Ancient Monuments Laboratory
Report 101/97

TREE-RING ANALYSIS OF BOOTH
HALL AND 16-18 HIGH TOWN,
HEREFORD

G Boswijk
I Tyers

Ancient Monuments Laboratory Report 101/97

TREE-RING ANALYSIS OF BOOTH HALL
AND 16-18 HIGH TOWN, HEREFORD

G Boswijk
I Tyers

Summary

Tree ring analysis has been carried out on a large number of timbers from Booth
Hall and 16-18 High Town, Hereford, which form a complex of late Medieval civic
buildings between High Town and East Street, Hereford. Before the analysis Booth
Hall was thought to have been built in the late fourteenth century. According to
documentary evidence a Guildhall was built somewhere in the area in AD 1490, and
a Freeman's Prison was also built at about the same time. The tree-ring analysis
has produced a site chronology dated AD 1302 - AD 1489 inclusive. These results
show that a programme of extensive (re-) building occurred throughout this area
in the late fifteenth century. Timbers from Booth Hall have a felling date range
of AD 1454 - AD 1492. A timber frame located to the south of Booth Hall, thought
to be the remains of the Freeman's Prison, was built from timbers felled AD 1470
- AD 1515. A building incorporated into 16 High Town has a felling date of
spring AD 1490, suggesting that this may have been the site of the documented
Guildhall. The samples from 18 High Town could not be dated.

Authors' addresses :-

G Boswijk
SHEFFIELD DENDROCHRONOLOGY LABORATORY
Archaeological Science Research School
Dept. Archaeology, Sheffield University
Sheffield
S10 2TN

I Tyers
SHEFFIELD DENDROCHRONOLOGY LABORATORY
Archaeological Research School
University of Sheffield West Ct 2 Mappin St
Sheffield
S1 4DT

TREE-RING ANALYSIS OF BOOTH HALL AND 16-18 HIGH TOWN, HEREFORD

Introduction

This document is a technical archive report on the tree-ring analysis of timbers from 16-18 High Street and Booth Hall, Hereford (NGR SO511400). It is beyond the dendrochronological brief to describe the buildings in detail or to undertake the production of detailed drawings. As part of a multifaceted and multidisciplinary study of the buildings, 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 buildings. The conclusions presented here may therefore have to be modified in the light of subsequent work.

The analysis of Booth Hall and 16-18 High Town is a continuation of the 'Secular buildings of Hereford' project in which a series of timber framed buildings from the historic core of Hereford have been recorded and dendrochronologically dated (Tyers 1996; Morriss forthcoming). The three extant buildings (Fig 1, Fig 2 a - c) analysed for this report contain numerous fragments of timber framed buildings with modern property divisions apparently different from those of the surviving fragments. The medieval complex, apparently constructed around a central courtyard, have been interpreted as a civic group including a trading hall, a Guildhall, and the Freeman's prison (Fig 2 A - C), it should be noted that there is a considerable weight of documentary evidence that argues against this interpretation (Hughes 1995a, b). The site is located between High Town and East Street, Hereford. All the following descriptions of the buildings are taken from Shoesmith and Crosskey (forthcoming).

At the southern end of 18 High Town (Fig 2 a) timber framing survives from a rather grand building (Fig 2 A), once thought to be site of the prison (Watkins 1933, 49). This building had an open hall on the ground floor which had a moulded ceiling and fine panelling. There were three rooms on the first floor, one of which had similar features to the ground floor hall. This building has recently been re-interpreted as potentially being a Guildhall, known from documentary evidence to have been built in AD 1490 (Shoesmith and Crosskey forthcoming), although Hughes (1995a) argues from documentary sources that there is no evidence for a civic function for this building. The purpose of the building at 16 High Town (Fig 2 b) is not known and it is unknown whether this is part of the same structure as 18 High Town or if it was a separate building.

To the south of these Booth Hall, now incorporated into a hotel, was a former raised trading hall which (before this analysis) was thought to have been built in the late fourteenth century.

The first-floor Hall contains a fine hammerbeam roof (Fig 2 B), with alternating decorated trusses (Fig 3a and Fig 3b). On the ground floor of the hotel, to the south of the Hall, a single frame (Fig 2 c) survives from a structure which may have been associated with the Freeman's prison (Fig 2 C), built in the late fifteenth or early sixteenth century date, herewith referred to as Lower Booth Hall .

It is hoped that tree ring analysis will provide precise dates for the construction of the buildings and assist in the identification of the Freeman's prison and/or the Guildhall. The dating of the buildings will also place them in context with the series of secular buildings which have already been dated from Hereford (Tyers 1996).

Methodology

At each building, timbers with suitable sequences for tree ring analysis were identified. Those samples with sapwood and bark edge were particularly sought, but limited access in both of the shops and the Hall effectively restricted the number and type of timbers which could be sampled.

Extensive restoration work to the timber framing of Booth Hall was carried out in the early twentieth century. The sampling programme focused on the roof trusses which were still (largely) original. The extant trusses were labelled 1 to 7 (Fig 4a), however due to problems of safe access to the roof, only the principal rafters were sampled, with the exception of a single core taken from the Truss 1 tiebeam. Where possible cores were taken from each pair of principal rafters. Limited accessibility to the frame in Lower Booth Hall meant that only two samples could be obtained from separate posts in this area (Fig 4b).

In both 16 High Town and 18 High Town shop fittings as well as lath and plaster infill restricted access to many of the timbers. At 18 High Town the west wall, on the first floor was sampled (Fig 4c). At 16 High Town cores were obtained from timber frames A, B, and D, on the first floor. No cores were obtained from frame C. Frames A and B were connected but D was separate to the rear of the shop (Figs 4d to 4f).

