Ancient Monuments Laboratory
Report 17/98

TREE-RING ANALYSIS OF TIMBERS FROM FYFIELD HALL, ESSEX

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Summary

This complex building appears to be centred on a two-day aisled hall, the earth-fast corner posts of which are carved in a style which suggests that they date from AD 1160 - AD 1240 (Hewett 1980). The central arcade posts and arched braces are from a later rebuild of the hall. Two tree-ring dates had previously been obtained, both based on material taken in 1985. One date was from what is thought to be a re-used timber forming an aisle tie on the north side of the central north post and had an outside ring (the fifth sapwood ring) formed in AD 1135, and the second from the central northern arcade post itself had an outer ring (the fourth sapwood ring) formed in AD 1385. Neither sample had the bark edge present. The present study confirms both these dates and extends the data set to include several elements of the roof structure, all of which were of oak. It gives narrower felling date ranges based on multiple samples which date the felling of the timbers for the first phase, assuming them to come from a single batch of timbers, to AD 1167 to 1185, and the felling of timbers for the major rebuild including the central arcade posts and easternmost arcade plates to AD 1397 to 1416, again assuming that these represent a single batch of timbers, using the sapwood number range 10-55 rings. This information shows Fyfield Hall to be one of the oldest inhabited houses in England.

Author's address :-

Dr M C Bridge
INSTITUTE OF ARCHAEOLOGY (LONDON)
University College London
31-34 Gordon Square
London
WC1H OPY

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Introduction

This report outlines previous attempts at dating phases of construction at Fyfield Hall (TL57250690) both by radiocarbon and dendrochronological study. It then details new dendrochronological evidence carried out at the request of Richard Bond of English Heritage in association with John Walker, an independent building historian. The results of each of these studies are discussed and conclusions drawn. It should be pointed out however that many other aspects of the building and its history are being investigated by other workers, and that the conclusions drawn as a result of the dendrochronological studies may need subsequently to be modified in the light of new evidence.

The building has been of great interest to building historians for many years. It contains examples of work from many periods, but some features are thought to be very early, particularly the carved arcade posts, which Hewett dated on stylistic grounds to be probably between AD1160 and AD1240 (Hewett 1980). Hewett also describes how the main-span roof and tie beams are not integrated with the substructure. The arcade posts have had secondary posts added on the inner side of the building and the arched braces between these posts (Fig 1) are presumably also secondary.

The building's importance in the evolution of various phases of development made it an early target for dendrochronological investigation. In 1985 Gwyn Meirion-Jones, Jon Pilcher, and Don Shewan took cores from various timbers, but found most of them to have few rings. A sample from an aisle tie abutting post 2 on the north side (Fig 1) was dated - its last ring (the fourth sapwood ring) being formed in AD 1135, with the sapwood estimate applied at that time (32 ± 9) giving a likely felling date in the range AD 1154 to AD1172. This tie is now thought to be a re-used timber (Walker pers comm) so this does little to date the structure.

A radiocarbon date was sought in 1987 on wood taken from post 1 (HAR-8601), although I have found no reference to what part of the post this sample came from. This result was reported as 1140 ± 40 BP. Like many radiocarbon results there appears to have been a great deal of confusion on the part of the recipients of the result, but Pilcher (pers comm 1988) suggests that the calibrated date range AD 785 to 985 (based on Stuiver and Pearson 1986) quoted in the Harwell report should be the date range reported for this sample. With no evidence of whether this sample included sapwood, or even how many rings the sample contained, many years may need to be added to this range to arrive at a date for the outermost rings of the original tree.

Ian Tyers later visited the structure to try and ascertain the locations of the 1985 samples, but did not resample on that occasion (Tyers pers comm). Using Pilcher's data he attempted crossmatching with the many more datasets that had become available since the original investigation, and stated that arcade post 2 (Fig 1) came from a later period - with a felling date range of AD 1390 to 1425, giving good crossmatching with his chronology from Cressing Temple, only some 28 km away (Tyers 1993).

The present study is based on samples taken in March 1997, with four additional cores taken in August 1997. Samples from several elements of the roof over the early two-bayed hall were taken and some of the timbers sampled previously were resampled to overcome any doubts about the origin of the earlier samples.

