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TREE-RING ANALYSIS OF TIMBERS FROM THE OLD HAT SHOP, 100 CHURCH STREET, TEWKESBURY, GLOUCESTERSHIRE

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Summary

This report describes the results of dendrochronological analysis of samples taken from the three surviving ranges of a building complex located on the burgage plot at 100 Church Street, Tewkesbury, Gloucestershire (NGR SO895326), a grade II* listed building presently empty and listed as a building at risk. A single, dated sample from a tiebeam in the back range indicates a terminus post quem of AD 1517 for its construction. The roof of the middle range is dated to AD 1664 along with that of the front range. Earlier in situ timber elements are suggested by the presence of decorated ceiling beams on the ground floor of the middle range (which on typological grounds appear to be sixteenth century), and a corner post and two adjoining girding beams in the rear corner of the front range for which timber was felled in the date range AD 1465 - 95. The extensive presence of reused timbers, particularly in the front range, may reflect the use of timbers from buildings previously occupying the plot which had been demolished, but these were excluded in the dendrochronological brief.

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Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from the Old Hat Shop, 100 Church Street, Tewkesbury, Gloucestershire (NGR SO895326; Fig 1). Analysis of the timbers was requested by Nick Molyneux of English Heritage in order to complement the Buildings at Risk survey (English Heritage 1999, 79) and to improve replication and extent of the Gloucestershire tree-ring chronology.

The building, occupying the forward part of a burgage plot with a 7.3m wide street frontage, comprises three ranges. The front range occupies the full width of the plot on three storeys with a double jetty including wide central canted oriels providing an impressive facade topped by a later hipped roof (Figs 2-6). Left of a modern ground-floor shop front, over an early wide-plank door, a decorated lintel is inscribed 'BKR 1664'. This has been taken to refer to the construction of this range by Bartholomew Read, following the demolition of earlier buildings on the site (Architecton 1999). Each main floor is occupied by a single, large room, lit by the oriel windows.

The middle range is dominated by two stairways and a brick chimney breast. The principal stairblock, to the west of the chimney, runs from the ground floor to the roof level, and carries a later staircase. A secondary stair, east of the chimney, originally ran from ground level to the second floor, bypassing the 'Great Chamber' on the first floor of the front range. This may be a nineteenth- or twentieth-century insertion added when the property was divided and this part of the property became a milliner's shop (ibid 1999). Notable features of this range are the partially-exposed, painted, close-set , chamfered beams in the ground-floor ceiling, possibly dating to the mid-sixteenth century on stylistic grounds and the truncated chimney stacks sealed by the roof at a lower level than that over the front range.

The back range is set on a different level to the middle and front ranges, with a significantly lower roof line. Its function is poorly 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 brief survey identified those oak timbers from the three ranges 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. Timbers with less than 50 rings present were rejected as such short ring patterns may not be unique in time and may be repeated at a period of time other then the one over which the parent tree was growing (English Heritage 1998, 12; Mills 1988). The dendrochronological sampling programme attempted to obtain cores 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. The partially-exposed ceiling joists in the ground floor of the middle range were not sampled at the request of the Conservation Officer. These await full exposure, recording, and conservation. The identification of suitable timbers was often complicated by overpainting or plastering of timbers, obscuring their growth characteristics. Numerous timbers, especially in the front range, exhibited indications of reuse, and were not selected for sampling.

The most promising 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 cores.

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 microcomputer based travelling stage (Tyers 1997a). 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 visually 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 satisfactory visual matching supports these positions. Timbers originally derived from the same parent tree generally have *t*-values greater than 10.0. Lower values from timbers obviously derived from the same parent tree (eg. on morphological grounds) are however quite common. It is the visual similarity in medium term growth trends of the samples that is the critical factor in determining 'same tree' origin.

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, following sapwood estimates given by Tyers (1998a; English Heritage 1998). Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. Where the bark edge is particularly well preserved it may be possible to determine the season of felling. Where the final ring contains both earlywood, laid down in the spring, and complete latewood, laid down in the summer, then it is reasonable to conclude that the parent tree had been felled during the tree's dormant period. This is commonly referred to as 'winter felled'. Where only earlywood, or a combination of earlywood and incomplete latewood is present in the final ring, then the tree has been felled during its period of active growth. This is commonly referred to as 'spring/summer felled'. 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

A total of 32 samples, numbered **1-32** inclusive, were taken from the three ranges (Table 1; Figs 3-6). Three samples (**1**, **24**, and **30**) were abandoned during coring when the fast-grown nature of the timbers became apparent.

Following cleaning of the cores, samples from both corner posts on the front façade of the front range at first-floor level (**6** and **9**), a rafter from the front range roof (**28**), and samples from two principal rafters (**20** and **23**) and the eastern wallplate (**21**) of the back range were rejected for analysis as they had insufficient rings. The remaining 23 samples were measured and the resultant ring sequences compared.

Three samples from the north-east corner of the back wall of the second-floor, front range (**14**, **15**, and **17**), crossmatched (Table 2a), while a further five samples from both the front and middle ranges (**11**, **26**, **29**, **31**, and **32**) also crossmatched (Table 2b). Two mean sequences for these (OHSTMID and OHSTLAT respectively) were calculated for these groups of crossmatching timbers. These mean sequences and the sequences from the remaining, unmatched, individual timber measurements were then compared with dated reference chronologies from throughout the British Isles and northern Europe. Table 3 shows the

correlation of the mean sequences OHSTMID and OHSLAT with reference series at the dating positions identified of AD 1325-AD 1458 and AD 1484 -AD 1664 respectively. Correlations are also given for one sample (**10**) dated to AD 1244-AD 1325, and another (**22**) dated to AD 1439-AD 1561. Table 4 lists the dated means and individually dated samples and the relationships between the dated timbers are indicated graphically in Figure 7. None of the remaining sequences could be reliably dated.

