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Summary

The church of St Mary the Virgin in Yatton, has a south aisle ceiling consisting of moulded ribs, panelling, and carved bosses. The church is thought to be principally thirteenth century, but the aisles are thought to be fifteenth century with nineteenth-century additions. The south aisle roof is currently undergoing an English Heritage grant-aided programme of repair. This report covers the dendrochronological analysis of a series of samples taken from the moulded ribs in the ceiling, and the structure above. This analysis was undertaken to clarify the dating of the surviving timbers so as to inform repair decisions. The results indicate that the moulded ribs in the ceiling date from the first half of the fifteenth century, and that the trusses above include timbers felled c AD 1691/2. The results seem to provide convincing evidence for the extensive survival of the original fifteenth-century ceiling, and demonstrate that there has been later repairs, or modifications, to the structure

Authors' addresses :-

R Wilson
SHEFFIELD DENDROCHRONOLOGY LABORATORY
Archaeology Research School
University of Sheffield West Ct 2 Mappin St
Sheffield
S1 4DT

I Tyers
SHEFFIELD DENDROCHRONOLOGY LABORATORY
Archaeology Research School
University of Sheffield West Ct 2 Mappin St
Sheffield
S1 4DT

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Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from the roof of the south aisle of the church of St Mary the Virgin, Yatton, North Somerset (NGR ST 431654). It is beyond the scope of this report to describe the building in detail or to undertake the production of detailed drawings. As part of a multifaceted and multidisciplinary study of the building, elements of this report may be combined with detailed descriptions, drawings and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the building. The conclusions may therefore have to be modified in the light of subsequent work.

Yatton parish church lies to the south-west of the main highway through the village (Fig 1). The area is currently in the unitary authority of North Somerset, although formerly in the county of Avon. The nave of the church has a ten-bay wagon roof structure with two aisles (north and south) each of which have five bays. Prior to the tree-ring analysis it was thought that the church was originally built in the thirteenth century and remodelling of the nave, aisles, and chancel was undertaken in the fifteenth century. Later fifteenth-century remodelling was also undertaken on the south porch and chancel chapel. Both the north and south aisles were thought to have nineteenth-century ceilings with moulded ribs and decorative bosses.

English Heritage grant-aided repair work is currently focussed upon the roof of the south aisle where substantial decay of the ceiling timbers has occurred. The bays in the ceiling are defined by major north-south moulded beams. Each bay is then sub-divided by further moulded east-west and north-south beams creating a framework for panelling in a four by four grid within each bay (Fig 2). There are applied carved bosses at the junctions of the moulded beams. Above the visible ceiling framing, there is a series of roof trusses which are not aligned with the ceiling beams (Fig 3). The north aisle ceiling appears from casual inspection from the floor to be of similar construction.

The tree-ring analysis of timbers in the ceiling, including the panelling, and the roof above was commissioned by Arnold Root, from English Heritage South West regional team to test the current understanding of the chronology and structural development of the roof, which has hitherto been based on documentary and structural evidence. The brief included the identification of any original fifteenth-century roof and ceiling elements and sampling of the ceiling panels to date the supposedly nineteenth century phase.

Methodology

The general methodology and working practises used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The methodology used for this building was as follows.

A brief survey was undertaken of the moulded ceiling beams and the roof trusses, as well as the currently *ex-situ* panels for timbers with suitable ring sequences for analysis. Oak timbers with more than 50 annual rings and some survival of the original sapwood and bark-edge were sought.

The most promising timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The core holes were left open. The renovation work uses a bay numbering scheme from west to east which was adopted for the purposes of sample location on the moulded ceiling beams (Fig 2; Table 1). The labelling of the roof truss timber was more complicated since they do not align with the ceiling timbers. Each truss was numbered from the first moulded rib in the west side of each bay. Samples were sanded with decreasing grades of sand paper until the surface was highly polished and the ring sequences were revealed.

Samples were measured to an accuracy of 0.01 mm using a micro-computer based travelling stage (Tyers 1997a). Cross-correlation algorithms (Baillie and Pilcher 1973) were employed to search for positions where the ring-sequences were highly correlated. Each series was then plotted onto semi-log graph paper and the positions identified from cross-correlation analysis were visually verified. Where satisfactory statistical and visual matches were observed between samples, new mean sequences were constructed from the synchronised sequences. The *t*-values quoted in this report 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.