Methodology

Most samples of the *in situ* timbers took place immediately following an assessment of their suitability for dendrochronological study in March 1997. The timbers appeared to have sufficient numbers of rings, and several also showed sapwood surviving. Four additional cores were extracted in August 1997 to further assist in the interpretation of the building. Samples were removed using purpose-made 15mm diameter corers attached to an electric drill (a system developed from commercially available corers by Don Shewan at London Guildhall University). The location of samples is shown in Figure 1 and listed in Table 1.

The cores were glued to wooden laths, labelled, and stored for subsequent analysis. The holes were filled with softwood dowels held in place with Evostick wood adhesive. The cores were prepared for measuring by sanding using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Those samples with more than 50 annual rings had their sequences measured to an accuracy of 0.01 mm using a specially constructed system utilizing a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to an Atari desktop computer. The software used in measuring and subsequent analysis was written by Ian Tyers (pers comm 1992).

Suitably long ring sequences were plotted on translucent semi-log graph paper to allow visual comparisons to be made between sequences on a light table. This activity also acts as a measure of quality control in identifying any errors in the measurements. Statistical comparisons were made using Student's t-test (Baillie and Pilcher 1973; Munro 1984). Any internal site mean sequences produced are then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date them. The *t*-values quoted below were derived from the original CROS program (Baillie and Pilcher 1973) in which *t*-values in excess of 3.5 are taken to be indicative of acceptable matching positions provided that they are supported by satisfactory visual matches (Baillie 1982, 82-5).

The dates thus obtained represent the time of formation of the rings available on each sample; interpretation of these dates then has to be undertaken to relate these findings to the likely felling dates of the trees used and then relate these in turn to the construction date of the phase under investigation. Where only heartwood is found on the sample, one can make allowances for the expected number of sapwood rings on the tree and add this to the date of the last available ring to give a date after which felling took place; one does not know how many heartwood rings may be missing in these cases. Where the heartwood/sapwood boundary is found, or some sapwood rings survive, a felling date range can be calculated using the best available estimate of the number of sapwood rings likely to have been on the original tree (Baillie 1982).

In this report, the sapwood estimate employed is a minimum of 10 rings and a maximum of 55 rings, representing the 95% confidence limits derived by Hillam *et al* (1987). Where bark is present, the year of felling will be the date of the last surviving ring. In such cases it is often possible to determine the season of cutting by looking at how much of the ring has been formed. In the previous study by Jon Pilcher, the sapwood estimate was taken as 32 ± 9, based on work in the Belfast tree-ring laboratory (Baillie 1982).

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the roof. Evidence suggests that, except in the re-use of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

Results

All timbers sampled were of oak (*Quercus* spp.). Details of where the samples were taken are given in Figure 1 and Table 1 along with some samples from the 1985 investigation. Very strong crossmatching was found (Table 3) between all four samples from the central north arcade post (Q5953, Q5954, FYF11, and FYF12) and these were combined into a single sequence of 93 years representing post 2. Similarly, samples FYF07 and Q5962 crossmatched (t = 5.6) and were combined to yield a 66 year sequence for post 4. Samples FYF01 and FYF02 from the central tie beam crossmatched well (t = 26.2) and were combined into a single tree-ring sequence for subsequent analysis.

Nine sequences (Q5955A+Q5955B, FYF01+FYF02, FYF03, FYF04, FYF05, FYF06, and FYF13, FYF15, and FYF16) were combined into a single chronology **FYFIELD 1** (Table 6), This was crossmatched with several reference and site curves (see Table 5). The crossmatching between the individual elements in this chronology is shown in Table 2 and illustrated in Figure 2a.

The post 2 sequence crossmatched well with the samples from both the arcade plates from the east bay, FYF08 and FYF17 (Table 4) and these were combined (Fig 2b) to form a second sequence **FYFIELD 2** (Table 6), which was dated against a number of curves, the results being shown in Table 5.

