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Summary

The analysis of 22 tree-ring samples from the bell chamber and bell frame are described. All the dated timbers appear to be contemporary and produce an estimated felling date range of AD1512-1538. No date was obtained for the sample taken from the early inner octagon.

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Timber recording by the Test Valley Archaeological Trust in the bell tower of Romsey Abbey, prior to restoration of the bell frame, provided an opportunity for tree-ring sampling. The roof timbers in the bell chamber were sampled during June 1993, whilst the posts and braces, and the bell frame itself, were sampled in July 1993. The samples were analysed during September 1993.

Methods

A brief examination of the accessible timbers was made to locate those most suitable for dating purposes. These are timbers with sapwood and/or the longest measurable ring patterns. A note was also made of the orientation of the growth rings, whether the rings were wide or narrow, and the location of the timber in the parent trunk. Cores were taken with a 15mm diameter corer attached to an electric drill. The sampled timbers were labelled with dymo tape so that the dendrochronological samples numbers could be incorporated into the timber recording.

In the laboratory, the cores were first polished using a sander with paper of medium grit and then finished by hand with fine silicon carbide paper. Any core with less than about 50 rings was rejected at this stage since their ring pattern is unlikely to be unique (Hillam *et al* 1987). The ring widths were measured to an accuracy of 0.01mm on a travelling stage, which is connected to an Atari microcomputer. This 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. The longest ring sequence was selected, and each of the remaining graphs slid past this on a light box until the position of best fit was found. The process was repeated using the next longest sequence and so on until all the samples had been crossmatched. The Atari was used to provide a measure of the correlation between the matching sequences. The crossmatching routines are based on the Belfast CROS program (Baillie & Pilcher 1973; Munro 1984), and all the *t* values quoted in this report are identical to those

produced by the first CROS program (Baillie & 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. Potential tree-ring dates are then checked by examining the quality of the visual match between the graphs. Unmatched sequences are also tested against the reference chronologies.

If a sample has bark or bark edge, the date of the last measured ring is the date in which the tree was felled. 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.

Once a date range or *terminus post quem* has been obtained for the felling of a timber, factors such as transport, seasoning, stockpiling and re-use, have also to be taken into account. Thus whilst the tree-ring dates for the rings of the timbers are precise and independent, the interpretation of those dates with respect to the construction of a building will be affected by other evidence.

Results

An initial examination of the timbers showed that they were boxed hearts and that very little sapwood remained (Fig 1). The curved heartwood-sapwood transition was visible on many timbers but

whether the sapwood was removed during construction or more recently could not be determined.

A total of 22 samples were taken from 21 timbers (Table 1). Of these, 17 proved suitable for dating purposes. They were measured, and the data analysed, in three groups. The samples from the roof of the bell chamber, taken during the first sampling trip, were examined first, then those from the bell frame, and finally those from the posts and braces of the bell chamber.

All the measured ring sequences from the bell chamber crossmatched (Table 2). The five sequences from the bell chamber roof produced a master of 97 years, RA_ROOF5, and the three measured sequences from a post and two braces gave a 124-year master sequence, RA_RING3.

Of the seven measured sequences from the bell frame, five cross-matched to give a 113-year master, RA_BELL5. The sequences from the two jowl posts and the joist from the inner octagon did not match. The two jowl post sequences were almost identical (t=13.0) and were probably taken from the same tree. A tentative match was found with some of the other Romsey sequences which suggested that the jowl posts are contemporary with the other dated timbers, but this cannot be confirmed at present by dendrochronology. The sequence from the early octagon showed no similarity to any of the other sequences. It may be possible to date this sample some time in the future, particularly if more of the inner octagon timbers become accessible.

There was crossmatching between the three groups as well as within them (Table 2). The data from the three sub-masters were therefore combined to give the 135-year site master, ROMSEY (Table 3). This was found to be synchronous with numerous dated reference chronologies over the period AD1362-1496 (Table 4).

Examination of the results suggests that the dated timbers from the bell tower are contemporary (Fig 2). The removal of most of the sapwood rings prohibits the production of a precise felling

date, but a felling date range of AD1512-1538 is obtained by combining the estimated felling dates from each timber (Table 5).

The timbers

The sampled timbers contained 43-117 annual rings and, allowing for missing sapwood plus a few inner rings, probably came from trees aged 80-150 years old when felled. Their average ring widths varied from 1.5mm to 4.3mm which suggests that the trees did not all grow under the same conditions. The variable, and sometimes low, correlation between the ring sequences also suggests a wide range of growing conditions, perhaps from more than one woodland source. Examination of the Abbey documents might produce additional information about timber sources.

Conclusion

All the dated timbers appear to be contemporary and have an estimated felling date range of AD1512-1538. This indicates that much of the present bell tower was probably constructed just prior to the Dissolution. The only timber from the earlier inner octagon that could be sampled remains undated. The study has also produced a 135-year reference chronology for Romsey which spans the period AD1362-1496.

