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Ancient Monuments Laboratory
Report 77/98

DENDROCHRONOLOGICAL ANALYSIS OF LIGHTSHAW HALL, GOLBORNE, GREATER MANCHESTER

C Groves

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Summary

Lightshaw Hall is an L-shaped farmhouse of timber and brick construction. Dendrochronological analysis was undertaken on 11 timbers associated with the west or solar wing and a single timber, possibly a sill beam, located in a gully at the north-east corner of the house below the surface of the cobbled yard. Seven timbers from the west wing crossmatched and dated to produce a tree-ring chronology spanning the period AD 1414-1552. The presence of bark edge on one of these timbers produced a felling date of spring AD 1553, suggesting that the solar wing was probably erected in the mid-sixteenth century shortly after felling occurred. The ring sequences from a tiebeam from the solar wing and the possible sill beam date to AD 1150-1209 and AD 1106-1270 respectively. The lack of sapwood on either timber precludes the provision of either precise felling dates or felling date ranges. However supporting evidence is provided for the presence of an earlier building on the site and re-use of timber within the building is also clearly identified. No analysis was undertaken on the nineteenth-century north range.

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DENDROCHRONOLOGICAL ANALYSIS OF LIGHTSHAW HALL, GOLBORNE, GREATER MANCHESTER

Introduction

This document is a technical archive report on the dendrochronological analysis of timbers from Lightshaw Hall, Golborne. It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. As part of a wider study of the building, elements of this report have previously been summarised and combined with detailed descriptions, drawings, and excavation records to form an extensive report on the building (Lewis 1996).

Lightshaw Hall is a grade II* listed timber-framed and brick structure which lies approximately 1.75 km north of Golborne, near Wigan (SJ61559955). It has recently been the subject of an archaeological survey both prior to relisting and during an English Heritage grant-aided repair programme (Lewis 1990; 1996). It stands on the eastern half of a moated enclosure and consists of two adjoining ranges, both two storeys high, forming an L-shaped plan (Fig 1). Although largely rebuilt in the eighteenth and nineteenth centuries it encompasses the remains of an late medieval structure. However Lewis (1996) indicates that the earliest known references to an estate at Lightshaw date from the last quarter of the thirteenth century implying that the extant building may be a replacement for an earlier medieval structure. Further evidence for an earlier building was provided by limited archaeological investigation. This revealed the remains of sandstone walls and a timber, possibly a sill beam, which had no structural associations with the present building (Lewis 1996).

The two-bay north range abuts the west range and is thought to date to the first half of the nineteenth century (Lewis 1996). It is potentially contemporaneous with the inserted brick walling of the west range. The west range however contains the surviving remnants of a two-storey timber-framed building, interpreted as the solar range of a sixteenth-century house. Two cross-frames, A and B, divide the range into three bays; the frames at the north and south ends of the range having been replaced entirely in brick (Fig 1). Although the east post from frame A was also replaced by brick, the decorative open roof truss, with a pair of quatrefoil panels, remained intact (Fig 2). Bays 1 and 2 appear to have originally formed a single room at both ground- and first-floor levels. Bays 2 and 3 are divided by a framed-wall and closed roof truss, B (Fig 3). Longitudinal elements had also survived in the form of wall-plates, purlins, windbraces, and even the remnants of a sole plate, though there was originally some doubt as to whether some of these elements, such as the wall-plates, were perhaps re-used. The ground-floor ceiling was supported on four moulded beams running on a east-west axis (Fig 1). One of these beams, beam 2, is a structurally integral part of frame A. It is supported on a jowl on wall-post A and tenoned and pegged into a mortice cut into the post. Although clearly part of the same phase of construction, Lewis (1996) suggests that it is just possible that the beams were re-used from another building.

The dendrochronological analysis was undertaken at the request of English Heritage in order to assist the archaeological survey. Its principal aim was to provide independent dating evidence for the initial construction of the solar range and, despite the difference in appearance of trusses A and B, confirm that it had been raised in a single building phase. It was also hoped that it may provide supporting evidence for the presence of an earlier building on the site.

Methodology

The general practical and analytical techniques used a the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The following summarises relevant methodological details used for the dendrochronological analysis of this building.

Immediately prior to sampling an initial brief assessment survey was undertaken throughout the structure in order to identify the presence of timbers suitable for analysis and to allow a suitable sampling strategy to be formulated. Oak (*Quercus* spp.) is currently the only species used for routine dating purposes in the British Isles, though research on other species is being undertaken (eg Tyers 1998a; Groves 1997). Timbers with less than 50 annual growth rings are generally considered unsuitable for analysis as their ring patterns may not be unique (Hillam *et al* 1987). Thus timbers were sought which had at least 50 rings and if possible had either bark/bark edge or some sapwood surviving (see below). The sampling strategy was designed to take in as wide a range of structural elements as possible and was discussed on site with Jen Lewis in order to ensure that there were no obvious omissions with respect to the current understanding of the building.

In standing buildings samples are generally removed from selected timbers in the form of either cross-sectional slices or cores. Slices are taken from timbers that are either wholly or partially replaced during restoration, whereas cores are removed from timbers that will remain *in situ*. The cores are taken, using a 15mm diameter corer attached to an electric drill, in a position and direction most suitable for maximising the numbers of rings in the sample, whilst ensuring the presence of sapwood and bark edge whenever possible.

The ring sequence of each sample was revealed by sanding until the annual growth rings were clearly defined. The exception to this was the waterlogged sample which was prepared by being frozen for a minimum of 48 hours before being cleaned with a surform plane and scalpels. Any samples which fail to contain the minimum number of rings or have unclear ring sequences are rejected. The sequence of growth rings in the samples selected for dating purposes were measured to an accuracy of 0.01mm using a purpose built travelling stage attached to a microcomputer based measuring system (Tyers 1997a). The ring sequences were plotted onto semi-logarithmic graph paper to enable visual comparisons to be made between them. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. The Student's *t* test is then used as a significance test on the correlation coefficient and those quoted 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 (Baillie 1982, 82-5), provided that high *t* values are obtained at the same relative or absolute position with a range of independent sequences and that the visual match is satisfactory.

