DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS FROM BROTHERHOOD HALL, CHURCH STREET, STEYNING, WEST SUSSEX, ENGLAND

Tree-Ring Services Report: SYBH/15/14

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SUMMARY

Brotherhood Hall is a large *c.* 25 m long by 7.5 m wide open hall of seven bays of roughly equal width. The roof is hipped with gablets and of crown-post construction. The crown posts are moulded. The wall-frame consists of close studding with a mid-rail. The front facing Church Street has a continuous jetty.

Seven of the nine timbers sampled are matched together to form an 82-year site chronology which is dated to span AD 1369 to AD 1450. Timbers probably felled in AD 1446 and AD 1447, together with timbers felled in the winters of AD 1447/8 and AD 1450/51 provide good evidence that construction of the building is likely to have occurred in AD 1451, or soon after.

The four-year range of felling dates suggests that there was some stockpiling of timbers and the build may have been protracted over a few years, which might be expected for a building of this large size. The average age of the trees felled for construction was *c.* 80 years and high cross-matching with local reference chronologies suggests these were sourced locally.

KEYWORDS

Dendrochronology, 15th Century, Standing building, West Sussex, Steyning.

Figures

Tables

Photos

INTRODUCTION

The increased interest in Britain's past is demonstrated by such television programmes as "Time Team" and "The House Detectives". More and more people wish to know precisely when ancient buildings were constructed in order to better understand the history of their occupants and land in which we live. Although it is sometimes possible to date a building on stylistic grounds, a precise date is rare except when there is a date-stone or documentary evidence.

The increasing use of dendrochronology (tree-ring dating) has changed this scenario, at least for buildings with timbers containing sufficient rings for analysis. The science is simple in concept. The width of a tree's growth rings varies from year to year, so that each series of years has a unique pattern of narrow and wide rings. We now know in detail the pattern of rings shown by oak trees in England for at least the last 2000 years, and there is some work in progress on other species, such as pine, beech and yew. Tree-ring dating typically involves small cores of wood being taken from the structural timbers of a building. Once sanded to a polished finish, these samples show the pattern of rings laid down during the lifetime of the trees from which the timbers were cut. If this pattern is then compared with "master chronologies" it is often possible to identify the felling date of the trees with astonishing accuracy. Where bark is present, it is possible to give a precise year, sometimes even the season of the year. We know that oak for building was almost always used "green", (unseasoned, not having been felled and prepared until required), so construction dates can be determined in which we can place considerable confidence.

Recording Timber-Framed Buildings

National trends in building activity inevitably conceal regional differences that can only be explained by detailed local studies. The Royal Commission on the Historical Monuments of England (RCHME) has analysed 53 medieval buildings in Kent (Pearson 1994). Hampshire County Council has analysed well over 100 buildings in the county (Roberts 2003). These projects utilize the specific dates provided by tree-ring analysis to refine the typological and stylistic dating of buildings.

Tree-Ring Services is committed to the development of date-range spans for stylistic features to help refine the dating of timber-framed buildings. Buildings are recorded using a ‘Tick-Box’ sheet (available at www.buildingarchaeology.co.uk) which is used to summarise the most common and distinctive ‘key features’. This information is entered into a purpose-built Building Archaeology Research Database (BARD), a resource then available for further analysis (Moir *et al.* 2012). BARD has been used to analyse 177 dwellings in Surrey and establish date ranges for 52 key features (Wild and Moir 2013). Each additional building tree-ring dated by Tree-Ring Services adds to this research and should eventually allow date ranges to be extended to other counties.

Harris (1978) provides a useful introduction to the study of timber-framed buildings, while Brunskill (2000) details the study of vernacular architecture. Alcock's (1996) glossary provides illustrative drawings which are particularly useful in facilitating the naming of timbers in a building.

