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Tree-Ring Analysis of Timbers from Ringing-Chamber Floor to the Tower, Church of St Mary the Virgin, Axminster, Devon

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Summary

Four timbers from the main structure of the ringing-chamber floor were dated. All retained the heartwood-sapwood boundary, and the interpreted likely felling date range for the four timbers is AD 1425-57. A fifth timber, supporting the floor on the western side, had been identified as a later insertion. The series from this timber was dated to the period AD 1393-1520, with the most likely date range for its felling being AD 1529-61.

Keywords

Dendrochronology
Standing Building

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Introduction

The Church of St Mary the Virgin, Axminster (NGR SY 2964 9849; Fig 1) is a grade II* listed building. It has Norman origins, though the earliest extant elements are thought to date to around the early thirteenth century. The floor to the ringing-chamber, located in the fifteenth century crossing tower, incorporates heavily moulded beams with decorative bosses. A large beam has been added below the western side of the floor for additional support. Dendrochronological dating was requested to date the construction and subsequent modifications and hence inform repairs being grant-aided by English Heritage, who commissioned this study.

Methodology

The site was visited in June 2005. In the initial assessment, accessible oak timbers with more than 50 rings and traces of sapwood were sought. Those building timbers judged to be potentially useful were cored using a 15mm auger attached to an electric drill. The cores were glued to wooden laths, labelled, and stored for subsequent analysis.

The cores were prepared for measuring by sanding, using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Suitable samples had their tree-ring sequences measured to an accuracy of 0.01 mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (1999). Cross-matching and dating was accomplished by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared on an IBM-compatible computer for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted to allow visual comparisons to be made between sequences on a light table. This method provides a measure of quality control in identifying any errors in the measurements when the samples cross-match.

In comparing one sequence or site sequence against another, *t*-values over 3.5 are considered significant, although in reality it is common to find *t*-values of 4 and 5 which are demonstrably spurious because more than one matching position is indicated. For this reason, it is necessary to obtain some *t*-values of 5, 6, and higher, and for these to be well replicated from different, independent chronologies and with local and regional chronologies well represented, unless the timber is imported. Where two individual sequences match with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they most likely came from the same parent tree.

When cross-matching between samples is found, their ring-width sequences are averaged to form an internal 'working' site mean sequence. Other samples may then be incorporated after comparison with this 'working' master until a final site sequence is established. This is then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to

date it. Individual long series which are not included in the site mean(s) are also compared with the database to see if they can be dated.

The dates thus obtained represent the time of formation of the measured rings in each sample. These dates require interpretation for the construction date of the phase under investigation to be determined. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. The sapwood estimates used here are based on those proposed for this area by Miles (1997), in which 95% of oaks contain 9–41 rings. Where complete sapwood or bark is present, the exact date of tree felling may be determined.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the building. However, evidence suggests that, except in the re-use of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