Table 1: List of samples taken from Fyfield Hall, Essex

Sample No.	Origin of core	Total number of years	Sapwood details	Average growth rate (mm yr^{-1})	Date of sequence	Felling date of sequence
FYF01	Central tie beam	71	not determined	1.27	1096 - 1166	1167 - 1211
FYF02	Central tie beam	95	8	1.20	1070 - 1164	1167 - 1211
FYF03	Rafter 10 south	103	-	0.66	1007 - 1109	after 1119
FYF04	Collar to rafter 11	80	-	0.66	1052 - 1131	after 1141
FYF05	Rafter 12 south	54	5	1.22	1101 - 1154	1159 - 1204
FYF06	Collar to rafter 16	72	-	0.79	1040 - 1111	after 1121
FYF07	Arcade post 4	51	-	2.25	unknown	-
FYF08	South arcade plate, east bay	79	12	1.29	1295 - 1373	1374 - 1416
FYF09	Brace 3	27	not measured			
FYF10	North arcade plate, west bay	65	18	sample broken, not measured		
FYF11	Arcade post 2 north	71	-	1.24	1298 - 1368	1391 - 1436
FYF12	Arcade post 2 north	52	-	1.42	1306 - 1357	1391 - 1436
FYF13	Post 3A	64	-	1.61	1061 - 1124	after 1134
FYF14	Additional lower collar, east end	not measured				
FYF15	Additional lower collar, east end	148	-	1.01	981 - 1128	after 1138
FYF16	Additional lower collar, west end	188	-	0.80	946 - 1133	after 1143
FYF17	North arcade plate, east bay	75	1	2.09	1314 - 1388	1397 - 1442
Samples taken in 1985 by Jon Pilcher, Don Shewan, and Gwyn Meirion-Jones						
Q5953	Arcade post 2 north	91	-	1.19	1293 - 1383	1391 - 1436
Q5954	Arcade post 2 north	86	4	0.99	1300 - 1385	1391 - 1436
Q5955A	Aisle tie (re-used)	180	5	0.29	956 - 1135	1140 - 1185
Q5955B	Aisle tie (re-used)	92	-	0.57	944 - 1035	1140 - 1185
Q5962	Arcade post 4	62	-	2.14	unknown	-

Table 2: Correlation between the dated series from the primary phase of Fyfield Hall, Essex. The values are *t*-values derived from CROS 73 (Baillie and Pilcher 1973). Dashes represent values less than $t = 3.0$, * = overlap less than fifteen years.

	FYF01+02	FYF03	FYF04	FYF05	FYF06	FYF13	FYF15	FYF16
Aisle tie	-	7.1	4.3	-	4.3	3.7	5.8	3.6
FYF01+02		-	6.1	5.5	4.0	5.1	3.9	-
FYF03			3.3	*	5.3	4.8	6.0	4.6
FYF04				-	6.1	6.6	3.0	3.8
FYF05					*	-	-	-
FYF06						4.7	4.9	4.1
FYF13							4.3	4.8
FYF15								8.4

Note: FYF05 has very little overlap with most timbers, see Figure 2.

