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DENDROCHRONOLOGICAL ANALYSIS OF THE TITHE BARN, ENGLISHCOMBE, NEAR BATH, AVON, 1994

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Summary

Dendrochronological analysis of samples from the medieval tithe barn at Englishcombe resulted in the production of a tree-ring chronology spanning the period AD 1157-1304. A felling date range of AD 1314- *circa* 1358 was obtained for two timbers, whilst the other dated timbers had *termini post quem* for felling in the latter half of the thirteenth century.

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Introduction

The tithe barn, adjoining the seventeenth-century Rectory Farmhouse, lies in the village of Englishcombe approximately five miles south-west of Bath (NGR: ST716628). It was subject to a major program of repair and conservation work between July 1993 and September 1994, grant-aided by English Heritage. Recording and archaeological survey work were carried out prior to and during the refurbishment and as part of this a dendrochronological study was requested by Arnold Root, the local English Heritage Historic Buildings Architect.

The following resume has been produced from discussions with Martin Benson of Feilden Clegg Design and from Rodwell (1993). The barn, originally built for Bath Abbey, is largely constructed of Bath stone ashlar with some dressed rubble to the gables. It is a five bay structure, with a central porch on the south side opposite a smaller door in the north wall (Figure 1). There are four timber trusses of which the two outermost (1 and 4) are raised crucks and the central two (2 and 3) are raised base crucks. The archaeological survey work, and the information obtained from the specialist contractors, strongly suggest that the extant medieval structure is the product of a single construction programme. It is also suggested that the structural differences between the two truss pairs are likely to be due to scarcity of timber of suitable scantling. However, stylistically trusses 1 and 4 are earlier than trusses 2 and 3 and, although none of the medieval timbers showed any obvious signs of re-use, it is possible that the former are constructed wholly or partly from re-used timber. The architectural style suggests a mid fourteenth- to late fifteenth-century date for the initial construction of the barn, although there is clear evidence of later repairs and modifications.

The dendrochronological analysis was undertaken with the aim of producing precise dates for the timbers from the primary structure and hence additional dating evidence for the initial construction of the barn. It was also hoped that the analysis would help resolve the issue concerning the contemporaneity, or otherwise, of the timbers utilised in the two different truss types.

Method

All accessible timbers thought to be associated with the primary construction phase of the tithe barn were briefly assessed during the sampling visit in November 1993. Those which looked most suitable for dendrochronological analysis were selected for study and sampled. Cores were taken from the timbers using a 15mm diameter hollow borer attached to an electric drill. Access to several areas of the barn was not possible during this visit and it was thus agreed that further samples, in the form of cross-sectional slices from timbers being wholly or partly replaced, would be made available for analysis. The cross-sectional slices were sent to the Sheffield Dendrochronology Laboratory in September 1994.

Each core or slice was polished, first using an electric sander with paper of medium grit and then finished by hand using fine silicon carbide paper, so that the boundaries of the annual growth rings were clearly defined.

Any samples unsuitable for dating purposes were rejected before measurement but, where possible, a note was made of the number of rings and the average ring width estimated. Unsuitable samples are usually those with unclear ring sequences or fewer than 50 rings. Samples with fewer than 50 rings are generally unsuitable for dating purposes as the ring sequence may not be unique (Hillam *et al* 1987).

The growth rings of the samples selected for dating purposes were measured to an accuracy of 0.01mm on a travelling stage. This is connected to an Atari microcomputer which uses a suite of dendrochronology programs written by Ian Tyers (pers comm 1993). The ring sequences were plotted as graphs using an HI-80 Epson plotter attached to the Atari. The graphs were then compared with each other to check for any similarities between the ring patterns which might indicate contemporaneity. This process is aided by the use of programs on the Atari microcomputer. The crossmatching routines are based on the Belfast CROS program (Baillie and Pilcher 1973; Munro 1984) and measure the amount of correlation between two ring sequences. The Student's *t* test is then used as a significance test on the correlation coefficient. All *t* values quoted in this report are identical to those produced by the original CROS program (Baillie and Pilcher 1973). Generally a *t* value of 3.5 or over represents a match, provided that the visual match between the tree-ring graphs is acceptable (Baillie 1982, 82-5).

