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Ancient Monuments Laboratory
Report 22/96

TREE-RING ANALYSIS OF THE TOWER OF ST JOHN THE BAPTIST CURCH, MAMBLE, HEREFORD AND WORCESTER

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Summary

Dendrochronological analysis of timbers from the original tower, the later superstructure, and some of the repair elements of the tower of the church of St John the Baptist, Mamble, has shown that this large well-preserved tower is primarily of early thirteenth-century date. In addition a new upper structure of late sixteenth- or early seventeenth- century date and a series of repairs of c AD 1753 were identified.

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TREE-RING ANALYSIS OF THE TOWER OF ST JOHN THE BAPTIST CHURCH, MAMBLE, HEREFORD AND WORCESTER

Introduction

The purpose of the study was to carry out dendrochronological analyses of timber elements of the tower of the church of St John the Baptist, Mamble, Hereford and Worcester (NGR SO688716). The spire has been the subject of a major programme of repair and stabilisation. The analysis reported here was requested by David Heath, English Heritage Historic Buildings Architect, as part of this programme.

The tower of the church is timber framed throughout, and is composed of four main posts with a complex series of cross-braces and horizontal beams. A number of supporting braces run from outside the footprint of the tower, up into the structure (Fig 1). This phase is clearly of considerable age. The use of half lap dove-tail joists, notched lap joints, and long passing braces is suggestive of a thirteenth-century date by analogy with those found in several other thirteenth-century structures (eg Cressing Temple Barley Barn, Cathedral Barn Hereford). The tower is not aligned precisely with the present church, which has led to suggestions that it was originally a free-standing tower that has subsequently been enveloped by the church building (David Heath pers comm). The key features of the timbers of this phase are: notch laps joints and simple passing joints, timber of boxed heart sections usually of young fast growing trees, a surface patina that is too eroded to see tool marks, and very soft and friable sapwood.

Two later groups of timbers are clearly present. There is an upper extension of the tower, incorporating new sills, corner posts, a bellframe, and a spire. This sits above the original main structure. These timbers are decorated with chamfer stops, tool marks are readily visible, and the sections are mostly quartered trees. There are in addition a number of repairs and modifications to the primary structure that may represent one or several phases of intervention. The outer passing braces have mostly been removed or shortened, presumably at the time of its incorporation into the main body of the church. The later timbers are visually rather distinctive since they have clear scappling and saw marks and are mostly quartered, although there are a few very small whole trees incorporated. Sapwood and bark is also abundant, and the joints are very unsophisticated.

Methodology

The tower was visited and all the timbers were assessed. Those timbers which had less than 50 rings were rejected as unsuitable for analysis. There were timbers from all three major phases which contained sufficient rings. The bellframe also contained some suitable timbers although it was not sampled because the dating of this structure was not of primary concern. Samples were taken using a 15mm diameter hollow corer attached to an electric drill. Cores were taken within the beams at positions which maximised the numbers of rings obtained and, where possible, included sapwood or the outer-most heartwood rings. The ring sequences in the cores were revealed by sanding the cores in the original horizontal plane of the parent tree. Two additional samples from the ends of fractured timbers were made available for study by the architect, John Wheatley of Wheatley Taylor Stainburn Lines, responsible for the restoration programme.

The complete sequences of growth rings in the samples that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that these positions are supported by satisfactory visual matching.

All the measured sequences from this assemblage were compared with each other and those that were found to cross-match were combined to form three site master curves. These master curves and the remaining unmatched ring sequences were then tested against a range of reference chronologies, using the same matching criteria: high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequences.

These tree-ring dates can initially only date the rings present in the timber. Their interpretation relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings that may be missing. This *tpq* may be many decades prior to the real felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The sapwood estimates applied through-out this report are a minimum of 10 and maximum of 55 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Hillam *et al* 1987). The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the reuse of timbers and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

The entire structure appeared to be of oak (*Quercus* spp.). Sixteen samples were obtained in all: fourteen cores and two slices, numbered **1** to **16** inclusive (Table 1). Two pairs of timbers were sampled twice: the original north-west tower post was sampled in two separate places (samples **3** and **7**) in an attempt to extract the entire ring sequence; whilst a passing brace was cored (sample **5**) and a section removed from it was subsequently made available for study (sample **15**). It is possible that the fragmentary slice **16** was also part of this timber. Twelve samples (eleven cores and one slice) from ten separate timbers proved to contain enough rings to be suitable for the technique. Samples **2**, **4**, **10**, and **16** contained too few rings for any subsequent analysis.