The most promising timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken from the timbers in the most suitable direction for maximising the numbers of rings for subsequent analysis. The core holes were left open. The ring sequences in the cores were revealed by sanding. Those samples with less than 50 rings or which had unmeasurable rings were rejected.

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. The

ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked using the graphs 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 these positions are supported by satisfactory visual matching.

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 may be 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. Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 55 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Hillam *et al* 1987). 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 of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Tree ring analysis may also assist in the identification of 'same tree' timber groups with an assemblage. Within a structure, similar patterns of knots or branching on separate timbers can indicate that they may have been derived from the same tree. Tree ring analysis can sometimes

provide additional support for this. Evidence of same tree groups may be derived from a combination of high levels of matching between samples, very similar long term growth trends, and anatomical anomalies within the timbers. High t-values are not necessarily indicative of two sequences being derived from the same tree; conversely, low t values do not exclude the possibility. It is the balance of information that provides the link.

Results

All the timbers sampled from Booth Hall and 16-18 High Town were oak (*Quercus* spp.). In total 27 cores were obtained from the three sites (Table 1). The location of the cores is shown in Figures 4a to 4f.

Samples **1** to **6** were from 18 High Town. **1,3,5**, and **6** were obtained from studs and **2** and **4** from posts. Sample **5** was the only core to contain over 50 rings; it also had sapwood surviving. The remaining cores were not suitable for analysis because they did not have enough rings.

Eleven cores (**7** to **17**) were taken from a series of posts and rails from 16 High Town. All the cores from this structure were suitable for analysis. Three samples had heartwood/sapwood boundaries and four samples retained sapwood, including **9** which was complete to bark edge.

Ten samples (**18** - **27**) were obtained from Booth Hall. **18** and **19** were from two posts in the surviving frame on the lower floor. The remaining samples came from the roof trusses of the Hall. Nine of the ten samples taken from Booth Hall were suitable for analysis. Sample **27** had fractured badly during coring. A single sample, **24**, had heartwood/sapwood boundary and another sample, **18**, retained some sapwood.

All 21 measured sequences were compared against each other and 17 timbers were found to match internally to form a site chronology, HIGHTOWN (Table 2 and Fig 5). This was tested against a range of master chronologies and dated to AD 1302 - AD 1489 (Table 3). The remaining unmatched sequences were also tested against the master chronologies but no acceptable visual and statistical matches were forthcoming. Therefore these sequences remain undated. The master chronology HIGHTOWN is listed in Table 4.

Discussion

The timbers included in the HIGHTOWN chronology form three distinct groups corresponding to 16 High Town, Lower Booth Hall, and the roof trusses of Booth Hall (Fig 5). The single suitable sample obtained from 18 High Town could not be dated.

Booth Hall and lower Booth Hall

Booth Hall is considered to be the earliest building in the High Town group, since, stylistically it is thought to date from the late fourteenth century (Watkins 1918). None of the cores obtained from this building included sapwood, but sample **24** extended to the heartwood/ sapwood transition. The similar end dates of **21, 22, 24**, and **26** suggests that only sapwood has been lost (Baillie 1982, 57). **25** has an early end date but it is quite possible that **24** and **25**, both from Truss 5, originated from the same tree as the sequences produce a high *t* value (11.31) against each other and good visual matches. The difference in end dates may have been caused by the conversion techniques used. The dating of the timbers provides a felling date range of AD 1454 - AD 1492 for the Hall. The sampling strategy clearly shows that the structure is of a single build. Therefore, rather than being of late fourteenth century date, the results of tree ring analysis show that Booth Hall was built in the latter half of the fifteenth century.

The two samples obtained from lower Booth Hall were both dated as part of the HIGHTOWN chronology. Sample **18** retained some sapwood and provides a felling date range of AD 1470 - AD 1515 for this structure. Although based on two timbers only, this correlates with recent documentary research which suggests that the prison was built on this site in the late fifteenth or early sixteenth century (Shoesmith and Crosskey forthcoming).

16-18 High Town

With the location of the Freeman's Prison being reassessed, the surviving frame in 18 High Town has been reinterpreted as possibly being the Guildhall. This was built in AD 1490 and largely demolished early this century (Shoesmith and Crosskey forthcoming*)*. Unfortunately the only timber **(5)** obtained from this frame which was suitable for analysis could not be dated. The growth sequence shows that the tree was subject to severe stress for several years, perhaps as a result of deliberate woodland management techniques. Therefore the influence of immediate conditions has over-ridden the climate signal on which tree ring dating is dependant. Even if this timber had produced a result there are problems associated with the dating of a building on the basis of a single sample only as the timber may have been reused or a later replacement.

The samples from 16 High Town were all suitable for tree ring dating. Nine sequences from the frames A and B form an internally consistent group. The two posts sampled from Frame D could not be dated. The dated group included three samples with sapwood and three samples with heartwood/sapwood transition. High *t*-values and very good visual correlation between

four samples in particular (**9, 10, 11,** and **12**; see Table 2) suggests that these timbers may be derived either from the same tree or from trees which were growing very close together.

