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Summary

Dendrochronological analysis of samples from the medieval Tithe Barn at Bradford-on-Avon resulted in the production of a probable felling date range for timbers of AD1334-79, and a tree-ring chronology spanning the period AD1174-1324.

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TREE-RING ANALYSIS OF BRADFORD-ON-AVON TITHE BARN, WILTSHIRE, 1993

Introduction

The Tithe Barn stands on Barton Farm which is on the western edge of Bradford-on-Avon (ST823605). Barton Farm was the demesne farm for the rich manor of Bradford which had been granted to the abbey of Shaftsbury in AD 1001. The Tithe Barn is a 14-bay structure with large porches on the north side and lesser porches on the south side (Figure 1). Extensive repair work was carried out earlier this century during World War I (Burder 1917) and also during the 1950s and 1960s when the barn was reroofed, the carpentry restored, and the north wall rebuilt (Kelly pers comm). Despite such comprehensive repair work the remains of the medieval timber roof are quite substantial. The roof is of raised cruck type with extended principals of three types (Figure 2). The use of extended principals was common in the fourteenth-century (Burder 1917) and a recent comparative study of cruck roofs suggested that, on stylistic grounds, this type of construction probably dates to the latter half of the fourteenth-century (Kelly pers comm). Dendrochronological analysis was undertaken in late 1993 to determine precise dates for the timbers, and hence provide additional dating evidence for the construction of the Tithe Barn.

Method

The timbers thought to be associated with the primary construction phase of the Tithe Barn were briefly assessed. 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. Each core 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 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. During timber conversion a large number of outer rings could be removed but as this is unquantifiable the actual felling date could be much later.

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 timbers thought to be associated with the primary construction phase of the Tithe Barn were all oak. The principals and arch-braces appeared to be shaped from either complete, or halved, trunks. The conversion of the remaining timbers from lower collar level upwards was not determined, as access to these timbers was not possible. Traces of sapwood were present on only a few of the accessible timbers, although the method of conversion suggests that many of these may only have sapwood and a few heartwood rings missing. The pith was probably present in many of the timbers, although it was not necessarily sampled. The majority of the medieval principals and arch braces appear to have been derived from trees less than approximately 150-years-old when felled.

Many of the medieval timbers were unsuitable for sampling as they had been extensively repaired with 20th century timber and concrete. All badly cracked timbers were also rejected. Thus, although it had been hoped that all three truss types would be represented by several samples, this could not be achieved. Full details of the tree-ring samples are given in Table 1.

The ring patterns of five of the measured samples crossmatched and were combined to form a 151-year site master curve (Figure 3; Table 2). This was dated to the period AD 1174-1324 by comparison with numerous reference chronologies from the British Isles (Table 3). No consistent results were obtained for sample *03*, so this timber remains undated.

Felling date ranges for samples *06, 11,* and *12* and a *terminus post quem* for felling for samples *08* and *13* were calculated (Table 4). The results indicate that these five timbers, from truss types B and C, are broadly contemporary and were therefore all likely to have been felled after AD 1333 but probably before AD 1380 and possibly before *c.*AD 1370. The tree-ring analysis therefore indicates a construction date for the Tithe Barn in the mid fourteenth-century.

Other barns in the area that have been analysed dendrochronologically include Winterbourne Tithe Barn (Hillam 1991) and Glastonbury Abbey Barn (Bridge 1988). These were constructed from timbers felled in the mid fourteenth-century and are therefore broadly contemporary with Bradford-on-Avon Tithe Barn. Englishcombe Tithe Barn is of a very similar construction type to Bradford-on-Avon but although a number of timbers have been sampled no dendrochronological date has been obtained (Groves and Hillam forthcoming(a)). Siddington Tithe Barn, near Cirencester, is however about a century earlier in date as it was constructed from timbers felled in AD 1245-7 (Groves and Hillam 1992).

