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TREE-RING ANALYSIS OF OAK TIMBERS FROM THE ABBEY FARM COTTAGE AND BARN, THETFORD, NORFOLK, 1992

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Summary

Analysis of timbers from the medieval Abbey Farm barn resulted in the production of a felling date range of AD1532-c.1540 for three timbers. No conclusive dating was obtained for the timbers analysed from the Abbey Farm cottage.

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Introduction

The medieval Abbey Farm barn and cottage (TL865835) stand adjacent to each other and are situated at the north west corner of the former precinct of the Cluniac Priory. The barn is an eight bayed, two storey building. The four western bays, in which the most striking feature is the central moulded crown post truss, were originally an independent building within the monastic precinct. A date of *circa* AD1400 is proposed on stylistic and constructional grounds for the initial erection of this building (Heywood pers comm). The four eastern bays, which contain much re-used timber, represent an extension. They were probably added when the function of the original building was changed shortly after the dissolution of the monastery towards the mid-16th century AD (Heywood pers comm).

The cottage which stands to the east of the barn could be of a slightly earlier date (Mitchell pers comm). The roof structure has clearly been altered with new wall plates being inserted. It also contains re-used timbers.

Tree-ring analysis was undertaken in 1992 with the aim of producing precise dates for the timbers, and hence providing more precise dating evidence for the construction and subsequent modifications to both the barn and cottage.

Method

In April 1992 all safely accessible timbers in both buildings were briefly appraised and the timbers most suitable for dendrochronological analysis (ie those with sapwood and/or long ring sequences) noted. At the time of sampling little architectural information was available apart from the importance of the moulded crown post truss (truss 7) in the barn and the scarf jointed north lower wall plate in the cottage roof (Figures 1; 2; 3). The sampling of timbers not closely associated with the key architectural features was carried out with the aim of at least providing a basic chronology and thereby increasing the chances of successfully dating timbers that were from the crown post truss and the scarf jointed wall plate (see below).

The samples were obtained by use of a corer attached to an electric drill which leaves a hole of approximately 13mm diameter. It is usual to remove only one core per timber. However if the first core is clearly unusable due to it having broken or perhaps the ring pattern being badly distorted, a second core will be taken (eg B7a, B7b). Each core was polished with an electric sander and then by hand using fine silicon carbide paper so that the annual growth rings were clearly defined. The position of each sample has been recorded and has been indicated on the plans of the barn and cottage made available by English Heritage and Breckland District Council (Figures 1; 2; 3). The numbers of the trusses in the barn were allocated by the authors during sampling to aid the recording of the position of each core.

Any samples unsuitable for dating purposes were rejected before measurement but a note was made of the number of rings and the average growth rate. Unsuitable samples are usually those with unclear ring sequences or less than 50 rings. Ring patterns with fewer than 50 rings are generally unsuitable for absolute dating as they 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 built by the City of London Polytechnic. The travelling stage is connected to an Atari microcomputer which uses a suite of dendrochronology programs written by Ian Tyers (pers comm 1992). 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 of crossmatching is aided by the use of programs on the Atari microcomputer. The crossdating routines are based on versions of CROS (Baillie & 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 & 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). Although there is no precisely defined limit, individual oak timbers which match with *t* values over approximately 10.0 are likely to have been derived from the same tree.

Dating is achieved by crossmatching ring sequences within a phase or building and combining the matching patterns to produce a site master curve. All previously unmatched ring sequences from the site are compared with this master curve and if any additional patterns are found to crossmatch these are incorporated into the site master curve. This master curve and all unmatched ring sequences from individual timbers 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 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. The possibility of a timber structure having undergone repair work should also be taken into account. 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 archaeological and documentary evidence.

Results

The timbers

The major structural timbers in the two buildings were oak (*Quercus* spp). Those in the cottage seemed to have been shaped from complete trunks, whilst the barn appeared to contain a mixture of timbers converted from either whole or halved trunks. The pith was probably present in the majority of timbers, although it was not necessarily sampled. Although it did not survive coring, sapwood was apparent on nearly all of the cottage timbers but was less common in the barn. The method of conversion suggests that many of the remaining timbers may only have sapwood and a few heartwood rings missing.

The presence of many timbers with fewer than 50 rings and the fact that none of the cores had more than 92 rings suggests that most of the timbers used in both buildings probably originated from relatively small young trees under approximately 100 years old when felled.