First, the two pairs of samples from single timbers were combined to form new single timber sequences labelled **3+7** and **5+15**. The ten separate timber sequences were then compared with each other and three groups of samples were found to match together in a consistent fashion. The three groups of timbers, comprising groups of three timbers each (Table 2a-c, Fig 2), were combined together to form three separate site master sequences. The average growth rates and quality of the cross-matching demonstrate that within each group the material is similar, although the sample size is too small to be sure that they were derived from single woodland areas. The three site master sequences were compared to an extensive range of dated chronologies from elsewhere in Britain, and in each case a consistent matching position was revealed (Table 3a-c), which was supported by visual comparison. The single unmatched sample, **12**, has failed to produce a visually and statistically acceptable match and is thus undated by the technique. The site master chronologies MAMBLE_A, dating from AD 1109 to AD 1204 inclusive, MAMBLE_B, dating from AD 1348 to AD 1582 inclusive, and MAMBLE_C, dating from AD 1700 to AD 1753 inclusive, are listed in Table 4a-c.

Interpretation

The original structure.

The timbers that combined to form the sequence MAMBLE_A are representative of the original construction phase of the tower. Sample **1** is the south-west main post, **3+7** is the north-west post, and **5+15** is a major passing brace. The sequences end at AD 1202, AD 1204, and AD 1200 respectively. The last ring on each of these timbers is recorded as a heartwood/sapwood boundary, implying that only the sapwood is lost. This enables a felling date range to be calculated for each of the timbers in this phase. These timbers appear to be contemporary. Combining the felling date ranges for them indicates felling of the timbers used in the original structure between AD 1214 and *c* AD 1255.

If the material is used green, which appears to be normal practice (Rackham 1990, 69), this interpretation indicates the tower was built in the first half of the thirteenth century.

The later superstructure

The timbers that combined to form the sequence MAMBLE_B are representative of the later superstructure on the tower. The three dated samples are all corner posts from the belfry. They share a number of distinctive anatomical features and it seems probable that all were originally derived from a single parent tree. Since these corner posts are quartered logs the discovery that they are all from the same tree does not require anything particularly extraordinary in terms of the usable length of the parent tree. Sample **11**, ending at AD 1582 retained 19 sapwood rings whilst the other two samples, ending at AD 1567 and AD 1565 both ended at the heartwood/sapwood transition zone. Applying the 10 - 55 sapwood range suggests the felling of this tree occurred sometime between AD 1582 and *c* AD 1618. Since the use of freshly felled timber would be expected at this period, the construction would probably have also occurred within this period.

The tower repairs

The three short sequences that combined to form the sequence MAMBLE_C are representative of a later repair phase of the original tower. All include some sapwood and sample **6** appears to be complete to the bark. This would indicate felling of this timber in late AD 1753 or early AD 1754. The other two dated timbers appear to be contemporary with this finding. The use of green timber is likely and therefore a repair phase using timbers felled in AD1753/4 appears to be indicated by this analysis.

Discussion

The provision of a series of tree-ring dates for phases of the tower provides a useful chronological framework for interpreting the various modifications to it. The original structure is clearly part of the notched lap joint tradition still visible in a number of buildings, particularly in Hereford and Worcester, and Essex, counties lacking quality building stone. This church tower appears to be one of several similar structures in the north-west corner of Hereford and Worcester, and neighbouring counties, using this early technology suite.

Pembridge is perhaps the best known but there are a number of others, including one in the neighbouring parish of Knighton-on-Teme (John Wheatley pers comm). Dendrochronology perhaps provides a suitable method for investigating the development of this apparently local tradition.