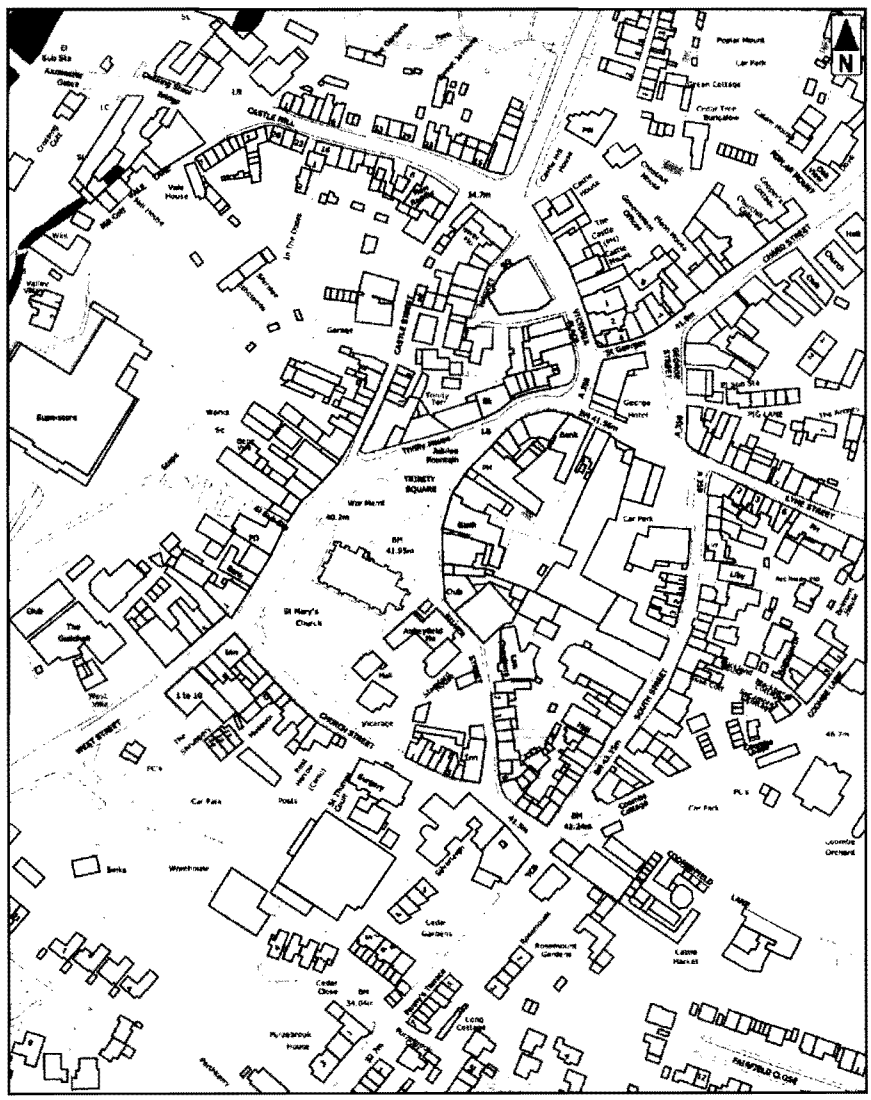

Figure 1: Map showing the location of the Church of St Mary the Virgin, Axminster.

Results

Many of the timbers were quite degraded, and not all of them had any indication of sapwood or the existence of the heartwood-sapwood boundary. For this reason, a relatively small number of samples was taken. All of the samples taken were of oak (*Quercus* spp.). Details of the samples are given in Table 1.

Two samples were taken from beam A2 as the outer rings broke off the first core. Two samples were also attempted in Beam 1 (Fig 2), but both cores fractured badly and contained few rings.

The first step was to try and combine the two series from the same timber (SAX06a and b). The two did not match well statistically (t = 3.4, 62 years overlap) although clear visual similarities could be seen in the plots of series. However, individually the two series matched other timbers reasonably well at corresponding positions:

SAX01	*v*	SAX06a, t = 4.7 with 62 years overlap
		SAX06b, t = 5.9 with 68 years overlap
SAX02	*v*	SAX06a, t = 5.1 with 62 years overlap
		SAX06b, t = 4.0 with 66 years overlap

Series SAX06 a and b were therefore combined to form a single series, SAX06m. Cross-matching was then found between four of the series, SAX 01, 02, 06m, and 07 (Table 2) and these were combined into a single site master series, **AXMNSTER**. This 99-year sequence was then dated, by comparison with the dated reference material, to the period AD 1324–1422, the best results being shown in Table 3. The relative positions of overlap of these dated series are shown, along with their interpreted likely felling date ranges, in Figure 3.

Other non-dated series were then compared individually with the dated reference material. Sample SAX03, from a beam below the level of the main floor in a supporting position (Fig 4), which had been indicated as a likely later insertion, was found to match at a position dating the series to the period AD 1393–1520 (Table 4).

The data for the site master, **AXMNSTER**, and sample SAX03 are given in Tables 5 and 6.

