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Summary

This report describes the results of dendrochronological analysis of samples taken from this Grade II listed town house undergoing repair through the Heritage Economic Regeneration Scheme, which on stylistic grounds was previously believed to date to the sixteenth century.

Four samples taken from roof and wall frame timbers associated with the primary phase of construction were dated and all probably felled in the winter of AD 1474/5. The building therefore appears to be slightly earlier than the expected sixteenth-century date.

Keywords

Dendrochronology
Standing Building

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Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from 66 Church Street, Tewkesbury, Gloucestershire (NGR SO895326; Figure 1). The small, jettied, timber-framed house is a Grade II listed building, currently on the English Heritage Buildings at Risk register (EH 1999). Dating on stylistic grounds is uncertain although a sixteenth-century date is suggested in the listing description. Analysis of the building was requested by Nick Molyneux of English Heritage to provide a precise date for the original construction of the building which is undergoing major repair by the new owner with grant aid under a Heritage Economic Regeneration Scheme. Any successful dating would also assist in the development of a dated typology for an area which is currently not well understood.

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 may therefore have to be modified in the light of subsequent work.

Methodology

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage (1998). Details of the methods used for the dating of this building are described below.

A tour of the building was made in order to identify those oak (*Quercus* spp.) 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 dendrochronological sampling programme attempted to obtain samples from as broad a range of timbers, in terms of structural element types, scantling sizes, and carpentry features, as was possible within the terms of the request whilst also meeting health and safety requirements.

Much of the ground floor has been altered through the replacement of the shop frontage, so sampling was concentrated on temporarily exposed beams and joists in

the ground-floor ceiling/ first-floor floor (Figure 2), offcuts from wall-frame elements cut back for repair (Figures 3-4), and elements of the roof including purlins and principal rafters (Figure 4). A single sample was taken from a beam in the cellar (Figure 5). The joists in the first-floor ceiling/second-floor floor were elm (*Ulmus* sp.) and therefore not sampled.

Cross-sectional slices were taken from sections of five suitable timbers removed during the repair programme. Suitable *in situ* timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The core holes were left open. Sanding revealed the ring sequences in the samples.

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 (Tyers 1999). Cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. The ring sequences were plotted electronically and exported to a computer graphics software package (Coreldraw™ v.8) to enable visual comparisons to be made between sequences at the positions indicated, 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 satisfactory visual matching supports these positions. 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 are 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. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Tyers 1998). Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. 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 re-use 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

Of the thirteen samples taken, twelve had sufficient rings to merit measurement (Table 1). The resultant ring sequences were compared with one another and crossmatching was identified between several samples. Samples 01 and 04, both first-floor joists, crossmatched (Table 2a) and were combined to produce a mean sequence 66CHT2 (Table 4a). Samples from a first-floor rail (06) and a first-floor strut (10) correlated with a sufficiently high *t*-value and close visual match to suggest that these timbers were derived from the same parent tree (Table 2b). A two sample mean calculated from these sequences (06/10) crossmatched with sequences from a purlin (07) and a principal rafter (09). A mean sequence, 66CHT4, was calculated for these matching samples (Table 4b). The two site master sequences and sequences from unmatched individual timber samples were then compared with dated reference chronologies from throughout the British Isles and northern Europe. No consistent results were obtained for 66CHT2, but 66CHT4 was successfully dated. Table 3 shows the correlation of the mean sequence 66CHT4 with dated series at the dating position identified of AD 1371-1474. The relationships between the dated timbers are indicated graphically in Figure 6.

Interpretation

Four of the samples taken have produced absolute tree-ring dates. A felling date has

been calculated for each timber (Figure 6, Table 1). The dated timbers thought to be associated with the primary construction phase appear likely to represent a single felling phase in the winter of AD 1474/5. These are a rail (06), and a post (10) from the first-floor wall frame, and a purlin (07) and a principal rafter (09) from the roof (Figures 2-4). The precision of the dating results highlights the potential of dendrochronology to test and refine our understanding of building typologies, especially in regions where these developments are poorly understood.

Acknowledgements

The sampling and analysis programme was funded by English Heritage. The owner and developer, John Dimylow, provided access, a power supply, and offcuts from repaired timbers. I am grateful to Jacqueline Demaus (Chartered Architect) for permission to reproduce plans and elevations of the building. Cathy Groves and Alex Bayliss kindly made comments on a first draft of the report.