Conclusion

Analysis of the medieval roof timbers at Bradford-on-Avon Tithe Barn resulted in the production of a dated site chronology spanning the period AD 1174-1324. The tree-ring results show that the five dated timbers thought to be associated with the primary construction phase were probably contemporary and were felled during the period AD 1334-1379. This corresponds with the fourteenth-century construction date indicated by the architectural style. Additional dendrochronological work on the timbers from the lower collar level and above may allow the felling date range to be refined, thus producing a more precise date for the construction of the Tithe Barn. However any further dendrochronological work should be carried out in conjunction with a detailed modern survey of the building.

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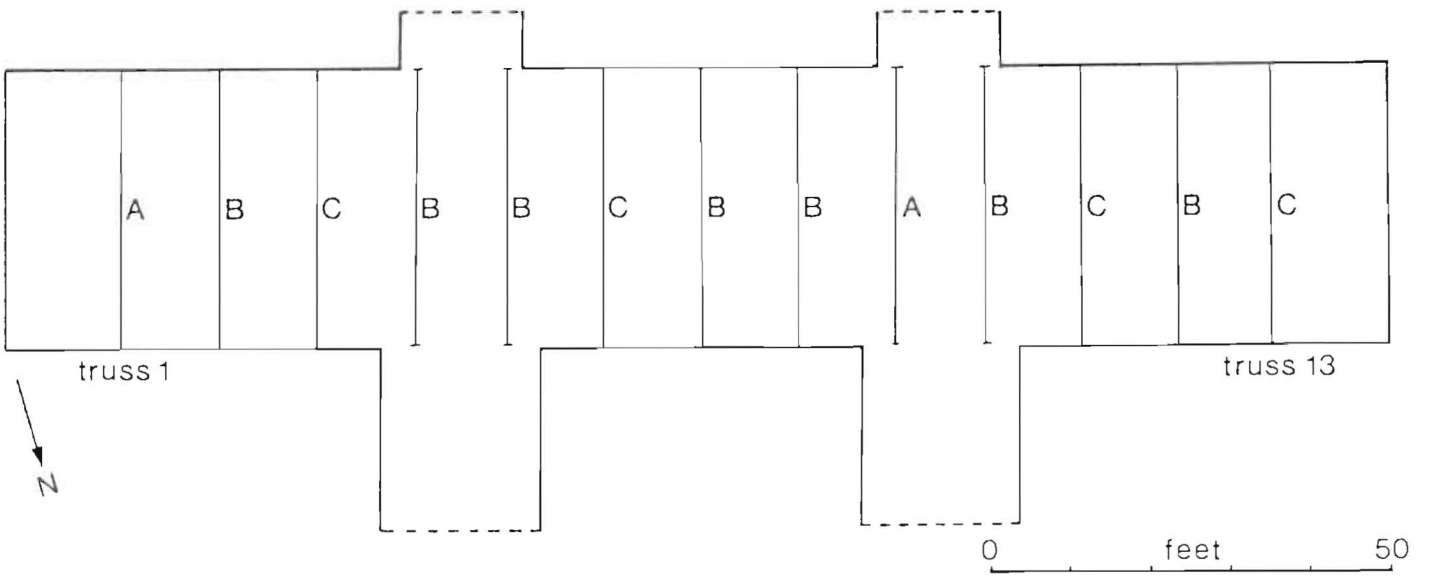

Figure 1: Schematic plan of the Tithe Barn (reproduced from Burder 1917). Trusses are numbered 1-13 from east to west. Each truss is labelled A, B or C according to its construction type (see Figure 2).