Figure 1: Area location map

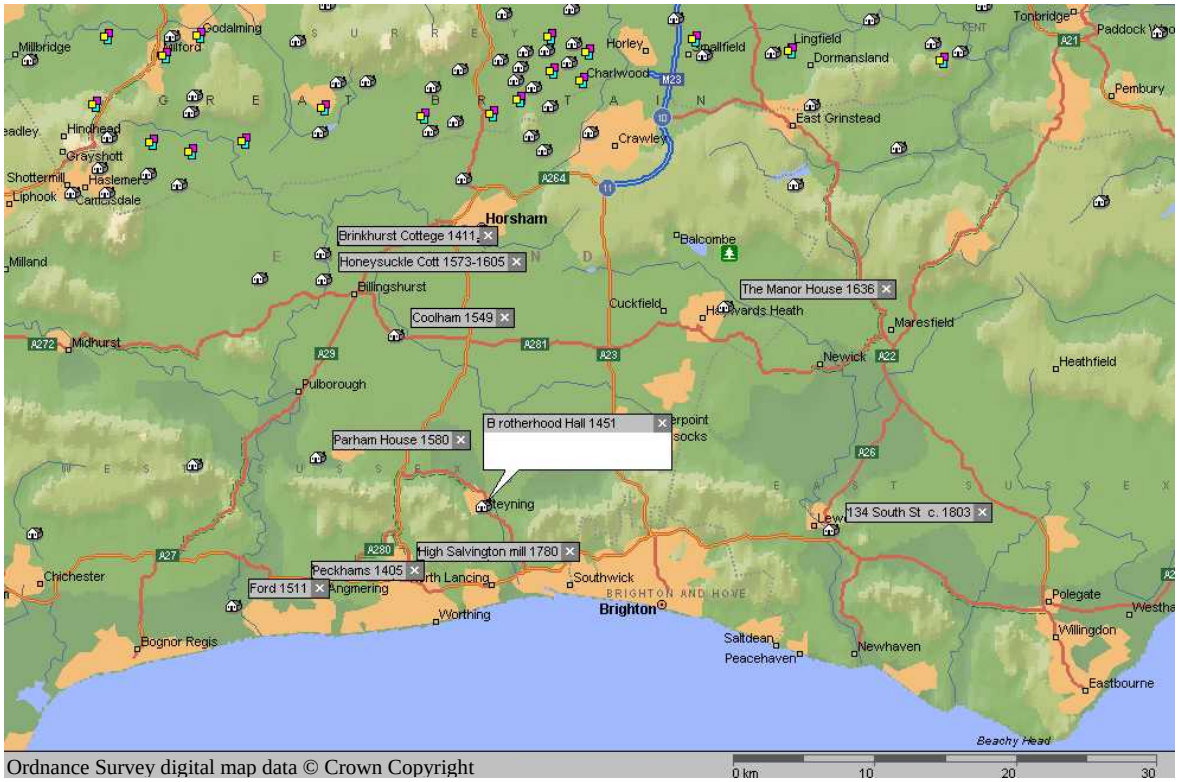
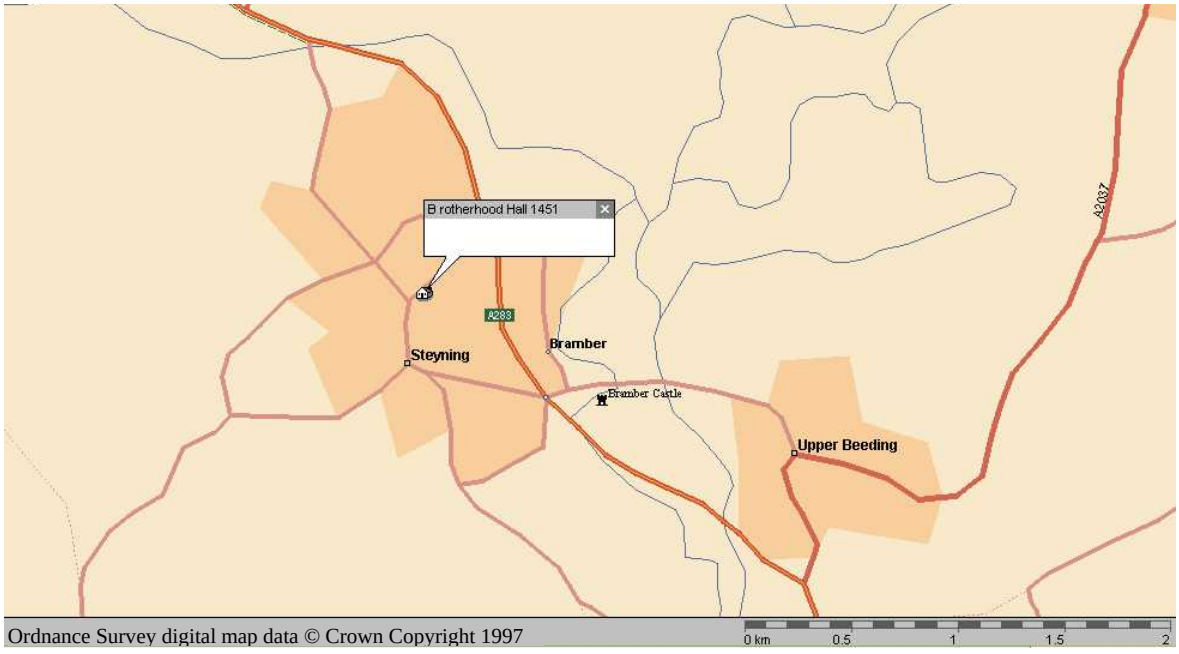