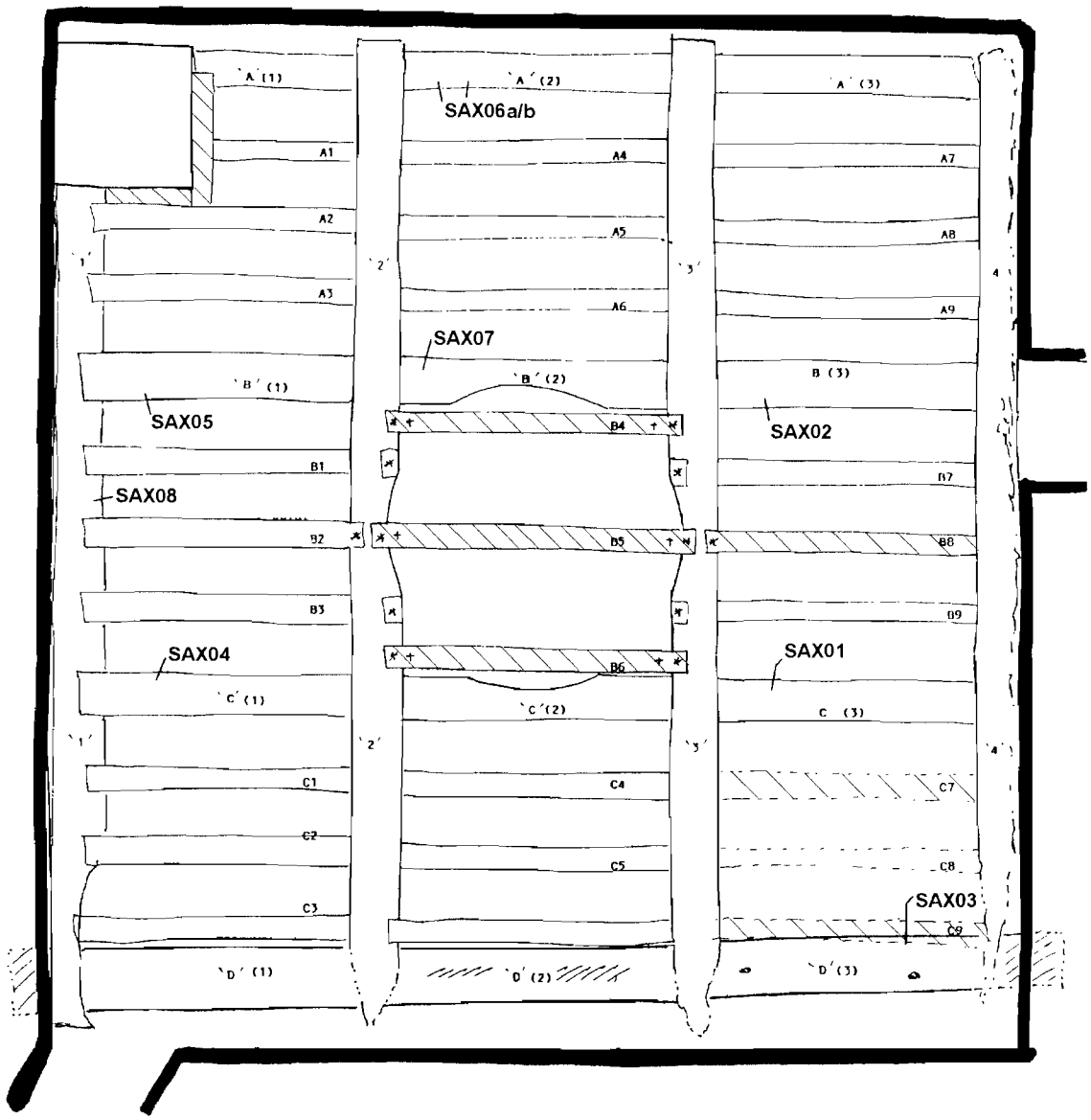

Figure 2: Plan of the floor with the positions of the samples taken for dendrochronology marked. Hatched timbers are not original to the structure. Adapted from a drawing by P J Stow and Associates, Axminster

Table 1: Details of oak (*Quercus* spp.) timbers sampled from the tower floor at the Church of St Mary the Virgin, Axminster

Sample Number	Timber and position	No of rings	Mean width (mm)	Mean sens (mm)	Dates AD Spanning	H/S bdry AD	Sapwood complement	Felling seasons and dates/date ranges (AD)
SAX01	Beam C3	99	1.85	0.18	1324–1422	1422	h/s	1431–63
SAX02	Beam B3	92	1.33	0.15	1325–1416	1416	h/s	1425–57
SAX03	Beam D3	128	1.00	0.25	1393–1520	1520	h/s	1529–61
SAX04	Beam C1	51	2.46	0.13	undated	-	h/s	unknown
SAX05	Beam B1	<50	NM	-	undated	-	h/s	unknown
SAX06a	*Beam A2*	*62*	*2.26*	*0.14*				
SAX06b	*Beam A2*	*68*	*1.45*	*0.16*				
SAX06m	SAX06a + SAX06b	68	1.80	0.14	1351–1418	1418	h/s	1427–59
SAX07	Beam B2	67	2.14	0.17	1340–1406	1406	h/s	1415–47
SAX08a	Beam 1	<50	NM	-	undated	-	h/s	unknown
SAX08b	Beam 1	<50	NM	-	undated	-	h/s	unknown