Dating is usually achieved by cross-correlating, or crossmatching, ring sequences within a phase or structure and combining the matching patterns to form a phase or site master curve. This master curve and any remaining unmatched ring sequences are then tested against a range of reference chronologies, using the same matching criteria as above. The position at which all the criteria are met provides the calendar dates for the ring sequence. 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.

During the crossmatching stage of the analysis an additional important element of tree-ring analysis is the identification of 'same-tree' timber groups. The identification of 'same-tree' groups is based on very high levels of similarity in both year to year variation and longer term growth trends, and anatomical anomalies. Such information should ideally be used to support possible 'same-tree' groups identified from similarities in the patterns of knots/branches during detailed recording of timbers for technological and woodland characterisation studies. Timbers originally derived from the same parent log generally have *t* values of greater than 10.0, though lower *t* values do not necessarily exclude the possibility. It is a balance of the range of information available that provides the 'same-tree' link.

The crossdating process provides precise calendar dates only for the rings present in the timber. The nature of the final rings in the sequence determines whether the date of the youngest ring also represents the year the timber was felled. Oak consists of inner inert heartwood and an outer band of active sapwood. If the sample ends in the heartwood of the original tree, a *terminus post quem* 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 may be missing. This is the date after which the timber was felled but the actual felling date may be many decades later depending on the number of outer rings removed during timber conversion. 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. Alternatively, if bark-edge survives, then a felling date can be directly obtained from the date of the last surviving ring. In some instances it may be possible to determine the season of felling according to whether the ring immediately below the bark is complete or incomplete. However the onset of growth can vary within and between trees and this, combined with the natural variation in actual ring width, means that the determination of felling season must be treated with great caution. The sapwood estimate applied throughout this report is a minimum of 10 and maximum of 55 annual rings, where these figures indicate the 95% confidence limits of the range. This is a generally applicable estimate for the British Isles (Hillam *et al* 1987) though work in progress suggests that this range may be narrowed (Tyers pers comm).

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 reuse of timbers and the repairs or modifications of structures, as well as factors such as stockpiling or seasoning, before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

The structural elements of the solar range were all oak but most were unsuitable for dendrochronological dating purposes as they clearly contained insufficient numbers of rings. There was also a notable lack of surviving bark edge and sapwood. The range of timbers available for sampling was therefore rather limited. Eleven timbers from the standing building were selected for sampling, the location of which is indicated on the plans provided by Jen Lewis (Figs 1-4) and details of the samples are given in Table 1. Eight timbers (**1-8**) were sampled in late June 1994 by the removal of cores but the poor condition of some of these severely hampered coring causing the cores to disintegrate. Duplicate samples were taken from three timbers (**2**, **4**, and **6**) in an attempt to overcome these problems. After two unsuccessful attempts timbers **2** and **4** were abandoned. The second attempt at timber **6** was however successful. Three timbers (**9-11**), which were clearly in an extremely poor state of preservation, were to be replaced during refurbishment. These were sampled by the removal of cross-sectional slices that were delivered to the laboratory in December 1995. Sampling was concentrated on the major structural elements as those of smaller scantling, such as the purlins and framing, clearly contained too few rings for analysis. The moulded ceiling timbers were also rejected prior to sampling as these were considered unsuitable. The final sample (**316**) was taken from a waterlogged timber, possibly a sill beam, uncovered during building work for the new foul water system. This was located at the north-east corner of the north range of the building and was on a north-south alignment (Fig 1).

As indicated above samples **2a**, **2b**, **4a**, and **4b** were rejected, as was sample **8** which contained too few rings for reliable dating purposes. The remaining eight samples from the solar range and the waterlogged timber were measured, though the outermost rings on three samples were counted rather than measured as the ring boundaries were not sufficiently clearly defined for precise measurement due to degradation.

The ring sequences of seven of the timbers from the solar were found to match and were combined to form a 139-year master curve, LIGHTSHAW2 (Fig 5; Tables 2 and 3). This was tested against an extensive range of dated reference chronologies spanning the last two millennia from the British Isles. It was immediately apparent that LIGHTSHAW2 dated to the period AD 1414-1552 inclusive (Table 4).

A tentative match (t = 4.12) was found between the ring sequences from timbers **6** and **316**. Both sequences were compared individually to the same extensive range of reference chronologies used above. Dates were obtained for both sequences, confirming the tentative intra-site match, and they were combined to form a 165-year master curve, LIGHTSHAW1, which dates to the period AD 1106-1270 inclusive (Fig 5; Tables 5 and 6).

Interpretation and Discussion

One (**9**) of the seven samples combined to form the master chronology LIGHTSHAW2 has bark edge. The outermost measured ring of this sample dates to AD 1552 but the first signs of spring growth for AD 1553 (ie the spring wood vessels are just starting to form) are apparent (Fig 6). This indicates that this timber was felled during the early part of the growing season in spring AD 1553. Of the remaining six dated timbers one (**5**) has some sapwood, the outermost ring of three others (**1**, **3**, and **11**) marks the heartwood/sapwood boundary, and **10** also ends at the probable heartwood/sapwood boundary. The felling date ranges calculated for these timbers are consistent with a felling date in the spring of AD 1553, as is the *terminus post quem* for felling for sample **7** (Fig 5).

Evidence indicates that seasoning of timber was a fairly rare occurrence until relatively recent times and that timber was generally felled as required and used whilst green (eg Rackham 1990). Physical evidence for the rapid use of trees is widespread in buildings as many timbers show clear evidence of warping or splitting after having undergone conversion. Thus assuming that these dated timbers are all contemporary a construction date shortly after felling in the spring of AD 1553 is implied for the solar range. The dendrochronological evidence also supports the other architectural information which, despite the different appearance of the two extant trusses, indicates that the solar range is the product of a single building campaign. However with only one timber producing a precise felling date any variation in felling date of perhaps a handful of years would not be apparent. The dendrochronological results (Tables 2 and 4) do nevertheless indicate that this is a coherent single-source group of timbers likely to have been obtained from local woodlands.