Dating is usually achieved by crossmatching ring sequences within a phase or building and combining the matching patterns to produce a site master curve. This master curve and any unmatched ring sequences are then tested against reference chronologies to obtain absolute dates. A master curve is used for absolute dating purposes whenever possible as it enhances the common climatic signal and reduces the background noise resulting from the local growth conditions of individual trees.

The results only date the rings present in the timber and therefore do not necessarily represent the felling date. If the bark or bark edge is present on a sample, the exact felling year can be determined. In the absence of bark surface the felling date is calculated using the sapwood estimate of 10-55 rings. This is the range of the 95% confidence limits for the number of sapwood rings on British oak trees over 30 years old (Hillam *et al* 1987). Where sapwood is absent, the addition of 10 rings (the minimum number of sapwood rings expected) to the date of the last measured heartwood ring produces a probable *terminus post quem* for felling, the date after which the timber was felled. The actual felling date may be much later because during timber conversion a large number of outer rings could be removed .

Once the felling date range or *terminus post quem* for felling has been calculated, factors such as stockpiling, re-use, repairs, and seasoning of timber must be considered since they might affect the

interpretation of the tree-ring dates. Seasoning of timber is thought to have been a fairly rare occurrence until relatively recent times. Evidence indicates that timber was generally felled as required and used whilst green (eg Rackham 1990, 69). Construction which utilises primary, rather than re-used, timber is therefore likely to have occurred shortly after felling. Thus, whilst the date obtained for the measured tree-ring sequence is precise and has been achieved by a completely independent process, the interpretation of tree-ring dates can be refined by studying other architectural and documentary evidence.

Results

The major structural timbers thought to be associated with the primary construction phase of the tithe barn were all oak (*Quercus* spp). Oak is relatively easy to recognise as it is a ring porous species with wide medullary rays running from pith to bark (Schweingruber 1990).

The way the trees were converted was highly variable with timbers shaped from whole, halved and quartered trees used for similar purposes. For instance truss 2 north cruck (*02/16*) appears to be a quartered tree at the sampling point, whilst truss 4 north cruck (*07*) appears to be a halved trunk; the bay 2 south lower purlin (*12*) is a shaped whole trunk, whilst the bay 3 north upper purlin (*13*) is a heavily trimmed quartered trunk (Table 1). Sapwood was present on only a small proportion of the timbers and was generally in very poor condition, but the heartwood-sapwood boundary was recognisable on a number of other timbers. Many timbers were rejected prior to sampling as they were clearly derived from young, fast-grown trees and would not have contained sufficient rings for dating purposes. This suggests that the majority of the medieval structural elements were derived from trees under approximately 100 years old when felled, with many apparently substantially younger.

Other timbers were rejected as they were extensively decayed. Truss 1 was in a particularly poor state of preservation and the entire north side had been replaced in the post-medieval period. Truss 3 was not accessible for coring as the scaffolding did not allow the timbers to be cored at the correct angle in order to maximise the ring sequence and no cross-sectional slices were obtained during renovation. Thus no samples were obtained from Trusses 1 and 3, leaving each of the two truss types only represented by samples from a single truss.

Most of the longitudinal timbers running between the trusses were not sampled. This was due to two factors: firstly many of them were thought to be later replacements, and secondly those thought to be from the primary construction phase generally contained too few rings for dating purposes.

A total of ten cores from nine timbers were taken, although the general condition of the timbers did cause difficulties and several cores fragmented (Table 1). No sapwood was successfully cored as this crumbled during sampling but its presence was noted on several timbers (eg *01*, *04*, and *10*) either at or

very close to the position from which cores were removed. In some instances the state of preservation of the timbers prevented positive identification of the heartwood-sapwood boundary at the sampling point. Thus the outermost measured heartwood rings of samples *01* and *10* either mark the sapwood transition or are probably within a maximum of ten rings of it. A further six samples were provided in the form of cross-sectional slices; one of these (*16*) was a duplicate sample taken from truss 2 north cruck which had also been cored (*02*).