By cross-correlation analysis and visual matching of individual series and synchronised means, a site (or phase) master curve is developed by averaging the synchronised series together. These, and any remaining unmatched ring-sequences were tested against a range of reference chronologies using the same matching criteria (ie 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-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. Interpretation of these dates and their relevance to the dating of potential construction phases 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 which are missing. This *tpq* may be many decades prior to the real felling date. For master series which have been developed from samples that may have the heartwood/sapwood boundary or even some sapwood rings, a felling date can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates used throughout this report are a minimum of 10 and maximum of 46 rings, where these figures indicate the 95% confidence limits of the range (Tyers 1998). These figures are applicable to oaks from England and Wales. In an optimal situation, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring in those timbers. It must be noted that the dates derived using these techniques do not necessarily indicate the date of the structure from which they are derived. The presence of re-used timbers or unidentified repairs to structures can lead to incorrect interpretations. Thus it is necessary to incorporate other specialist evidence before the dendrochronological dates given here can be reliably interpreted as the date of construction of a structure.

A further important element of the tree-ring analysis of buildings and archaeological assemblages is the identification of 'same tree' groups within the sampled material. Inspection of timbers, both in buildings and archaeological sites, often suggests that the patterns of knots or branching in timbers are so similar that they appear to be derived from a single tree. Tree-ring analysis is often used to support these suggestions. The identification of 'same tree' groups is based on a combination of high levels of matching between samples, extremely similar longer term growth trends, and individual anatomical anomalies within the timbers. It must be stressed however, that high *t*-values do not by themselves necessarily indicate that two series have come from the same tree. Conversely, low *t*-values do not necessarily exclude the possibility. It is the balance of a range of information that provides the evidence.

<u>Results</u>

As there was potential for two phases of construction, the dendrochronological sampling program attempted to obtain cores from as broad a range of timbers as possible within the terms of the request. This included sampling of both the moulded ceiling beams and the roof trusses. The panels and the moulded ceiling bosses were identified on site as softwoods. They were rejected for sampling for two reasons: neither element type could be sampled without unacceptable visual damage and presently softwoods used in England cannot be routinely dated by dendrochronological techniques.

Access to the ceiling timbers was relatively easy due to the scaffolding for the renovation work. The moulded ceiling beams were accessible from the upper surface of the scaffolding with a step ladder. To minimise impact upon the mouldings we were discriminating about which timbers to sample and the selected timbers were sampled from above. Access to the roof timbers was more difficult because the ceiling beams were in the way of optimal access, in addition the roof had already been re-leaded and coring of these timbers had to avoid puncturing this. In spite of these difficulties it was possible to collect more material from this part of the structure due to reduced concern about the visual impact of the sampling.

The moulded beams appeared to be principally composed of quarters and halves of large oaks. Sampling locations were not always optimal due to the areas of repair and our attempts to avoid damaging the structure. No bark edges and little evidence for the heartwood/sapwood boundary were found across the entire ceiling structure, this is not unexpected for highly moulded and decorated beams. In contrast the roof timbers were derived from smaller quartered trees, and some timbers had a distinct bark edge. Seventeen samples were taken from throughout the roof and ceiling and their locations are shown in Figure 2. Twelve samples were taken from the roof timbers, many of these clearly contained more than the minimum necessary numbers of rings and included visible heartwood/sapwood boundaries or bark edge. Many of the ceiling beams, on the other hand, did not have enough rings to warrant sampling. However, four suitable timbers were located from the moulded ceiling and these were sampled. The repair of the aisle roof has involved the removal of sections of timbers throughout the structure. The removed sections that were still present in the church were examined for suitability and a single loose piece of wood that may have been part of the roof was also sampled by removal of a cross-section. The samples were numbered **1-17** (Table 1; Fig 2).

Of the 17 samples obtained from the building, two were rejected for laboratory analysis. Sample **6** was too badly fragmented for reliable measurement. Sample **10** was a relatively short sample with a intensely suppressed period in the middle where the individual rings could not be distinguished.