The other two dated phases should allow a more focused search to be made of the appropriate archives in order to locate associated information. The tree-ring dates as reported here nevertheless provide useful evidence for the functionality of the original structure, and the continuing need, or desire, to use and reuse it rather than replace it entirely. This is particularly noteworthy for the late sixteenth- or early seventeenth-century changes when so much additional, and high quality, timber was used in conjunction with workmanship of the highest quality. For this major modification it seems difficult to argue for resource shortages as the reason for continuing to employ a lower structure already approaching 300 years of age. The absence of any obviously reused elements in the superstructure leaves open questions about the nature of the top of the tower in its original medieval state.

Conclusion

The date of the original tower at the church of St John the Baptist, Mamble, Hereford and Worcester, is identified as between *c* AD 1214 and *c* AD1255. This is yet another example of early notched laps joints dating from the thirteenth century. A major alteration phase involving the addition of a new superstructure, including belfry and spire, is dated to between *c* AD1582 and *c* 1618. A later repair phase to the original lower tower appears to date from AD 1753/4 or shortly after.

Acknowledgements

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Figure 1

Diagram showing some of the surviving timbers in the tower (based on a figure kindly provided by John Wheatley of Wheatley Taylor Stainburn Lines)

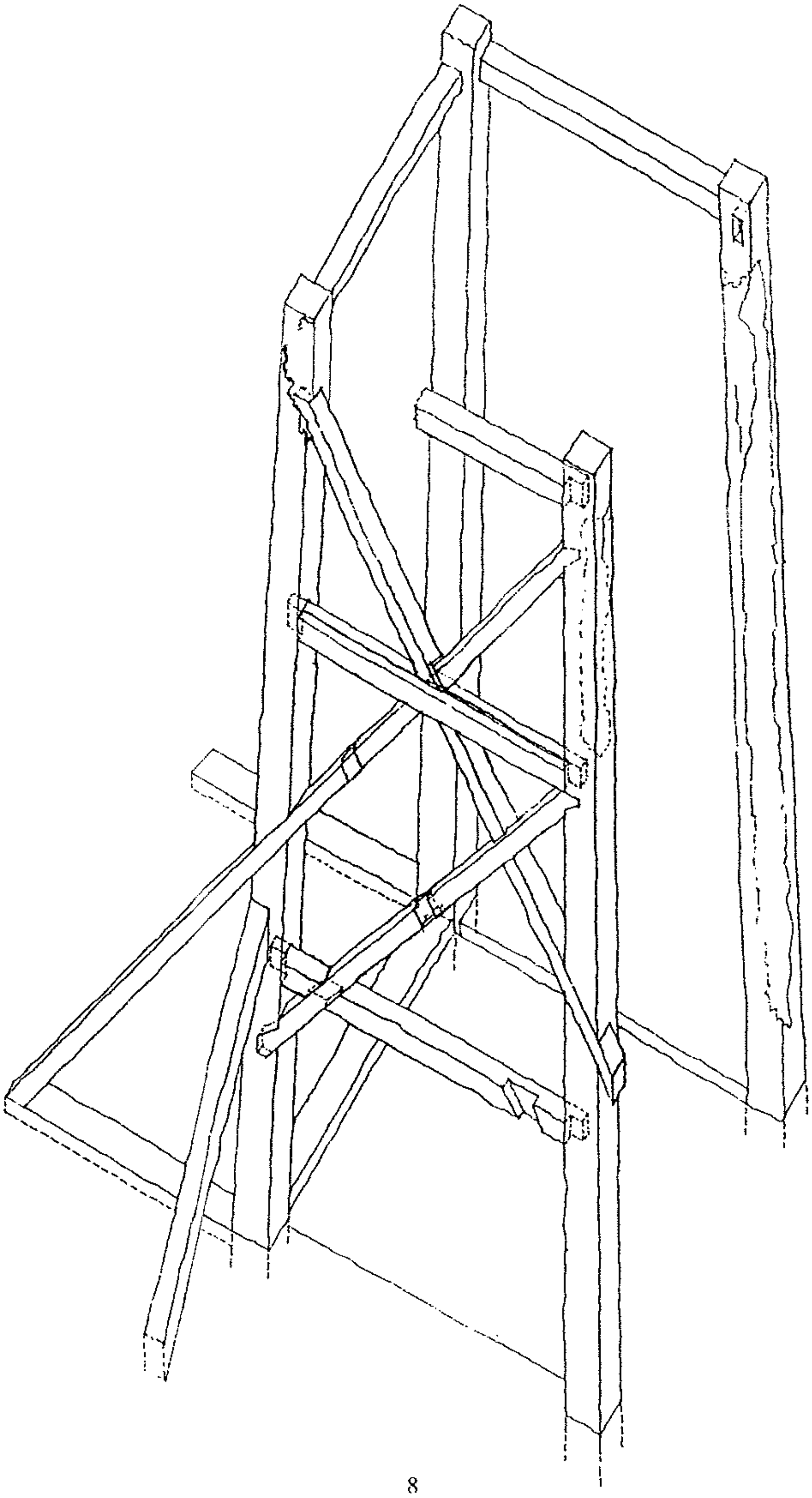

Figure 2