Neither of the two samples combined to form LIGHTSHAW1 has any trace of sapwood and it is therefore only possible to provide a *terminus post quem* for felling. Although these timbers are clearly broadly contemporary their actual felling dates could be significantly different. It is highly unlikely that either have lost several hundred additional outer rings and they therefore must be associated with an earlier structure or structures.

Lewis (1996) suggests that the waterlogged sill beam (**316**) and the sandstone masonry remains below rooms 4 and 5 in the north range could represent the remains of a timber-framed cross-wing. If this is so then the dendrochronological evidence from this single timber implies a construction date of after AD 1280.

The tiebeam from truss B had not been flagged up as a probable re-used timber but the dendrochronological evidence indicates otherwise as it has a *terminus post quem* for felling of after AD 1219. It had been noted during the architectural survey that there was clear evidence, in the form of large angled empty mortices, for substantial arch braces to have been attached to this tiebeam (Lewis 1996). However the wall posts lack any clear evidence for mortices which could relate to these arch-braces. This information combined with the dendrochronological evidence indicates that this structurally integral tiebeam must have been re-used from an earlier building constructed sometime after the early-thirteenth century and demolished by the mid-sixteenth century when the solar range was constructed.

The dendrochronological evidence from these two early timbers cannot determine whether **6** and **316** were from the same building or two different buildings, or indeed whether these buildings were on the same site or another nearby site. However the dendrochronological results do suggest that both timbers were likely to have been derived from local woodlands (Table 6).

Conclusion

The tree-ring analysis of the primary timbers associated with the initial construction of the solar range has indicated that it was the product of a single building campaign in the latter half of the sixteenth century, with a single timber with bark edge suggesting that construction occurred in or shortly after AD 1553. A re-used timber, potentially originally used as early as the thirteenth century was identified in the solar range. The waterlogged sill beam, also potentially initially used as early as the thirteenth century, has provided additional support for the presence of an earlier building on the site.

Acknowledgements

The analysis was funded by English Heritage. I am very grateful to the owners of Lightshaw Hall, Jim and Jean Hewitt for their interest and invaluable practical assistance in the form of a replacement generator and ensuring that slices were taken from relevant timbers. Without their care the bark edge would not have survived on sample **9** and hence a precise felling date would not have been possible. I would also like to thank Jen Lewis for all her assistance and discussion; Jennifer Hillam assisted on site with coring; Alex Bayliss searched out relevant information from the English Heritage files; and finally Ian Tyers for valuable discussion and encouragement.

References

Baillie, M G L, 1982 *Tree-Ring Dating and Archaeology*, London

Baillie, M G L, and Pilcher, J R, 1973 A simple crossdating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7-14

Brown, D, 1993 Dendrochronological analysis, in *A medieval industrial complex and its landscape: the metalworking watermills and workshops of Bordesley Abbey* (G G Astill), CBA Res Rep, **92**, 242-5

English Heritage, 1998 *Dendrochronology - guidelines on producing and interpreting dendrochronological dates*, London

Groves, C, 1997 The dating and provenancing of imported conifer timbers in England: the initiation of a research project, in *Archaeological Sciences 1995: proceedings of a conference on the application of scientific methods to archaeology* (eds A Sinclair, E Slater, and J Gowlett), Oxbow Books Monograph Series, **64**, 205-11

Groves, C, forthcoming *Dendrochronological analysis of Hall I' Th' Wood, Bolton, Greater Manchester*, Anc Mon Lab Rep

Hillam, J, Morgan, R A, and Tyers, I, 1987 Sapwood estimates and the dating of short ring sequences, in *Applications of tree-ring studies: current research in dendrochronology and related areas* (ed R G W Ward), BAR Int Ser, **333**, 165-85

Howard, R E, Laxton, R, and Litton, C, 1996 *Tree-ring analysis of timbers from Mercer's Hall, Mercer's Lane, Gloucester*, Anc Mon Lab Rep, **13/96**

Howard, R E, Laxton, R, and Litton, C, 1998a *Tree-ring analysis of timbers from 26 Westgate Street, Gloucester*, Anc Mon Lab Rep, **43/98**

Howard, R E, Laxton, R, and Litton, C, 1998b *Tree-ring analysis of timbers from Naas House, Lydney, Gloucestershire*, Anc Mon Lab Rep, **36/98**

Howard, R E, Laxton, R, and Litton, C, 1998c *Tree-ring analysis of timbers from Brockworth Court Barn, Brockworth, Gloucestershire*, Anc Mon Lab Rep, **46/98**

Leggett, P A, 1980 *The use of tree-ring analyses in the absolute dating of historical sites and their use in the interpretation of past climatic trends*, unpubl PhD Thesis, CNAA (Liverpool Polytechnic)

Lewis, J, 1990 unpubl *Lightshaw Hall, Golborne, near Wigan: an archaeological assessment of the standing structure*, North West Archaeological Trust Rep

Lewis, J, 1996 unpubl *Lightshaw Hall, Golborne, near Wigan*, Univ Liverpool Rep

Miles, D W H, forthcoming *The tree-ring dating of Hergest court, Kington, Hereford and Worcester*, Anc Mon Lab Rep

Miles, D H, and Haddon-Reece, D, 1995 List 64 - Shropshire Dendrochronology Project phase three, *Vernacular Architect*, **26**, 68-74

Munro, M A R, 1984 An improved algorithm for crossdating tree-ring series, *Tree Ring Bulletin*, **44**, 17-27

Nayling, N, 1998a *Dendrochronological analysis of timbers from Old Abbey Farm, Risley, Cheshire*, ARCUS Rep, **412**

Nayling, N, 1998b Oak dendrochronology, in *Magor Pill medieval wreck* (N Nayling), CBA Res Rep, **115**, 116-22

Rackham, O, 1990 *Trees and woodland in the British Landscape*, 2nd edn, London

Tyers, I, 1996 *The tree-ring analysis of six secular buildings from the City of Hereford*, Anc Mon Lab Rep, **17/96**

Tyers, I, 1997a *Dendro for Windows program guide*, ARCUS Rep, **340**

Tyers, I, 1997b *Tree-ring analysis of timbers from Sinai Park, Staffordshire*, Anc Mon Lab Rep, **80/97**

Tyers, I, 1998a Beech dendrochronology, in *Magor Pill medieval wreck* (N Nayling), CBA Res Rep, **115**, 123-28

Tyers, I, 1998b *Tree-ring analysis of oak timbers from Penrhos Court, near Kington, Herefordshire*, Anc Mon Lab Rep, **31/98**

Figure 1: Ground floor plan of Lightshaw Hall, Golborne, showing the location of samples **1**, **10**, **11**, and **316**, after Lewis 1996.