Key: h/s bdry = heartwood/sapwood boundary - last heartwood ring date; NM = not measured; mean sens = mean sensitivity;
Sapwood estimate of 9–41 used (Miles 1997)

Table 2: Cross-matching between sample series from the ringing-chamber floor, Church of St Mary the Virgin, Axminster

	t - value		
Sample number	**SAX02**	**SAX06m**	**SAX07**
SAX01	5.3	7.5	4.4
SAX02		6.3	5.1
SAX06m			3.3

Table 3: Dating evidence for the site chronology **AXMNSTER,** AD 1324–1422
(regional multi-site chronologies have the file name in **bold**)

County or region	*Chronology name*	*Short publication reference*	*File name*	*Spanning (yrs AD)*	*Overlap (yrs)*	*t-value*
Devon	Bowhill, Exeter	(Groves 2002)	BOWHILL	1292–1468	99	6.1
Yorkshire	Yorkshire Buildings Chronology	(Hillam pers comm)	**YORKS1**	1192–1648	99	5.8
Gloucestershire	Mercer's Hall, Gloucester	(Howard *et al* 1996)	GLOUCMH	1289–1541	99	5.5
Somerset	Church of St Mary the Virgin	(Tyers and Wilson 1999)	YATTON 1	1321–1400	77	5.3
Somerset	Shapwick House	(Miles and Haddon-Reece 1996)	SHAPWCK1	1268–1488	99	5.1
Somerset	Muchelney Abbey	(Bridge 2002)	MUCHNEY	1148–1498	99	5.0
Great Britain	British Isles Master Chronology	(Haddon-Reece and Miles 1993)	**MASTERAL**	404–1987	99	5.0
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882–1981	99	4.9
Somerset	Tickenham Court	(Miles and Haddon-Reece 1994)	TICKNHM1	1372–1476	51	4.9

Table 4: Dating evidence for the sample SAX03, AD 1393–1520 (regional multi-site chronologies have the file name in **bold**)

County or region	*Chronology name*	*Short publication reference*	*File name*	*Spanning (yrs AD)*	*Overlap (yrs)*	*t-value*
Somerset	George Inn, Norton St Philip	(Miles and Worthington 1998)	GEORGIN2	1290–1509	117	7.1
Avon	Acton Court	(Haddon-Reece and Miles 1994)	ACTON	1328–1575	128	7.0
Yorkshire	Nostell Priory	(Tyers 1998)	NOSTELL1	1263–1536	128	6.8
Hampshire ‡	King's Somborne Manor	(Miles and Worthington 1999)	KNGSMBRN	1273–1503	111	6.8
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	128	6.4
Devon	Exeter Master Chronology	(Mills 1988)	EXMED	1367–1616	128	6.3
Hampshire ‡	Mottisfont Abbey	(Miles 1996)	MOTISFNT	1388–1538	128	6.3
Oxfordshire	Christ Church Cathedral	(Fletcher pers comm)	KITCHEN	1389–1484	92	6.0
Hampshire ‡	Chawton House	(Miles and Worthington 1998)	CHAWTON3	1446–1582	115	5.8