Bar diagram showing the relative positions of the dated sequences

White bars - heartwood rings; hatched bars - sapwood rings; HS - heartwood/sapwood boundary; ?B possible bark-edge

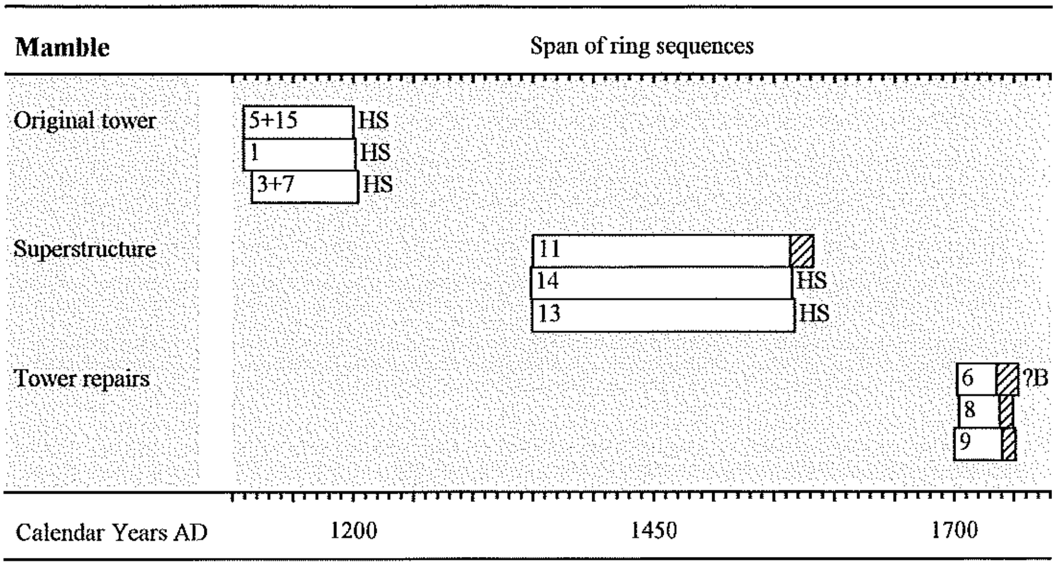

Table 1

List of samples.

Sample	Origin of core	Analysis undertaken	Wood type	Total Rings	Sap Rings	mm/year	Result	Date of sequence
1	SW post (architects #2)	Tree-ring sequence measured	Oak	94	0	1.90	Dated	AD1109 - AD1200
2	SE post (architects #1)	Species Identification only	Oak				-	-
3	NW post (architects #3)	Tree-ring sequence measured	Oak	83	0	2.80	Dated	AD1116 - AD1198
4	W brace NW post (architects #39)	Species Identification only	Oak				-	-
5	W brace SW post (architects #11)	Tree-ring sequence measured	Oak	91	0	1.42	Dated	AD1109 - AD1199
6	SE post secondary (architects #6)	Tree-ring sequence measured	Oak	52	18	3.89	Dated	AD1702 - AD1753
7	NW post (architects #3) higher up	Tree-ring sequence measured	Oak	54	0	2.76	Dated	AD1151 - AD1204
8	N X-brace (architects #66)	Tree-ring sequence measured	Oak	46	11	2.52	Dated	AD1704 - AD1749
9	S X-brace (architects #80)	Tree-ring sequence measured	Oak	52	11	3.11	Dated	AD1700 - AD1751
10	S X-brace (? architects #11)	Species Identification only	Oak				-	-
11	SE belfry corner post	Tree-ring sequence measured	Oak	233	19	1.05	Dated	AD1350 - AD1582
12	W belfry centre post	Tree-ring sequence measured	Oak	116	39	1.84	Undated	-
13	NW belfry corner post	Tree-ring sequence measured	Oak	219	0	1.52	Dated	AD1349 - AD1567
14	NE belfry corner post	Tree-ring sequence measured	Oak	218	0	1.00	Dated	AD1348 - AD1565
15	Slice (architects #11)	Tree-ring sequence measured	Oak	75	0	1.66	Dated	AD1126 - AD1200
16	Slice (from unknown)	Species Identification only	Oak				-	-