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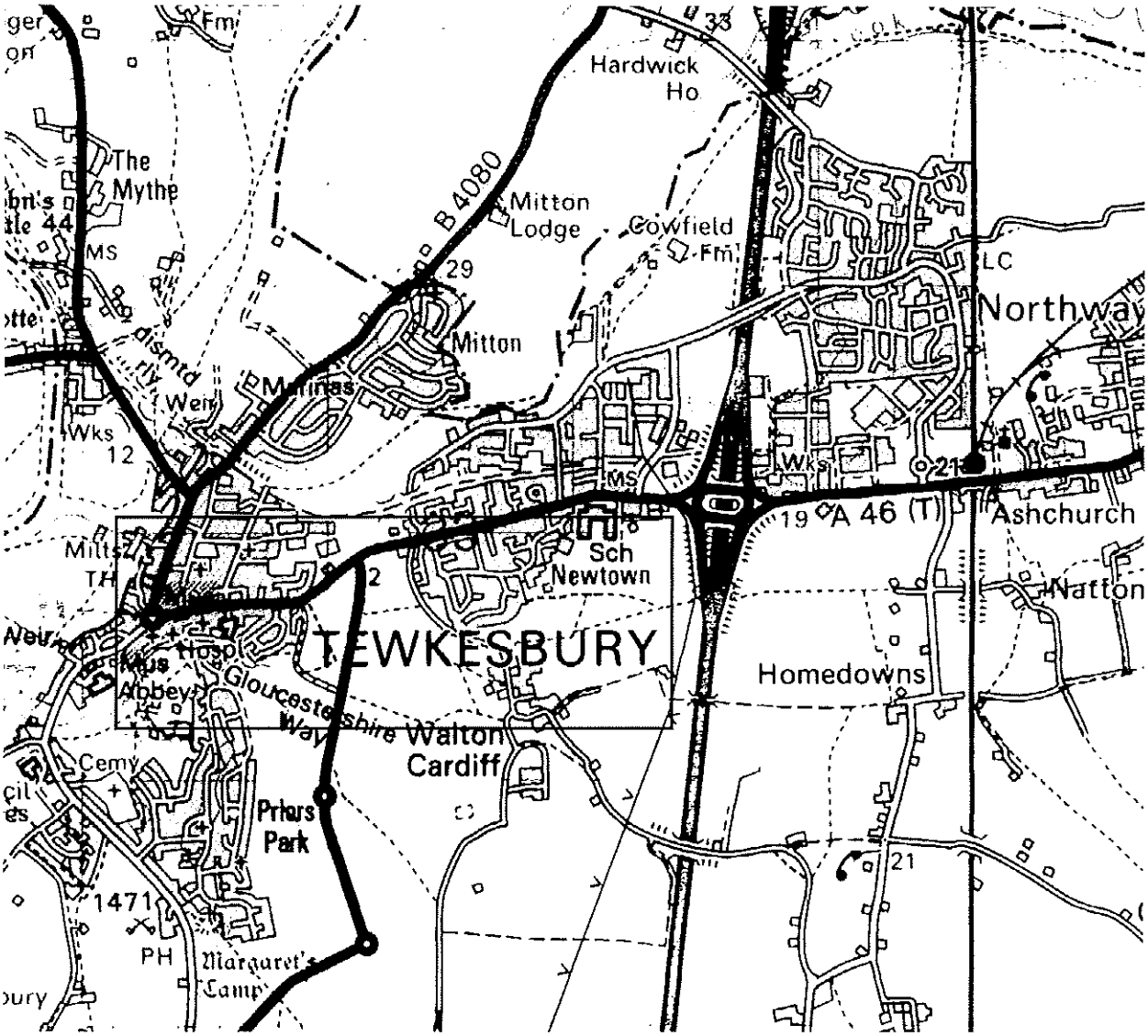