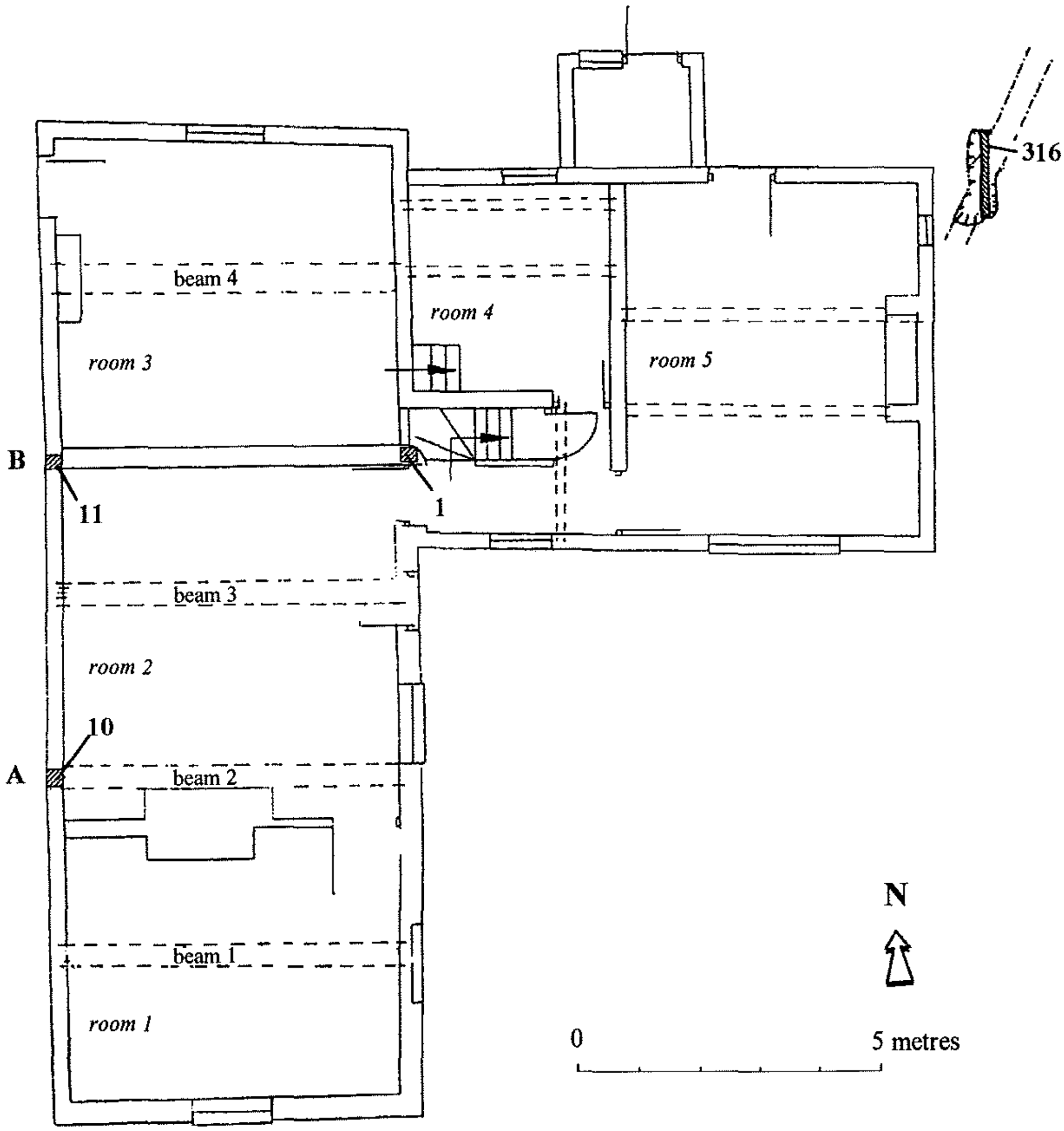


Figure 2: The north face of Frame A of Lightshaw Hall, Golborne, showing the approximate location of samples **2-5** inclusive, after Lewis 1996.