The ring patterns of eight samples representing seven timbers were measured. Sample *02* had less than 50 rings but, as it was a duplicate of sample *16*, it was measured in case it extended the ring sequence for this cruck blade. The sequences obtained from *02* and *16* crossmatched and were combined to form a single ring pattern for truss 2 north cruck. This sequence and the remaining six measured samples crossmatched and were combined to form a 148-year site master curve (Figure 2; Table 2). This was dated to the period AD 1157-1304 by comparison with numerous reference chronologies from the British Isles (Table 3).

Felling date ranges for samples *01* and *10* were estimated (Table 4) taking into account the possible loss of as many as ten outer heartwood rings (see above). A *terminus post quem* for felling for the remaining dated samples were calculated (Table 4). These range from after AD 1256 (*02/16*) to after AD 1290 (*05*). If all seven dated timbers are contemporary a combined felling date range of AD1314 - *circa* 1358 is produced. This suggests that the timbers were probably felled and primarily used during the early to mid fourteenth century.

Discussion

1. The dating of Englishcombe tithe barn

All eight measured samples were successfully dated but the quality of the surviving timber has prevented the production of precise felling dates and caused difficulties in the interpretation of the dendrochronological results. Felling date ranges have been estimated for only two of the timbers, *01* and *10*, both of which were felled in the early to mid fourteenth century. The remaining timbers have *termini post quem* for felling in the latter half of the thirteenth century.

The dates of the outermost measured heartwood rings are equally variable for the timbers from both trusses (Figure 2; Table 4). This variation could imply that some timbers were felled earlier than others but it may also be due to the method of conversion employed to produce sufficient quantities of suitable sized timbers. It is noticeable that the cross-sectional slices from *13* and *02/16*, which have the two earliest *termini post quem*, suggest that the timbers are both quartered trunks with no pith and no trace of sapwood. These may have been heavily trimmed and therefore could be missing a substantial number of heartwood rings. Thus, taking into account the observed variety of conversion types and the poor preservation of the outer surfaces of many of the timbers, the tree-ring evidence suggests that all of

the timbers are contemporaneous and were all felled after AD 1314 but probably before *circa* AD 1358. Assuming that these are primary timbers associated with the initial construction phase, a date in the early to mid fourteenth century is indicated for the erection of the barn.

There is no evidence to indicate that the truss types differ in date, although in this instance any slight differences in date cannot be identified from the tree-ring results. This provides additional support to the theory that the extant medieval structure is the product of a single construction programme. This analysis also appears to substantiate the suggestion that the barn was constructed from sub-optimal trees, as the variety of conversion types seen in timbers performing the same function implies that suitable size timbers were in short supply.

2. Comparison with other barns in the region

A number of other barns in the area have been analysed dendrochronologically. Bradford-on-Avon tithe barn (Groves and Hillam 1994), Glastonbury Abbey barn (Bridge 1988), and Winterbourne tithe barn (Hillam 1991) are also large stone monastic barns. They were constructed from timbers felled in the mid fourteenth century and are therefore all potentially slightly later in date than Englishcombe tithe barn. The remains of West Barn, Barton Farm, stand adjacent to the tithe barn at Bradford-on-Avon. The dated timbers from West Barn appear to indicate that this barn may be of a similar or slightly later date than Englishcombe tithe barn (Howard *et al* 1993). Siddington tithe barn, near Cirencester, is however over half a century earlier in date as it was constructed from timbers felled in AD 1245-7 (Groves and Hillam 1992).

Rodwell (1993) points out that although the masonry work at Englishcombe is similar to that of the Bradford-on-Avon tithe barn, the timber trusses have more in common with Winterbourne (trusses 1 and 4) and Stanway, Gloucestershire, and Doulting, Somerset (trusses 2 and 3). Stanway and Doulting, both large stone monastic barns, are thought to date to the fifteenth century (Williams and Gilson 1979; Mercer 1975). Neither these, nor the monastic barn at Frocester Court, thought to date to about AD 1300 (Mercer 1975), have been subject to dendrochronological study. It may be useful for comparative purposes, architecturally and dendrochronologically, to carry out dendrochronological analysis in conjunction with any necessary modern recording/survey work on these two barns.