The sequences from the remaining 15 samples were measured and then compared with each other. Two internally consistent groups were identified. The first of these consisted of three sequences from the moulded ceiling (samples **13**, **15**, and **16**) which were found to correlate to form a consistent group (Table 2). The second group consisted of eight correlated samples from the roof (samples **2-5**, **7**, **9**, **11**, and **14**) which were found to correlate to form a separate consistent group (Table 3). From this group samples **4** and **9** correlated highly with each other (*t*-value of 13.08, Table 3) and were probably from the same tree. The sequences for each of the two groups were averaged together to form site master sequences. The first 30 years of the second group came only from one sample (**11**) which exhibited particularly narrow rings for this period, this data was truncated prior to the construction of the site master. The first group formed a sequence 80 years in length (named YATTON1; Table 4), and the second group formed a sequence 128 years in length (named YATTON2; Table 5). These sequences were then compared with dated reference chronologies from throughout the British Isles. YATTON1 was dated to AD 1321-1400 inclusive (Table 6), whilst YATTON2 was dated to AD 1564-1691 inclusive (Table 7).

No matches could be identified for the samples **1**, **8**, **12**, and **17**. It is likely that the reason for samples **1**, **8**, and **12** not dating is due to the presence of a suppressed period of ring-growth in the sequences obtained. Sample **17** was the loose timber and its failure to correlate with the others may indicate it was not associated with the other roof timbers.

Interpretation

Two sequences were developed from 10 of the original 17 samples taken from the south aisle of Yatton church. The earlier chronology (YATTON1) is dated AD 1321 to 1400 inclusive. Two of these samples retain the heartwood/sapwood boundary or the probable heartwood/sapwood boundary (Table 1; Fig 4). Assuming both of these identifications is correct a common felling period for these trees can be calculated by adding the minimum and maximum likely number of sapwood rings missing to the last ring date of each of these timbers. This gives an likely felling date range for these ceiling beams of between AD 1410 and AD1432.

The later chronology (YATTON2) is dated AD 1564 to 1691 inclusive. It was created from 8 samples (Fig 4). This group comprises samples from the roof. Four of these (samples **2-4**, and **7**) have bark edge and for all of these the last complete ring dates to AD 1691. Sample **3** shows evidence of the spring vessels of the following growing season. This may indicate that the trees were all felled sometime early in the spring of AD 1692, or that two groups of material are present felled in late AD 1691 and early AD 1692. The estimated felling dates of the other timbers that do not have bark edge could be contemporaneous with this date.

Conclusion

The felling dates in the first half of the fifteenth century obtained from three of the four sampled ceiling timbers suggest that there is significant survival of original fifteenth-century elements in the ceiling. Until the current phase of refurbishment fifteenth-century timbers probably made up the majority of the structure of the aisle ceiling. The felling dates obtained from the roof timbers above the ceiling suggests that a new roof was installed in AD 1692 which has not been previously identified. This work probably involved taking down the fifteenth century ceiling. It seems likely that the failure of the original roof in the seventeenth century, resulting in rain-water leakage on to the ceiling, has led to the present poor state of the ceiling timbers. A search of the building accounts for the church may reveal discussion of the problem and identify the extent of the contemporary works. There is no information derived from this analysis that relates to the date of the softwood panels and the applied softwood mouldings since these were not considered suitable for sampling, these may represent the documented nineteenth-century work. The unexpected construction of a replicated seventeenth century chronology from the church is a useful addition to regional data sets.

Acknowledgements

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Figure 1: Location of the church of St Mary the Virgin, Yatton

