beach and 26 from Fishbourne Beach died after 2928 BC, 2918 BC, and 2909 BC respectively. 2369 from Quarr fell in 2879 BC, probably summer, whilst 24 and 602 from Fishbourne fell in 2777/6 BC, probably in winter. 25 and 604 from Fishbourne died after 2688 BC and 2719 BC respectively, and 13 from Quarr some time in the period 2699-2663 BC. Finally the single dated timber from Newtown East Spit (2312) probably died in 2694/3 BC.

For the deaths of trees younger than 2694/3, it is necessary to return to the radiocarbon results. Rings 44-62 from Fishbourne timber 28 has a 2σ date range of 2880-2495 Cal BC (GU-5298, 4100±50 BP). 2386 from the Newtown East Spit platform appears to be broadly contemporary. Also from Fishbourne Beach are a group of three trees (182, 263, and 603) which date to between 2195 and 1750 Cal BC (see above and Table 7). There are no matches between the ring sequences from these three samples. The youngest dated sample from amongst those sent for tree-ring analysis is stake 5 from Quarr Beach which has a 2σ calibrated date range of 400-200 Cal BC (GU-5253, 2270±50 BP).

There appears to be no distinct trend in the average ring widths through this chronological spread of timbers. For example, 24 and 602, both felled in 2777/6 BC, have average ring widths of 0.82mm and 1.77mm respectively (Table 8). Many of the trees at the Fishbourne and Quarr sites show very narrow rings but this is not dependent on time. It appears that the trees were subject to stressful growing conditions throughout much of the prehistoric period.

Conclusion

Dendrochronology and radiocarbon dating indicate that trees were growing near Quarr Beach (site 2027) from at least 3463 BC to 2699 BC, and near Fishbourne Beach (site 1526) from 3282 BC to between 2195 and 1750 Cal BC. The trees, which were often relatively long-lived and subject to severe conditions of growth, fell at intervals during these periods. As well as a detailed dating framework, the study has also produced a well-replicated tree-ring chronology for the 770-year period 3463-2694 BC.

