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TREE-RING ANALYSIS OF UPMINSTER TITHE BARN, GREATER LONDON

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Summary

Dendrochronological analysis of fifteen aisle and arcade posts from Upminster Tithe Barn, Greater London, projeced a tree-ring chronology for the period AD 1276-1414. The timbers were felled between AD 1423 and AD 1440. There is a close stylistic affinity between this barn and the nearby barn at Great Tomkyns, Upminster. Since the timbers fron the latter are unsuitable for dendrochronology the felling date range obtained for the Upminster Tithe Barn can perhaps be used as a guide to the construction date of the Great Tomkyns Barn.

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TREE-RING ANALYSIS OF UPMINSTER TITHE BARN, GREATER LONDON

Introduction

This document is a technical archive report on the tree-ring analysis of timbers from Upminster Tithe Barn (NGR TQ565877). It is beyond the dendrochronological brief 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 presented here may therefore have to be modified in the light of subsequent work.

This medieval timber-framed aisled barn with nine bays and crown post roof is thought to have been built by Waltham Abbey; it is now used as a museum. Its construction date on stylistic grounds is thought to be mid-fifteenth century (Hewett 1969). It shows a number of constructional similarities to the barn at Great Tomkyns, Upminster (Bond 1993), which has also been the subject of a dendrochronological study (Tyers 1997a). The tree-ring dating at Upminster Tithe Barn was undertaken at the request of Richard Bond from English Heritage primarily to provide a more precise construction date for the barn. A secondary aim was to provide data which will strengthen the Essex chronology (see eg Tyers 1993).

Methodology

A plan was provided of the barn by Don Paterson of the Hornchurch Historical Society. A rough sketch was prepared of a typical truss (Fig 1) and the trusses were labelled using the numbering system used for the museum displays (Fig 2). A brief survey identified those timbers with the most suitable ring sequences for analysis. Those 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 from the timbers in the most suitable direction for maximising the numbers of rings for subsequent analysis. The core holes were left open. The ring sequences in the cores were revealed by sanding.

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 any found to cross-match were combined to form a site master curve. These, and any remaining unmatched ring sequences were 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-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates 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 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 throughout 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

All the major structural timbers in the barn that could be safely sampled were examined with a view to determining their suitability for analysis. A total of fifteen of the aisle and arcade posts were selected as most suitable for sampling (Fig 2 and Table 1). All these timbers were successfully sampled although sample **4** was badly broken and sample **11** included a rather large knot which made analysis somewhat difficult. The rest of the elements of the structure were rejected for sampling either because they contained too few rings, were difficult to access whilst meeting the necessary health and safety regulations, or because they did not have surviving sapwood.

Sequences from samples **1-15** were measured and compared with each other. Samples **1**, **2**, **3**, part of **4**, **7**, **9**, **10**, **12**, **13**, **14**, and **15** were found to match (Table 2) and were combined to form a 139 year master curve, UPBARN. This was tested against a comprehensive collection of dated tree-ring chronologies from England in an attempt to identify a date for the sequence. It was immediately apparent that the master sequence is dated to AD 1276 - AD1414 inclusive (Table 3). The ring sequence from this master is listed in Table 4.

Sample **11** was also found to match with the master curve ($t = 4.8$), several of the other matched individual sequences (eg $t = 4.2$ to sample **3**, and $t = 4.4$ to sample **10**), and several other chronologies (eg $t = 5.8$ to Netteswellbury (Tyers 1997b), $t = 5.0$ to Harmondsworth (Tyers and Hibberd 1993), and $t = 5.0$ to Wanborough (Tyers 1997c)). The dating obtained has no impact upon the interpretation of the structure, and the distortions caused by the knot in the core were felt sufficiently serious that the sequence has been excluded from the master curve. The remaining measured samples have failed to produce any visually and statistically acceptable matches and are thus undated by the analysis.