Figure 1 Map showing the location of 66 Church Street, Tewkesbury

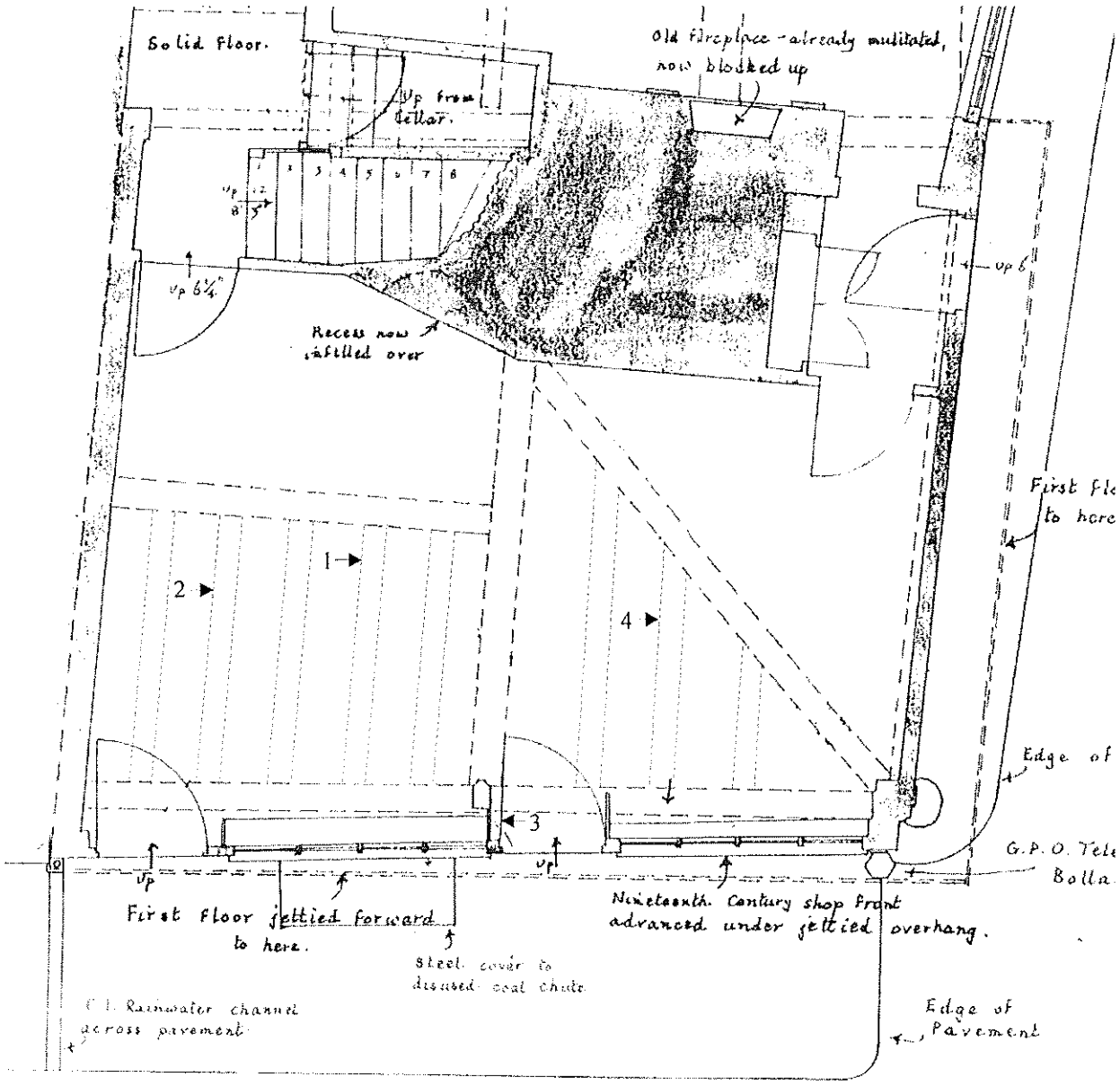

Figure 2 Location of samples **1-4**: Joists and beam in ground-floor ceiling/first-floor floor

Figure 3 Location of samples **5-6**, **10** and **12** in front, south elevation