Acknowledgements

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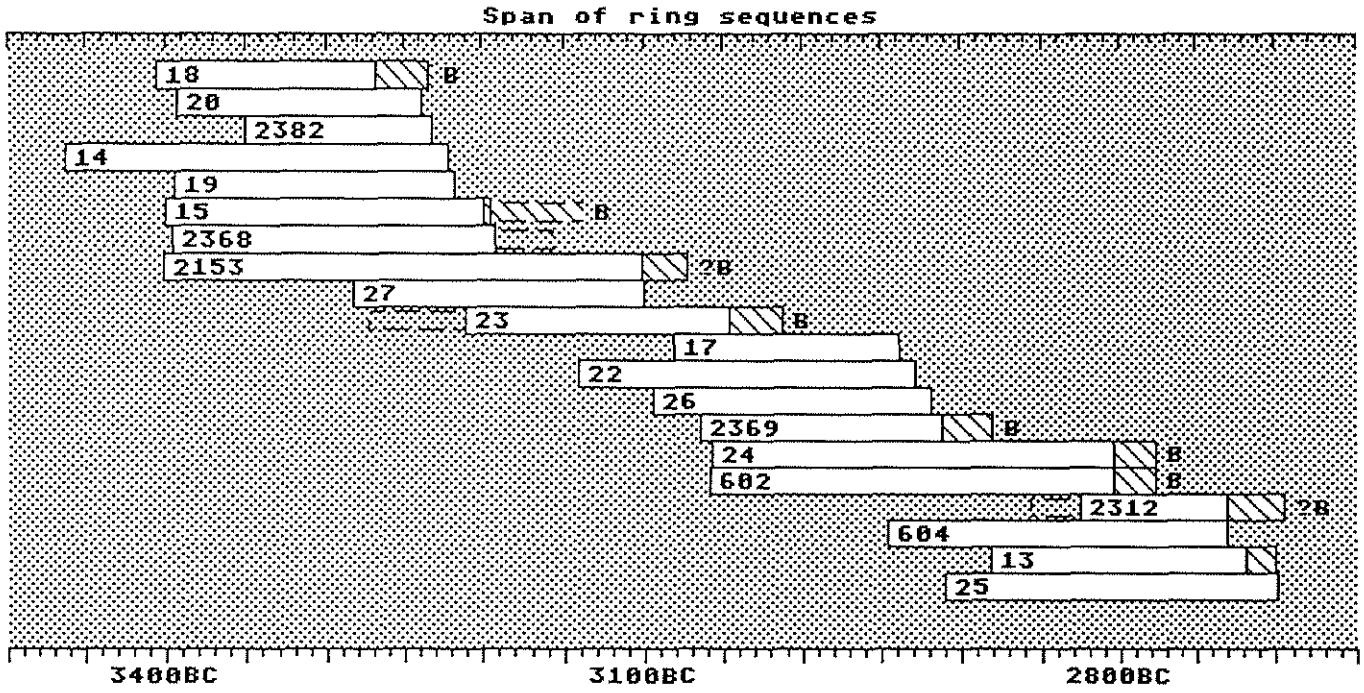
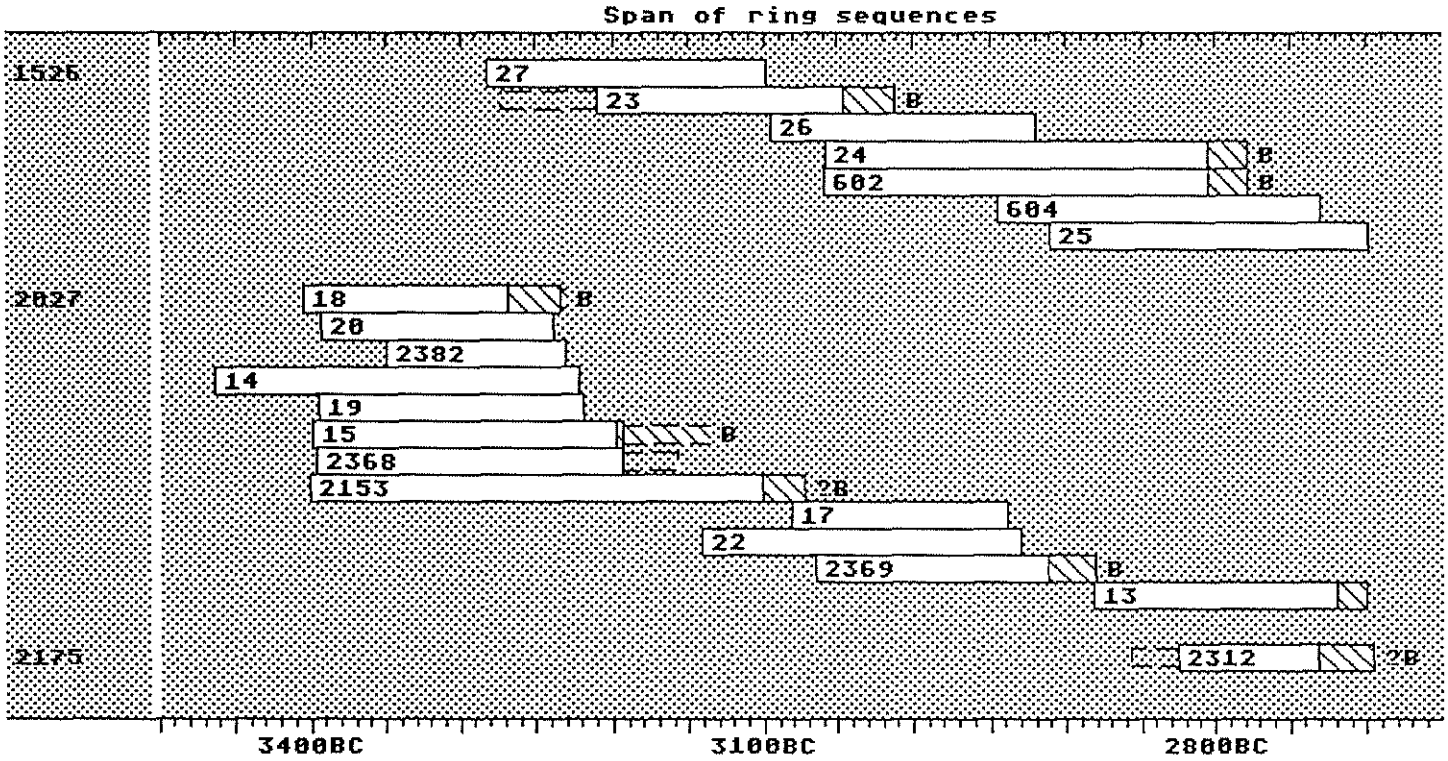