The average ring width of the cores ranges from 1.3-4.0mm, with the majority growing at a rate of at least 2.0mm per year. The average ring width of the timbers rejected before sampling is also likely to be relatively wide as the selection of timbers suitable for dating purposes chooses those with the most, and therefore probably the narrowest, rings. Thus it seems likely that, with the possible exception of B4 which had an average growth rate of 1.3mm/year, the trees used in the construction of the barn and cottage were probably from a relatively open environment rather than dense woodland where competition would have been more severe.

Dating

Four cores from the barn and three from the cottage had less than 50 rings and were therefore rejected before measurement. The remainder from the barn contained 53-92 rings, whilst those from the cottage had 54-60 rings (Table 1). The ring patterns of the nine measured samples were compared. The visual matches between samples B1, B2 and B3 were excellent and produced t values of around 10.0 (Figures 4; 5). This suggests that the three timbers were probably derived from the same tree (see above). The ring width data from the three samples were combined to produce a single 70 year ring pattern, BARN/S3 (Table 2). The ring sequences from C2 and C4 also crossmatched (t = 6.2) and were combined to form a 71 year master sequence, COTT/T2 (Figure 6; Table 3). No other conclusive matching was obtained between the samples, although at this stage tentative matches were noted between COTT/T2 and samples C6 and B4.

The curves BARN/S3 and COTT/T2 and the unmatched ring patterns from the individual timbers were compared with dated reference chronologies from the British Isles spanning the period AD404 to present day. Consistent results were obtained for BARN/S3 when it covered the period AD1461-1530 (Table 4). This date was confirmed by visual and statistical comparison of the individual ring sequences included in the master curve with dated reference chronologies (Table 4). Conclusive results were not produced by COTT/T2 or any of the previously unmatched individual timbers so these remain undated. The tentative matching noted between COTT/T2 and samples C6 and B4 was not confirmed.

All three dated cores (B1, B2, B3) from the barn had some sapwood rings present which by applying the 10-55 sapwood estimate (95% confidence limits) indicates that their parent trunk was felled during the period AD1530-1567. Bark edge was recognised on timber B3 and some sapwood was also lost from B1 and B2. In each case by examining sections of the timbers where the rings were visible in cross-section (ie in mortises) it was possible to estimate the number of rings lost from the outer edge of the cores (Table 1). Using this information it is possible to refine the above felling date range and suggest that the three dated tiebeams from trusses 2, 3 and 5 in the barn were felled after AD1531 but probably before *circa* AD1540 (Table 5).

These tiebeams are however from the eastern half of the barn, the later extension, and therefore do not date the construction of the original building comprising of the four western bays. If the three timbers were used primarily in the extension, a date of AD1532-*c*.1540 is indicated by the tree-ring results for the construction of the current roof. However it was noted by Haywood (pers comm) that much of the timber in the eastern half of the barn appeared to be re-used. Consequently more detailed architectural information is required to determine whether these three tiebeams are primary timbers or whether they are secondary timbers re-used at a later date from another building. If the latter is the case then the tree-ring results can only indicate that they were used in the construction of the roof of the extension after the mid-16th century AD. It is however noticeable that the timbers were felled and initially used during the period of dissolution of the monasteries.

Conclusion

The analysis has not been able to provide any additional dating evidence for the cottage but tree-ring dates have been obtained for three tiebeams from the eastern half of the barn. Further architectural evidence is required to determine whether these timbers are primary and therefore indicate a date of construction for the extension to the barn of AD1532-*c*.1540 or whether they have been re-used from another building. Future renovation of the buildings may allow access to previously inaccessible timbers. The acquisition of additional samples may help resolve some of the dating problems.

The relative shortness of the ring sequences and lack of relative dating must be contributory reasons for the remaining timbers not dating. However there is also a lack of local reference material spanning the second millennium AD. Timbers from East Anglia have proved particularly difficult to date in the past (eg Hillam 1985) and it is only relatively recently that late medieval and post medieval chronologies have successfully been produced from buildings in Essex (Tyers 1992).