Conclusion

Analysis of the medieval timbers at Englishcombe tithe barn resulted in the production of a dated site chronology spanning the period AD 1157-1304. The tree-ring results show that the seven dated timbers thought to be associated with the primary construction phase were probably contemporary and were felled during the period AD 1314-*circa* 1358. This suggests that the two truss types are coeval and that the initial construction of the barn occurred in the early to mid fourteenth century. This is possibly slightly earlier than the dating evidence provided by the stylistic evidence. The results from this analysis

provide a useful addition to the growing body of data available from large stone monastic buildings in this region.

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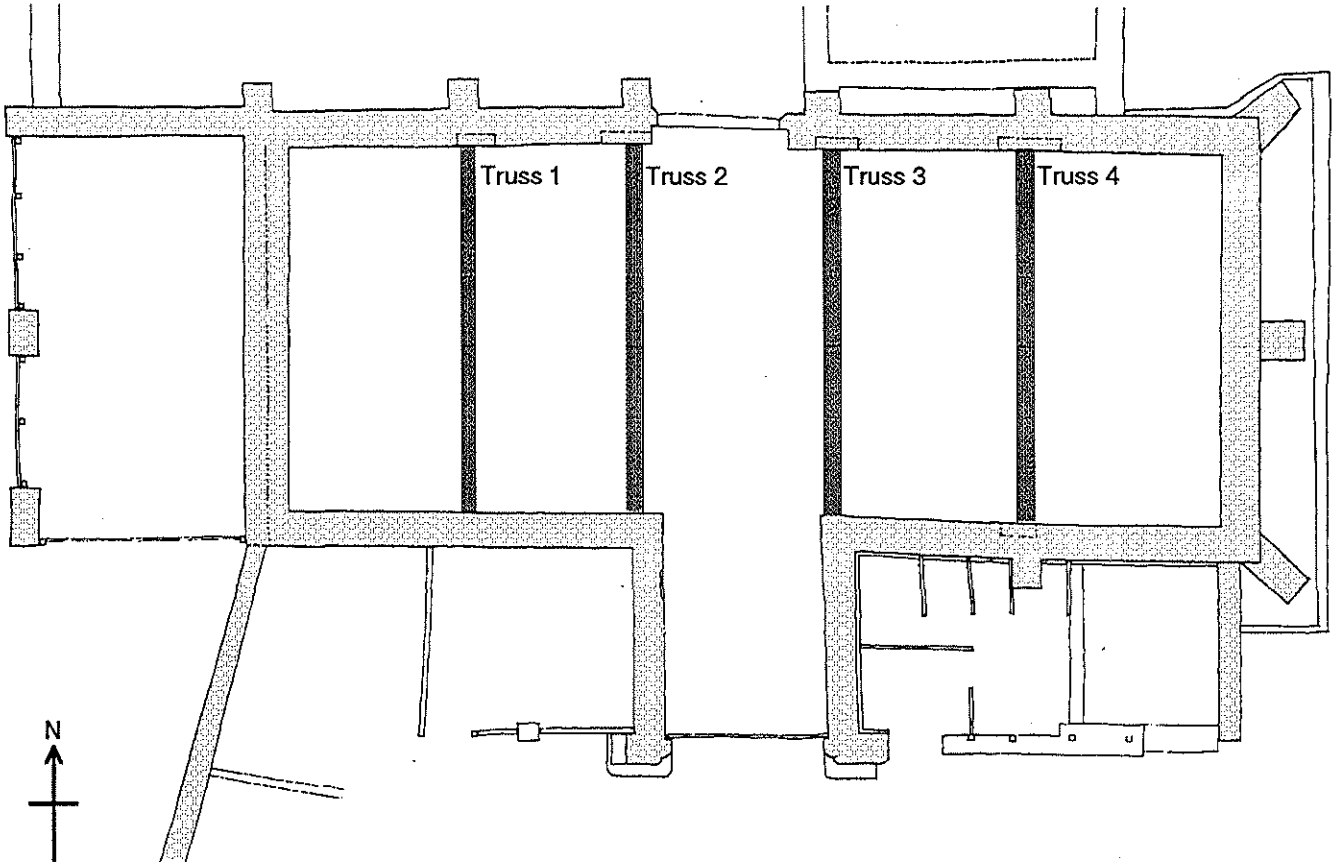

Figure 1: Plan of Englishcombe tithe barn showing the position of the trusses, after drawings provided by Feilden Clegg Design.