Key

White bars	- heartwood rings
Hatching	- sapwood
Broken bars	- unmeasured rings
B	- bark edge

Fig 1: Bar diagram showing the chronological spread of the dated ring sequences.

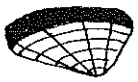
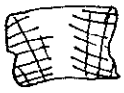
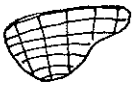
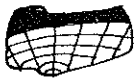
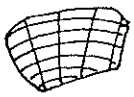
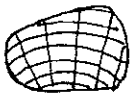
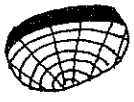
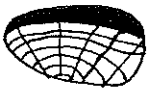


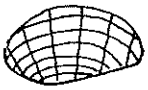
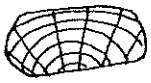
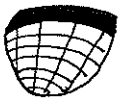
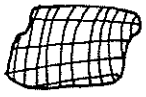
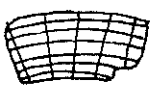
Key

White bars	- heartwood rings	Site 1526 - Fishbourne Beach
Hatching	- sapwood	Site 2027 - Quarr Beach
Broken bars	- unmeasured rings	Site 2175 - Newtown East Spit
B	- bark edge	

Fig 2: Bar diagram showing the relative positions of the dated ring sequences from each site.

Table 1: Details of the tree-ring samples. Cross-sectional sketches are not to scale; HS - heartwood-sapwood transition; "+" - unmeasured rings. Sample numbers have been shortened for ease of computation: 5-28 are 1000005-1000028; 182-605 are 1820001-6050001; 1835-2386 are 1001835-1002386.

sample no.	site	total rings	sapwood rings	av. ring width (mm)	sketch	dimensions (mm)	comments
5	2027	91	22	1.54		175x140	post; felled winter?
13	2027	183	18	1.55		490x380	very knotty
14	2027	243	-	0.92		480x240	
15	2027	207+	4+	0.68		330x250	plus 57-60 rings to bark edge
16	2027	109	-	1.61		315x170	
17	2027	145	-	1.31		345x250	
18	2027	173	33	1.08		345x190	plus about 4 to bark
19	2027	178	-	0.92		260x180	
20	2027	156	-	1.44		350x210	sapwood not measurable
21	2027	260	25	0.91		500x290	bark edge?
22	2027	214	-	1.04	-	-	sample broken
23	1526	+200	33	1.08		515x310	plus 63 inner rings; felled summer?

sample no.	site	total rings	sapwood rings	av. ring width (mm)	sketch	dimensions (mm)	comments
24	1526	282	26	0.89		390x275	felled winter?
25	1526	213+	-	0.83		340x185	knotty; plus many narrow rings
26	1526	177+	-	1.15		380x215	plus narrow rings
27	1526	185+	-	0.75		295x150	plus narrow rings
28	1526	138	-	1.97		450x345	
182	1526	+83+	24	0.53		250x160	rings mostly too narrow; about 83-6 to bark edge
263	1526	+58	56	0.43		180x165	inner rings too narrow; felled summer
602	1526	283	26	1.77		530x530	bark edge
603	1526	317+	22+	0.62		400x400	about 13 rings to bark edge
604	1526	+217	-	0.75		490x340	inner rings too narrow
605	1526	76	-	2.46		220x200	
1835	2027	235+	-	0.64		450x170	21 rings to bark edge
2153	2027	330	27	0.71		390x330	felled winter?