Figure 2: Site location map



Brotherhood Hall (TQ 1774 1119).

Brotherhood Hall was earlier called the Guild Hall of the Fraternity of the Holy Trinity. The earliest known document shows a lease of a portion of the property was granted in 1539 by the feoffees of the Fraternity (http://steyningmuseum.org.uk/brotherhood.htm).

At *c*. 25 m long by 7.5 m wide, this large building of box-frame construction consists of seven bays, each around 3.6 m in width (**Photo 1 & 2**).

The roof is hipped with gablets and is of crown-post construction. The crown posts are moulded, some with four up-braces (**Photo 3**), some with two up-braces. Only the south-west half of the roof space was accessed but smoke-blackened rafters clearly identify the building as an open hall. The common rafters are all laid flatways and some have Roman numeral builder's marks (**Photo 4**).

The wall-frame consists of close studding with a mid-rail. Internally the posts were observed not to have jowls, but **Photo 2** shows a corner post with a slight jowl. The front north-west of the building facing Church Street has a continuous jetty. Some flat-step stops and a side-halved scarf occur.

There are two highly decorative forward-facing gables and a three-storey brick porch. These are later and were not dated

Photo 1: Brotherhood Hall – north aspect

Photo 2: Brotherhood Hall – west aspect

Photo 3: Moulded crown post, with four up-braces.

Photo 4: One of the builder's marks on a rafter

Objective of the Analysis

The main objective of this analysis was to provide dendrochronological evidence to date the primary phase of construction of the building.

Dendrochronological Assessment

Brotherhood Hall was visited on the 8th March 2014 and the timbers assessed for their potential use in dendrochronological study. Oak timbers with more than 50 rings, traces of sapwood or bark, and accessibility were the main considerations. Access was limited to above ground-floor level. The survival of timber framing is remarkably complete. However, while most timbers appeared to contain more than 50 rings, few timbers with full sapwood were identified in the wall-frame. A number of timbers with full sapwood were identified in the roof and so it was thought that the precise dating of this building could be achieved.

METHODOLOGY

Methods employed by Tree-Ring Services in general are those described in English Heritage guidelines (Hillam 1998). Part 2 of the Guidelines is designed for large projects in conjunction with other specialist disciplines and is not applicable to the type of privately commissioned dendrochronological analysis generally conducted by Tree-Ring Services and is therefore not used. Details of the methods employed for the analysis of this building are described below.

Sampling and Preparation

Photo 5: Extraction of a core in progress

Whenever possible, timbers with more than 50 annual growth rings are selected for sampling. This is necessary to provide a pattern of rings of sufficient length to be unique to the period of time when the parent tree was growing. Timbers are sampled using purpose-made 12mm and 15mm diameter corers attached to an electric drill. Sampling is located as discreetly as possible in what appear to be original timbers and is orientated in the most suitable direction to maximize the numbers of rings for subsequent analysis. Extracted core samples are immediately taped and glued onto wooden laths on site and then labelled, ready for subsequent analysis.

Tree-ring series are revealed through sanding with progressively finer grits to a 600 abrasive grit finish to produce results suitable for measuring, see **Photo 5**. When required, for example where bands of narrow rings occur, further preparation is performed manually. Where requested, extraction holes are "made good", employing pine dowelling, wood-glue, sawdust and wood stains to restore the timbers to their original appearance.