Interpretation

Sapwood was present on four of the dated samples and heartwood-sapwood transition on another six (Fig 3). The range of heartwood-sapwood transitions is consistent with a group of timbers which were felled at the same time (Baillie 1982, 57), indicating that they were probably felled at the same time. Using this assumption, and applying the 10-55 year sapwood estimate to each dated sample enables the common period of AD 1423-1440 to be derived as the likely felling date range of the assemblage. Since medieval timbers were usually felled as required and used green (Rackham 1990, 69), a construction date within the range indicated by the tree-ring results is implied.

The result obtained by this analysis suggests that the Upminster Tithe Barn is broadly contemporary with another surviving timber-framed barn in Greater London, the Tithe Barn at Harmondsworth dated to *c* AD 1426 (Tyers and Hibberd 1993). The inability to date the nearby Great Tomkyns Barn by dendrochronological techniques means that no comparable independent evidence of the date of this structure is available (Tyers 1997a).

Acknowledgements

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Figure 1

A sketch of a typical truss, drawn on site by the author.

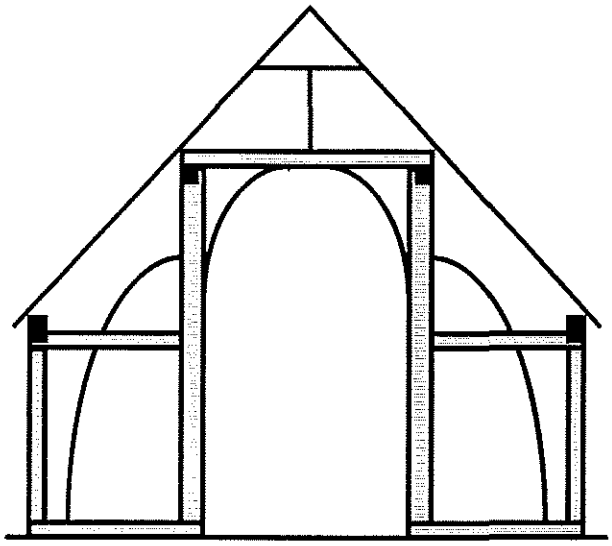


Figure 2

A sketch plan of the barn showing the museum's bay numbering scheme used during sampling. The smaller numbers with arrows show the sample numbers and approximate direction of coring in each timber