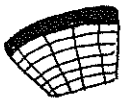
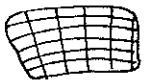
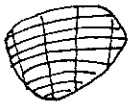
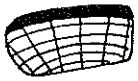
sample no.	site	total rings	sapwood rings	av. ring width (mm)	sketch	dimensions (mm)	comments
2312	2175	+132	35	0.68		220x185	inner 32 rings unmeasured; bark edge?
2347	2027	+100	-	1.02		260x195	bark; inner rings unmeasured
2368	2027	205+	-	0.59		380x140	plus at least 36 rings
2369	2027	186	30	0.84		465x290	bark edge - ?felled summer
2382	2027	121	-	1.56		295x200	
2383	2027	97	41	1.29		230x140	felled winter
2386	2175	116	-	1.71		340x210	timber from platform or causeway

Table 2: *t* value matrix showing the level of correlation between the dated ring sequences. Values less than 3.0 are not listed; / - overlap less than 15 years.

	13	**14**	**15**	**17**	**18**	**19**	**20**	**22**	**23**	**24**	**25**	**26**	**27**	**602**	**604**	**2153**	**2312**	**2368**	**2369**	**2382**
13	*	\	\	\	\	\	\	\	\	5.7	8.3	\	\	3.2	4.8	\	4.4	\	\	\
	14	*	5.6	\		5.1	3.8	\	\	\	\	\		\	\		\		\	
		15	*	\	6.3	5.6	4.2	\		\	\	\	4.8	\	\	5.2	\	5.3	\	4.8
			17	*	\	\	\	7.1	6.0	6.3	\	7.8	\	5.3	\	\	\	\	7.2	\
				18	*	6.2	4.8	\	\	\	\	\		\	\	7.8	\	5.3	\	5.5
					19	*	5.2	\	\	\	\	\	3.7	\	\	5.8	\	4.4	\	4.5
						20	*	\	\	\	\	\	4.9	\	\	6.4	\	3.2	\	4.2
							22	*	7.9	5.3	\	8.8	4.0	5.7		3.5	\	\	7.4	\
								23	*	4.8	\	6.4	6.8	5.6	\	3.0	\		4.2	\
									24	*	8.2	58	\	6.8	4.6	\	4.3	\	6.3	\
										25	*	\	\	4.0	8.0	\	7.2	\		\
											26	*	\	5.8		4.6	\	\	10.1	\
												27	*	\	\	7.8	\	4.6	\	4.6
													602	*	6.2	\		\	9.4	\
														604	*	\	4.8	\		\
															2153	*	\	4.5	\	5.5
																2312	*	\	\	\
																	2368	*	\	3.3
																		2369	*	\
																			2382	*

Table 3: Isle of Wight tree-ring chronology, 3463-2694 BC; total number of samples is 20.