Photo 6: An example of the tree-ring series revealed through the sanding of cores

Measuring and Cross-matching

Tree-ring series are measured under a ×20 stereo microscope to an accuracy of 0.01mm using a microcomputer-based travelling stage. All samples are measured from the centremost ring to the outermost. Samples considered unsuitable for dating purposes are then rejected. These include samples with disturbed ring series which cannot be measured due to knots or bands of extremely narrow rings, and those samples with fewer than 40 rings.

Samples of fewer than 50 rings are sometimes rejected from dendrochronological analysis because their ring patterns may not be unique (Hillam *et al.* 1987). Although this is certainly true of all ring series of fewer than 30 rings, which should not be used in dating (Mills 1988), samples with 30 to 50 rings may be dated in some circumstances (Hillam 1998). Because samples taken by Tree-Ring Services are often from listed structures, it has been felt wise to maximize the recorded amount of data, and series of 40–50 rings are included in analysis and considered for dating, usually when they match well with a number of other series. Samples are measured twice and the two sets of measurements cross-matched and plotted visually as a check. Where series match satisfactorily they are averaged and the resulting series are used in subsequent analysis. Series containing fewer than 50 rings are suffixed '-S', and series from managed trees '-M' to help indicate that additional caution must be exercised in dating.

Cross-correlation algorithms are then employed to search for the positions where tree-ring series correlate and therefore possibly match. All statistical correlations are reported as *t*-values derived from the original CROS73 algorithm (Baillie and Pilcher 1973). A value of 3.5 or over is usually indicative of a good match as it represents the value of *t* which should occur by chance only once in every 1000 mismatches (Baillie 1982), and the higher the *t*-value the closer to congruency in the cross-matching. However, due to the remaining small risk of high *t*-values being produced by chance, all indicated correlations are further checked to ensure that corroborative high results are obtained at the same relative position against a range of independent tree-ring series. Visual comparisons of series are also employed to support or reject possible cross-matches and serve as a means of identifying measuring errors.

Timber Groups

A further element of the tree-ring analysis of buildings and archaeological assemblages is the grouping of timbers within the sampled material. Inspection of *in situ* timbers may indicate that samples derive from a common timber, while common arrangements of anatomical features (knots & branching) may also indicate that samples are derived from a single tree.

Tree-ring analysis is used to support suggestions of same-tree groups between samples based on a combination of information. Timbers derived from the same tree are generally expected to have *t*-values over 10, although lower *t*-values may be produced when different radii measured from the same tree are compared. Tree-ring series producing *t*-values of 10 or above are examined to identify same-tree groups. Good comparisons of visual matching, growth rates, short and longer-term growth patterns, are combined with pith information, sapwood boundaries, bark and anatomical anomalies, to help decide whether timbers are likely to come from the same tree. Where timbers are assessed as deriving from the same tree, to avoid bias the series are averaged to produce a single tree-ring series before

inclusion in the final site chronology, but inevitably some same-tree samples go undetected by dendrochronology.

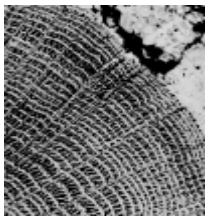
Chronology Building and Cross-dating

The process of cross-matching compares all tree-ring series against one another and those found to cross-match satisfactorily together are combined to create an average series. The site mean(s) and individual ring series which remain unmatched with the site mean are then tested against a range of established reference series (reference chronologies). Significant *t*-values replicated against a range of series at the same position with satisfactory visual matching are similarly used to establish cross-matches with reference chronologies. Where cross-matching is established against dated reference chronologies, calendar dates can be assigned to the site series. The dates of the first and last rings of dated series are produced as date spans. These dates should not be confused with felling dates.

Felling Dates

Series dated by the cross-dating process provide calendar year dates for the final tree-ring present in the measured timber sample. The interpretation of these dates then relies upon the nature of the final rings in the series. Where bark survives intact on a sample a felling date is given as the date of the last ring measured on the tree-ring series. Based on the completeness of the final ring it is sometimes even possible to distinguish between spring, summer or winter fellings, corresponding to approximately March to May, June to September and October to February, respectively. Where timbers were felled in either spring or summer and the final ring is incomplete and therefore not measured, allowance has to be made for the one-year discrepancy between the end of a measured series and the actual year of felling.