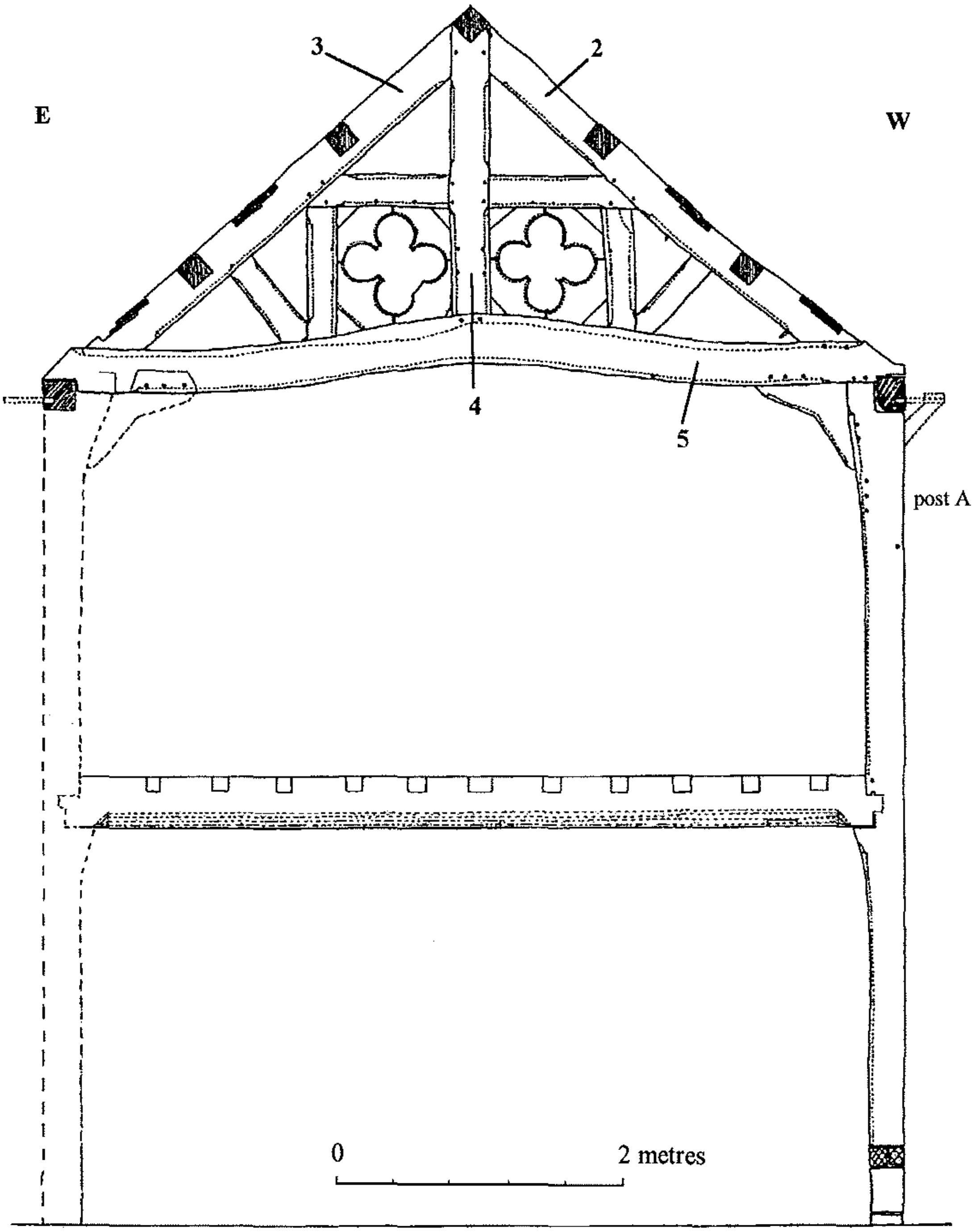


Figure 3: The south face of Frame B of Lightshaw Hall, Golborne, showing the approximate location of sample **6**, after Lewis 1996.