year	ring widths (0.01mm)										number of samples									
3463 BC	193	132	129								1	1	1							
	151	223	156	116	179	108	141	192	153	120	1	1	1	1	1	1	1	1	1	1
3450 BC	133	133	153	177	126	101	139	72	97	87	1	1	1	1	1	1	1	1	1	1
	114	87	71	124	96	113	64	47	95	94	1	1	1	1	1	1	1	1	1	1
	68	87	91	91	87	93	93	84	85	76	1	1	1	1	1	1	1	1	1	1
	72	83	94	88	65	80	110	75	83	94	1	1	1	1	1	1	1	1	1	1
	106	84	73	81	104	143	118	166	115	81	1	1	1	1	2	2	2	2	2	3
3400 BC	80	84	118	91	93	87	120	100	121	94	4	4	4	4	5	6	6	7	7	7
	97	90	102	96	141	131	99	70	73	99	7	7	7	7	7	7	7	7	7	7
	154	179	159	145	128	116	107	114	137	148	7	7	7	7	7	7	7	7	7	7
	141	154	155	176	138	145	126	111	122	141	7	7	7	7	7	7	7	7	7	7
	119	144	138	109	81	104	145	136	185	146	7	7	7	7	7	7	7	7	7	7
3350 BC	153	143	115	91	99	105	130	91	107	99	8	8	8	8	8	8	8	8	8	8
	102	91	105	97	115	90	123	126	117	100	8	8	8	8	8	8	8	8	8	8
	99	117	102	121	89	131	95	97	127	94	8	8	8	8	8	8	8	8	8	8
	109	77	89	93	94	94	95	83	100	109	8	8	8	8	8	8	8	8	8	8
	112	89	95	96	98	93	112	89	98	74	8	8	8	8	8	8	8	8	8	8
3300 BC	84	97	89	70	59	68	86	84	89	114	8	8	8	8	8	8	8	8	8	8
	94	93	86	86	68	69	76	91	81	92	8	8	8	8	8	8	8	8	9	9
	92	77	78	91	73	72	76	87	80	74	9	9	9	9	9	9	9	9	9	9
	79	73	75	53	92	78	80	79	91	68	9	9	9	9	9	9	9	9	9	9
	66	94	72	79	69	67	77	62	72	74	9	9	9	9	9	9	9	9	9	9
3250 BC	76	83	89	77	68	98	92	81	75	65	9	9	9	9	9	9	9	9	9	9
	65	69	66	59	65	59	50	65	84	65	9	9	9	8	8	8	8	7	7	7
	80	60	63	72	61	59	56	77	57	60	7	6	6	6	6	6	6	6	6	6
	53	68	55	48	68	63	58	59	57	68	5	5	5	4	4	4	4	4	4	4
	50	59	65	71	66	67	72	57	69	66	5	5	5	5	5	5	5	5	5	5
3200 BC	95	80	71	60	66	68	80	83	109	100	5	5	5	5	5	5	5	4	4	3
	92	85	69	94	85	76	84	83	90	95	3	3	3	3	3	3	3	3	3	3
	92	115	80	104	88	87	71	88	90	101	3	3	3	3	3	3	3	3	3	3
	123	81	73	68	90	100	110	91	112	73	3	3	3	3	3	3	3	3	3	3
	82	93	95	70	72	81	84	64	79	66	3	3	3	3	3	3	3	3	3	3
3150 BC	77	75	59	68	91	76	86	71	64	86	3	3	3	3	3	3	3	3	3	4
	95	106	90	76	86	105	102	96	83	94	4	4	4	4	4	4	4	4	4	4
	87	104	105	98	97	93	116	88	72	72	4	4	4	4	4	4	4	4	4	4
	98	105	125	110	121	104	87	97	126	86	4	4	4	4	4	4	4	4	4	4
	106	103	111	91	83	76	102	138	121	84	4	4	4	4	4	4	4	4	4	4
3100 BC	128	136	118	117	132	118	107	78	127	134	4	4	4	3	3	4	4	4	4	4
	133	117	129	120	141	93	128	135	131	119	4	4	4	4	4	4	4	4	5	5
	127	111	80	100	92	108	145	183	134	119	5	5	5	5	5	5	5	5	5	4
	156	174	175	119	146	136	97	146	146	112	4	4	4	4	4	5	5	5	5	5
	147	180	125	149	130	149	176	119	113	90	5	6	7	7	7	7	7	7	7	7
3050 BC	150	114	105	112	111	113	131	130	168	167	7	7	7	7	7	7	7	7	7	7
	111	136	189	159	119	133	131	171	163	129	7	7	7	7	7	7	7	7	7	7
	179	136	115	114	153	147	138	135	159	149	7	7	7	7	7	7	7	7	7	7
	157	142	98	162	137	132	137	142	161	119	7	7	7	7	7	7	7	7	7	7
	124	175	145	176	147	123	141	121	175	116	6	6	6	6	6	6	6	6	6	6