Interpretation

A total of ten samples have been dated for which individual felling dates have been estimated (Table 1). These are considered with reference to the ranges from which they derive.

Front Range

One sample (**10**) from a girding beam in the wall separating the middle and front ranges on the first floor gave a felling date range of AD 1325-60. Although this timber exhibited no signs of reuse, it was only partially visible where plaster had become detached from the wall. The mid fourteenth-century felling date suggests the timber had been reused.

The combined felling date range from three, apparently contemporary timbers (a corner post and two girding beams) along the same wall line but on the second floor (**14**, **15** and **17**) is AD 1465-95. Unlike numerous timbers visible in the east and west walls of this range, these timbers exhibited no clear evidence of reuse. These therefore imply the *in situ* survival of elements of a building for which timber was felled in the date range AD 1465-95 (possibly restricted to AD 1465-89 if the possible heartwood /sapwood boundary on sample **17** is correct).

The timber for a transverse beam in the ceiling of the second floor (sample **11**) was felled in the spring or summer of AD 1664, whilst the sole surviving original tiebeam (sample **29**), immediately to the north of the brick stack, was felled in AD 1660-87. The dating of these two timbers is consistent with construction of the front range in AD 1664 as indicated by the inscribed lintel. The limited number of timbers dating to the seventeenth century reflects the widespread reuse of timbers in the wallframes and the small number of suitable original timbers surviving in the roof which has clearly undergone substantial alteration with the later construction of a hipped roof at the front of the building. Timbers from the front façade have been reused in this alteration, and new, softwood principals and a front tiebeam inserted.

Middle Range

Three samples (**26**, **31**, and **32**) from two principal rafters and a tiebeam in the middle range date to the second half of the seventeenth century with the latter two samples felled in AD 1664. This suggests that substantial parts of the middle range, including the roof, were rebuilt in AD 1664 at the same time as the new front range was constructed. It may be possible to determine the primary construction date for the middle range during any repair works which allow access to the decorated ceiling beams on the ground floor.

Rear Range

The poor condition of the back range, with some patently unstable areas present, and a relative scarcity of suitable timbers, limited the number of possible samples. Of the six timbers sampled from the back range, five had sufficient rings for measurement, but only one sample has been dated. This sample from the tiebeam of the northern truss gave a *terminus post quem* of AD 1517. Again, as with the middle range, additional, unsampled areas within this range may become available for analysis once repairs commence.

Conclusions

Although a substantial number of samples were taken, a significant proportion had insufficient rings to merit measurement and, of those analysed, a relatively small proportion dated successfully. This partly reflects the difficulty of assessing the suitability of painted, and partially-exposed timbers prior to sampling and highlights the need for extensive sampling in such circumstances. A further programme of sampling and analysis during repairs, when improved access to timbers, particularly from the rear and middle ranges, should prove possible, could provide a fuller understanding of the development of this building complex.

Acknowledgements

The sampling and analysis programme was funded by English Heritage. The Conservation Officer, Sarah Higgins, arranged access with permission from Mrs Grimshaw, the owner, and also provided additional drawings and an insight into the building's development and possible future. The occupants of the adjacent Rupert's Delicatessen (101 Church Street) kindly provided access to an electricity supply.

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Figure 1 Map showing the location of the Old Hat Shop, 100 Church Street, Tewkesbury.