Sample **9** had sapwood complete to bark edge. The presence of spring vessels but no summer wood on the final ring indicates that the tree was felled in early AD 1490. The range of heartwood/sapwood transitions within this group is consistent with timbers which were felled at the same time (Baillie 1982, 57). These frames may have been part of a larger building, located to the north of Booth Hall. Assuming that the timbers were used while still green as was usual during this period (Rackham 1990, 69) this gives a construction date of AD 1490 for the building. Interestingly, this is exactly the same date as documentary records give for the building of the Guildhall! Therefore, could this building be the Guildhall? If so, what was the function of the building at 18 High Town? It is unfortunate that the samples from 18 High Town proved to be either unsuitable for analysis, or undatable. Obtaining a date for this structure would have assisted in placing it in context with the other buildings in the civic complex.

The fifteenth century civic complex
Within the site, the distribution of heartwood/sapwood boundaries throughout the whole group is indicative of two phases of building (Baillie 1982, 57) with Booth Hall probably being constructed first. The close grouping between lower Booth Hall and 16 High Town suggest that these two buildings were probably constructed at about the same time, soon after Booth Hall had been finished.

The original survey studied several secular buildings from Hereford city. These were dated from the mid thirteenth century to the early seventeenth century, although no structures were dated to the period AD 1371 to AD 1491 (Tyers 1996). The construction date for 16 High Town and felling date ranges of the other buildings overlaps with the end of this period and are also closely contemporary with the re-roofing of the Cathedral Barn, dated to AD 1492 (Tyers 1996) (Fig 6). It is possible to speculate that the construction of the High Town complex was part of a programme aimed at improving existing buildings and developing new civic facilities for the city.

Conclusion
The results from analysis of Booth Hall and 16-18 High Town are an interesting and positive contribution to the secular buildings project. Although no dating has been obtained for 18 High Town and one frame in 16 High Town, the results obtained for Booth Hall and parts of 16 High Town call for a reinterpretation of the development of this key part of Hereford. Based on

the results of tree ring analysis it would appear that this area underwent an extensive construction programme in the late fifteenth century providing a new complex of civic buildings for the city. The construction date of Booth Hall has been shown to be a century later than was previously thought. Although the frame surviving in 18 High Town is undated, the close agreement between the date for 16 High Town and the documented construction date of the Guildhall requires a reassessment of the both the function of these two buildings and the documentary evidence.

Acknowledgements

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

Groves, C, and Hillam, J, 1993 *Tree-ring analysis of oak timbers from the medieval barn, King's Pyon, near Leominster, Hereford and Worcester 1992 - Interim Report*, Anc Mon Lab Rep, **24/93**

Groves, C, and Hillam, J, 1997 Tree-ring analysis and dating of timbers, in *A Multi-period Salt Production Site at Droitwich: Excavations at Upwich 1983-4* (ed J D Hurst), CBA Res Rep, **107**, 121-6

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

Hillam, J, forthcoming *Tree-ring analysis of timbers from the fire-damaged areas of Windsor Castle, Berkshire*, Anc Mon Lab Rep

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**

Hughes, P, 1995a *18 High Town* unpubl ms

Hughes, P, 1995b *The Boothall 16, 17, and 18 High Town* unpubl ms

Morriss, R K, forthcoming *Hereford pre-1700 timber framed buildings*

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

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

Shoesmith, R, and Crosskey R, forthcoming Go To Gaol ... In Hereford, *Trans Woolhope Natur Field Club*

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

Watkins, A, 1918 Three early timber Halls in the City of Hereford *Trans Woolhope Natur Field Club*, **1918-20**, 164-171

Watkins, A, 1933 The Freeman's Prison at the Booth Hall *Trans Woolhope Natur Field Club*, **1933-35**, 49-53

Figure 1

Map showing the location of Booth Hall and 16-18 High Town (based upon the Ordnance Survey digital 1:1250 Superplan with the permission of The Controller of Her Majesty's Stationery Office, © Crown Copyright 1996).

Figure 2

Map showing the location of the buildings and the interpretation of the framing proposed by Shoesmith and Crosskey (forthcoming), after Shoesmith and Crosskey (forthcoming).

KEY
a. 18 High Town
b. 16 High Town
c. Booth Hall, and Lower Booth Hall
A. Guildhall?
B. Trading Hall?
C. Freeman's Prison?
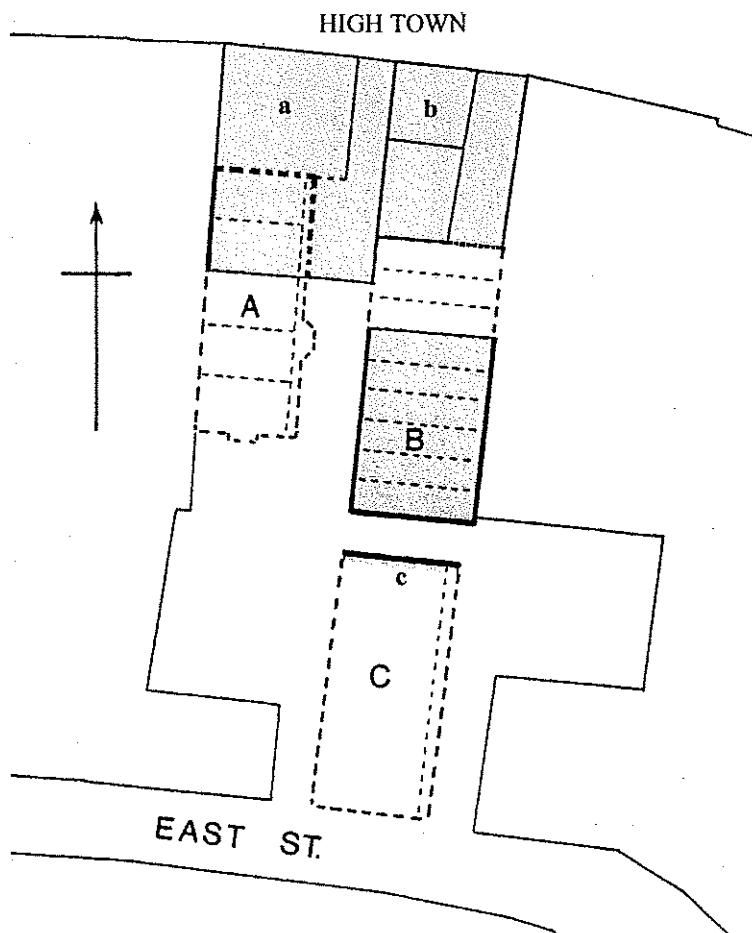
Figure 3a