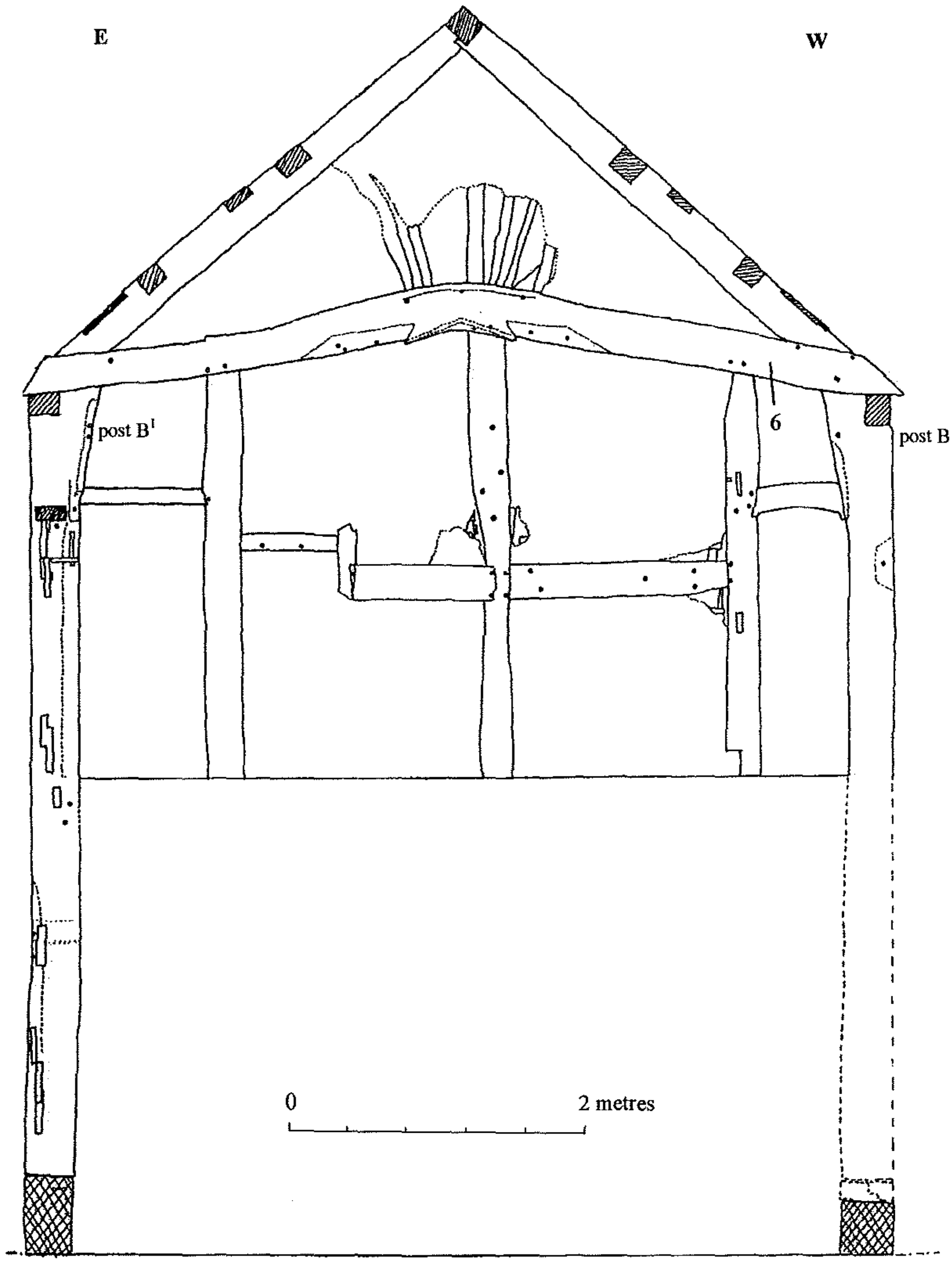
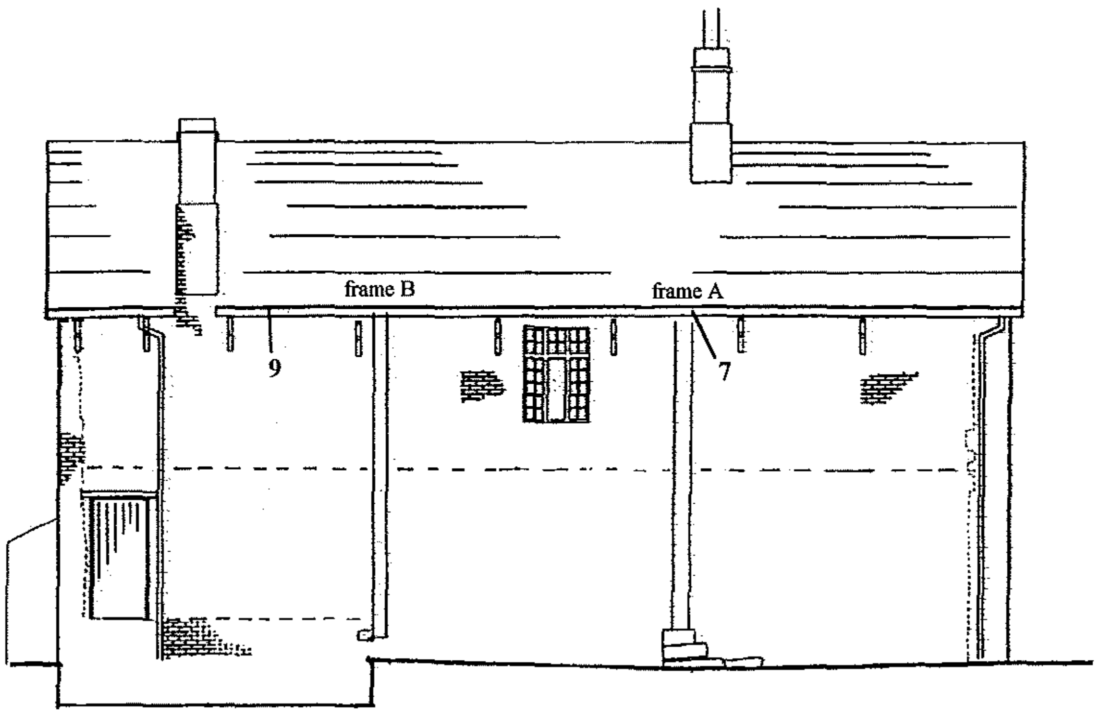
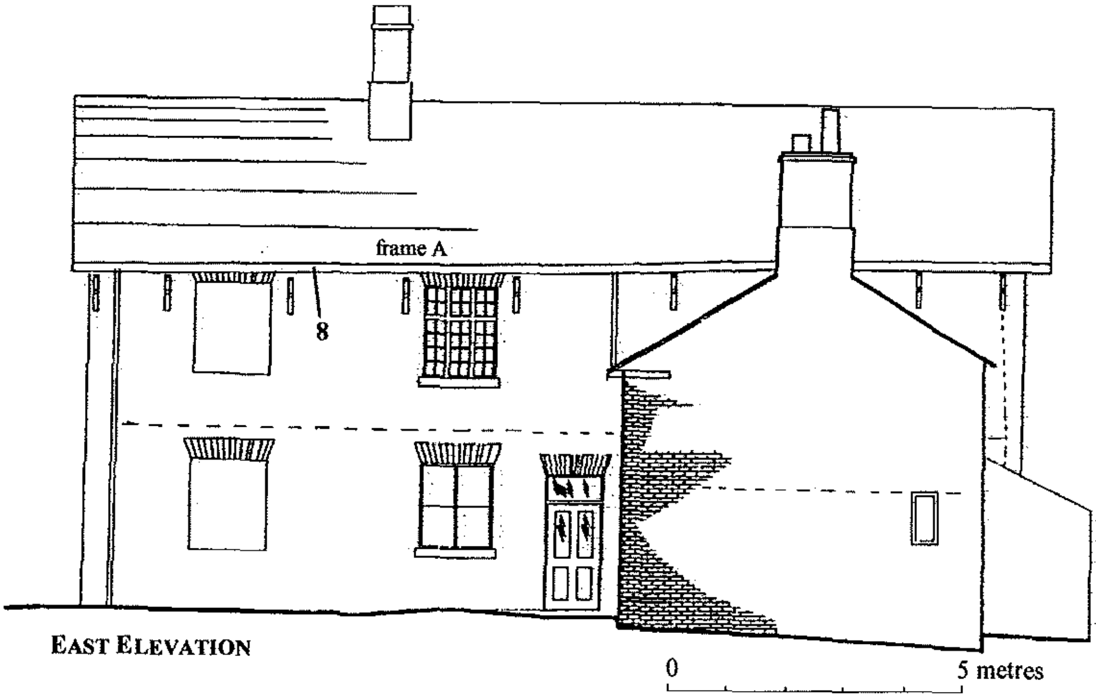


Figure 4: The external west and east elevations of Lightshaw Hall, Golborne, showing the approximate locations of sample **7-9** inclusive, after Lewis 1996.