Table 2a

Correlation between the dated material from the original phase

sample	*t*-values samples *3+7*	*5+15*
1	3.5	3.5
3+7		5.2

Table 2b

Correlation between the dated material from the later superstructure phase

sample	*t*-values samples *13*	*14*
11	8.1	6.6
13		10.1

Table 2c

Correlation between the dated material from the later repair phase

sample	*t*-values samples *8*	*9*
6	3.2	3.8
8		7.4

Table 3a

Dating of the master curve, MAMBLE_A, for the original phase. *t*-values with dated reference chronologies. All the reference curves are independent.

Area	Reference chronology	*t*-values
Cheshire	36 Bridge St, Chester (Groves pers comm)	5.7
Devon	Rudge, Morchard Bishop (Groves forthcoming)	6.1
Gloucestershire	Blackfriars Priory, Gloucester (Hillam and Groves 1993)	9.1
	Tithe Barn, Siddington (Groves and Hillam 1992)	6.2
Hereford and Worcester	20 Church St, Hereford (Tyers 1996)	6.8
	Cathedral Barn, Hereford (Tyers 1996)	8.1
West Sussex	Bishops Kitchen, Chichester (Tyers and Hibberd 1993)	6.6
Ireland	Dublin 1 (Baillie 1977)	5.4

Table 3b

Dating of the master curve, MAMBLE_B, for the later superstructure phase. *t*-values with dated reference chronologies. All the reference curves are independent.

Area	Reference chronology	*t*-values
Hereford and Worcester	The Commandery, Worcester (Pilcher pers comm)	5.7
	14 Church St, Hereford (Tyers 1996)	6.0
	Farmers Club, Hereford (Tyers 1996)	9.0
	Kings Pyon Barn (Groves and Hillam 1993)	5.7
	Droitwich Upwich 3 (Groves and Hillam forthcoming)	8.1
	Manor Farm Barn, Lower Wick (Bridge 1981)	5.9
England/Wales	Welsh Border (Siebenlist-Kerner 1978)	8.7
Somerset	Lancin Farmhouse (Tyers 1994)	5.5

Table 3c

Dating of the master curve, MAMBLE_C, for the later repair phase. *t*-values with dated reference chronologies. All the reference curves are independent.

Area	Reference chronology	*t*-values
Buckinghamshire	Claydon House (Tyers 1995)	4.1
Devon	Exeter Cathedral 2 (Mills 1988)	6.1
Essex	Tilbury Fort (Groves 1993)	5.5
	Thaxted Church 3 (Tyers 1990)	4.9
Hereford and Worcester	Droitwich Upwich 4 (Groves and Hillam forthcoming)	4.5
Oxfordshire	Mill Farm Barn, Mapledurham (Haddon-Reece *et al* 1990)	7.1
England	HMS Victory (Barefoot 1975)	7.5