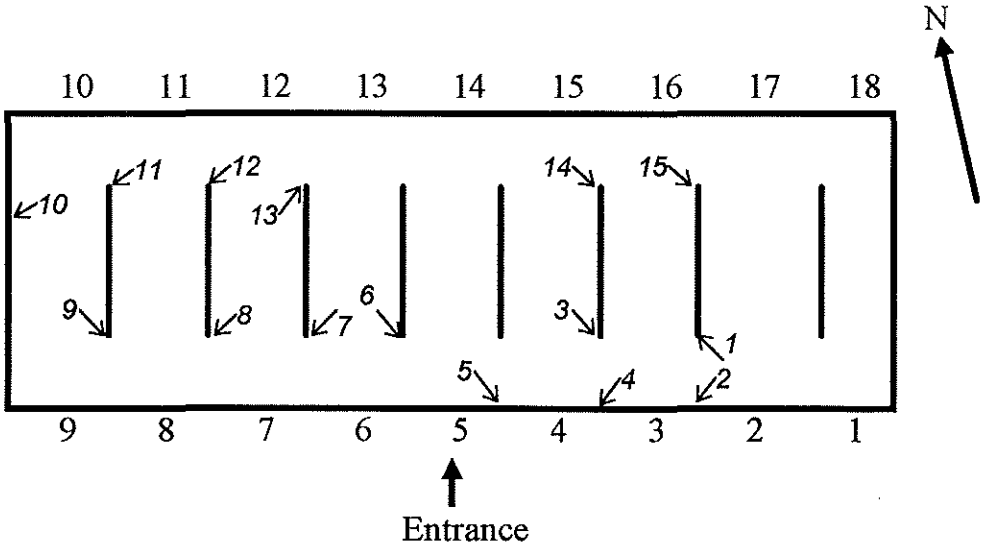
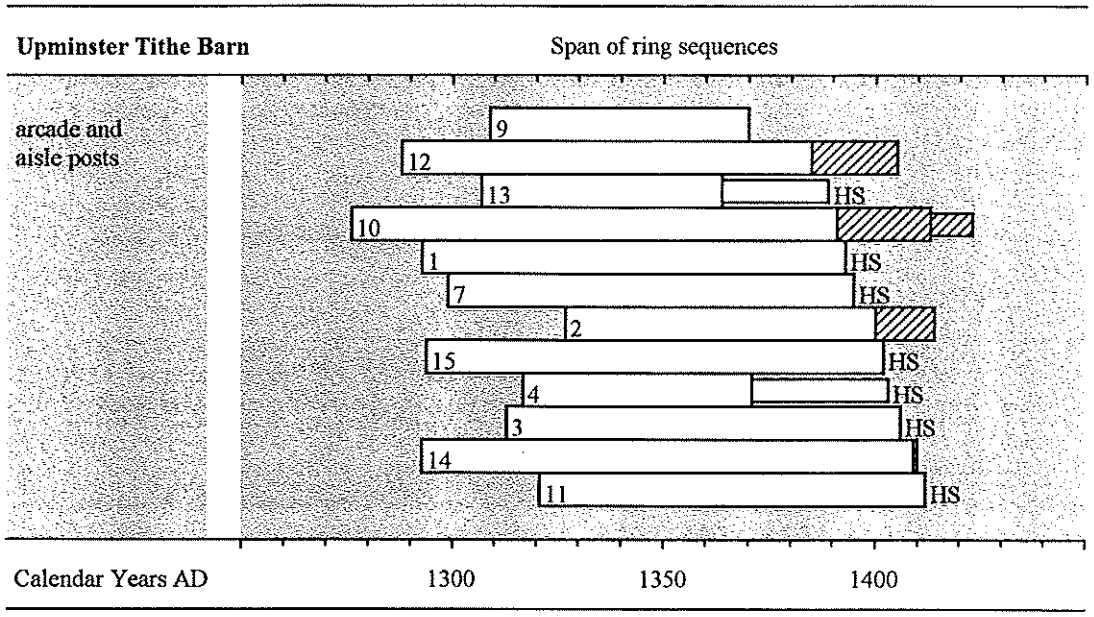


Figure 3

Bar diagram showing the position of the dated sequence



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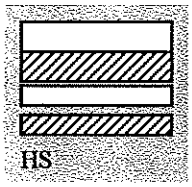

heartwood
sapwood
unmeasured heartwood
unmeasured sapwood
heartwood/sapwood boundary

Table 1

List of samples

Core	Origin of core	Total rings	Sap rings	mm/year	Date of sequence	Felled
1	Bay 2/3, arcade post	101	h/s	1.96	AD 1293-AD 1393	AD 1403-AD 1448
2	Bay 2/3, aisle post	88	14	1.28	AD 1327-AD 1414	AD 1414-AD 1455
3	Bay 3/4, arcade post	94	h/s	2.09	AD 1313-AD 1406	AD 1416-AD 1461
4	Bay 3/4, aisle post	55 [1]	h/s	2.66	AD 1317-AD 1371	AD 1413-AD 1458
5	Bay 4/5, aisle post	66	h/s	2.63	-	-
6	Bay 5/6, arcade post	57	h/s	2.60	-	-
7	Bay 6/7, arcade post	97	h/s	2.44	AD 1299-AD 1395	AD 1405-AD 1450
8	Bay 7/8, arcade post	98	h/s	1.97	-	-
9	Bay 8/9, arcade post	62	0	1.84	AD 1309-AD 1370	AD 1380+
10	West wall, post	138	22 [2]	1.56	AD 1276-AD 1413	AD 1423-AD 1446
11	Bay 10/11, arcade post	92	h/s	1.63	AD 1321-AD 1412	AD 1422-AD 1467
12	Bay 11/12, arcade post	118	20	1.57	AD 1288-AD 1405	AD 1406-AD 1440
13	Bay 12/13, arcade post	58 [3]	h/s	1.19	AD 1307-AD 1364	AD 1399-AD 1444
14	Bay 15/16, arcade post	118	1	1.46	AD 1293-AD 1410	AD 1419-AD 1464
15	Bay 16/17, arcade post	109	h/s	1.68	AD 1294-AD 1402	AD 1412-AD 1457