Acknowledgements

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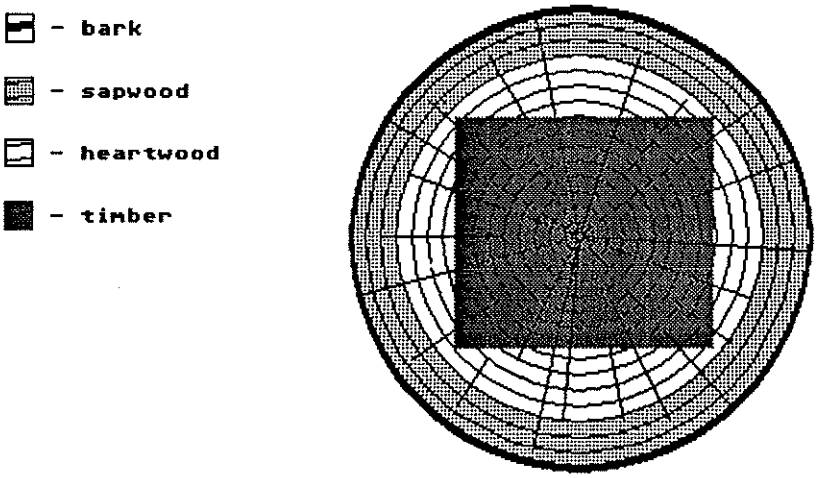

Fig 1: Sketch showing the method of conversion.

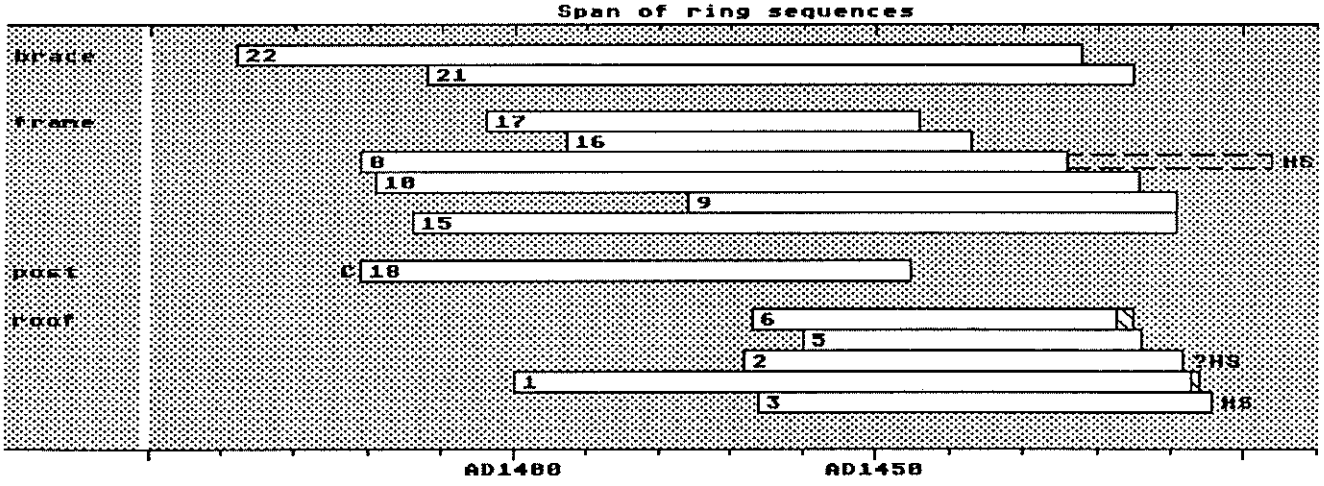

Fig 2: Bar diagram showing the relative positions of the dated ring sequences. White bars - heartwood rings; hatching - sapwood; broken bars - unmeasured rings; HS - heartwood-sapwood transition; C - centre of tree.

Table 1: Details of the tree-ring samples. HS - heartwood-sapwood transition; "+" - unmeasured rings present.

sample no	timber no/function	total no of rings	sapwood rings	average ring width (mm)	comments
a) bell chamber roof					
1	J348 - ceiling joist	95	1	1.98	
2	J346 - ceiling joist	61	HS?	2.63	centre of timber rotten
3	J347 - ceiling joist	63	HS	2.44	
4	AJ356 - chamfered beam between centre tiebeams	25	-	-	insufficient rings
5	J364 - ceiling joist	47	-	2.87	knotty
6	J343 - ceiling joist	53	2	2.18	knotty
b) bell frame					
7	DJ268 - SW diagonal joist	44	-	-	insufficient rings
8	HP264 - horizontal plate	98+	-	1.88	about 36 rings unmeasured, including 8 sapwood
9	DJ263 - NW diagonal joist	68	-	2.31	
10	HP276 - horizontal plate	106	-	1.69	near to HS?
11	DJ268 - SW diagonal joist	37	-	-	duplicate of sample 7; nearer bottom of tree
12	J318 - joist, early inner octagon	67	-	1.88	
13	SP138 - secondary jowl post	66	6	4.30	same tree as 14 (t=13.0)
14	SP78 - secondary jowl post	69	-	3.41	
15	SP73 - secondary post	106	-	1.98	near or at HS?
16	SP127 - secondary post	57	-	3.30	
17	SP93 - secondary post	61	-	1.52	