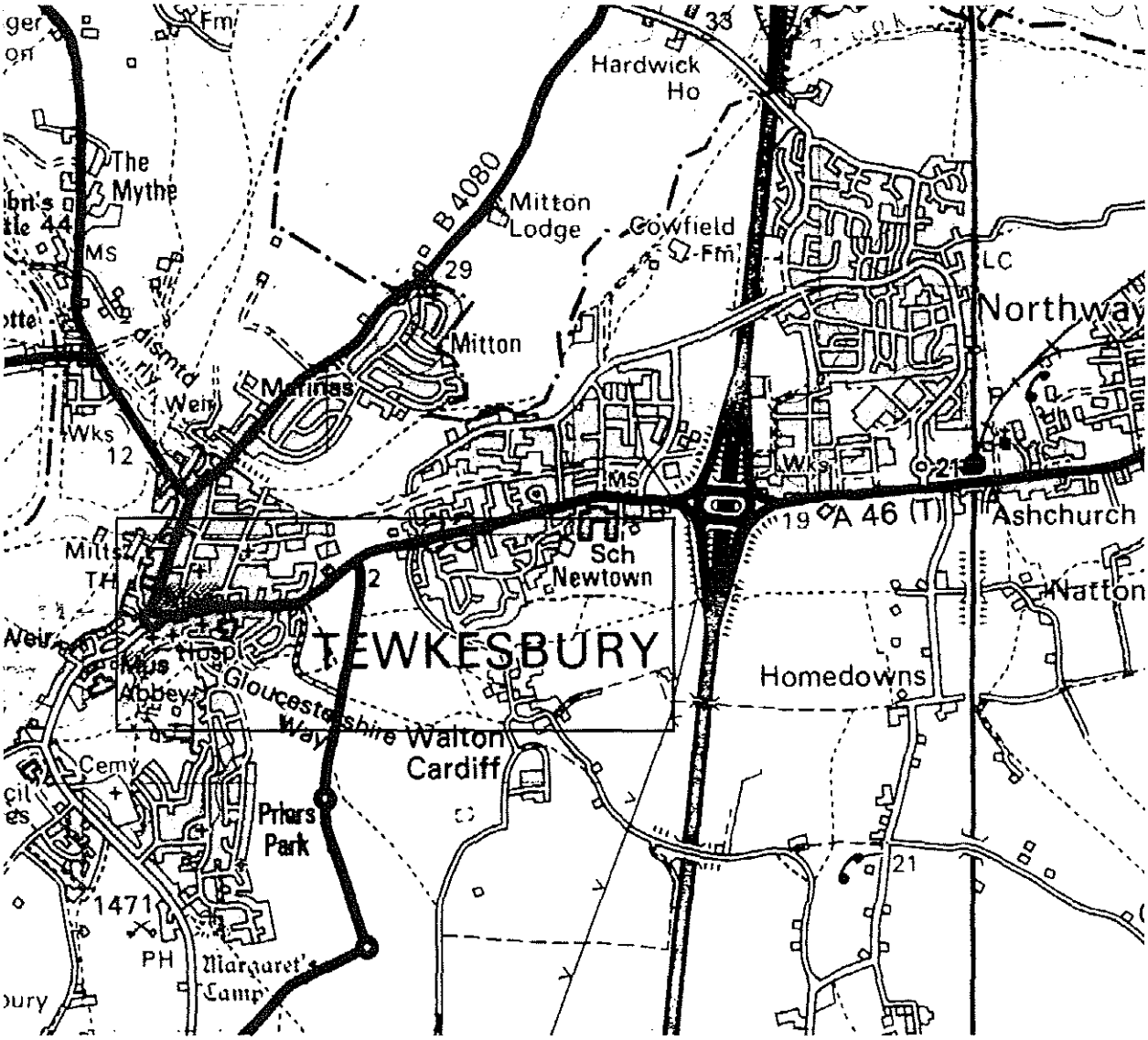

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Figure 2. The Old Hat Shop, 100 Church St, Tewkesbury. The street frontage.

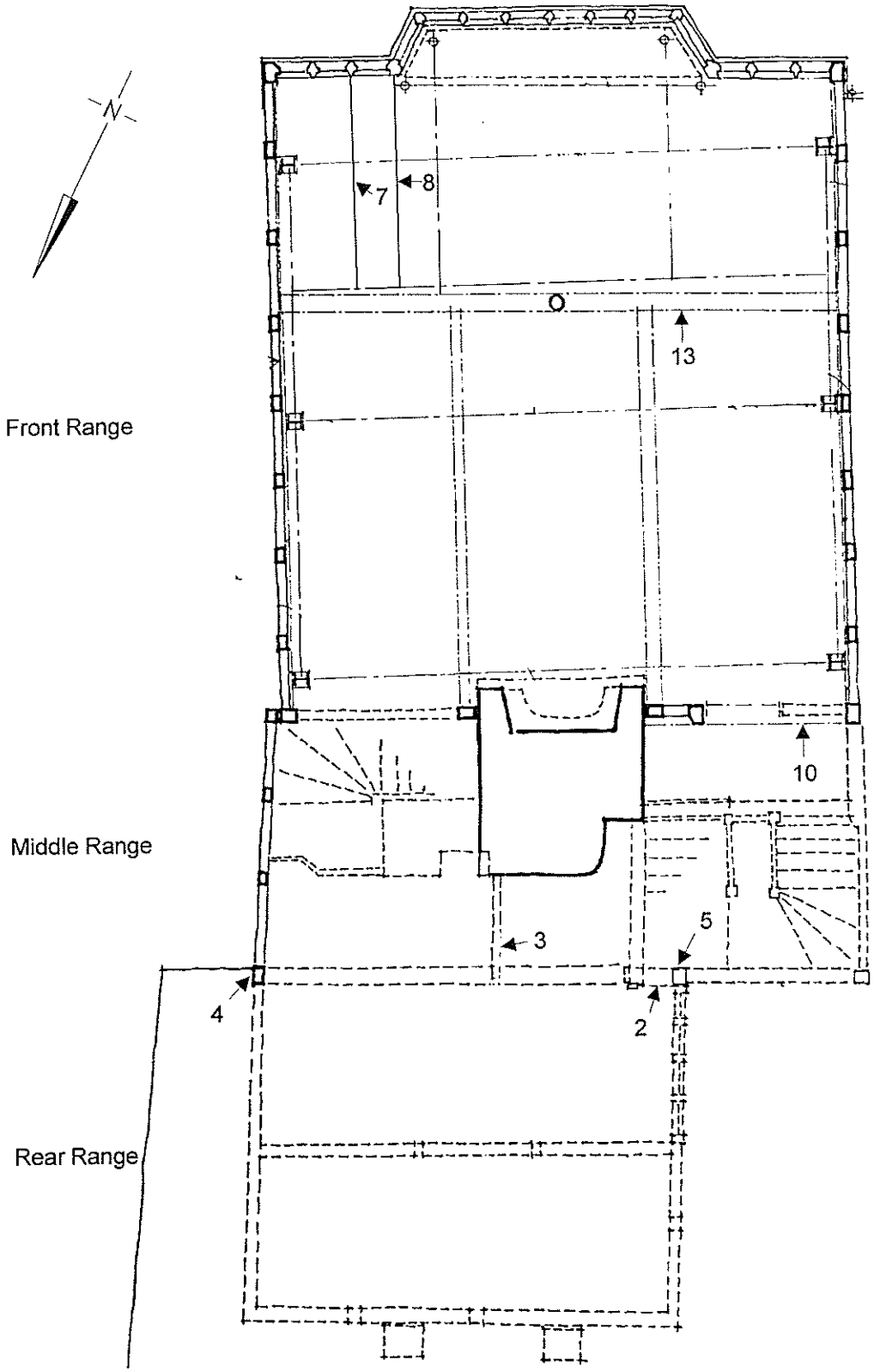

Figure 3. The Old Hat Shop, 100 Church St, Tewkesbury. First-floor plan indicating location of tree-ring dating samples