[1] This sample included at least 32 other heartwood rings that could not be reliably joined to the measured sequence.

[2] This sample included at least 10 other sapwood rings that could not be reliably joined to the measured sequence.

[3] This sample included at least 25 other heartwood rings that could not be reliably joined to the measured sequence.

Table 2

t-value matrix for the matching sequences. Values less than 3.0 are not given.

	2	**3**	**4**	**7**	**9**	**10**	**12**	**13**	**14**	**15**
1	3.10	5.81	5.69	3.70	5.54	4.47	4.93	3.55	4.27	-
2		3.62	3.09	-	3.51	3.70	-	3.27	-	4.40
3			8.24	5.96	4.09	4.89	6.87	3.03	6.62	4.59
4				5.61	7.29	4.92	8.51	4.21	4.70	3.40
7					6.67	6.63	5.67	3.29	5.33	-
9						6.00	5.89	5.05	4.15	3.34
10							6.11	4.80	5.57	4.03
12								3.93	5.44	3.59
13									-	-
14										7.84

Table 3

Dating the Upminster barn chronology, AD 1276-1414. *t*-values with independent reference chronologies.

Area	Reference chronology	*t*-values
Berkshire	Reading (Groves *et al* forthcoming)	6.7
Essex	Essex chronology - 155 timbers (Tyers unpubl)	6.6
	Netteswellbury, Monks Barn (Tyers 1997b)	7.2
Gloucestershire	Twyning (Tyers 1996)	5.3
London	Harmondsworth barn (Tyers and Hibberd 1993)	7.8
	Trig Lane (Tyers 1992)	5.7
Surrey	Wanborough barn (Tyers 1997c)	6.8

Table 4

Ring-width data from site master UPBARN, dated AD 1276-1414 inclusive

Date	Ring widths (0.01mm)										No of samples									
AD 1276						254	322	282	409	466						1	1	1	1	1
	336	203	288	180	198	219	252	265	408	527	1	1	1	1	1	1	1	2	2	2
	500	509	360	318	264	327	279	244	274	294	2	2	4	5	5	5	5	5	6	6
AD 1301	256	306	294	235	228	239	227	225	237	232	6	6	6	6	6	6	7	7	8	8
	184	217	219	315	326	261	298	271	292	267	8	8	9	9	9	9	10	10	10	10
	273	295	275	265	216	133	211	249	272	230	10	10	10	10	10	10	11	11	11	11
	160	137	137	175	207	166	125	120	196	160	11	11	11	11	11	11	11	11	11	11
	107	94	102	123	132	132	119	155	153	118	11	11	11	11	11	11	11	11	11	11
AD 1351	150	136	156	120	94	114	146	122	135	130	11	11	11	11	11	11	11	11	11	11
	100	97	153	155	156	135	156	164	202	190	11	11	11	11	10	10	10	10	10	10
	156	174	159	160	157	165	161	176	156	152	9	8	8	8	8	8	8	8	8	8
	161	146	127	114	139	175	156	176	144	134	8	8	8	8	8	8	8	8	8	8
	106	112	134	135	137	145	127	127	145	102	8	8	8	7	7	6	6	6	6	6
AD 1401	95	85	102	138	129	148	113	110	125	129	6	6	5	5	5	4	3	3	3	3
	157	131	109	132							2	2	2	1						