Table 1/cont

sample no	timber no/function	total no of rings	sapwood rings	average ring width (mm)	comments
c) bell chamber posts & braces					
18	PP333 - west wall post	77	-	1.84	
19	DB334 - diagonal brace	-	-	-	core shattered during sampling
20	PP324 - east wall post	43	-	-	insufficient rings
21	DB325 - diagonal brace for PP324	98	-	1.74	
22	DB321 - diagonal brace	117	-	1.88	

Table 2: *t* value matrix showing the degree of similarity between the matching ring sequences. Values less than 3.0 are not shown.

	1	2	3	5	6	8	9	10	15	16	17	18	21	22
1	*		3.1		3.6	3.9		4.0	4.6					
	2	*			4.5	3.0		4.0	3.9				4.7	3.6
		3	*		5.5									
			5	*				3.1	3.1					
				6	*	3.5		3.5	3.3					
					8	*		5.4	9.2	3.7	4.2	3.4	3.3	3.8
						9	*		4.8				3.3	4.0
							10	*	5.9	4.8	5.2	3.7	3.9	3.3
								15	*	6.4	6.4		4.0	5.0
									16	*	6.3	3.6	3.2	3.7
										17	*			4.8
											18	*	5.1	3.6
												21	*	7.3
													22	*

Table 3: Romsey tree-ring chronology, AD1362-1496.

year	ring widths (0.01mm)										no of samples/year									
AD1362		267	212	151	190	187	162	282	218	290		1	1	1	1	1	1	1	1
	229	180	176	134	198	152	200	307	292	249	1	1	1	1	1	1	1	3	3
	270	296	306	291	336	336	251	244	227	210	4	4	4	4	4	5	5	6	6	6
	298	232	215	228	289	298	247	246	272	257	6	6	6	6	6	7	7	7	7	8
AD1401	201	150	176	234	196	209	270	294	255	218	8	8	8	8	8	8	9	9	9	9
	238	252	213	198	204	138	166	232	174	227	9	9	9	9	9	9	9	9	9	9
	178	184	225	222	179	150	150	193	166	133	9	9	9	10	10	10	10	10	10	10
	177	244	169	208	220	240	191	170	159	180	10	11	12	13	13	13	13	13	13	14
	230	204	210	185	162	152	193	171	189	193	14	14	14	14	14	14	14	14	14	14
AD1451	221	191	181	208	180	212	223	196	191	200	14	14	14	14	14	13	12	12	12	12
	160	156	239	166	203	252	224	230	268	285	12	12	12	11	11	11	11	11	11	11
	216	209	235	202	275	200	146	164	207	184	11	11	11	11	11	11	10	10	9	9
	212	199	188	235	191	235	291	325	253	244	9	9	9	9	9	7	5	5	5	5
	227	207	253	282	275	255					5	3	2	2	1	1				

Table 4: Dating the Romsey master and its 3 sub-masters. *t* values with dated reference chronologies; values less than 3.0 are not shown.

chronology	ROMSEY	ROOF5	FRAME5	RING3
Acton Court, Avon (Miles & Haddon-Reece pers comm)	5.7	6.5	9.7	
Cowfold Barn (Tyers pers comm)	8.5	4.3	7.1	6.1
East Midlands (Laxton & Litton 1988)	6.0	4.3	7.0	
Field Place Barn, W Sussex (Bridge pers comm)	5.6	4.9	6.2	4.7
Kent (Laxton & Litton 1989)	5.4	3.0	6.3	3.6
London, Skin Market Place (Tyers pers comm)	5.3	3.9	5.8	3.9
London, Southwark boats - T30 (Tyers 1990)	7.3	4.6	8.4	4.3
Nuffield, Upper House Farm (Miles pers comm)	6.1	4.1	5.9	
Sherborne Abbey Church (Bridge pers comm)	6.0	4.8	7.2	3.6

Table 5: Summary of the tree-ring dates and estimated felling dates. A sapwood estimate of 10-55 rings (95% confidence limits) is used to calculate the felling date; HS - heartwood-sapwood transition. All dates are AD.

sample	timber	date span of rings (sapwood)	felling date
1	J348	1400-1494(1)	1503-1548
2	J346	1432-1492(HS?)	1502-?1547
3	J347	1434-1496(HS)	1506-1551
5	J364	1440-1486	1496+
6	J343	1433-1485(2)	1493-1538
8	HP264	1379-1476+*c*.36(8)	*c*.1512-1559
9	DJ263	1424-1491	1501+
10	HP276	1381-1486	1496+
15	SP73	1386-1491	1501+
16	SP127	1407-1463	1473+
17	SP93	1396-1456	1466+
18	PP333	1379-1455	1465+
21	DB325	1388-1485	1495+
22	DB321	1362-1478	1488+