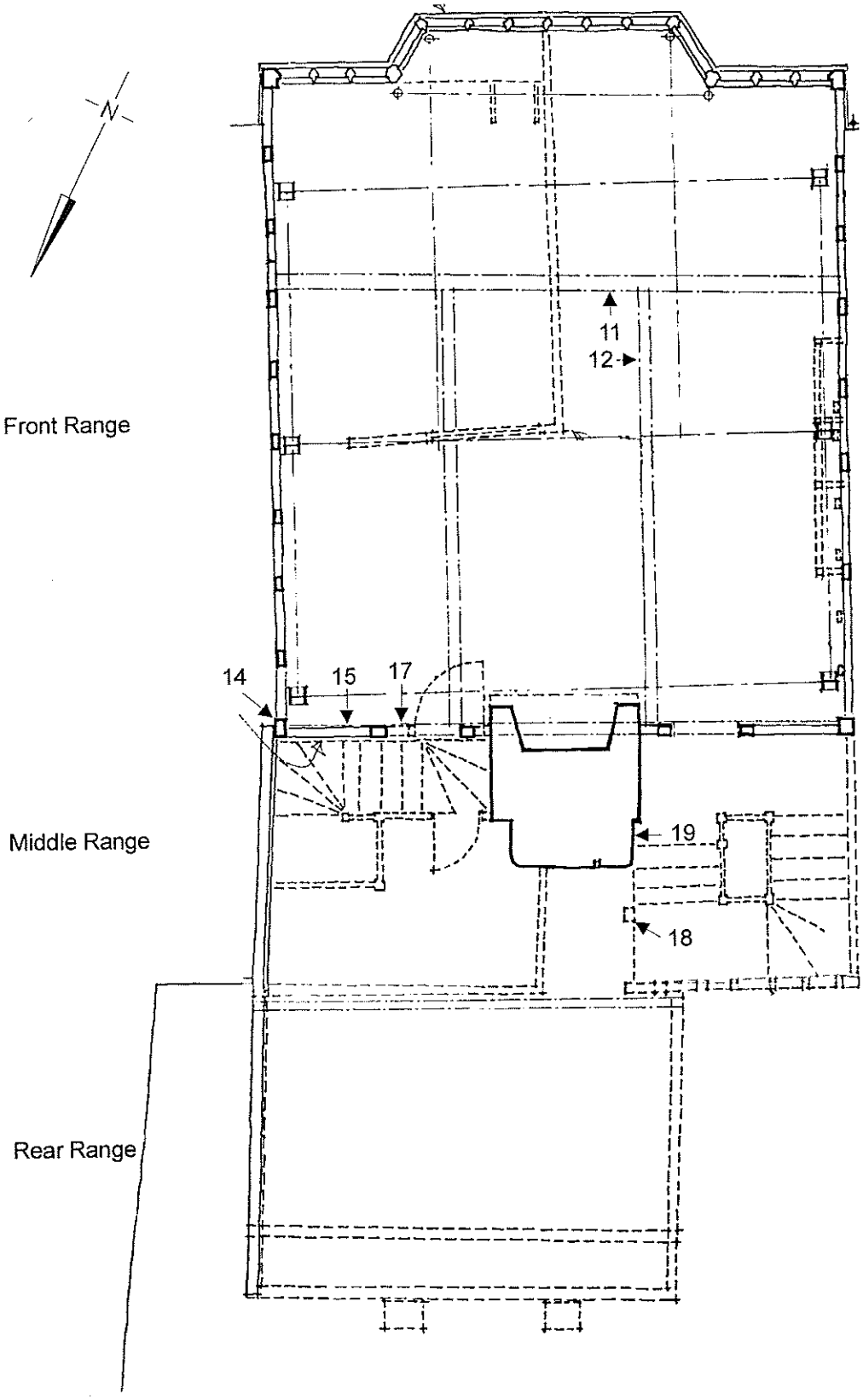

Figure 4. The Old Hat Shop, 100 Church St, Tewkesbury. Second-floor plan indicating location of tree-ring dating samples