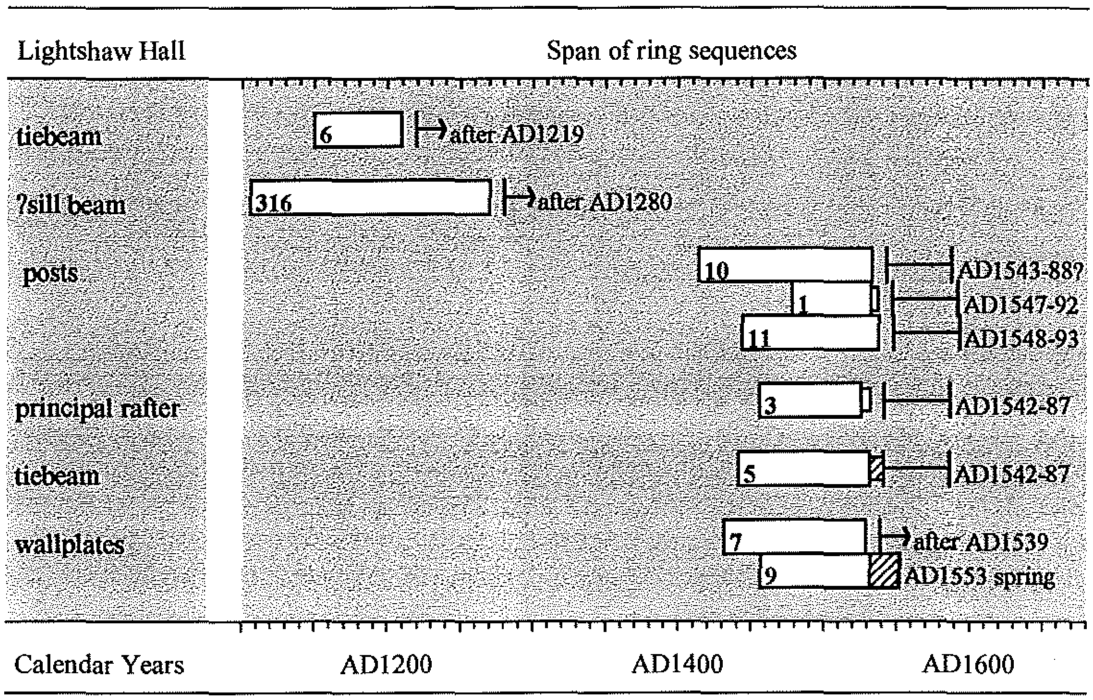


WEST ELEVATION



EAST ELEVATION

Figure 5: Bar diagram showing the relative positions of the dated ring sequences and their associated felling dates.



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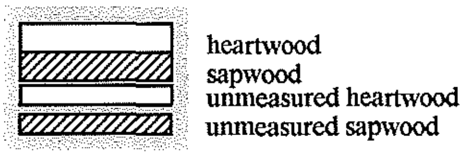
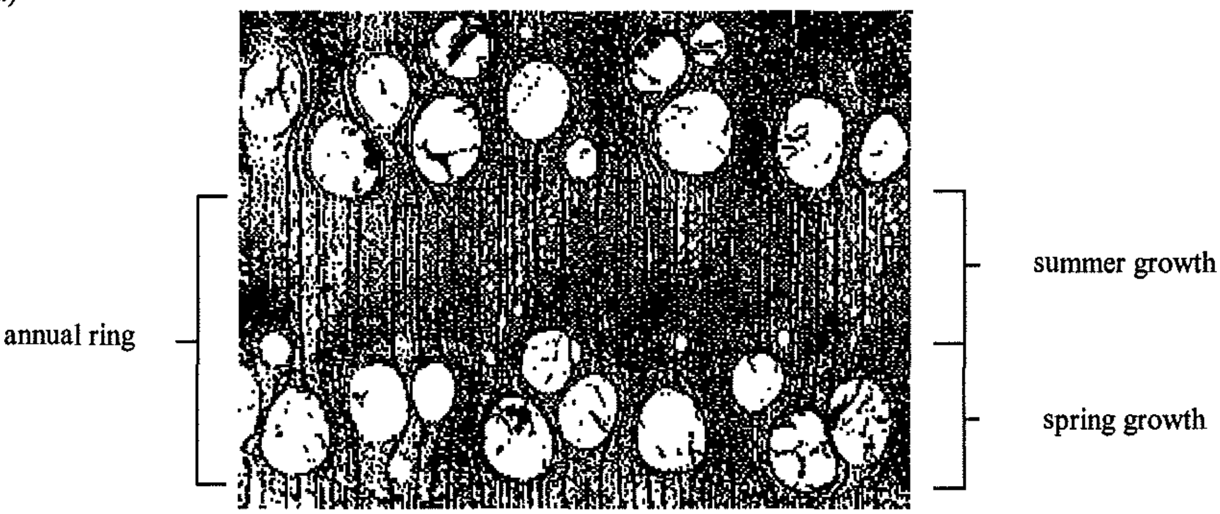


Figure 6: Diagrams showing a) cross-section of an annual growth ring on a oak sample (magnification approximately x30), b) schematic cross-section of the outermost rings immediately below the bark of sample 9.

a)



b)

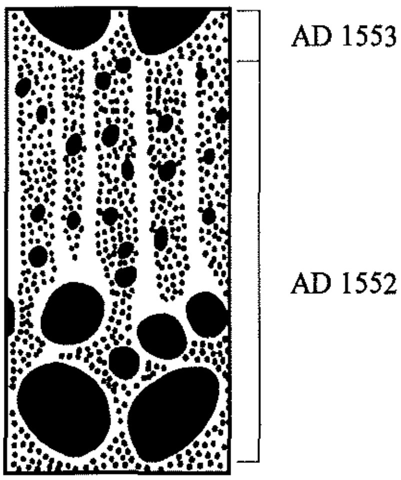


Table 1: Details of the structural element samples from Lightshaw Hall, Golborne.

Number of rings - total number of measured rings including both heartwood and sapwood
+ - unmeasured rings; hs - heartwood/sapwood boundary; bs - bark edge present, felled summer
AGR - average growth rate in millimetres per year
cross-section size - maximum dimensions of the cross-section in millimetres
cross-section type - guide to conversion type

Sample	Timber function /provenance	Wood type	Sample type	Total number of rings	Sapwood rings	AGR	Cross-section dimensions	Cross-section type	Date of measured ring sequence	Comment
1	Truss B, east post - B[1]	oak	core	55 +5	+*hs*	1.26	-	halved	AD 1478-1532	-
2	Truss A, west principal rafter	oak	core	-	-	-	-	halved	-	rejected; duplicate samples, 2a and 2b, both shattered during coring and therefore abandoned

Table 2: Matrix showing the t values obtained between the matching ring sequences.