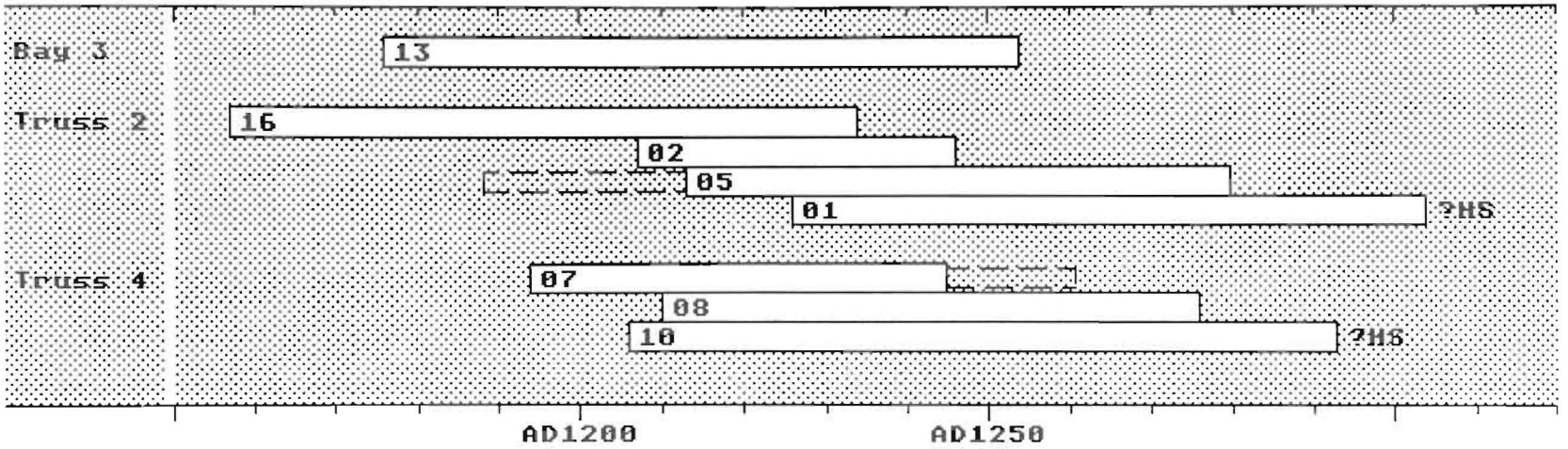

Figure 2: Bar diagram showing the relative positions of the dated ring sequences from Englishcombe tithe barn. White bars - heartwood rings; dashed lines - unmeasured rings; HS - heartwood/sapwood transition.

Table 1: Details of the tree-ring samples from Englishcombe tithe barn, Avon. + - unmeasured rings; hs - heartwood/sapwood transition; ARW - average ring width (mm/year).