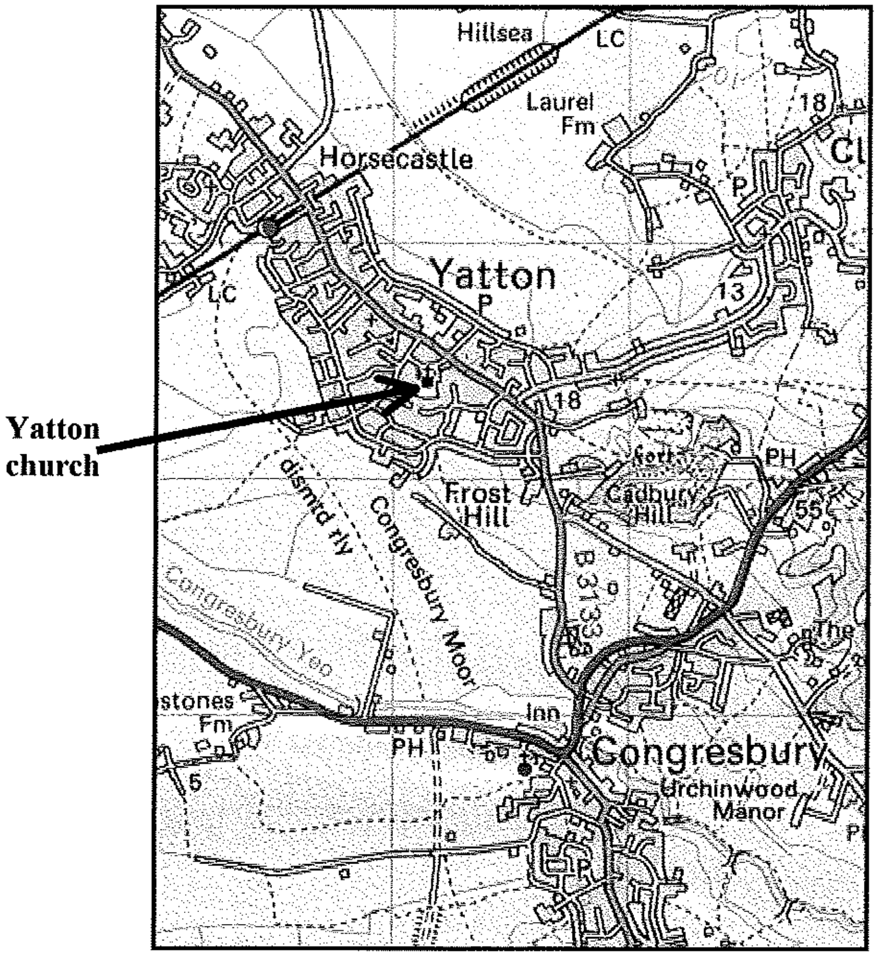

Figure 2 Sketch plan of ceiling timbers. Samples taken from the decorated ceiling beams are marked with numbers and arrows. The approximate locations of the sampled rafters and purlins from the roof above are marked by boxed numbers around the figure. After a diagram supplied by English Heritage, original from The Demaus Partnership.