3000 BC	135	158	143	125	145	116	126	102	72	107	6	6	6	6	6	6	6	6	6	6
	133	162	129	131	126	107	92	95	126	135	6	6	6	6	6	6	6	6	6	6
	133	102	107	122	82	113	89	96	116	116	6	6	6	6	6	6	6	6	6	6
	109	140	141	111	111	72	87	103	123	106	6	6	6	6	6	6	6	6	6	6
	116	135	95	103	90	92	109	103	92	98	6	6	6	6	6	6	6	6	6	6
2950 BC	111	88	79	93	99	124	97	98	98	86	6	6	6	6	6	7	7	7	7	7
	89	94	100	104	133	134	133	95	90	75	7	7	7	6	6	6	6	6	6	6
	80	116	94	136	109	101	101	101	90	86	6	6	6	5	5	5	5	5	5	5
	112	88	95	114	101	91	103	117	103	114	5	5	4	4	4	4	4	4	4	4
	117	122	106	135	135	116	99	124	123	126	5	5	5	5	5	5	5	5	5	5
2900 BC	110	138	89	82	117	111	106	116	105	98	5	5	5	5	5	5	5	5	5	5
	147	158	121	127	104	120	148	121	145	126	5	5	5	5	5	5	5	5	6	6
	110	113	127	127	115	127	108	153	117	148	6	5	5	5	5	5	5	5	5	5
	145	119	145	145	141	133	88	119	98	105	5	5	5	5	5	5	5	5	5	5
	118	134	158	182	111	137	93	93	121	104	5	5	5	5	5	5	5	5	5	5
2850 BC	96	109	117	120	108	112	116	120	92	94	5	5	5	5	5	5	5	5	5	5
	146	137	103	98	109	97	109	78	99	95	5	5	5	5	5	5	5	5	5	5
	88	100	73	102	80	74	94	108	80	98	5	5	5	5	5	6	6	6	6	6
	90	90	88	93	111	86	95	101	93	75	6	6	6	6	6	6	6	6	6	6
	78	87	101	78	87	95	83	99	69	89	6	6	6	6	6	6	6	6	6	6
2800 BC	71	91	61	75	94	80	73	60	83	77	6	6	6	6	6	6	6	6	6	6
	74	78	87	63	100	72	69	82	89	73	6	6	6	6	6	6	6	6	6	6
	100	64	94	67	97	92	105	97	108	89	6	6	6	6	4	4	4	4	4	4
	82	70	84	74	93	84	77	100	73	81	4	4	4	4	4	4	4	4	4	4
	94	74	91	83	89	96	94	92	83	52	4	4	4	4	4	4	4	4	4	4
2750 BC	59	84	62	71	73	67	86	59	86	71	4	4	4	4	4	4	4	4	4	4
	78	65	77	71	63	76	63	75	73	78	4	4	4	4	4	4	4	4	4	4
	69	69	109	74	95	108	78	87	82	94	4	4	3	3	3	3	3	3	3	3
	89	74	88	95	99	86	78	75	73	88	3	3	3	3	3	3	3	3	3	3
	87	143	99	154	88	117	92	64	60	45	3	3	3	3	3	3	3	3	3	3
2700 BC	70	48	33	65	41	51	47				3	2	2	1	1	1	1			

Table 4: Matching with other prehistoric chronologies. Details of the chronologies are given in the Appendix.

chronology	*t* value
Colwick Hall 1, Notts	5.2
Croston 1, Lancs	4.3
East Anglia	6.8
Eskham Farm, Lancs	4.0
Hereford and Worcester palaeochannel	6.0
Northern Ireland	5.0
Woolaston submerged forest 2/3, Gloucs	7.8

Table 5: *t*-value matrix for the undated 3 timber master sequence.