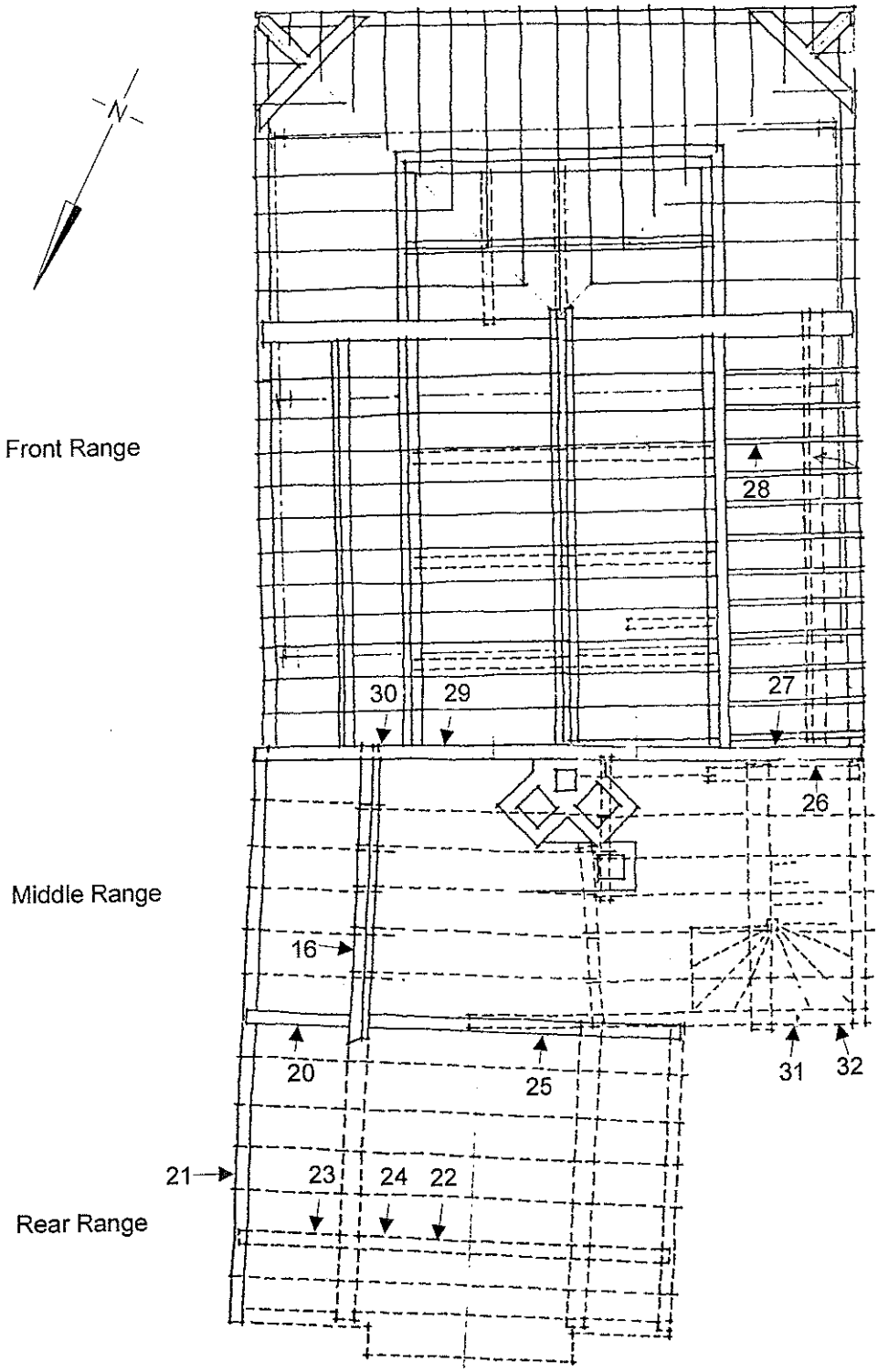

Figure 5. The Old Hat Shop, 100 Church St, Tewkesbury. Roof plan indicating location of tree-ring dating samples