Booth Hall Truss type 1, after Byron pers comm.
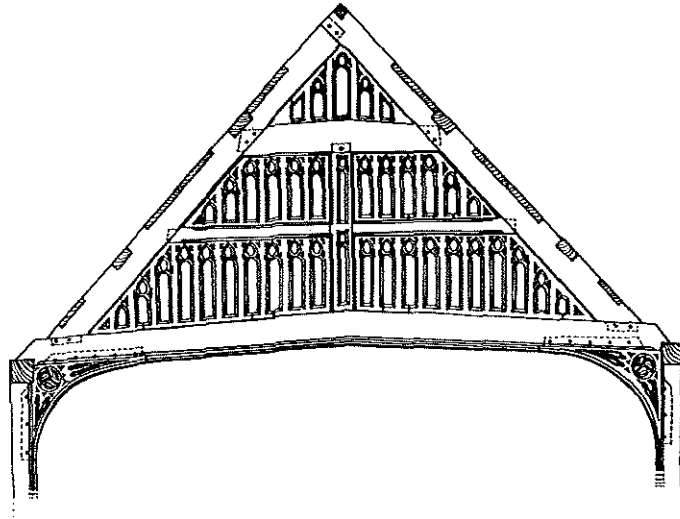
Figure 3b

Booth Hall Truss type 2, after Byron pers comm.
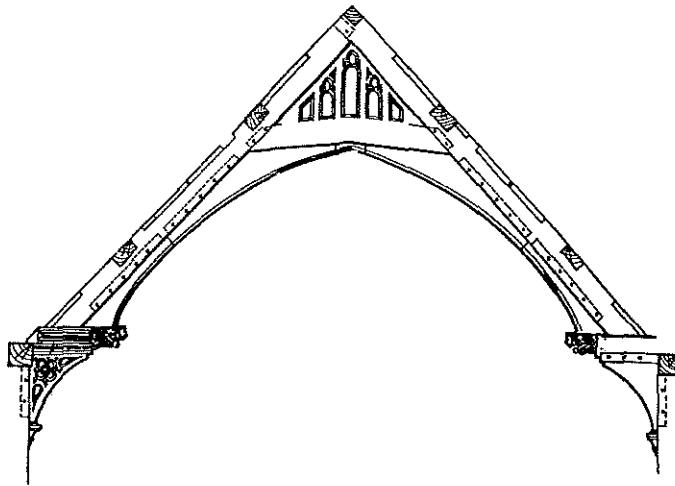
Figure 4a

Sketch plan showing the location of the samples obtained from Booth Hall. The roof trusses are labelled 1 to 7 inclusive, south to north. Solid lines indicate Truss type 1 (Fig 3a); dotted lines indicate Truss type 2 (Fig 3b).
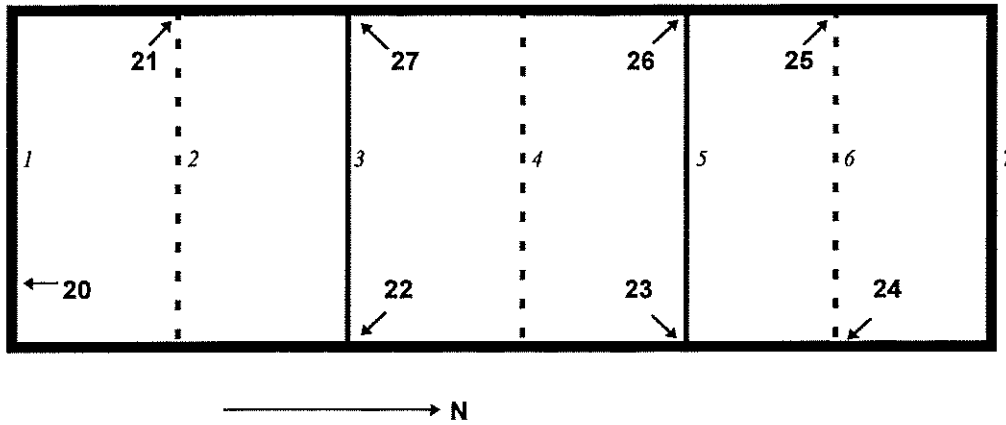
Figure 4b

Sketch showing the location of the samples obtained from Lower Booth Hall.
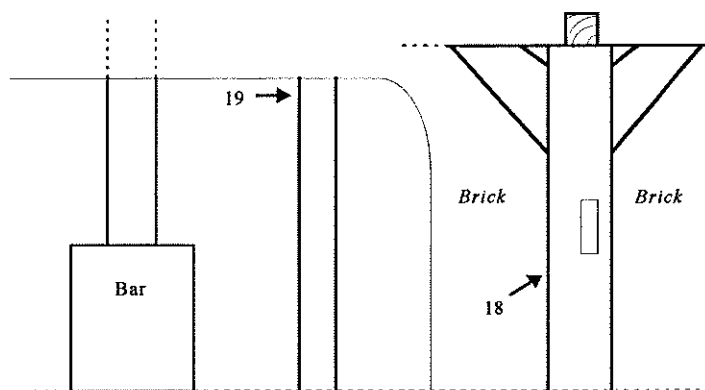
Figure 4c