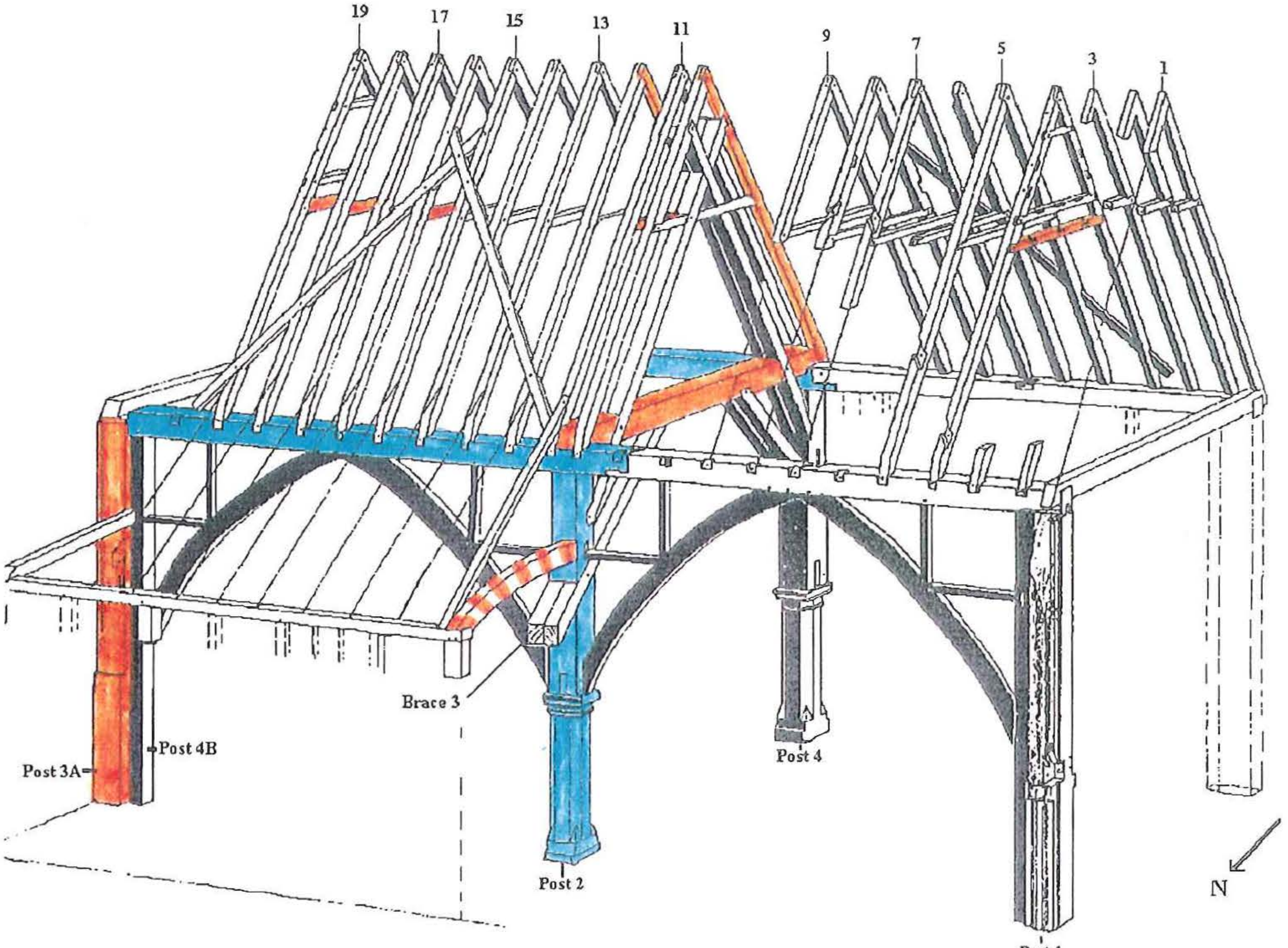
Table 3: Correlation between the individual samples from post 2 of Fyfield Hall, Essex. The values are *t*-values derived from CROS 73 (Baillie and Pilcher 1973)

	Q5954	FYF11	FYF12
Q5953	12.9	9.2	5.6
Q5954		8.2	6.4
FYF11			5.2

Table 4: Correlation between the dated series from the rebuilding phase of Fyfield Hall, Essex. The values are *t*-values derived from CROS 73 (Baillie and Pilcher 1973).

	FYF08	FYF17
POST 2	5.2	5.4
FYF08		5.0

Figure 1: Drawing of the extant timbers of Fyfield Hall, showing phases of dated timbers, based on an original drawing by John Walker.