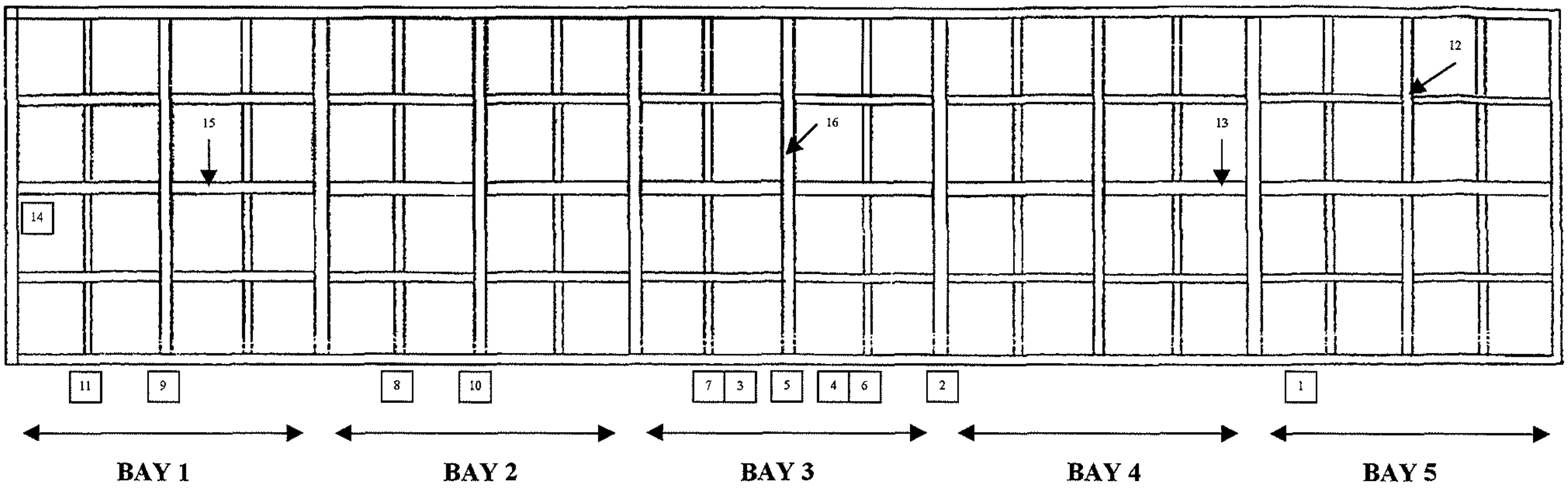

Figure 3 Sections of the south aisle, showing the decorated ceiling ribs and the roof trusses above. After a diagram supplied by English Heritage, original from The Demaus Partnership.

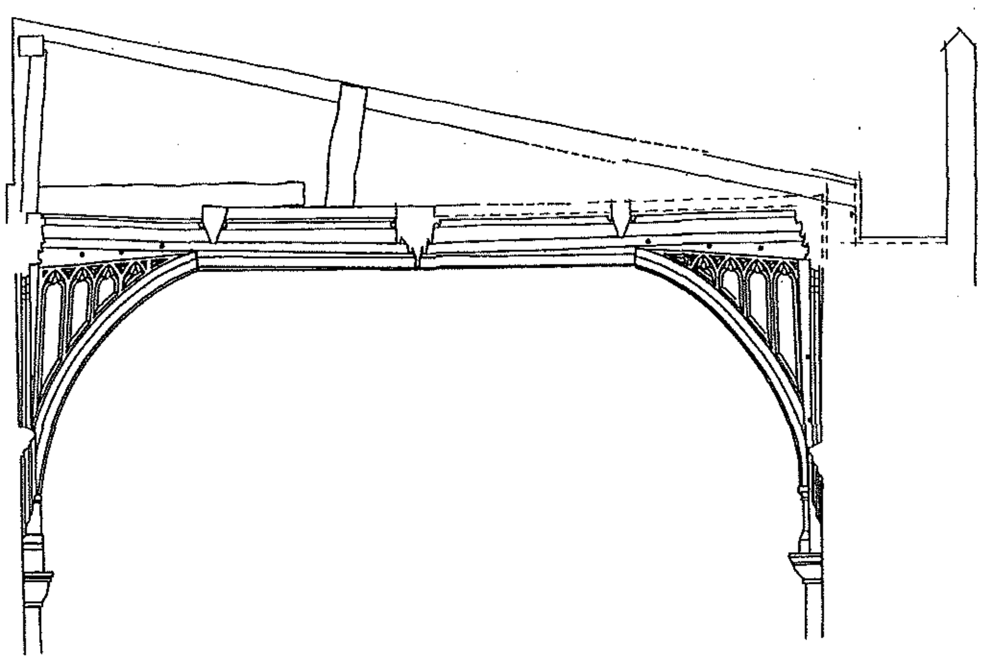

Figure 4 Bar diagram showing the absolute and relative positions of the dated tree-ring sequences from Yatton church. The two groups are clearly distinct. The interpreted felling period for each sequence is also shown.