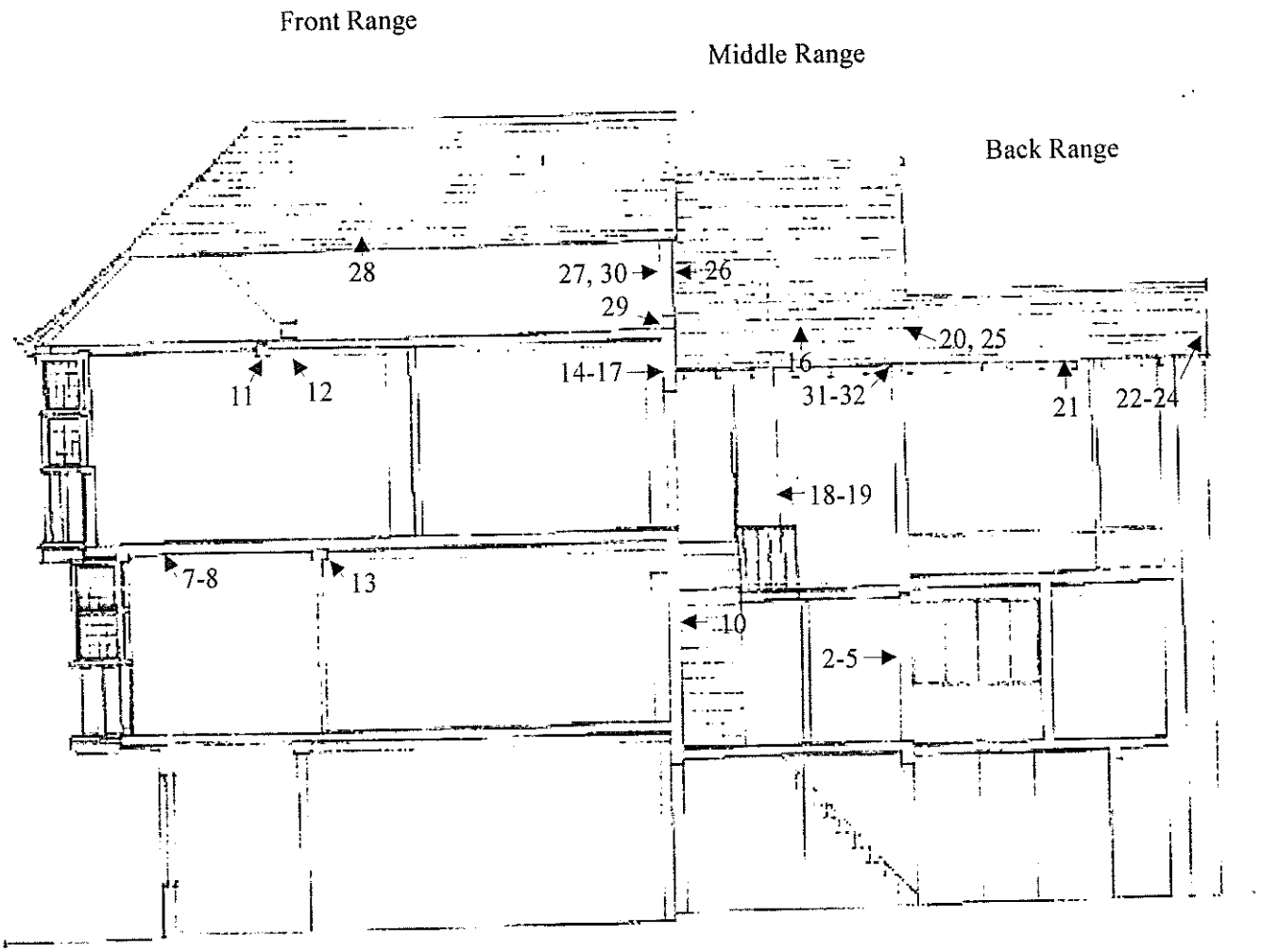

Figure 6. The Old Hat Shop, 100 Church St, Tewkesbury. Longitudinal section. View towards south-west

Figure 7 Bar diagram showing the chronological positions of the dated timbers by phase.