Acknowledgements

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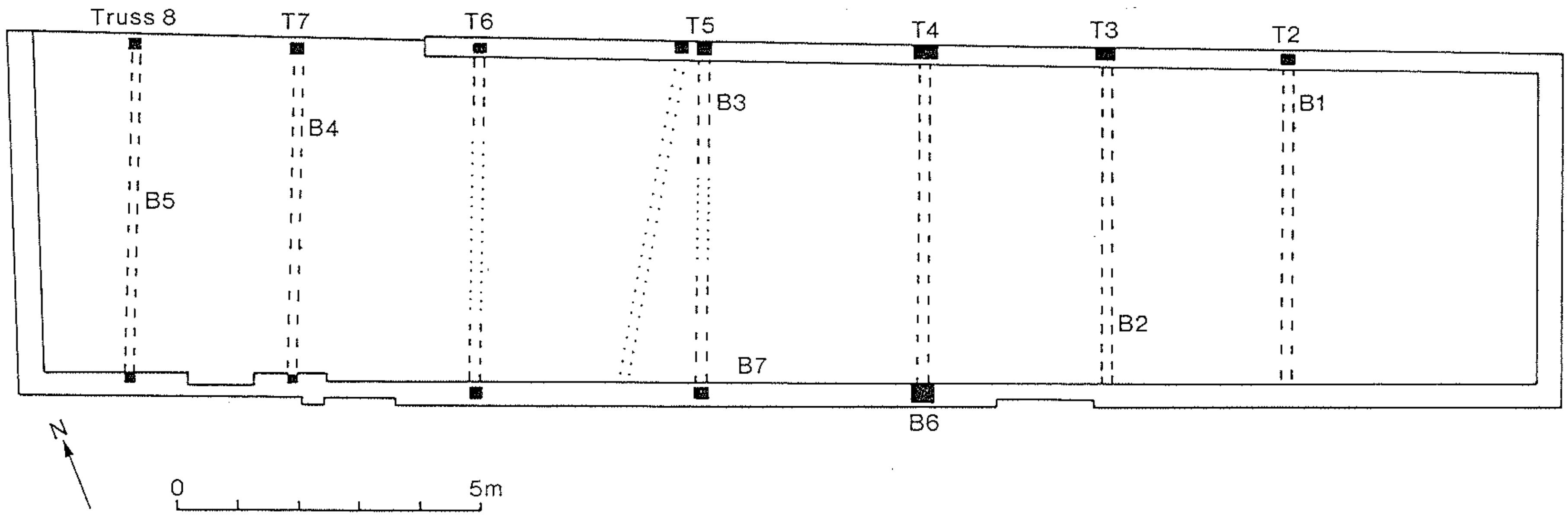


Figure 1: Plan of Abbey Farm barn reproduced from drawings made available by Breckland District Council and English Heritage. The timbers sampled are indicated by the sample number (B*n*). The precise location of each core is not given on the plan but can be found in Table 1.