Location of cores taken from the rear west wall of 18 High Town, after CHAU survey drawing.
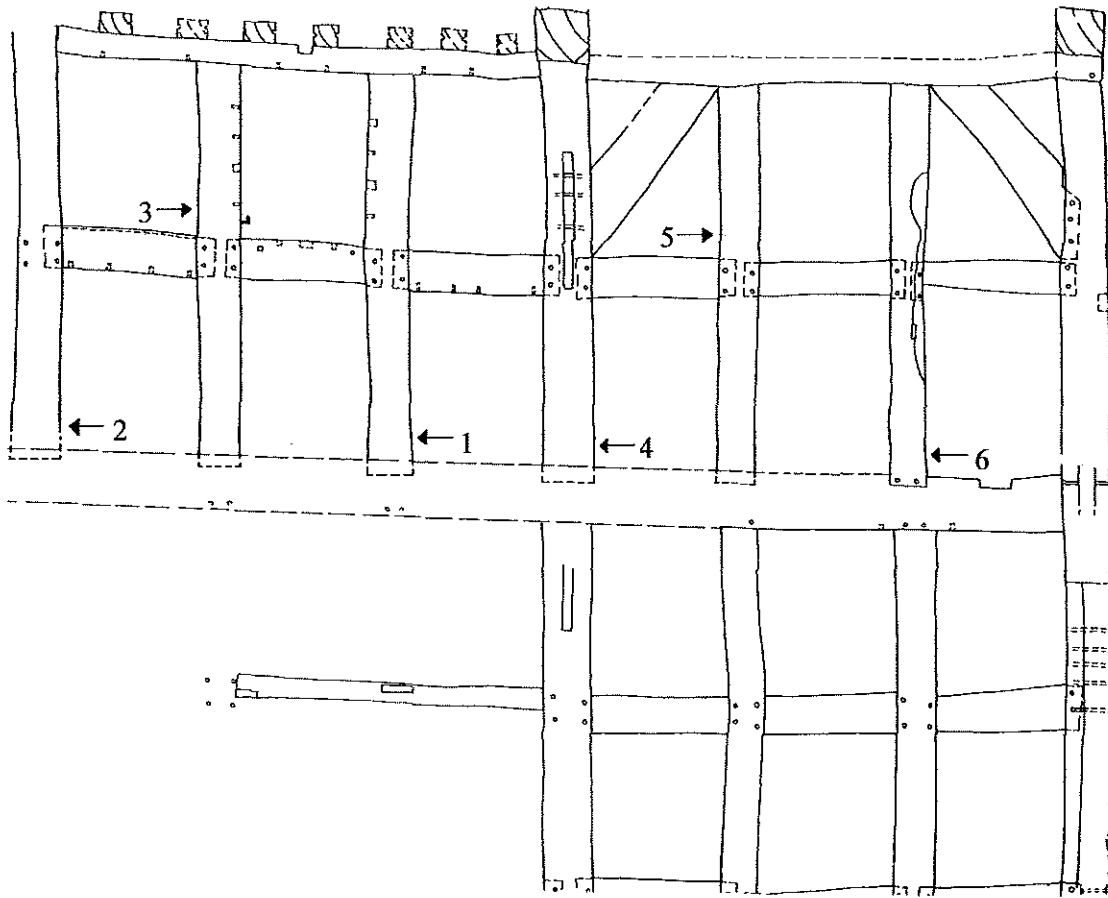
Figure 4d

Sketch plan showing the location of the cores taken from the south frame A of 16 High Town.
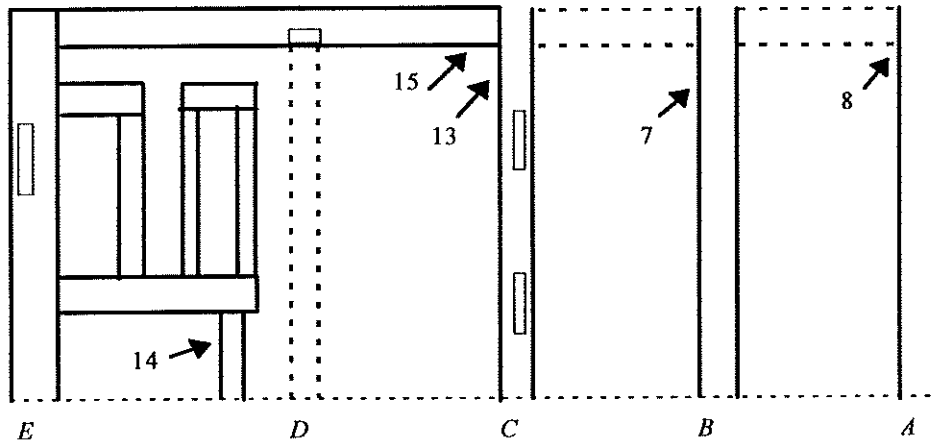
Frame C
joins here

Frame B
joins here

Figure 4e

Location of the cores taken from the west frame B of 16 High Town, after CHAU survey drawing.