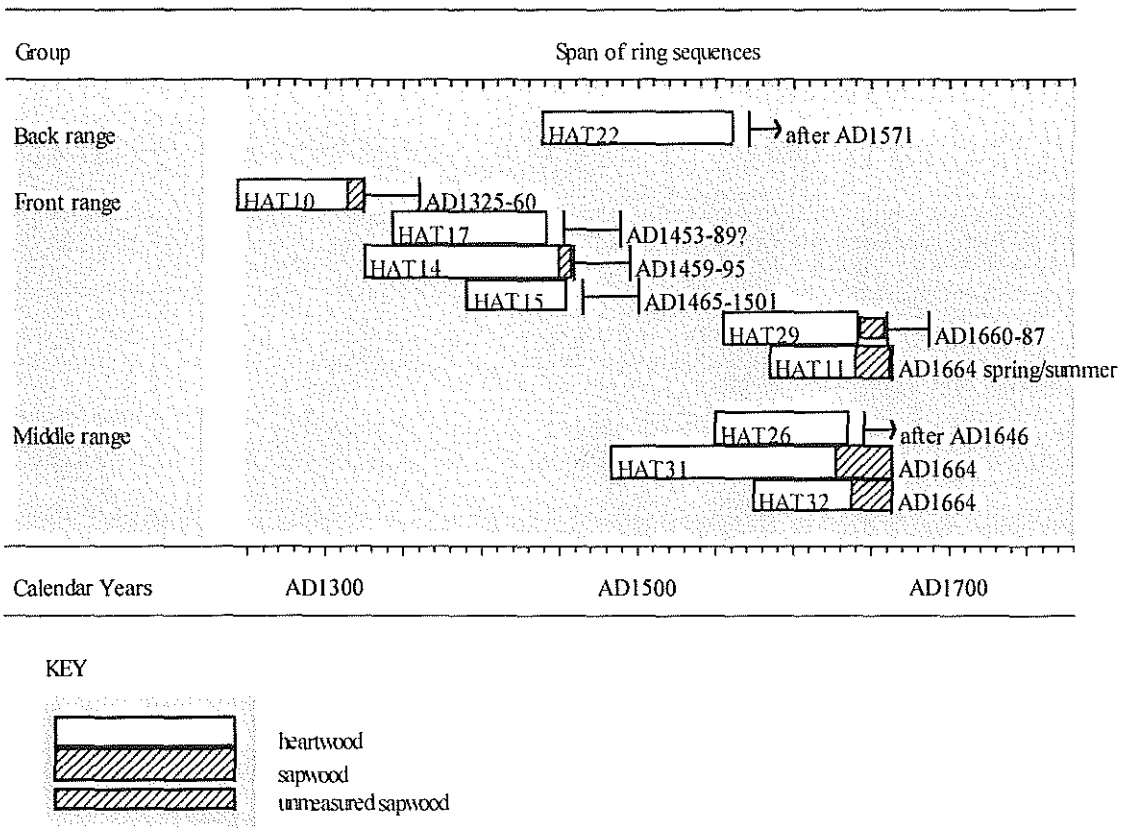

Table 1

List of samples

Core No	Origin of core	Cross-section of tree	Cross-section size (mm)	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
01	Post, ground floor, middle range, abandoned during coring	Whole?	230 x 190	-	-	-		
02	Brace, first-floor, middle range	Quarter	250 x 140	65+1H	-	2.17		-
03	Beam, first-floor ceiling, middle range	Quarter	130 x 120	71	3	1.83		-
04	Post, first-floor, middle range	Quarter	280 x 190	118	6	1.80		-
05	Beam, first-floor, middle range	Whole	215 x 150	67	-	1.45		-
06	Corner post, first-floor, front range	Quarter?	230 x 200?	<30	-	-		
07	Joist (reused), first-floor ceiling, front range	Quarter	110 x 100	114	35+B	0.77		-
08	Joist (reused), first-floor ceiling, front range	Quarter	100 x 90	90	13+Bw	1.07		-
09	Corner post, first-floor, front range	Quarter?	280? x 200?	<50	-	-		
10	Beam, first-floor, front range?	Whole	235 x 220	82	11	1.85	AD1244-AD1325	AD1325-60
11	Beam, second-floor ceiling, front range	Whole	250 x 190	79	23+Bs	1.59	AD1585-AD1663	AD1664 spring/summer
12	Beam reused, second-floor ceiling, front range	Whole	220 x 170	101	+HS	0.91		-
13	Beam, second-floor floor/first-floor ceiling, front range	Whole	200 x 200	65	+HS	1.67		-
14	Corner post, second-floor, front range	Quarter	200 x 130	134	9	1.20	AD1325-AD1458	AD1459-95
15	Beam, second-floor, front range	Quarter	140 x 130	65	+HS	1.95	AD1391-AD1455	AD1465-1501
16	Purlin reused?, middle range	Quarter	230 x 110	55	16+B	1.73		-
17	Beam, second-floor floor/first-floor ceiling, front range	Half	200 x 170	101	+?HS	1.05	AD1343-AD1443	AD1453-89?
18	Doorpost, second-floor, middle range	Quarter	200 x 130	66	16+B	2.24		-
19	Board detached from partition wall, middle range	Radial	125 x 15	78	-	1.54		-
20	Principal rafter, back range	Half	215 x 110	<50	-	-		
21	Wall plate, back range	Quarter	200 x 100	<50	-	-		
22	Tiebeam, back range, north truss	Quarter	210 x 170	123		1.38	AD1439-AD1561	after AD 1571
23	Principal rafter, north truss, back range	Half	230 x 100	<50	-	-		
24	Collar, north truss, back range, bandoned during sampling	Half	150+ x 90+	-	-	-		
25	Collar, south truss, back range	Half	260 x 120	57	-	1.72		-
26	Principal rafter, south truss, middle range	Half	300 x 250	87	-	2.28	AD1550-AD1636	after AD1646
27	Principal rafter, front range	Half	220 x 125	73	30+B	1.75		-

Core No	Origin of core	Cross-section of tree	Cross-section size (mm)	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
28	Rafter, front range	Quarter	100 x 90	<50	-	-		
29	Tiebeam, front range	Half	200 x 180	89	2+17s	1.24	AD1555-AD1643	AD1660-87
30	Principal rafter, front range, abandoned during coring	Half	220 x 115	-	-			
31	Principal rafter, north truss, middle range	Quarter	150 x 120	181	37+B	0.89	AD1484-AD1664	AD1664
32	Tiebeam, north truss, middle range	Quarter	200 x 120	90	26+B	1.19	AD1575-AD1664	AD1664

Total rings = all measured rings, +value means additional rings were only counted, the felling period column is calculated using these additional rings.
Sapwood rings: h/s heartwood/sapwood boundary, ?h/s possible heartwood/sapwood boundary, +bw = bark-edge winter felled, +bs = unmeasured spring growth also present; ARW = average ring width of the measured rings

Table 2

t-value matrix for dated samples. \ = overlap < 15 years. - = t-values less than 3.00

a) Samples 14, 15 and 17 (OHSTMID)

Samples	15	17
14	6.48	3.12
15	*	5.00

b) Samples 11, 26, 29, 31 and 32 (OHSTLAT)

Samples	26	29	31	32
11	5.33	5.46	6.39	4.49
26	*	4.37	4.72	4.62
29	*	*	4.00	-
31	*	*	*	-

Table 3

Dating the mean sequences OHSTMID, OHSTLAT, OHST10 and OHST22 at the indicated dating positions of AD 1325-1458, AD 1484-1664, AD 1244-AD1325 and AD 1439-1561 respectively. *t*-values with independent reference chronologies, \ = overlap < 15 years, - = t-values less than 3.50

Area	Reference chronology	*t*-values			
		ohstmid	**ohstlat**	**ohst10**	**ohst22**
Berkshire	Reading waterfront (Groves *et al* 1997)	-	\	6.06	\
Devon	Bowhill House, Exeter (Hillam 1991)	7.68	\	-	5.53
East Midlands	East Midlands 1988 (Laxton and Litton 1988)	7.05	6.10	5.62	5.15
Gloucestershire	26 Westgate Street Gloucester (Howard *et al* 1998)	4.88	9.22	\	7.22
Gloucestershire	Mercer's Hall, Gloucester (Howard *et al* 1996)	8.06	-	-	6.69
Gloucestershire	St Mary Magdalene, Twyning (Tyers 1996)	3.55	\	5.85	\
Herefordshire	Dore Abbey Church (Tyers and Boswijk 1998)	-	7.46	\	6.73
Herefordshire	Pembridge Belltower (Tyers 1999a)	\	5.45	\	\
Herefordshire	St Bartholomews, Lower Sapey (Tyers 1995)	7.78	-	\	5.10
Herefordshire	White House, Vowchurch (Nayling 1999)	5.35	6.80	\	5.06
London	Trig Lane (Tyers 1992)	-	\	6.25	\
Staffordshire	Black Ladies, nr Brewood (Tyers 1999b)	4.95	5.36	\	4.83
Staffordshire	Sinai Park (Tyers 1997b)	6.20	3.98	-	6.62
Surrey	Wanborough Barn, nr Guildford (Tyers 1997c)	-	\	5.37	\
Sussex	St Mary's Church, Sompting (Tyers 1988)	\	\	6.69	\
Welsh Border	Welsh Border (Siebenlist-Kerner 1978)	6.50	7.08	\	8.49
Worcestershire	Droitwich (Groves and Hillam 1997)	\	7.35	\	5.09
Worcestershire	St Nicholas' Church, Warndon (Tyers 1998b)	5.30	\	5.95	\