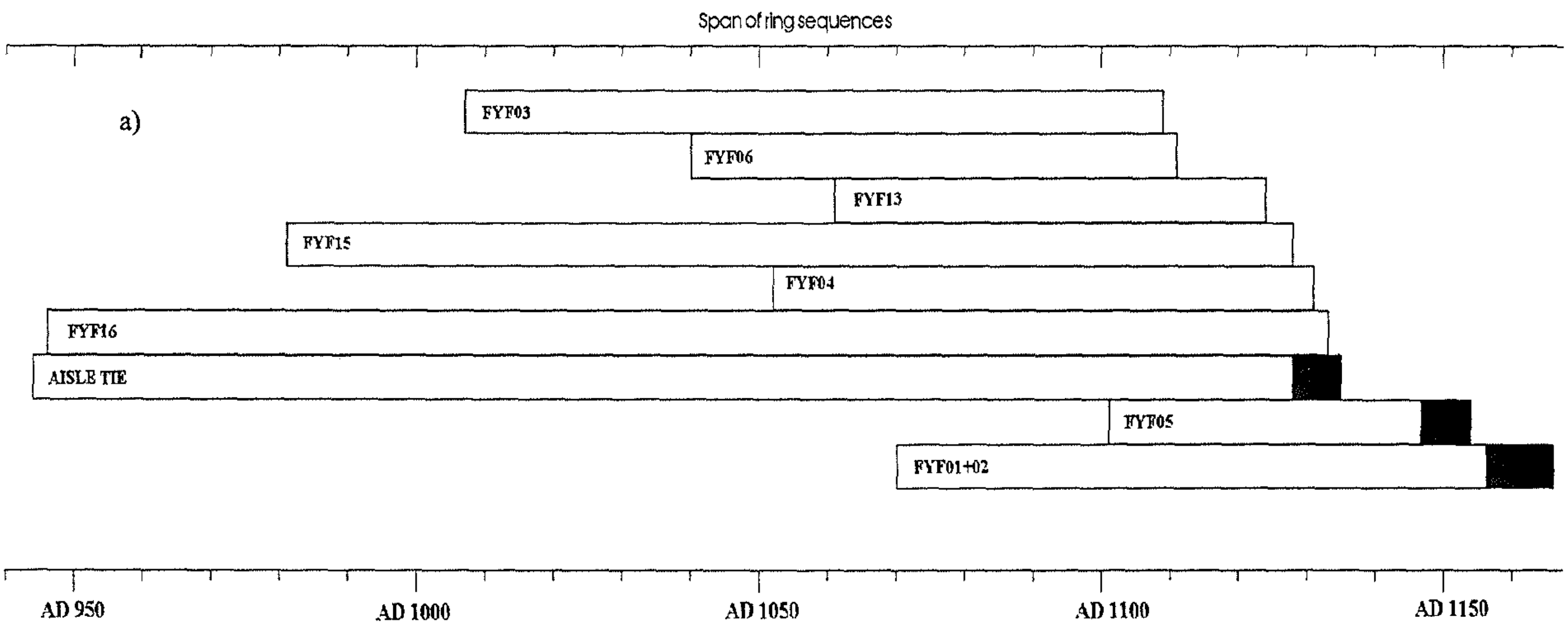



Timber dated to first phase (FYFIELD 3) AD 1167 - 1185


Re-used timber from the first phase


Timber dated from the second phase (FYFIELD 4) AD 1397 - 1416

Figure 2: Bar diagrams showing the relative positions of overlap of the sequences in a) FYFIELD 1 and b) FYFIELD 2. The shaded portions represent sapwood



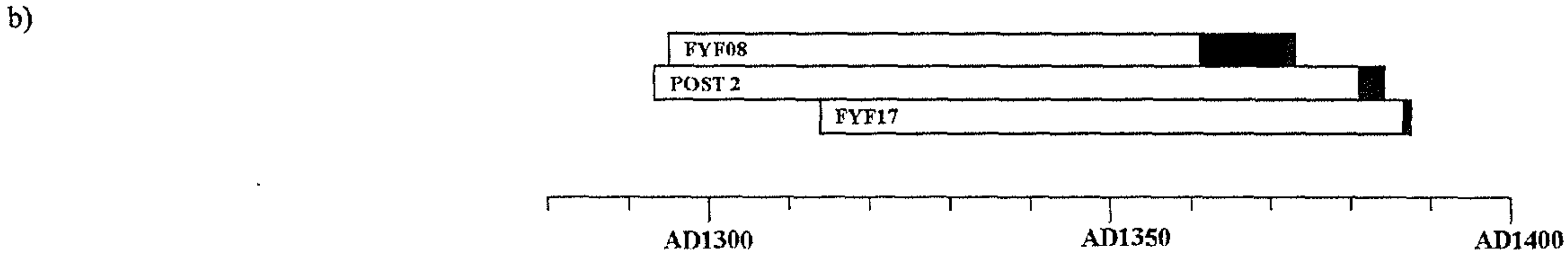


Table 5: Dating of the two master curves FYFIELD 1 and FYFIELD 2 for oak timbers from Fyfield Hall, Essex, giving the *t*-values with dated chronologies.