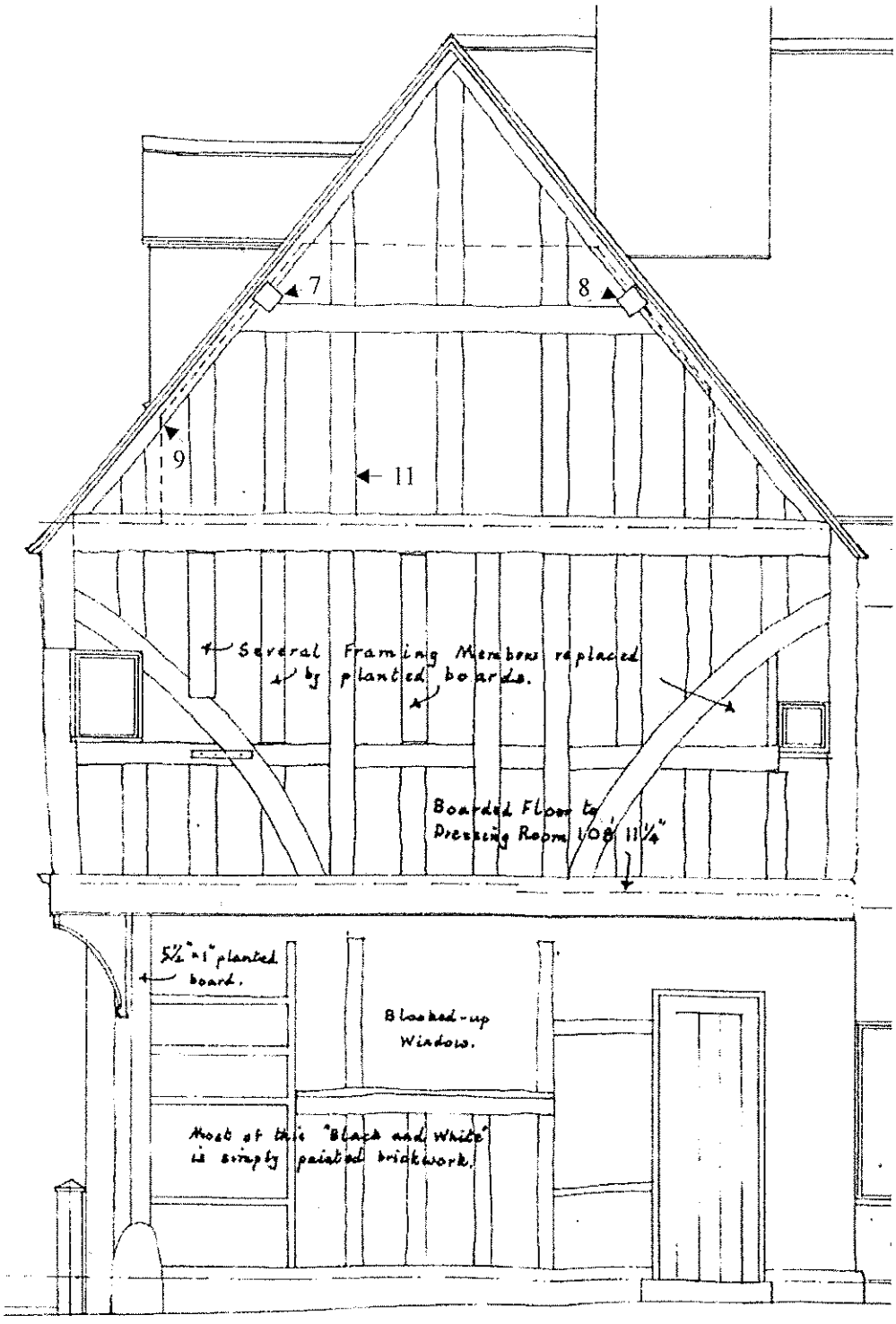

Figure 4 Location of samples **7-9** and **11**. Side, east elevation

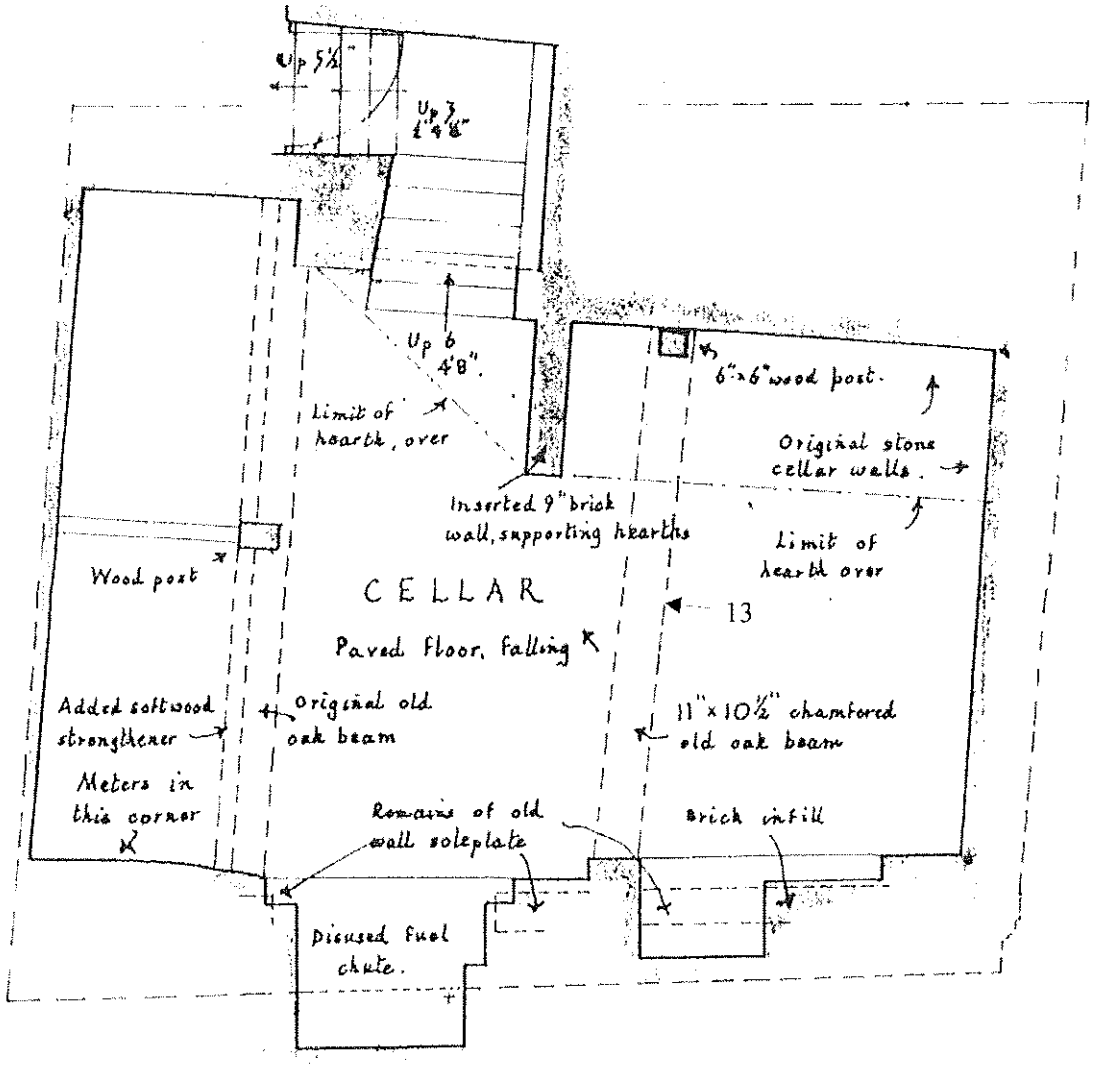

Figure 5 Location of sample **13**. Cellar plan

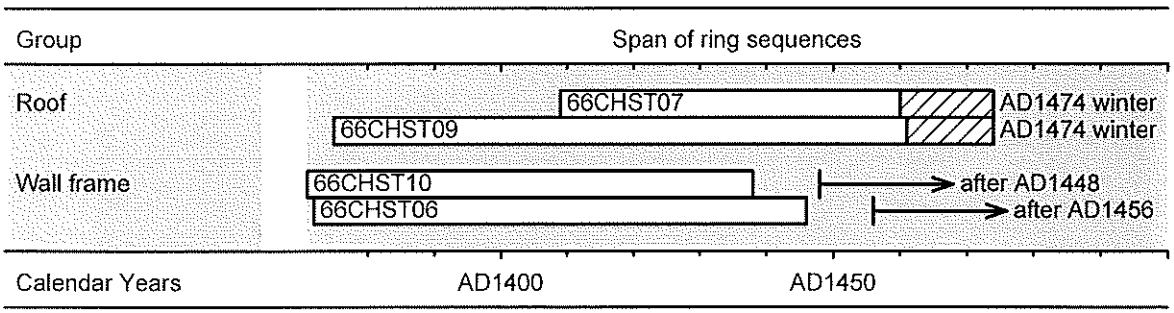

Figure 6 Bar diagram showing the chronological positions of the four dated timbers. The felling dates and *tpq*'s are also shown

Table 1 List of samples

Core No	Origin of core	Cross-section (mm)	Conversion	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
01	First-floor, joist	180 x 140	Half	103	35+B	0.75		
02	First-floor, joist	190 x 140	Half	80	-	1.21		
03	First-floor, beam	190 x 140	Half	73	+?HS	2.60		
04	First-floor, joist	190 x 140	Half	86	34+Bw	0.93		
05	First-floor, corner post (offcut from south face)	180 x 110	Quarter	86	+?HS	1.16		
06	First-floor, rail (offcut from south face)	180 x 110	Quarter	75	-	1.88	AD 1372-AD 1446	after AD 1456
07	Roof, purlin	170 x 150	Quarter	66	14+Bw	1.41	AD 1409-AD 1474	AD 1474 winter
08	Roof, purlin	170 x 150	Quarter	63	+HS	1.36		-
09	Roof, principal rafter	210 x 130	Half	100	13+Bw	1.87	AD 1375-AD 1474	AD 1474 winter
10	First-floor, strut (offcut from south face)	175 x 110	Quarter	68	-	1.78	AD 1371-AD 1438	after AD 1448
11	First-floor, strut (offcut from east face)	170 x 110	Quarter	81	11+?B	1.66		-
12	First-floor, strut (offcut from south face)	180 x 110	Quarter	<50	-	-	Not measured	
13	Cellar, beam	150 x 150	Quarter	95+83h	-	1.89		