⟶ N
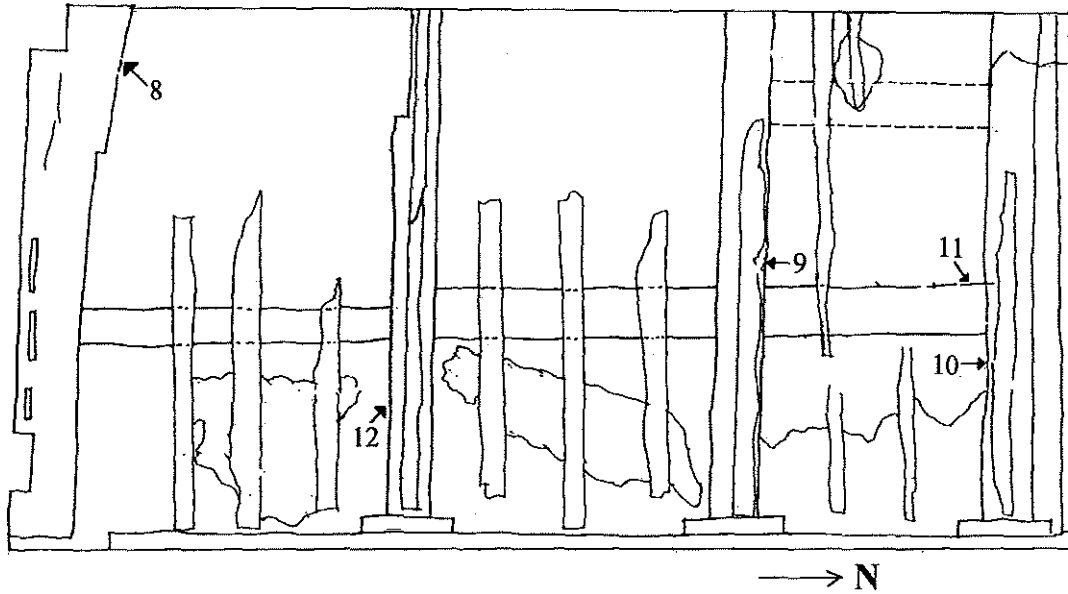
Figure 4f

Location of the cores taken from the rear south frame D of 16 High Town, after CHAU survey drawing.
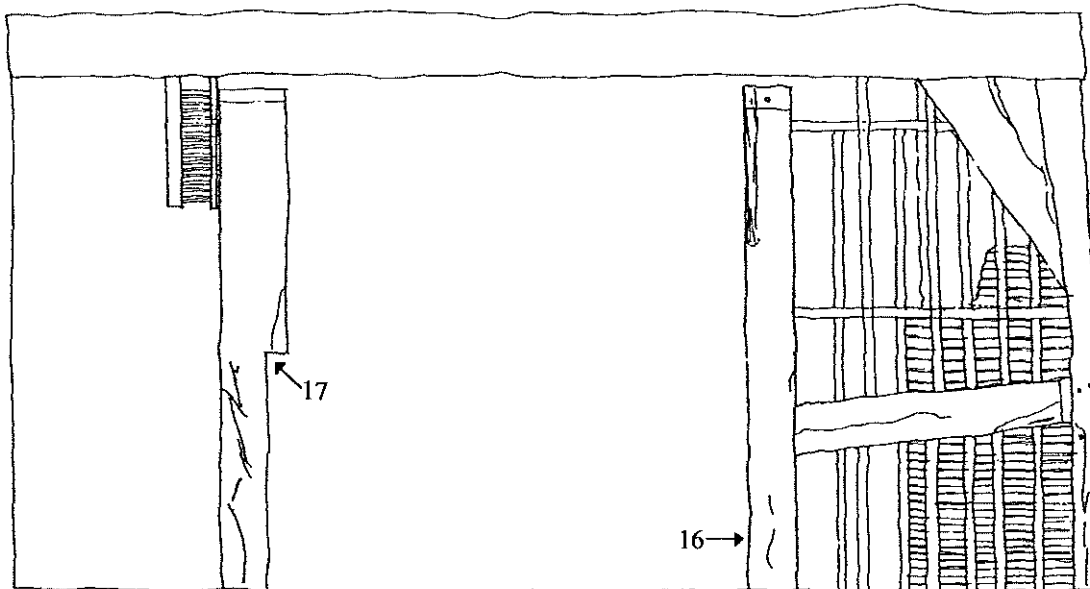
Figure 5

Bar diagram showing the relative positions of the dated sequences from Booth Hall and 16 High Town.