REFERENCE OR SITE CHRONOLOGY	FYFIELD 1 AD 944-1166 *t* - value	No. of years overlap
London1175 (Tyers pers comm)	7.2	223
Southwark (Tyers pers comm)	7.0	223
Ref 6 (Fletcher 1977)	4.9	223
Southern England (Bridge 1988)	4.7	84
Oxon93 (Miles pers comm)	4.7	223
Glastonbury (Bridge 1983)	5.0	72
Greensted (Tyers 1996)	4.9	110
Farnham (Bridge unpubl)	4.6	91
Cressing 1 (Tyers 1993)	4.1	61

REFERENCE OR SITE CHRONOLOGY	FYFIELD 2 AD 1293 - 1388 *t* - value	No. of years overlap
Southern England (Bridge 1988)	5.9	96
London1175 (Tyers pers comm)	5.3	96
Oxon93 (Miles pers comm)	4.6	96
Southwark (Tyers pers comm)	4.0	96
Upminster (Tyers 1997)	9.5	96
Cressing 2 (Tyers 1993)	5.9	69
Sutton House (Tyers and Hibberd 1993)	5.9	70
Wick (Bridge 1983)	5.8	96
Falconer (Bridge unpubl)	5.7	65
Bletchley (Bridge 1983)	5.0	83

Interpretation

These results confirm the earlier dates obtained separately by Pilcher and Tyers, based on the samples collected in 1985 (see above). The additional cores allow a narrower felling-date range for the timbers of the two phases. If one assumes for each batch that the timbers were all felled at the same time, the overlapping sapwood allowances, ie taking the most recent earliest sapwood ring of the batch and the earliest last sapwood ring of the batch, allow one to restrict the felling periods to **AD 1167 to 1185** for the first phase, and **AD 1397 to 1416** for the major rebuild of the hall. This also assumes that the re-used aisle tie was a member of the first phase group of timbers.

The first phase timbers include the central tie beam, rafters, collars and additional lower collars, the re-used aisle tie, and the outer post in the north-east corner. This presumably also means that the elaborately carved post (post 1) described by Hewett (1980) must also date to this period, though sadly its tree-rings and general condition made it unsuitable for sampling. Sapwood on FYF01 was not easily distinguished, but the eight rings present on FYF02 meant that the felling date for the tree was determined on the basis of this second sample.

The inner corner posts and the central arcade posts, along with the curved braces, represent a much later major rebuild of the hall. Interestingly, the arcade plate on the southern side, in the eastern bay, is also shown to be part of this work, as is the easternmost northern arcade plate. Sadly the sample from the westernmost northern arcade plate broke in several places, making it impossible to measure a continous sequence from this timber. The westernmost southern arcade plate was not accessible. Walker (pers comm) suggests that form of the scarves used in the arcade plates make it almost certain that the western sections were put in place after the eastern sections, concluding that the whole arcade plates must be replacements.

In the past, it has been suggested that only the lower part of post 2 (Fig 1) was replaced, with the replacement capital and shaft being scarfed on to the old post. This can be shown not to be the case as the 1985 samples taken by Meirion-Jones were from first floor level and those in the present study from the base, and they are all of the same date (Table 1).

Those building historians who have so far examined the dendrochronological data presented here suggest that it simplifies the analysis of the building and note that it is interesting that the rebuilding appears to have been carried out in the style of the original (Walker pers comm; Gibson pers comm). The dendrochronological evidence has proved essential in the interpretation of this important building.

The site master chronologies FYFIELD 1 and FYFIELD 2 crossmatch with material from throughout southern England, making it difficult to provenance the timbers. Those of the second phase certainly match well with those from Cressing (Tyers 1993) and Upminster (Tyers 1997) which may suggest a local origin.

The very early dates for the original hall timbers justify the past interest in this building and suggest that it is one of the earliest extant inhabited houses in England.