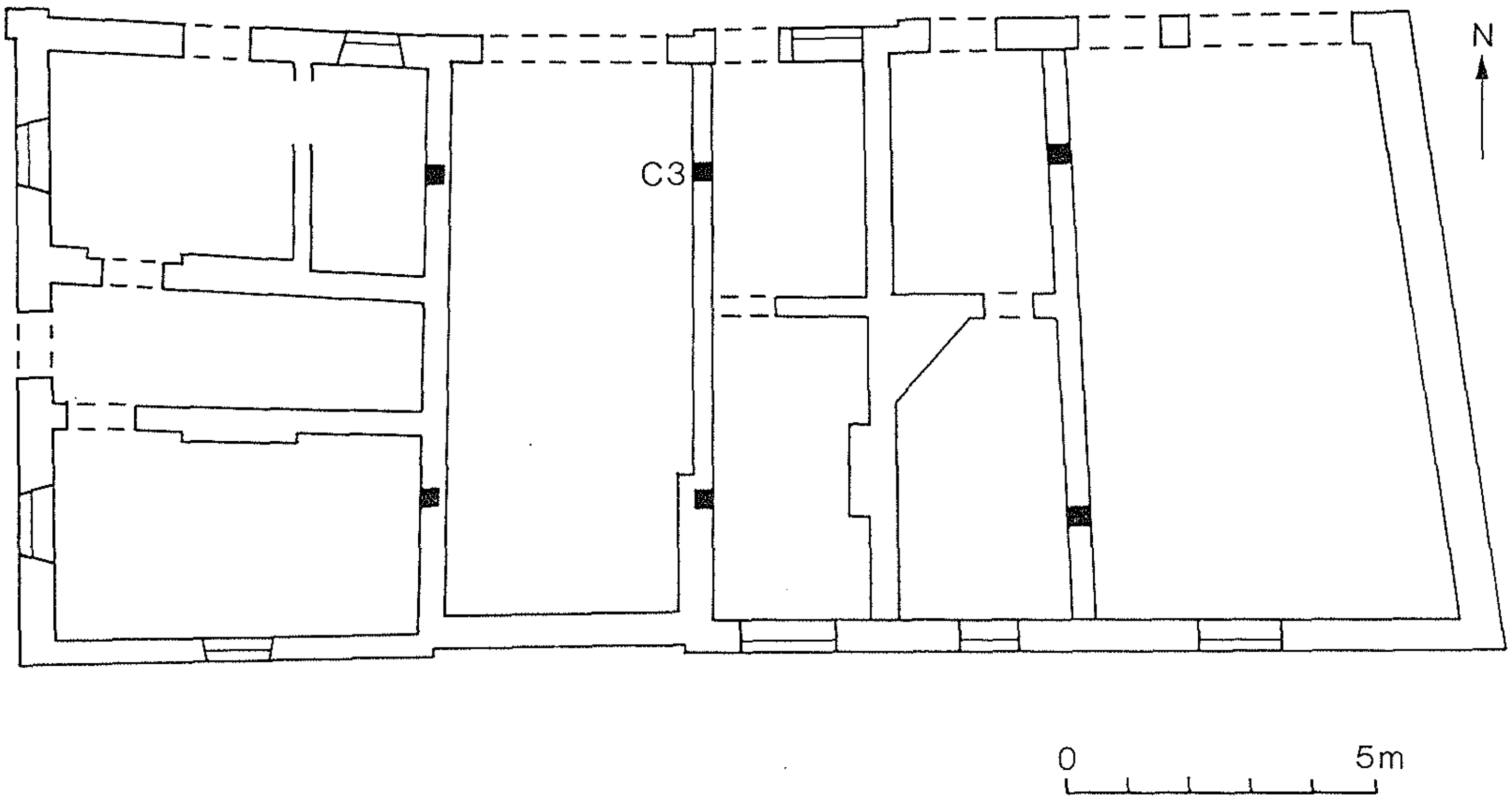
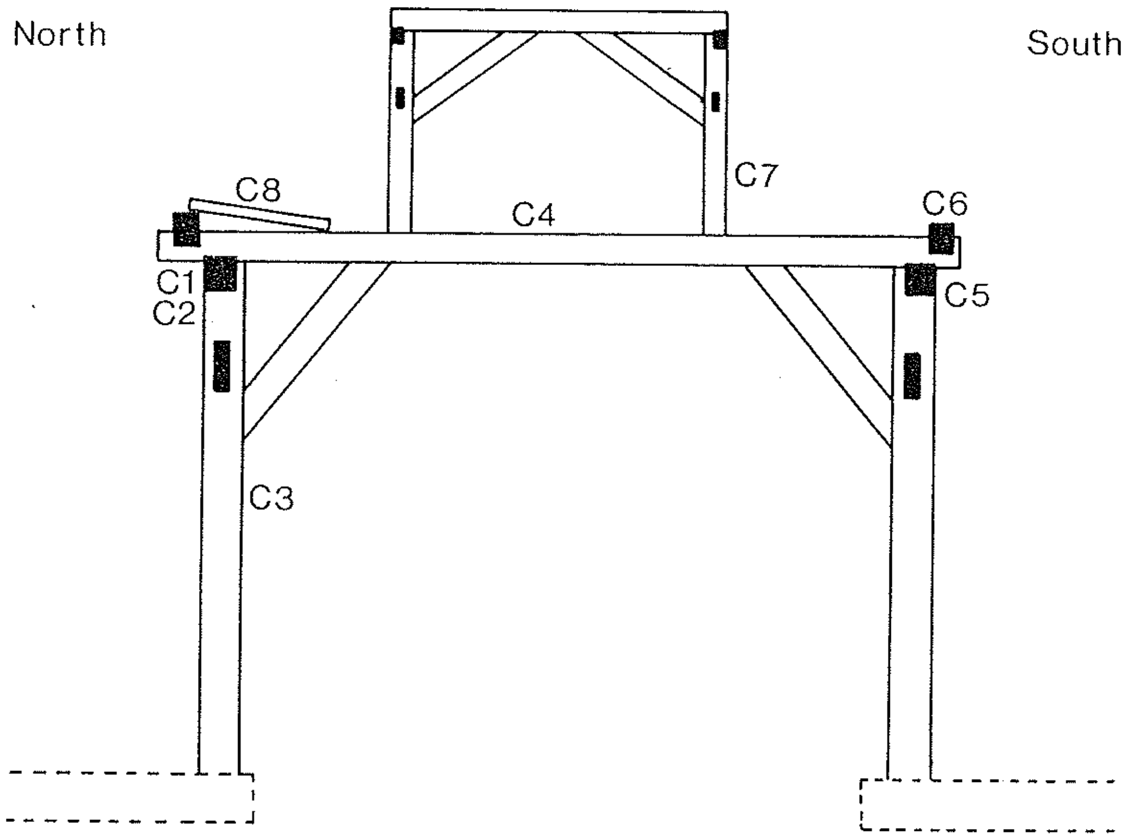