‡ Component of HANTS

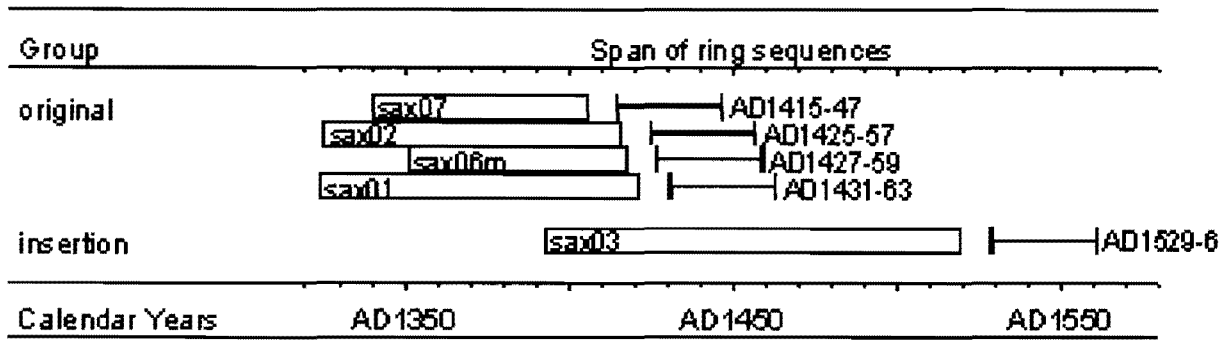

Figure 3: Bar diagram showing the relative positions of overlap of the dated timbers in chronology **AXMNSTER**, along with their interpreted felling dates

Figure 4: Photograph of the south west corner of the ringing chamber floor showing the approximate positions of coring on three of the timbers in this study

Interpretation and Discussion

The poor matching between two samples from the same timber is of interest, although it was noted that these series had very low mean sensitivity (Table 1), ie there was little year-to-year variation in the ring widths of these series compared to most oaks found in Britain. Most British oak series typically have sensitivity values in the region 0.18 – 0.23 (Bridge 1983) and this low value implies that few external factors are consistently limiting the growth of this tree.

Four dated timbers from the main structure of the ringing-chamber floor retained the heartwood-sapwood boundary. The mean date for this boundary was AD 1416, so assuming that they represent a single group of timbers felled at the same time, the interpreted likely felling date for these timbers is AD 1425–57. Although one of the

strongest matches for the site chronology formed from these four timbers was against a chronology of Yorkshire buildings (this is a very well replicated multi-site chronology that matches very widely), the other strong matches were from sites of a south-western origin, and it seems likely that the timber used was of relatively local origin. This date is in agreement with the known building of the tower, and the stylistic features of the structure.

The large beam against the west wall of the tower, inserted at some stage to support the floor structure, also retained the heartwood-sapwood boundary, and its likely felling date range was found to be AD 1529–61. This later series had much higher mean sensitivity (Table 1), and it dated readily against the reference material, giving higher *t*-values, despite the series representing only a single tree. It matched well against sites from further east, particularly in Hampshire, although this may represent the availability of data for this period, rather than the geographical origin of the sample.

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Table 5: Ring width data for the site chronology **AXMNSTER**, AD 1324–1422

Ring widths (0.01mm)										no of trees									
382	293	245	320	261	251	232	151	153	119	1	2	2	2	2	2	2	2	2	2
134	160	157	129	137	110	120	146	163	167	2	2	2	2	2	2	3	3	3	3
187	194	147	132	155	164	130	145	165	200	3	3	3	3	3	3	3	4	4	4
183	140	159	201	233	198	177	205	166	190	4	4	4	4	4	4	4	4	4	4
205	176	178	229	248	261	223	183	151	151	4	4	4	4	4	4	4	4	4	4
173	159	148	172	180	186	145	153	160	135	4	4	4	4	4	4	4	4	4	4
158	142	202	163	181	184	162	187	170	171	4	4	4	4	4	4	4	4	4	4
149	186	206	147	183	213	201	226	146	179	4	4	4	4	4	4	4	4	4	4
159	189	202	149	155	145	136	132	160	135	4	4	4	3	3	3	3	3	3	3
139	163	133	165	148	144	163	125	112		3	3	3	2	2	1	1	1	1	

Table 6: Ring width data for the sample SAX03, AD 1393–1520

Ring widths (0.01mm)									
50	53	68	131	93	61	47	77	104	109
137	111	109	161	142	100	130	205	147	186
198	241	280	98	69	167	138	183	140	114
253	208	116	95	87	151	119	93	116	120
110	106	165	149	234	176	128	133	152	133
87	83	90	108	90	72	64	66	97	86
59	86	82	93	63	74	63	86	65	63
89	55	69	73	59	44	37	52	49	32
49	51	83	51	39	32	41	67	102	72
55	69	107	87	91	83	55	69	64	68
75	90	79	188	153	105	89	89	101	93
89	128	83	94	68	92	74	96	95	107
80	71	75	47	66	75	120	76		