Table 4a

Ring-width data of the site master curve, MAMBLE_A, dated AD 1109 - AD 1204 inclusive

year	ring widths (0.01mm).										number of trees per year									
AD 1109									102	151									2	2
	101	100	90	103	98	157	163	205	137	162	2	2	2	2	2	3	3	3	3	3
	222	233	285	263	253	225	268	327	215	209	3	3	3	3	3	3	3	3	3	3
	211	196	231	247	254	237	181	223	180	232	3	3	3	3	3	3	3	3	3	3
	221	230	238	234	230	227	244	238	284	247	3	3	3	3	3	3	3	3	3	3
AD 1151	255	235	273	194	216	247	220	204	214	244	3	3	3	3	3	3	3	3	3	3
	208	209	145	182	209	174	173	198	217	180	3	3	3	3	3	3	3	3	3	3
	208	178	195	196	155	170	130	156	191	153	3	3	3	3	3	3	3	3	3	3
	181	193	193	121	213	182	216	131	202	235	3	3	3	3	3	3	3	3	3	3
	206	175	199	201	218	218	213	207	205	201	3	3	3	3	3	3	3	3	3	3
AD 1201	180	174	206	175							2	2	1	1						

Table 4b

Ring-width data of the site master curve, MAMBLE_B, dated AD 1348 - AD 1582 inclusive

year	ring widths (0.01mm).										number of trees per year									
AD 1348								194	171	178								1	2	3
AD 1351	157	138	138	115	110	90	142	152	147	94	3	3	3	3	3	3	3	3	3	3
	105	102	149	124	84	122	137	134	172	145	3	3	3	3	3	3	3	3	3	3
	172	187	144	179	168	160	146	150	203	149	3	3	3	3	3	3	3	3	3	3
	141	162	192	182	197	230	179	156	181	140	3	3	3	3	3	3	3	3	3	3
	171	123	116	86	85	123	110	114	101	91	3	3	3	3	3	3	3	3	3	3
AD 1401	128	85	88	72	52	68	62	63	73	70	3	3	3	3	3	3	3	3	3	3
	52	44	53	41	43	36	39	38	38	36	3	3	3	3	3	3	3	3	3	3
	48	39	43	46	47	39	37	39	39	36	3	3	3	3	3	3	3	3	3	3
	37	45	45	47	46	49	50	50	43	46	3	3	3	3	3	3	3	3	3	3
	40	37	33	42	41	55	46	49	52	58	3	3	3	3	3	3	3	3	3	3
AD 1451	53	50	60	58	63	70	65	62	60	84	3	3	3	3	3	3	3	3	3	3
	84	83	87	74	77	72	91	102	112	133	3	3	3	3	3	3	3	3	3	3
	141	120	155	132	223	171	154	139	172	154	3	3	3	3	3	3	3	3	3	3
	165	126	141	152	118	114	112	94	83	96	3	3	3	3	3	3	3	3	3	3
	101	100	111	110	89	118	111	95	113	126	3	3	3	3	3	3	3	3	3	3
AD 1501	114	118	109	122	140	139	137	125	148	148	3	3	3	3	3	3	3	3	3	3
	163	178	183	134	141	124	107	115	144	104	3	3	3	3	3	3	3	3	3	3
	118	135	111	105	101	130	126	131	139	153	3	3	3	3	3	3	3	3	3	3
	190	162	176	180	245	220	200	199	217	227	3	3	3	3	3	3	3	3	3	3
	241	157	174	176	152	166	134	158	182	189	3	3	3	3	3	3	3	3	3	3
AD 1551	202	172	189	164	210	210	177	153	162	169	3	3	3	3	3	3	3	3	3	3
	191	213	180	208	215	170	143	118	147	111	3	3	3	3	3	2	2	1	1	1
	131	145	118	140	124	134	99	107	98	155	1	1	1	1	1	1	1	1	1	1
	120	121									1	1								

Table 4c

Ring-width data of the site master curve, MAMBLE_C, dated AD 1700 - AD 1753 inclusive

year	ring widths (0.01mm).										number of trees per year									
AD 1700										202										1
AD 1701	255	266	355	274	250	337	332	343	450	269	1	2	2	3	3	3	3	3	3	3
	366	456	516	282	477	419	480	404	466	392	3	3	3	3	3	3	3	3	3	3
	422	387	252	475	321	417	435	444	379	317	3	3	3	3	3	3	3	3	3	3
	198	257	228	293	281	242	224	230	274	208	3	3	3	3	3	3	3	3	3	3
	159	152	199	187	210	266	257	269	281	310	3	3	3	3	3	3	3	3	3	2
AD 1751	345	503	242								2	1	1							