Figure 2: Plan of Abbey Farm cottage reproduced from drawings made available by Breckland District Council and English Heritage. The location of timber C3 is indicated. See Table 1 for the exact location of the cores.



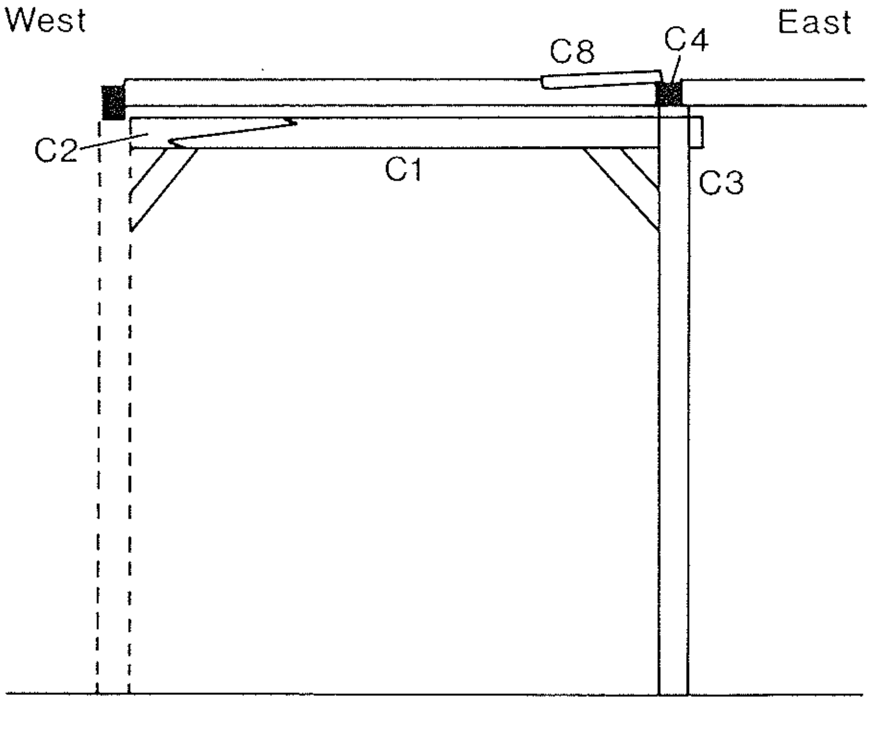


Figure 3: Diagrams indicating the timbers sampled in the Abbey Farm cottage. See Table 1 for the exact location of the cores.