\ = overlap < 15 years
- = t -values < 3.00

Sample	3	5	7	9	10	11
1	-	3.98	4.72	4.12	-	7.77
3		4.68	3.66	-	-	3.56
5			6.99	3.99	4.32	7.02
7				9.14	5.81	8.13
9					4.24	6.08
10						6.16

Table 3: The ring width data from the site master chronology, LIGHTSHAW2, dated AD 1414-1552 inclusive.

Date	**Ring widths (units of 0.01mm)**										**Number of samples**									
AD 1414				321	313	258	283	394	140	304				1	1	1	1	1	1	1
	364	128	203	112	156	140	180	198	148	149	1	1	1	1	1	1	1	1	1	1
	201	276	209	288	157	166	152	182	198	157	1	2	2	2	2	2	2	2	2	2
	231	163	267	377	329	268	227	326	263	177	2	3	3	4	4	4	4	4	4	4
AD 1451	278	226	176	232	184	221	160	212	157	181	4	4	4	4	4	5	6	6	6	6
	155	185	174	126	156	174	211	200	183	200	6	6	6	6	6	6	6	6	6	6
	189	165	182	182	254	217	212	187	215	233	6	6	6	6	6	6	6	7	7	7
	225	209	228	276	251	212	261	223	209	196	7	7	7	7	7	7	7	7	7	7
	162	152	193	173	199	275	166	153	202	248	7	7	7	7	7	7	7	7	7	7
AD 1501	177	192	145	183	234	214	226	159	270	247	7	7	7	7	7	7	7	7	7	7
	215	248	209	176	218	173	224	219	256	158	7	7	7	7	7	7	7	7	7	7
	233	199	192	182	174	199	223	246	172	161	7	7	7	7	7	7	6	6	6	5
	169	149	177	144	250	195	187	145	115	87	5	5	3	2	2	2	2	2	1	1
	93	68	125	130	147	123	90	131	127	131	1	1	1	1	1	1	1	1	1	1
AD 1551	151	99									1	1								

Table 4: Dating the site master chronology, LIGHTSHAW2. Results of comparisons between some relevant reference chronologies and LIGHTSHAW2 at AD 1414-1552 inclusive. All reference chronologies are independent.

Region	Reference chronology	*t* value
Cheshire	Old Abbey Farm 2, Risley (Nayling 1998a)	7.18
Gloucestershire	Mercers Hall, Gloucester (Howard *et al* 1996)	7.17
	26 Westgate Street, Gloucester (Howard *et al* 1998a)	7.16
	Naas House, Lydney (Howard *et al* 1998b)	7.32
Greater Manchester	Hall I' Th' Wood, Bolton (Groves forthcoming)	5.58
	Stayley Hall (Leggett 1980)	7.60
Herefordshire	Hereford Farmers Club (Tyers 1996)	6.11
	Hergest Court (Miles forthcoming)	6.48
	Penrhos Court 2, Kington (Tyers 1998b)	6.30
Shropshire	Bedstone Manor Farm (Miles and Haddon-Reece 1995)	6.30
Staffordshire	Sinai Park (Tyers 1997b)	9.16

Table 5: The ring width data from the site master chronology, LIGHTSHAW1, dated AD 1106-1270 inclusive.

Date	Ring widths (units of 0.01mm)										Number of samples									
AD 1106						150	140	182	171	127						1	1	1	1	1
	107	106	183	161	238	155	104	145	88	102	1	1	1	1	1	1	1	1	1	1
	88	98	159	159	144	120	140	68	79	114	1	1	1	1	1	1	1	1	1	1
	81	79	90	105	161	103	102	94	115	122	1	1	1	1	1	1	1	1	1	1
	133	92	62	68	48	41	46	39	39	108	1	1	1	1	1	1	1	1	1	2
AD 1151	97	103	136	114	113	148	128	118	135	137	2	2	2	2	2	2	2	2	2	2
	85	99	127	139	146	113	133	145	173	142	2	2	2	2	2	2	2	2	2	2
	150	133	158	119	141	150	125	148	205	131	2	2	2	2	2	2	2	2	2	2
	137	176	125	92	124	96	106	73	87	131	2	2	2	2	2	2	2	2	2	2
	103	113	143	177	152	138	115	109	121	110	2	2	2	2	2	2	2	2	2	2
AD 1201	137	107	162	100	100	96	73	110	120	156	2	2	2	2	2	2	2	2	2	1
	168	182	206	205	160	214	207	164	131	127	1	1	1	1	1	1	1	1	1	1
	149	114	158	109	111	108	101	115	152	148	1	1	1	1	1	1	1	1	1	1
	131	90	115	143	104	90	85	115	156	164	1	1	1	1	1	1	1	1	1	1
	120	104	118	119	102	123	114	108	148	141	1	1	1	1	1	1	1	1	1	1
AD 1251	130	106	129	113	135	110	118	104	109	166	1	1	1	1	1	1	1	1	1	1
	151	177	159	115	158	112	99	220	166	225	1	1	1	1	1	1	1	1	1	1

Table 6: Dating the site master chronology, LIGHTSHAW1. Results of comparisons between some relevant reference chronologies and LIGHTSHAW1 at AD 1106-1270 inclusive and its individual components. All reference chronologies are independent.

Region	**Reference chronology**	***t* value**
Cheshire	Old Abbey Farm, Risley 1 (Nayling 1998a)	6.01
	Nantwich (Leggett 1980)	6.18
	Bowers Row, Nantwich (Hillam unpubl)	7.48
	36 Bridge Street, Chester (Groves and Hillam unpubl)	5.66
Gloucestershire	Brockworth Court Barn (Howard *et al* 1998c)	5.13
Greater Manchester	Baguley Hall 2 (Leggett 1980)	5.40
Herefordshire	20 Church Street, Hereford (Tyers 1996)	4.87
Merseyside	Eccleston Hall, St Helens (Groves unpubl)	6.45
Worcestershire	Bordesley Abbey (Brown 1993)	5.14
Wales	Magor Pill Wreck (Nayling 1998b)	5.45