Table 4

a) Ring-width data from site master OHSTMID dated to AD1325 to AD1458 inclusive

Date	Ringwidths (0.01mm)										No of samples									
AD1325					166	191	234	241	214	208					1	1	1	1	1	1
-	176	203	257	215	210	175	165	190	175	189	1	1	1	1	1	1	1	1	1	1
-	193	212	162	156	204	184	172	172	186	188	1	1	2	2	2	2	2	2	2	2
AD1351	173	171	166	133	147	141	148	126	130	78	2	2	2	2	2	2	2	2	2	2
-	100	132	146	128	120	145	134	109	143	140	2	2	2	2	2	2	2	2	2	2
-	122	115	102	122	119	113	121	123	121	122	2	2	2	2	2	2	2	2	2	2
-	102	107	91	128	102	133	117	99	112	100	2	2	2	2	2	2	2	2	2	2
-	153	109	111	115	101	126	120	143	135	147	3	3	3	3	3	3	3	3	3	3
AD1401	157	122	162	130	121	120	99	114	161	147	3	3	3	3	3	3	3	3	3	3
-	105	134	108	111	121	119	97	105	72	99	3	3	3	3	3	3	3	3	3	3
-	106	92	111	104	92	66	91	122	101	118	3	3	3	3	3	3	3	3	3	3
-	100	111	87	109	119	113	106	132	102	117	3	3	3	3	3	3	3	3	3	3
-	118	90	126	171	132	121	116	145	182	173	3	3	3	2	2	2	2	2	2	2
AD1451	216	233	189	203	205	166	128	147			2	2	2	2	2	1	1	1		

b) Ring-width data from site master OHSTLAT dated to AD1484 to AD1664 inclusive

Date	Ring widths (0.01mm)										No of samples									
AD1484				179	185	145	139	117	141	190				1	1	1	1	1	1	1
-	173	98	123	111	125	149	115	101	143	103	1	1	1	1	1	1	1	1	1	1
AD1501	128	117	94	91	90	61	83	74	89	77	1	1	1	1	1	1	1	1	1	1
-	110	101	115	88	99	77	95	98	131	92	1	1	1	1	1	1	1	1	1	1
-	127	126	97	88	85	61	97	105	119	133	1	1	1	1	1	1	1	1	1	1
-	118	89	90	110	77	91	117	91	111	128	1	1	1	1	1	1	1	1	1	1
-	159	98	89	108	101	84	75	82	87	229	1	1	1	1	1	1	1	1	1	2
AD1551	239	178	211	244	396	209	219	303	257	367	2	2	2	2	3	3	3	3	3	3
-	203	357	217	295	265	168	178	192	254	242	3	3	3	3	3	3	3	3	3	3
-	180	153	172	222	274	241	235	186	176	268	3	3	3	3	4	4	4	4	4	4
-	167	131	150	198	231	155	176	186	183	107	4	4	4	4	5	5	5	5	5	5
-	152	147	158	183	188	161	136	138	136	102	5	5	5	5	5	5	5	5	5	5
AD1601	142	130	114	108	72	108	95	108	111	92	5	5	5	5	5	5	5	5	5	5
-	108	68	110	73	77	93	112	103	78	101	5	5	5	5	5	5	5	5	5	5
-	118	125	117	91	108	90	104	106	112	88	5	5	5	5	5	5	5	5	5	5
-	95	135	110	64	82	57	74	101	65	104	5	5	5	5	5	5	4	4	4	4
-	89	82	81	109	92	128	92	113	71	74	4	4	4	3	3	3	3	3	3	3
AD1651	65	67	69	43	85	74	74	95	76	66	3	3	3	3	3	3	3	3	3	3
-	64	61	102	58							3	3	3	2						

c) b) Ring-width data from sample OHST10 dated to AD1244 to AD1325 inclusive

Date	**Ring widths (0.01mm)**									
AD1244				150	178	215	249	206	327	225
AD1251	195	149	214	184	294	286	279	284	159	302
-	261	221	202	139	177	234	218	207	189	226
-	284	201	326	260	164	191	167	123	144	251
-	217	205	161	172	252	250	82	62	142	223
-	130	153	152	198	141	105	113	63	76	62
AD1301	92	137	101	90	80	142	133	120	137	166
-	159	176	235	257	248	311	208	134	170	208
-	230	229	121	127	144					

d) Ring width data from sample OHST22 dated to AD 1439 to AD 1561 inclusive

Date	**Ring widths (0.01mm)**									
AD1439									97	119
-	102	80	88	121	148	174	188	194	160	118
AD1451	191	132	179	180	190	192	142	182	156	254
-	165	173	155	89	142	125	130	110	112	140
-	95	96	87	115	162	121	128	117	168	165
-	178	196	212	186	202	177	164	157	145	169
-	160	121	139	161	126	184	139	133	210	162
AD1501	140	135	113	129	124	116	107	95	133	108
-	149	140	162	126	135	107	118	129	113	158
-	154	139	124	142	108	101	116	151	133	130
-	174	110	141	125	148	156	121	139	119	163
-	138	142	159	154	171	143	128	132	182	150
AD1551	165	124	113	109	158	83	109	133	139	148
-	149									