Sapwood Estimates



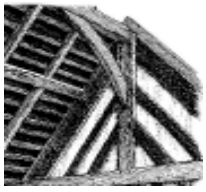
Where bark is missing from oak samples, as long as either sapwood or the heartwood/sapwood boundary have been identified, an estimated felling-date range can be calculated using the maximum and minimum number of sapwood rings that were likely to have been present. Sapwood estimates have varied over time with different data sets, geographical location and researchers. A general trend identified is that the number of sapwood rings in oak decreases from north to south and from west to east across Europe.

However, simply not enough is yet understood about sapwood variations and the mechanisms responsible for them. A generally accepted sapwood estimate of between 10 and 55 rings for British and Irish oaks (at 95% confidence) was given in 1987 (Hillam *et al.* 1987). Analysis of the increased data set available ten years later indicates a range of 10 to 46 rings to be more appropriate for England (Tyers 1998). Currently, as research in areas improves, sapwood estimates are refined and new estimates applied. Therefore, when dendrochronological dates are produced, the reference to the sapwood estimate used in its calculation should always follow.

This report applies a sapwood estimate of a minimum of 9 and maximum of 41 annual rings, which means that 19 out of every 20 trees examined is expected have between 9 and 41 sapwood rings. This sapwood estimate is currently applied to most of the south-east

region and has been arrived at by Oxford Dendrochronology Laboratory (Haddon-Reece *et al.* 1990, Miles 1997). Felling-date ranges have been calculated by adding the sapwood estimate of minimum and maximum missing rings to the date of the heartwood/sapwood boundary. Felling-date ranges have been refined by the presence of surviving sapwood where appropriate, see **Table 3**. Where samples ending in heartwood were dated, "felled after dates" have been calculated by adding the minimum expected number of missing sapwood rings to the samples' final ring dates. These dates represent the earliest probable felling dates. However, the actual felling date of a tree may be decades later due to an unknown number of missing heartwood rings.

Felling Groups



It is common to find that timbers used in the construction or repair of smaller buildings, or identifiable parts of larger buildings, date into groups whose felling dates occur within a narrow range of years. These groups are called associated fellings. Where they are identified the average heartwood/sapwood boundary of the component timbers is used to calculate an overall estimated period of felling. Close location association and a short (21 years at most) range of heartwood-sapwood boundary dates are normally used to define these groups. The estimates do not assume that trees within a group were felled at the same time. However, evidence published by the Nottingham University Tree-Ring Dating Laboratory indicates that the range estimate encompasses the possible different individual felling dates (English Heritage 2001). Where bark is present within a group of timbers and other evidence does not dispute the date, it is assumed that all the trees within a felling group were felled in the same year.

Date of Construction

It is vitally important to understand that dendrochronological analysis provides dates for when trees were felled and not necessarily when their timbers were used. Green or freshly felled wood is, however, far easier to work and it is standard practice to assume that medieval timbers were felled as required and used green (Rackham 1990, Miles 1997). However, the use of previously felled timbers in vernacular construction was not uncommon, with short-term stockpiling of usually not more than 1 to 2 years (Miles 1997), and the use of leftovers or re-used timbers may certainly give rise to differences between felling dates and the date of construction where samples are analysed in isolation. A number of samples having a close range of felling dates are required from different elements of a building either to strongly indicate a single date of construction or to identify separate phases of construction.

Tree-Ring Services - Methods and Criteria

Tree-ring analysis and graphics are achieved via a dendrochronological programme suite developed by Ian Tyers of Sheffield University (Tyers 1999). Location maps are produced using *Microsoft AutoRoute Express GB 98 Auto Street Navigator*, which uses Ordnance Survey digital map data © Crown Copyright 1997. Alcock's (1996) timber-framed building nomenclature has been adopted throughout to facilitate regional comparisons. Summary features of most buildings dated, are made available on the Building Archaeology Research Database (Moir *et al.* 2012). Tree-Ring Services reports are published with tree-ring data to enable independent verification and

allow their use in dating. Report may be ordered through the website at www.tree-ring.co.uk.

For the analysis of a building an initial assessment is conducted with the owner and recommendations in line with English Heritage guidelines on sampling strategies made, (i.e., that a minimum of 8 to 10 samples are obtained per building or per phase). However, the final decision concerning the number of samples taken for analysis rests with the individuals who commission the analysis. It is generally beyond the scope of an analysis to describe a building in detail or to undertake the production of detailed drawings. Without the benefit of other specialist disciplines there is always the danger that re-used timbers may be inadvertently selected, and the conclusions presented in a report may be modified in the light of subsequent work.