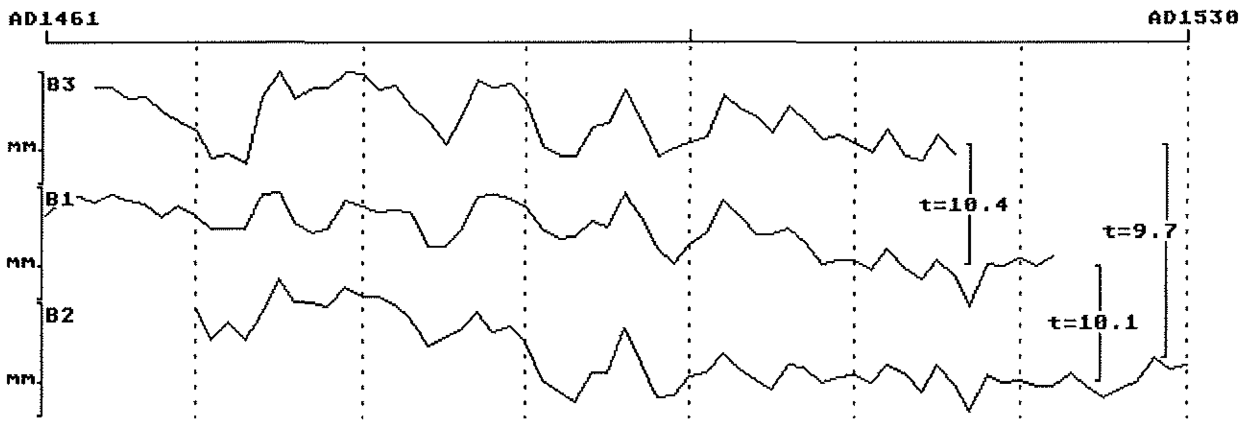


Figure 4: Diagram illustrating the matches between the ring sequences of samples B1, B2 and B3.

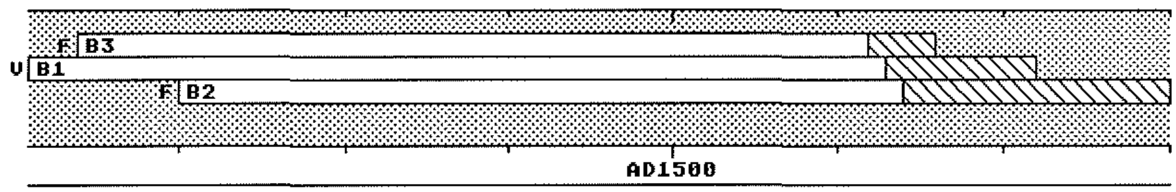


Figure 5: Bar diagram showing the relative positions of the dated ring sequences from Abbey Farm barn. White bars - heartwood rings; shaded bars - sapwood; V - innermost measured ring is within 5 rings of the pith; F - innermost measured ring is within 10 rings of the pith.

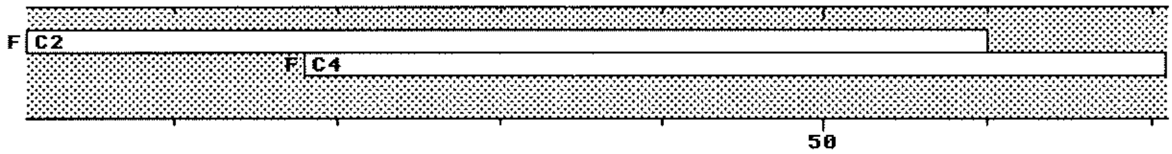


Figure 6: Bar diagram showing the relative positions of the matched rings sequences from Abbey Farm cottage. White bars - heartwood rings; F - innermost measured ring is within 10 rings of the pith.

Table 1: Details of the tree-ring samples from the Abbey Farm barn and cottage, Thetford, Norfolk.

Sample number	Location	Total number of rings	Sapwood rings	Average growth rate (mm/year)	Comment
Barn					
B1	Truss 2 tiebeam 67cm from north wall plate	62+	9	2.3	+6-8 sapwood rings
B2	Truss 3 tiebeam 138cm from south wall plate	61+	16	2.1	+2 sapwood rings
B3	Truss 5 tiebeam 78cm from north wall plate	53+	4	2.1	+15-25 sapwood rings to bark
B4	Truss 7 tiebeam 165cm from north wall plate	92	-	1.3	-
B5	Truss 8 tiebeam 221cm from north wall plate	40	-	4.0	ring pattern distorted
B6	Truss 4 south post 52cm down from tiebeam	46	-	3.4	-
B7a	Truss 4-5 south wall plate 28cm from truss 5 tiebeam	30	-	-	ring pattern very distorted
B7b	Truss 4-5 south wall plate 52cm from truss 5 tiebeam	28	-	2.3	-
Cottage					
C1	north lower wall plate 89cm from east post	47+	-	2.1	+10 rings
C2	north lower wall plate 391cm from east post	60	-	2.2	-
C3	north post 29cm down from tiebeam	40	-	2.2	+20-25 rings
C4	tiebeam 182cm from north post	54	hs	2.1	full sapwood but not sampled
C5	south lower wall plate 186cm from east post	59	?hs	2.0	full sapwood but not sampled
C6	south upper wall plate 70cm from east post	58	?hs	1.6	full sapwood but not sampled
C7	raised aisle post 23cm above tiebeam	<50	-	-	core fragmented
C8	dragon tie linking north upper wall plate to tiebeam	57	-	1.5	-