	16	**21**	**1835**
16	*	3.8	7.3
	21	*	4.3
		1835	*

Table 6: Undated master sequence of 268 years; rings 23-43 are dated by radiocarbon to 367-3360 Cal BC (GU-5299, 4730±60 BP).

year	ring widths (0.01mm)										number of samples									
1	197	94	168	166	125	152	120	159	190	131	1	1	1	1	1	1	1	1	1	2
	198	197	162	91	115	107	124	95	137	86	2	2	2	2	2	2	2	2	2	2
	121	160	147	143	103	128	124	111	148	104	2	2	2	2	2	2	2	2	2	2
	112	135	121	164	124	149	105	145	186	87	2	2	2	2	2	2	2	2	2	2
	127	119	67	72	66	101	57	83	65	77	2	2	2	2	2	2	2	2	2	2
51	73	87	168	166	146	112	156	165	137	125	2	2	3	3	3	3	3	3	3	3
	150	153	106	75	103	117	122	140	156	109	3	3	3	3	3	3	3	3	3	3
	118	70	74	88	91	91	113	81	88	99	3	3	3	3	3	3	3	3	3	3
	79	73	96	118	102	124	102	89	60	63	3	3	3	3	3	3	3	3	3	3
	63	70	92	94	87	91	69	66	77	64	3	3	3	3	3	3	3	3	3	3
101	101	110	89	76	78	84	95	74	53	96	3	3	3	3	3	3	3	3	3	3
	77	70	88	88	102	80	93	98	102	124	3	3	3	3	3	3	3	3	3	3
	107	79	111	97	119	105	95	100	82	96	3	3	3	3	3	3	3	3	3	3
	140	111	119	87	74	99	111	75	53	75	3	3	3	3	3	3	3	3	3	3
	91	102	115	90	119	91	83	82	94	77	3	3	3	3	3	3	3	3	3	3
151	85	110	127	84	76	68	96	90	131	87	3	3	3	3	3	3	3	3	3	3
	86	66	58	63	67	84	70	94	88	66	3	2	2	2	2	2	2	2	2	2
	82	101	93	66	83	84	85	90	78	85	2	2	2	2	2	2	2	2	2	2
	79	61	67	69	53	76	69	79	80	69	2	2	2	2	2	2	2	2	2	2
	100	88	74	88	66	78	80	66	82	63	2	2	2	2	2	2	2	2	2	2
201	69	56	68	56	79	72	84	77	64	78	2	2	2	2	2	2	2	2	2	2
	82	94	71	71	69	73	80	88	84	92	2	2	2	2	2	2	2	2	2	2
	90	66	78	91	82	95	63	77	61	54	2	2	2	2	2	2	2	2	2	2
	60	60	67	64	75	65	69	60	73	64	2	2	2	2	2	2	2	2	2	2
	60	59	58	50	51	52	46	53	42	45	2	2	2	2	2	2	2	2	2	2
251	61	59	59	44	47	43	47	43	47	48	2	2	2	2	2	2	2	2	2	2
	44	56	62	52	45	43	39	51			1	1	1	1	1	1	1	1		

Table 7: Summary of radiocarbon results.

timber	rings sampled	radiocarbon age (BP)	radiocarbon sample no.	2σ calibrated date range (Cal BC)	comment
5	-	2270±50	GU-5253	400-200	
20	29-41	4620±60	GU-5300	3610-3180	rings tree-ring dated to 3365-3353 BC
21	23-43	4730±60	GU-5298	3673-3360	also rings 23-43 of undated 268-year master curve
28	44-62	4100±50	GU-5298	2881-2497	
182	all	3528±37	UB-3271	1970-1749	
263	all	3640±38	UB-3272	2137-1908	
603	all	3681±38	UB-3274	2195-1962	
2386 (associated with)	-	4160±70	GU-5341	2920-2505	determination on piece of *Corylus* from same structure

Table 8: Summary of the tree-ring results. A sapwood estimate of 10-55 rings is used to calculate the felling date ranges in the absence of bark edge (Hillam *et al* 1987). ARW - average ring width; C - centre of tree (pith) present; V - within 5 rings of pith; F - 5-10 rings from pith; "+" - unmeasured rings.