Sample	Location	Total no of rings	Sapwood	ARW	Sketch	Comments
01	truss 2, south brace	75	hs or very close	1.5	-	core; measured
02	truss 2, north cruck	38	-	2.5	-	core; measured; duplicate of sample 16
03	truss 2, north primary rafter	*c*.48	-	3.6	-	core; rejected; fragmented during sampling
04	truss 2, tiebeam	47	hs	2.2	-	core; rejected
05	truss 2, north brace	+66	-	1.3	-	core; measured; +*c*.25 inner rings
06	truss 2, north brace	-	-	-	-	core; rejected; duplicate of 05; fragmented during sampling
07	truss 4, north cruck	52	-	3.4	-	core; measured
08	truss 4, north brace	67	-	1.3	-	core; measured
09	truss 4, south brace	40	?hs	1.9	-	core; rejected
10	truss 4, south cruck	88	hs or very close	1.8	-	core; measured in two halves due to core breaking during sampling
11	bay 1, ridge	42	-	2.6		slice; 145mm x 135mm; rejected
12	bay 2, south lower purlin	42	near hs	2.4		slice; 225mm x 170mm; rejected
13	bay 3, north upper purlin	79	-	2.1		slice; 160mm x 125mm; measured
14	bay 4, ridge	31	?hs	2.6		slice; 135mm x 130mm; rejected
15	bay 5, south lower purlin	47	-	3.8		slice; 195mm x 170mm; rejected
16	truss 2, north cruck	78	-	2.9		slice; 220mm x 175mm; measured, duplicate of sample 02

Table 2: Ring-width data of the site master curve from Englishcombe tithe barn, Avon, AD 1157-1304.

Year	Ring widths (units of 0.01mm)										Number of samples per year									
AD1157							496	314	263	493							1	1	1	1
	369	356	284	409	449	357	372	455	417	352	1	1	1	1	1	1	1	1	1	1
	208	268	387	521	317	510	280	232	222	196	1	1	1	1	1	2	2	2	2	2
	173	232	202	121	155	218	341	161	271	265	2	2	2	2	2	2	2	2	2	2
	290	264	315	347	391	333	273	280	263	296	2	2	2	3	3	3	3	3	3	3
AD1201	325	242	258	236	281	273	195	314	272	305	3	3	3	3	3	4	4	5	5	6
	220	194	235	265	286	268	230	200	248	263	6	6	7	7	7	7	7	7	7	7
	246	188	200	208	212	306	199	283	309	231	7	7	7	7	7	8	8	8	8	8
	155	119	137	172	175	136	205	210	200	181	8	8	8	8	7	7	7	7	7	7
	157	165	173	170	179	171	163	132	148	161	7	7	7	7	7	5	4	4	4	4
AD1251	169	150	180	180	193	156	128	96	115	132	4	4	4	4	3	3	3	3	4	4
	121	136	119	129	136	137	119	132	140	137	4	4	4	4	4	4	4	4	4	4
	178	118	135	125	93	96	124	114	128	141	4	4	4	4	4	4	3	3	3	3
	142	187	166	149	173	135	109	104	141	146	2	2	2	2	2	2	2	2	2	2
	138	177	210	165	125	112	133	132	127	156	2	2	2	1	1	1	1	1	1	1
AD1301	142	209	217	170							1	1	1	1						

Table 3: Results of comparisons between the site master curve, ENGLISHCOMBE (AD 1157-1304), and reference chronologies spanning the medieval period. All chronologies are independent.

Reference chronology	*t* value
Bradford-on-Avon, Wiltshire (Groves and Hillam 1994)	9.09
Bishops Kitchen, Chichester (Tyers and Hibberd 1993)	6.39
Droitwich: Upwich2 (Groves and Hillam forthcoming)	6.71
Dunstable, Bedfordshire (Bridge 1988)	5.82
Exeter: Cathedral 1 (Mills 1988)	10.66
Glastonbury Abbey Barn (Bridge 1988)	8.14
Reading Abbey, Berkshire (Groves *et al* forthcoming)	8.10
Sompting (Tyers 1988)	7.49
Winterbourne, Avon (Hillam 1991)	8.53

Table 4: Details of the tree-ring dates.

Sample	Date span of measured rings	Unmeasured outer rings	Felling date range	Comment
01	AD 1226-1304	-	AD 1314-*c.* 1369	-
02	AD 1207-1246	-	after AD 1256	same timber as 16
05	AD 1213-1280		after AD 1290	-
07	AD 1194-1245	+16	after AD 1271	-
08	AD 1210-1276	-	after AD 1286	-
10	AD 1206-1293	-	AD 1303-*c.* 1358	-
13	AD 1176-1254	-	after AD 1264	-
16	AD 1157-1234	-	after AD 1256	same timber as 02