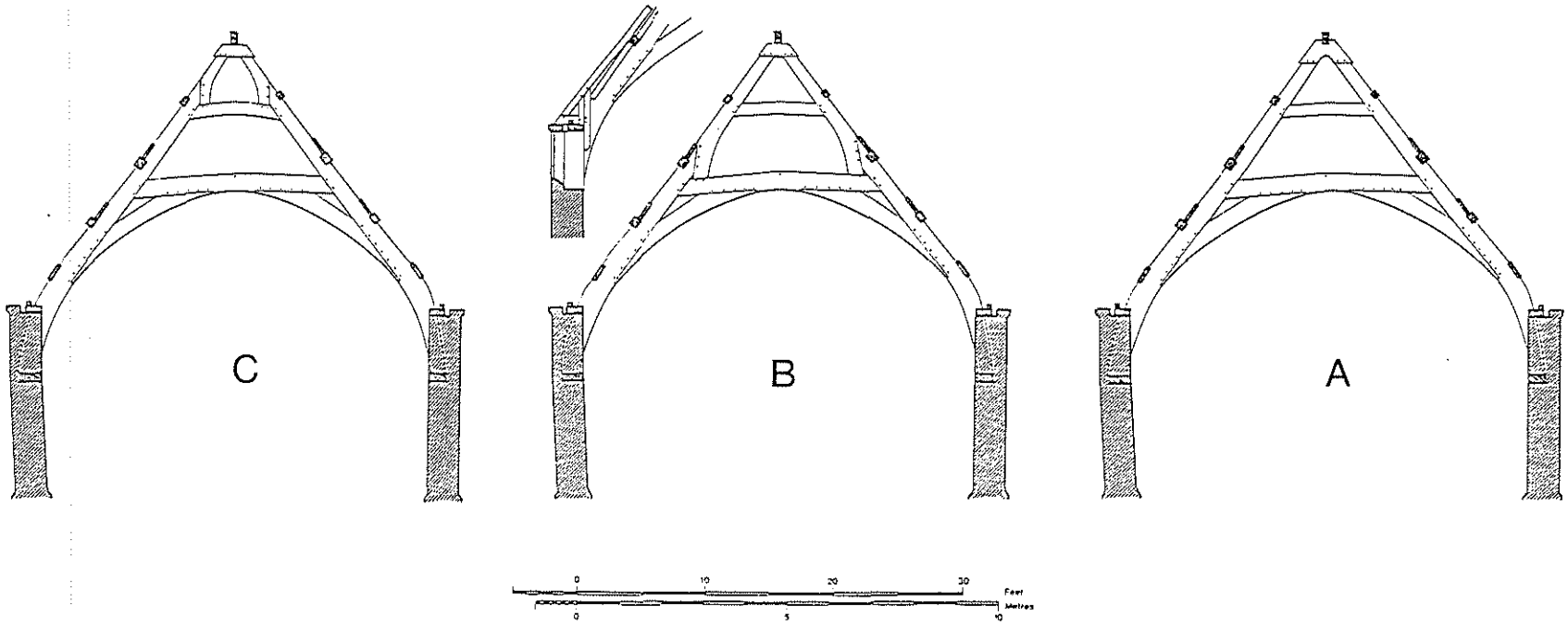

Figure 2: Diagram showing the three types of truss construction (reproduced from Fradgely pers comm).

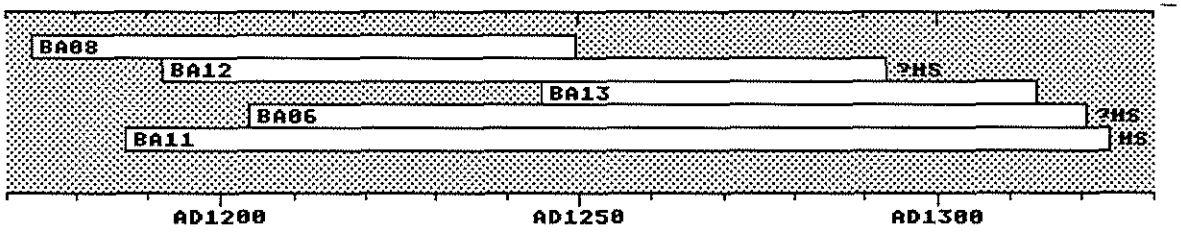

Figure 3: Bar diagram showing the relative positions of the dated ring sequences from the Bradford-on-Avon Tithe Barn. White bars - heartwood rings; HS - heartwood/sapwood transition.

Table 1: Details of the samples from Bradford-on-Avon Tithe Barn. hs - heartwood/sapwood transition; ARW - average ring width (mm/year).