Acknowledgements

I would like to thank Mr Richard Bond (English Heritage) for providing background information, and Mr John Walker for making the arrangements to sample, helping during the fieldwork, providing drawings, and for useful discussion of the results. I am grateful to Prof Gwyn Meirion-Jones for information regarding earlier coring work at the Hall, and access to correspondence about earlier studies. Prof Jon Pilcher very kindly provided samples and data

from the earlier work. The Hall is currently occupied in two separate dwellings and I am grateful to Mr White senior and Mr and Mrs White for their hospitality during my visits.

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Table 6: Ring-width data for the site chronologies for oak from Fyfield Hall, Essex.

FYFIELD 1

Year	ring widths (0.01mm)	number of trees per year
AD944	113 117 218 231 231 207 242	1 1 2 2 2 2 2
AD951	222 145 66 47 37 55 74 116 147 157	2 2 2 2 2 2 2 2 2 2
	129 105 105 100 123 84 81 73 75 54	2 2 2 2 2 2 2 2 2 2
	51 62 37 43 44 43 38 42 57 54	2 2 2 2 2 2 2 2 2 2
	67 66 78 66 79 95 82 56 65 49	3 3 3 3 3 3 3 3 3 3
	40 38 55 43 58 66 72 65 77 78	3 3 3 3 3 3 3 3 3 3
AD1001	67 62 60 64 58 51 58 69 71 57	3 3 3 3 3 3 4 4 4 4
	63 60 59 51 48 39 35 40 57 54	4 4 4 4 4 4 4 4 4 4
	67 61 64 59 43 61 60 62 60 70	4 4 4 4 4 4 4 4 4 4
	64 52 68 61 77 76 106 72 68 97	4 4 4 4 4 4 4 4 4 5
	70 51 65 66 59 47 50 47 54 41	5 5 5 5 5 5 5 5 5 5
AD1051	47 63 71 56 77 77 65 73 77 79	5 6 6 6 6 6 6 6 6 6
	105 97 100 106 73 106 105 99 91 89	7 7 7 7 7 7 7 7 7 8
	84 63 69 81 95 88 71 87 76 56	8 8 8 8 8 8 8 8 8 8
	58 72 95 72 111 120 82 80 87 66	8 8 8 8 8 8 8 8 8 8
	82 93 104 102 101 92 95 100 80 91	8 8 8 8 8 8 8 8 8 8
AD1101	74 77 91 79 91 85 78 85 92 78	9 9 9 9 9 9 9 9 9 8
	96 107 120 122 149 128 115 106 103 110	8 7 7 7 7 7 7 7 7 7
	70 74 85 126 84 79 74 91 65 81	7 7 7 7 6 6 6 6 5 5
	86 93 86 72 73 90 90 87 63 112	5 4 4 3 3 2 2 2 2 2
	139 116 108 101 102 92 85 130 122 116	2 2 2 2 2 2 2 2 2 2
AD1151	137 146 222 176 194 144 117 117 154 183	2 2 2 2 1 1 1 1 1 1
	178 209 152 178 171 174	1 1 1 1 1 1

FYFIELD 2

Year	ring widths (0.01mm)	number of trees per year
AD1293	263 257 174 202 150 208 184 162	1 1 2 2 2 2 2 2
AD1301	179 203 113 122 102 135 85 105 115 96	2 2 2 2 2 2 2 2 2 2
	74 87 107 203 228 190 196 228 247 219	2 2 2 3 3 3 3 3 3 3
	248 245 241 202 200 100 165 173 181 159	3 3 3 3 3 3 3 3 3 3
	115 126 140 174 174 170 120 122 171 166	3 3 3 3 3 3 3 3 3 3
	147 134 132 144 161 171 148 131 111 85	3 3 3 3 3 3 3 3 3 3
AD1351	97 92 90 87 73 74 95 72 75 67	3 3 3 3 3 3 3 3 3 3
	46 59 106 97 87 76 77 94 124 121	3 3 3 3 3 3 3 3 3 3
	90 99 81 79 88 104 91 126 109 120	3 3 3 2 2 2 2 2 2 2
	94 98 102 93 119 171 207 203	2 2 2 2 2 2 2 2