Total rings = all measured rings Sapwood rings: H/S heartwood/sapwood boundary, ?H/S possible heartwood/sapwood boundary, B= bark edge, Bw= winter felled, ?B= possible bark edge ARW = average ring width of the measured rings

Table 2 *t*-value matrix for samples a) **1** and **4**, b) samples **6** and **10**, and c) samples **6/10**, **07**, and **09**.

* = empty triangle

a)

Samples	**04**
01	5.30

b)

Samples	**06**
10	11.31

c)

Samples	**07**	**09**
06/10	5.08	8.09
07	*	7.12

Table 3 Dating the mean sequence **66CHT4**, dated to AD 1371 - 1474 inclusive. *t*-values with independent reference chronologies

Area	**Reference chronology**	***t*-value**
Devon	Bowhill, Exeter (Groves 2002)	7.24
Gloucestershire	Mercers Hall, Gloucester (Howard *et al* 1996)	8.88
Gloucestershire	Old Hat Shop, Tewkesbury (Nayling 2000)	6.77
Herefordshire	Kings Pyon barn (Groves and Hillam 1993)	6.29
Herefordshire	Booth Hall and 16-18 High Town, Hereford (Boswijk and Tyers 1997)	5.62
Herefordshire	Hereford Cathedral Barn (Tyers 1996)	7.78

Table 4

a) Ring-width data from site master **66CHT4**, dated to AD 1371 - 1474 inclusive

Date	Ring widths (0.01mm)										No of samples									
AD 1371	247	276	236	309	155	267	257	280	350	290	1	1	1	1	2	2	2	2	2	2
-	172	301	266	275	192	297	268	200	245	166	2	2	2	2	2	2	2	2	2	2
-	257	133	180	153	179	220	154	191	212	214	2	2	2	2	2	2	2	2	2	2
AD 1401	265	208	233	167	210	202	175	158	226	199	2	2	2	2	2	2	2	2	3	3
-	141	174	142	154	160	177	182	171	110	212	3	3	3	3	3	3	3	3	3	3
-	226	151	210	166	182	170	214	225	174	182	3	3	3	3	3	3	3	3	3	3
-	161	189	128	144	164	157	130	137	118	130	3	3	3	3	3	3	3	3	3	3
-	144	105	144	155	119	105	107	131	126	115	3	3	3	3	3	3	2	2	2	2
AD 1451	176	119	119	156	126	141	103	131	105	163	2	2	2	2	2	2	2	2	2	2
-	117	147	124	98	110	133	153	113	131	159	2	2	2	2	2	2	2	2	2	2
-	90	102	110	120							2	2	2	2						

b) Ring-width data from the undated site mean **66CHT2**

Date	Ring widths (0.01mm)										No of samples									
1	182	157	151	146	152	127	110	115	136	134	1	1	1	1	1	1	1	1	1	1
-	209	197	123	107	123	135	120	165	178	162	1	1	1	1	1	1	1	2	2	2
-	129	186	125	135	200	168	174	127	154	119	2	2	2	2	2	2	2	2	2	2
-	87	95	116	142	187	149	136	88	106	64	2	2	2	2	2	2	2	2	2	2
-	81	68	76	78	54	55	65	69	76	68	2	2	2	2	2	2	2	2	2	2
51	61	54	60	63	70	57	58	73	62	52	2	2	2	2	2	2	2	2	2	2
-	54	49	59	52	43	56	52	51	45	46	2	2	2	2	2	2	2	2	2	2
-	42	40	53	40	45	40	50	47	49	46	2	2	2	2	2	2	2	2	2	2
-	45	43	48	49	42	47	42	42	45	45	2	2	2	2	2	2	2	2	2	2
-	53	39	45	50	57	70	51	65	47	45	2	2	2	2	2	2	2	2	2	2
101	55	73	62								2	2	2							