Sample	Location	Truss type	Number of rings	Sapwood	ARW	Comments
01	Truss 1, south cruck	A	20	-	6.5	rejected
02	Truss 2, south cruck	B	39	-	3.1	rejected
03	Truss 2, south brace	B	65	-	1.6	measured, knotty
04	Truss 3, south brace	C	12	-	4.2	rejected
05	Truss 3, south cruck	C	32	-	4.1	rejected
06	Truss 4, south brace	B	118	near hs	1.7	measured; hs present on timber close to sampling position
07	Truss 4, north brace	B	24	-	2.6	rejected
08	Truss 7, north brace	B	77	-	2.6	measured
09	Truss 7, south brace	B	-	-	-	core fragmented during sampling
10	Truss 7, south cruck	B	45	-	3.1	rejected
11	Truss 8, south brace	B	138	hs	1.6	measured
12	Truss 11, south brace	C	102	near hs	1.8	measured; hs present on timber close to sampling position
13	Truss 11, south cruck	C	70	-	1.8	measured

Table 2: Ring-width data of the site master curve from Bradford-on-Avon Tithe Barn, AD 1174-1324.

year	ring widths (0.01mm)										number of trees per year									
AD 1174				541	529	598	296	249	257	184				1	1	1	1	1	1	1
	161	101	120	119	165	320	356	171	258	266	1	1	1	1	1	1	2	2	2	2
	173	243	286	290	332	273	249	186	184	234	2	3	3	3	3	3	3	3	3	3
AD 1201	221	218	217	169	189	161	125	207	144	227	3	3	3	4	4	4	4	4	4	4
	177	175	170	172	208	236	252	185	239	256	4	4	4	4	4	4	4	4	4	4
	261	208	197	230	278	332	199	287	320	224	4	4	4	4	4	4	4	4	4	4
	178	137	150	137	140	157	197	176	181	166	4	4	4	4	4	4	4	4	4	4
	148	135	166	148	188	199	188	153	206	197	4	4	4	4	5	5	5	5	5	5
AD 1251	169	140	156	131	217	158	138	122	127	157	4	4	4	4	4	4	4	4	4	4
	164	181	151	144	133	166	142	164	168	184	4	4	4	4	4	4	4	4	4	4
	232	184	244	235	144	123	142	186	196	201	4	4	4	4	4	4	4	4	4	4
	161	156	147	170	155	205	145	124	158	186	4	4	4	4	4	4	4	4	4	4
	163	234	210	175	154	139	147	129	112	175	4	4	4	3	3	3	3	3	3	3
AD 1301	192	185	109	110	120	164	198	175	128	140	3	3	3	3	3	3	3	3	3	3
	126	124	119	154	131	154	136	119	132	152	3	3	3	3	2	2	2	2	2	2
	136	213	182	141							2	1	1	1						

Table 3: Dating the site master curve from Bradford-on-Avon Tithe Barn, AD 1174-1324. *t* values with dated reference chronologies. All of the reference chronologies are independent.

Reference chronology	*t* value
Baylolls Manor, Harwell, Oxon (Haddon-Reece and Miles 1992)	6.01
Droitwich: Upwich2 (Groves and Hillam forthcoming(b))	6.61
Chichester: Bishop's Kitchen (Tyers and Hibberd 1993)	6.94
Exeter Cathedrall (Mills 1988)	9.86
Glastonbury: Abbey Barn (Bridge 1988)	7.57
Hall House, near Sherborne, Dorset (Bridge pers comm)	5.10
Reading, Berks (Groves *et al* fortchcoming)	7.50
Sompting Church, West Sussex (Tyers 1988)	7.54
Winterbourne Tithe Barn, Avon (Hillam 1991)	8.37

Table 4: Details of the tree-ring dates. hs - heartwood/sapwood transition.

Sample	Date span of measured rings	Felling date range	Comment
06	AD 1204-1321	AD 1331-*c.*1395	near hs
08	AD 1174-1250	after AD 1260	-
11	AD 1187-1324	AD 1334-1379	hs
12	AD 1192-1293	AD 1303-*c.*1370	near hs
13	AD 1214-1314	after AD 1324	-