sample	ARW	pith	total rings	date span (BC)	sap-wood	comment	felled (BC)
site 1526							
23	1.08	G	+200	3210-3011	33	felled summer?	3010
24	0.89	G	282	3058-2777	26	felled winter?	2777/6
25	0.83	G	213+	2910-2698	-		2688+
26	1.15	G	177+	3095-2919	-		2909+
27	0.75	G	185+	3282-3098	-		3088+
28	1.97	C	138	-	-		
182	0.53	G	+83+	-	24		
263	0.43	G	+58	-	56		
602	1.77	F	283	3059-2777	26	bark edge	2777/6
603	0.62	C	317+	-	22		
604	0.75	G	+217	2945-2729	-		2719+
605	2.46	G	76	-	-		
site 2027							
5	1.54	F	91	-	22		
13	1.55	G	183	2882-2700	18		2699-2663
14	0.92	G	243	3463-3221	-		3211+
15	0.68	G	207+	3400-3194	4	+57-60 rings to bark edge	3140-3137
16	1.61	G	109	-	-		
17	1.31	C	145	3028-2938	-		2928+
18	1.08	G	173	3406-3234	33	*c.*4 rings to bark edge	*c.*3230
19	0.92	G	178	3395-3218	-		3208+
20	1.44	F	156	3393-3238	-		3228+
21	0.91	F	260	-	25		
22	1.04	G	214	3141-2928	-		2918+
1835	0.64	G	235+	-	-		
2153	0.71	F	330	3410-3072	27	bark edge?	3072/1
2347	1.02	G	+100	-	-		
2368	0.59	G	205+	3396-3192	-	plus at least 36 rings	3146+
2369	0.84	V	186	3065-2880	30	felled summer?	2879
2382	1.56	G	121	3350-3230	-		3220+
2383	1.29	G	97	-	41		
site 2175							
2312	0.68	G	164	2857-2694	35	bark edge?	2694/3?
2386	1.71	G	116	-	-		

Appendix: Details of dated prehistoric tree-ring chronologies from Britain. Those marked with an asterisk were produced in the Bark edgelfast Tree-Ring Laboratory (eg Baillie and Brown 1988; Brown *et al* 1986); the remainder were produced at Sheffield (eg Hillam *et al* 1990), unless stated otherwise.

Region	Chronology	Date span (BC)
Cambridgeshire	Flag Fen/Fengate (Neve 1992)	1363-967
Durham	Swan Carr*	1155-381
East Anglia	East Anglia*	3196-1681
Gloucestershire	Woolaston submerged forest 2/3	2843-2692
	Woolaston submerged forest 6/7	4096-3869
Gwent	Caldicot oak	1131-998
	Caldicot ash	1169-990
	Goldcliff structural timbark edgers	518-392
	Goldcliff boat fragments	1139-1027
Hereford and Worcestershire	palaeochannel	2869-2698
Humbark edgerside	Bark edgeverley Long Lane	4197-3891
	Hasholme logboat	699-323
	Hasholme bog oaks	1687-1326
	Watton Carrs 1	1804-1655
Lancashire	Ashton*	4307-4023
	Balls Farm*	4433-4165
	Croston Moss 1*	3198-1682
	Croston Moss 2*	1584-970
	Eskham House Farm*	3601-3109
	Hill Farm 1*	3807-3494
	Hill Farm 2*	3519-3283
	Lancs 2*	4989-4569
Lincolnshire	Fiskerton	505-339
Northern Ireland	Bark edgelfast long chronology*	5289-AD1983
Nottinghamshire	Colwick Hall 1*	3045-2697
	Colwick Hall 2*	2792-2583
	Old Loop 1*	4186-3833
	Old Loop 2*	4852-4426
	Para Trent 1	2563-2258
Somerset	Skinners Wood	1162-1003
	Stolford submerged forest*	4050-3779
	Sweet Track	4202-3807