Hereford Civic complex   Span of ring sequences

KEY
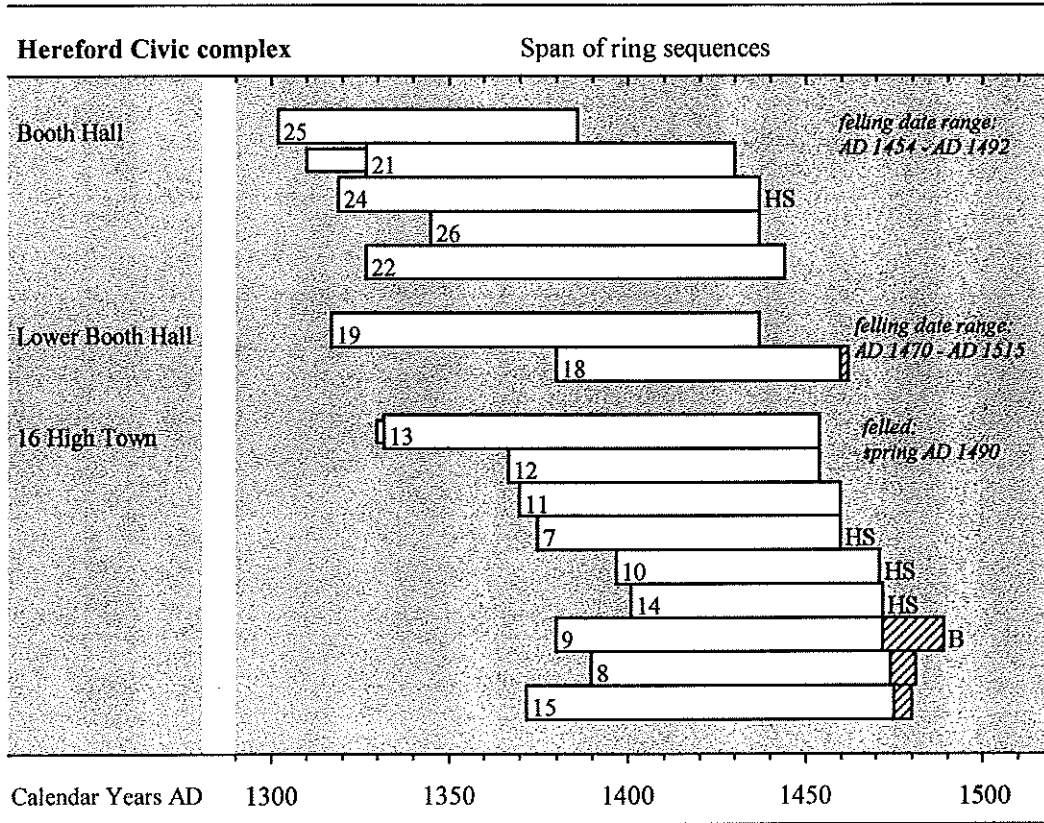
heartwood	
sapwood	
unmeasured heartwood	
HS	heartwood/sapwood boundary
B	bark boundary
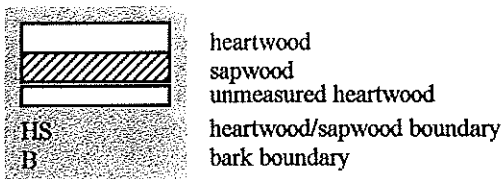
Figure 6

Bar diagram showing the relative position of the chronology 'HIGHTOWN' compared with other dated sequences from the historic core of Hereford.

Span of ring sequences

Hereford buildings	Cathedral Barn
	20 Church St
	Hightown
	Cathedral Barn
	East St
	14 Church St
	Farmers Club

| Calendar Years AD | 1150 | 1350 | 1550 |
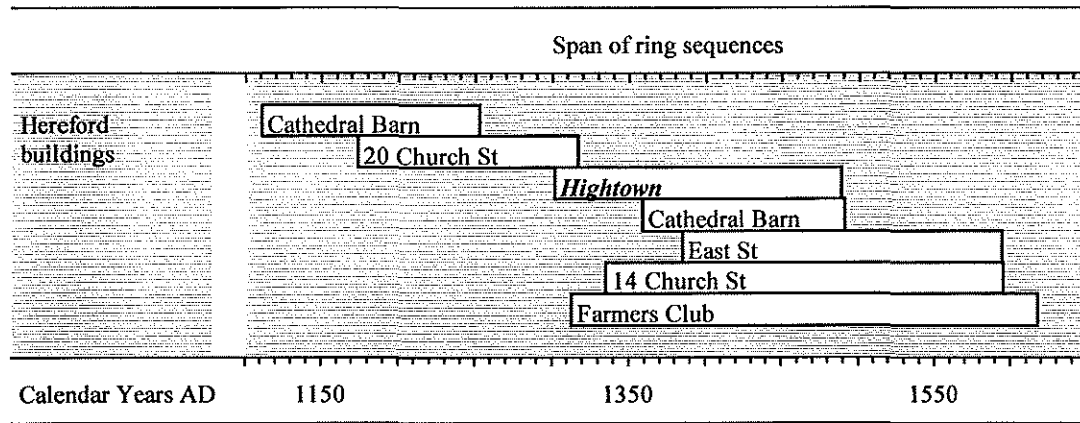
Table 1

List of samples from Booth Hall and 16 - 18 High Town.

Core	Origin	Total rings	Sapwood rings	mm/year	Date of sequence	Felling date range
18 High Town						
1	Stud	10	0	-	-	-
2	South post	29	0	-	-	-
3	Stud	44	0	-	-	-
4	Centre post	47	h/s	-	-	-
5	Stud	63	h/s +S12	1.87	undated	-
6	Stud	39	0	-	-	-
16 High Town						
7	Frame A storey post A	86	h/s	1.26	AD 1375 - AD 1460	AD 1470 - AD 1515
8	Frame A storey post B	92	7	1.79	AD 1390 - AD 1481	AD 1484 - AD 1529
9	Frame B post	110	17 +B	1.63	AD 1380 - AD 1489	AD 1490 spring
10	Frame B post	75	h/s	1.72	AD 1397 - AD 1471	AD 1481 - AD 1526
11	Frame B rail	91	0	1.95	AD 1370 - AD 1460	after AD 1470
12	Frame B post	88	0	2.41	AD 1367 - AD 1454	after AD 1464
13	Frame A storey post C	123	0	2.12	AD 1332 - AD 1454	after AD 1454
14	Frame A rail	72	h/s	2.03	AD 1401 - AD 1472	AD 1482 - AD 1527
15	Frame A top rail	109	5	2.18	AD 1372 - AD 1480	AD 1485 - AD 1530
16	Frame D post	84	19	1.80	undated	-
17	Frame D post	130	0	1.17	undated	-
Lower Booth Hall						
18	post	83	2	2.91	AD 1380 - AD 1462	AD 1470 - AD 1515
19	post	121	0	1.57	AD 1317 - AD 1437	after AD 1447
Booth Hall						
20	Truss 1 tiebeam	54	0	2.12	undated	-
21	Truss 2 west principal	104	0	1.53	AD 1327 - AD 1430	after AD 1440
22	Truss 3 east principal	118	0	1.54	AD 1327 - AD 1444	after AD 1454
23	Truss 5 east principal	61	0	2.77	undated	-
24	Truss 6 east principal	119	h/s	1.73	AD 1319 - AD 1437	AD 1447 - AD 1492
25	Truss 6 west principal	85	0	1.78	AD 1302 - AD 1386	AD 1447 - AD 1492*
26	Truss 5 west principal	93	0	2.18	AD 1345 - AD 1437	after AD 1447
27	Truss 3 west principal	-	-	-	-	