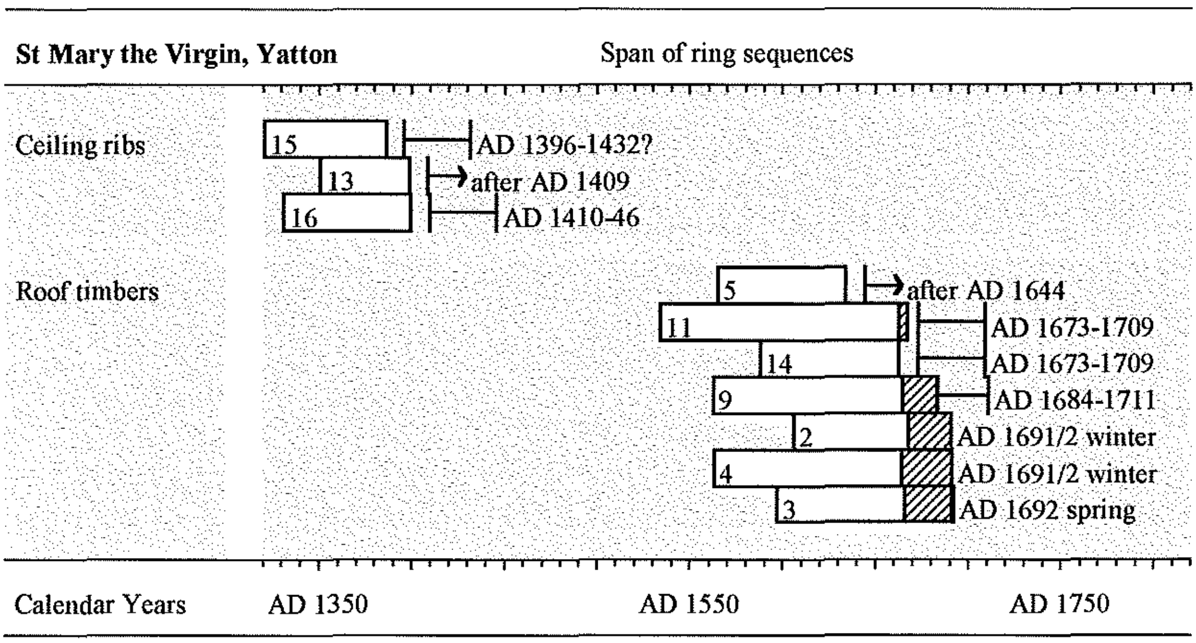

Table 1 List of samples

Sample No.	Origin of core	Cross-section (mm)	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
	Aisle Roof						
1	Bay 5, rafter 2	165 x 110	84	h/s	1.00	undated	-
2	Bay 4, rafter 1	150 x 105	86	23 + bw	1.04	AD1606-1691	AD 1691 winter
3	Bay 3, rafter 4	150 x 110	95	25 +½bs	1.12	AD1597-1691	AD 1692 spring/summer
4	Bay 3, rafter 6	140 x 110	129	27	1.03	AD1563-1691	AD 1691 winter
5	Bay 3, rafter 5	160 x 90	70	-	1.89	AD1565-1634	after AD 1644
6	Bay 3, rafter 7	140 x 120	Not measured	-	-	-	-
7	Bay 3, rafter 3	140 x 110	*25* + 94	31 + bw	0.73	AD1598-1691	AD 1691 winter
8	Bay 2, rafter 3	130 x 110	82	h/s	0.78	undated	-
9	Bay 1, rafter 5	150 x 120	122	19	1.15	AD1563-1684	AD 1684-1711
10	Bay 2, rafter 5	140 x 120	Not measured	-	-	-	-
11	Bay 1, rafter 3	150 x 130	134	4	0.77	AD1534-1667	AD 1673-1709
14	Bay 1, purlin	260 x 130	76	h/s	0.98	AD1588-1663	AD 1673-1709
17	Slice from loose timber ?rafter	?	68	h/s	0.88	undated	-
	Aisle ceiling						
12	Bay 5, north-south rib	250 x 200	69	h/s	1.39	undated	-
13	Bay 4, east-west rib	300 x 230	49	-	2.18	AD1351-1399	after AD 1409
15	Bay 1, east-west rib	250 x 250	66	?h/s	1.84	AD1321-1386	AD 1396-1432
16	Bay 3, north-south rib	230 x 170	70	h/s	1.77	AD1331-1400	AD 1410-1446

Total rings = all measured rings, *25+* = indicates additional rings which were only counted.
Sapwood rings: h/s = heartwood/sapwood boundary, ?h/s = possible heartwood/sapwood boundary, bw = winter bark edge, +½bs = spring bark edge.
ARW = average ring-width of the measured rings.

Table 2 *t*-value matrix for the timbers forming the chronology YATTON1.

	15	**16**
13	4.08	4.02
15		5.21

Table 3 *t*-value matrix for the timbers forming the chronology YATTON2. KEY : - = *t*-values under 3.0.

	03	**04**	**05**	**07**	**09**	**11**	**14**
02	6.81	-	3.69	-	-	3.25	4.43
03		3.89	4.86	-	-	-	4.41
04			5.81	5.58	13.08	3.32	3.37
05				-	3.98	4.59	6.72
07					5.67	-	-
09						3.27	-
11							5.60

Table 4 Ring-width data for chronology YATTON1, dated AD 1321-1400 inclusive.