Table 2: Ring width data of the curve BARN/S3, AD1461-1530.

years	ring widths (0.01mm)										number of samples per year									
AD1461	267	344	386	346	377	317	312	236	249	282	1	1	1	2	2	2	2	2	2	3
	173	206	171	352	544	326	336	329	490	437	3	3	3	3	3	3	3	3	3	3
	388	376	289	174	163	220	397	341	353	273	3	3	3	3	3	3	3	3	3	3
	136	113	111	171	168	350	193	100	95	126	3	3	3	3	3	3	3	3	3	3
AD1501	147	276	208	158	134	194	160	109	120	113	3	3	3	3	3	3	3	3	3	3
	95	143	102	80	128	89	50	108	101	109	3	3	3	3	3	3	2	2	2	2
	96	105	118	93	72	89	98	160	131	142	2	2	1	1	1	1	1	1	1	1

Table 3: Ring width data of the undated curve COTT/T2.

years	ring widths (0.01mm)										number of samples per year									
1	395	243	265	296	254	137	174	128	178	349	1	1	1	1	1	1	1	1	1	1
	397	175	198	186	157	198	337	317	267	258	1	1	1	1	1	1	1	2	2	2
	327	320	315	324	269	314	359	329	238	132	2	2	2	2	2	2	2	2	2	2
	130	235	309	281	232	211	221	226	210	121	2	2	2	2	2	2	2	2	2	2
	139	187	132	186	287	245	151	83	80	64	2	2	2	2	2	2	2	2	2	2
51	110	141	99	138	184	219	185	202	231	253	2	2	2	2	2	2	2	2	2	2
	245	244	254	215	175	123	170	171	215	269	1	1	1	1	1	1	1	1	1	1
	242										1									

Table 4: Results of comparisons between BARN/S3 (AD1461-1530) and the ring sequences B1 (AD1461-1522), B2 (AD1470-1530) and B3 (AD1464-1516) with dated reference chronologies. The East Midlands, Kent, Lowland England and Oxford curves are composite chronologies containing data from many sites and are not necessarily independent. SDL - Sheffield Dendrochronology Laboratory; *t* values of less than 3.0 are not given.

reference chronology	t value BARN/S3	B1	B2	B3
East Midlands (Laxton & Litton 1988)	4.5	3.6	4.8	4.4
Kent (Laxton & Litton 1989)	5.7	5.4	5.4	4.1
Lowland England (Tyers pers comm)	4.0		3.7	
Oxford (Haddon-Reece & Miles pers comm)	4.4	3.6	4.0	3.6
Cowfold barn, Sussex (Tyers 1990)	4.1		4.6	
Doncaster (SDL unpublished)	4.9	3.5	5.4	4.0
Exeter: 198 High Street (SDL unpublished)	4.7	4.4	4.4	
London: Southwark (Tyers pers comm)	4.3		3.8	4.1
Nuffield, Oxon (Haddon-Reece et al 1989)	4.7		4.0	
Rookwood Hall barn, Essex (Tyers pers comm)	4.8	4.1	4.9	3.4
France: La Pacaudiere (Trenard pers comm)	3.1		3.6	
Germany: South (Becker 1981)	4.2	3.7	4.2	3.1
Weser & Leine (Delorme 1972)	4.3	3.6	3.9	4.3
West (Hollstein 1980)	3.9	3.2	3.9	

Table 5: Details of the tree-ring dates for the three tiebeams from the Abbey Farm barn. The date of the heartwood-sapwood transition is given in brackets.

Sample number	Date span of measured rings (AD)	Comment	Felling date (AD)
B1	1461-1522 (1513)	+6-8 sapwood rings, same tree as B2 & B3	1532-*c*.1540
B2	1470-1530 (1514)	+2 sapwood rings, same tree as B1 & B3	1532-*c*.1540
B3	1464-1516 (1512)	+15-25 sapwood rings to bark, same tree as B1 & B2	1532-*c*.1540