Key:

h/s = heartwood/sapwood boundary.
+S12 = an additional 12 detached sapwood rings were present on the timber that were not measured
+B bark-edge present
* note: **24** and **25** may have originated from the same tree, hence the felling date range applied to **25**.

Table 2

t-value matrix for the HIGHTOWN chronology.

<u>Key</u>
- = *t*-value below 3.0;
\ = no overlap;
t-values in **bold** indicate samples which may be from the same tree

	8	9	10	11	12	13	14	15	18	19	21	22	24	25	26
7	6.69	6.97	5.53	6.83	6.11	6.44	5.31	3.14	3.08	3.80	-	-	4.59	\	5.03
8		5.35	5.11	5.46	4.90	6.88	5.80	3.06	3.96	-	-	-	3.68	\	3.79
9			**6.17**	**10.89**	**12.21**	5.93	6.23	6.81	6.93	5.28	-	3.55	7.00	\	5.44
10				**11.17**	**7.14**	6.64	6.34	4.45	5.77	3.69	-	-	4.48	\	-
11					**9.15**	7.28	8.04	5.41	5.86	5.71	5.06	-	7.28	-	5.19
12						5.69	4.61	6.71	6.19	4.19	3.11	3.61	7.01	-	5.22
13							6.10	3.44	4.38	7.74	4.23	4.69	6.33	4.62	5.51
14								3.92	3.91	5.07	3.04	-	4.93	\	3.55
15									4.85	-	4.00	3.22	4.28	-	3.70
18										-	-	5.06	5.74	\	-
19											3.51	-	7.13	4.03	3.68
21												-	6.17	3.65	3.38
22													6.01	4.87	4.62
24														**11.31**	4.21
25															-

Table 3

Dating of the HIGHTOWN chronology. *t*-values with dated reference chronologies. All the reference chronologies are independant.

Area	Reference chronology	*t*-values
Berkshire	Windsor Castle Kitchen (Hillam forthcoming)	6.01
Gloucestershire	Gloucester, Mercer's Hall (Howard *et al* 1996)	10.60
Herefordshire	Droitwich, Upwich 2 (Groves and Hillam forthcoming)	9.16
	Hereford, Cathedral Barn roof (Tyers 1996)	12.39
	Hereford, Farmers Club (Tyers 1996)	11.68
	King's Pyon (Groves and Hillam 1993)	9.15
	Staplow (Tyers unpubl)	9.13
London	Southwark (except Hay's Wharf) (Tyers unpubl)	9.46

Table 4

Ring-width data from site master HIGHTOWN, dated AD 1302 - AD 1489 inclusive

Date	Ring widths (0.01mm)										No of samples									
AD 1302		212	178	285	204	194	227	214	200	285		1	1	1	1	1	1	1	1	1
	248	363	321	228	226	214	166	155	241	233	1	1	1	1	1	1	2	2	3	3
	244	223	226	225	158	157	232	213	207	201	3	3	3	3	3	3	5	5	5	5
	164	178	172	165	238	244	255	241	225	215	5	6	6	6	6	6	6	6	6	6
	196	159	181	177	239	221	221	229	264	181	6	6	6	6	7	7	7	7	7	7
AD 1351	258	179	205	201	120	128	212	198	217	153	7	7	7	7	7	7	7	7	7	7
	154	207	247	241	159	180	158	140	205	218	7	7	7	7	7	7	8	8	8	9
	216	243	209	196	210	198	166	197	253	211	9	10	10	10	11	11	11	11	11	13
	183	193	206	184	202	233	202	211	196	180	13	13	13	13	13	13	12	12	12	13
	220	166	165	134	166	235	185	195	207	236	13	13	13	13	13	13	14	14	14	14
AD 1401	210	183	224	204	180	185	167	195	221	213	15	15	15	15	15	15	15	15	15	15
	180	203	203	182	177	145	149	137	114	182	15	15	15	15	15	15	15	15	15	15
	177	167	231	187	188	146	143	215	212	166	15	15	15	15	15	15	15	15	15	15
	155	225	150	152	202	165	179	212	125	144	14	14	14	14	14	14	14	11	11	11
	166	141	166	184	155	161	178	176	134	131	11	11	11	11	10	10	10	10	10	10
AD 1451	183	159	169	168	185	193	206	188	145	181	10	10	10	10	8	8	8	8	8	8
	203	207	184	148	144	163	179	182	190	200	6	6	5	5	5	5	5	5	5	5
	182	164	135	179	239	188	181	153	167	158	5	4	3	3	3	3	3	3	3	3
	181	151	128	173	106	143	121	114	150		2	1	1	1	1	1	1	1	1	