Date	Ring widths (0.01mm)									No of samples									
AD 1321	356	448	319	263	140	118	174	131	205	272	1	1	1	1	1	1	1	1	1	1
	170	261	196	178	268	215	184	227	256	238	2	2	2	2	2	2	2	2	2	2
	208	205	184	164	174	219	179	270	191	149	2	2	2	2	2	2	2	2	2	2
AD 1351	344	185	285	266	168	208	261	230	208	167	3	3	3	3	3	3	3	3	3	3
	224	237	273	298	191	163	175	162	182	195	3	3	3	3	3	3	3	3	3	3
	153	161	177	188	158	174	147	177	176	144	3	3	3	3	3	3	3	3	3	3
	166	156	156	132	139	148	110	129	117	98	3	3	3	3	3	3	2	2	2	2
	125	124	141	98	116	186	116	136	163	235	2	2	2	2	2	2	2	2	2	1

Table 5 Ring-width data for chronology YATTON2, dated AD 1564-1691 inclusive.

Date	Ring widths (0.01mm)									No of samples									
AD 1564				339	205	153	153	175	303	260				1	1	1	1	1	1	1
	291	209	154	155	196	171	179	145	118	168	1	1	1	1	1	1	1	1	1	1
	147	104	93	135	137	126	120	133	194	122	1	1	1	1	1	1	1	1	1	1
	126	147	157	146	156	136	171	159	112	133	1	1	2	2	3	3	3	3	3	3
AD 1601	137	152	141	153	110	202	156	149	121	151	3	3	3	3	3	3	3	3	3	3
	120	111	150	126	130	151	110	110	78	83	3	3	3	3	3	3	3	4	4	4
	107	103	100	94	87	96	99	101	123	102	4	4	4	4	4	4	5	6	6	6
	84	105	110	89	81	64	62	64	51	56	6	6	6	6	6	7	7	7	7	7
	45	46	54	55	56	70	60	70	60	67	7	7	7	7	7	7	7	7	7	7
AD 1651	56	60	84	78	90	80	77	93	61	75	7	7	7	7	7	7	7	7	7	7
	81	72	91	75	81	74	86	80	90	96	7	7	7	7	6	6	6	6	6	6
	85	83	88	74	86	59	56	44	47	51	6	6	6	6	6	6	6	6	6	6
	58	63	53	72	66	57	52	58	69	74	6	6	6	6	6	6	6	6	6	6
	72										6									

Table 6 Dating the chronology YATTON1, AD 1321-1400 inclusive. *t*-values with independent reference chronologies.

Area	Reference chronology	*t*-value
East Midlands	East Midlands master (Laxton and Litton 1988)	4.59
Gloucestershire	Gloucester Mercer's Hall (Howard *et al* 1996)	5.58
Herefordshire	Hereford Widemarsh St 'Farmers Club' (Tyers 1996)	4.95
Herefordshire	Hereford High Town/Booth Hall (Boswijk and Tyers 1997)	7.04
West Midlands	Coventry St Marys Guildhall (Tyers 1995)	5.59
Wiltshire	The Old Mansion Clarendon (Tyers 1999b)	5.35
Worcestershire	Droitwich Upwich (Groves and Hillam 1997)	5.07
Worcestershire	Colwall near Great Malvern (Hillam 1991)	5.28
Worcestershire	Worcester Commandery (Pilcher pers comm)	6.08

Table 7 Dating the chronology YATTON2, AD 1564-1691 inclusive. *t*-values with independent reference chronologies.

Area	Reference chronology	*t*-value
Berkshire	Windsor Castle St George's (Hillam forthcoming)	4.32
Essex	Cressing Temple Granary (Andrews *et al* 1994)	5.48
Essex	Cressing Temple New House (Tyers 1997b)	4.40
Gloucestershire	Gloucester 26 Westgate Street (Howard *et al* 1998)	6.19
Ireland	Belfast (Baillie 1977)	4.83
Oxfordshire	Newington House (Haddon-Reece *et al* 1987)	5.26
Staffordshire	Black Ladies near Brewood (Tyers 1999a)	4.53
Wales	Welsh Border (Siebenlist-Kerner 1978)	4.64
Yorkshire	Featherstone Church bell frame (Hillam 1978)	4.33