RESULTS

A total of nine core samples were taken from Brotherhood Hall on the 8th March 2014. The main timber trusses were labelled from A in the north corner to H1 in the south corner. Sampling locations are indicated on a sketch plan of the building (see **Appendix I**) and the locations of the samples taken are shown in the photographs below.

Photo 7: Cores SYBH01-S (bottom) & SYBH02 (top)

Photo 8: Cores SYBH03 (right) & SYBH04 (left)

Photo 9: Cores SYBH05-S (left) & SYBH06 (right)

Photo 10: Core SYBH07-S

Photo 11: Cores SYBH08 (top) & SYBH09 (bottom)

All nine samples were confirmed as oak (*Quercus* spp). Three series that contained less than 50 rings were identified by the suffix '-S'. Six samples were taken from where the sapwood was complete, but the end 15mm and 10mm of sapwood broke off from samples SYBH01-S and SYBH08, respectively. The sapwood sections broke off from samples SYBH03 and SYBH04 during coring, but no rings were thought lost. Sample SYBH08 contained a period of narrow rings which could not be measured reliably, therefore two series before and after the problem area were measured and named SYBH08A and SYBH08B.

All nine series were of sufficient length to be considered for cross-matching. Seven series were found to match together (see **Table 1**), and were combined to form an 82-year site chronology named STYNG-BH.

Table 1: Cross-matching between the seven series from Brotherhood Hall, which form the site chronology STYNG-BH

Filenames	Start date	End date	02	03	04	06	08	09
SYBH01-S	AD1397	AD1430	4.94	4.36	4.34	5.36	5.22	4.25
SYBH02	AD1371	AD1430		3.54	-	4.00	3.89	-
SYBH03	AD1379	AD1433			-	5.55	6.78	5.91
SYBH04	AD1369	AD1428				-	3.67	4.36
SYBH06	AD1386	AD1450					7.55	3.60
SYBH08	AD1369	AD1439						6.39
SYBH09	AD1397	AD1447						

KEY: - = *t*-values less than 3.00. \ = overlap < 30 years.

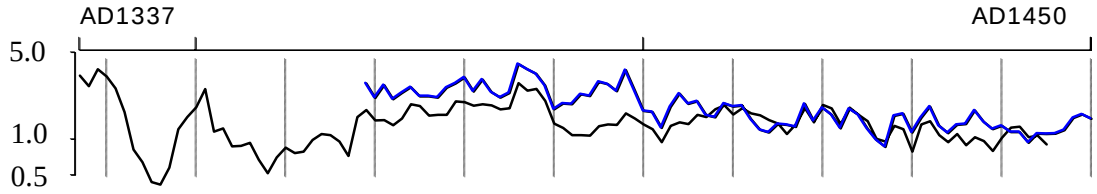
This site chronology was found to produce consistently high *t*-values against reference chronologies (**Table 2**) and to visually cross-match (**Figure 3**), with the first ring of the series at AD 1369 and the final ring of the series at AD 1450.

Table 2: Dating evidence for the site chronology STYNG-BH against reference chronologies

STYNG-BH dated AD 1369 TO AD 1450					
File	**Start Date**	**End Date**	***t*-value**	**Overlap (yr.)**	**Reference chronology**
CRANL-VH	AD1337	AD1445	10.80	82	Village Hospital - Cranleigh - Surrey (Moir 2008)
CHARL-32	AD1233	AD1727	9.30	82	Charlwood Parish - Surrey (Moir 2004a)
NWDGATE1	AD1261	AD1483	8.90	82	Home Farm - Newdigate - Surrey (Bridge 1998)
FORD	AD1286	AD1511	8.23	82	St Andrews Church - Ford - West Sussex (Bridge 2000)
CHARL-HI#	AD1368	AD1532	8.18	82	Hillands Farm - Charlwood - Surrey (Moir 2003c)
FIELDPB	AD1309	AD1465	7.89	82	Fieldplace Barn - Nr Broadbridge Heath - West Sussex (Bridge 1993)
CHARL-PA#	AD1338	AD1548	7.48	82	Pagewood Hse - Charlwood - Surrey (Moir 2003d)
CHARL-GB#	AD1330	AD1538	7.31	82	Greenings Farm Barn - Charlwood - Surrey (Moir 2004b)
CAPEL-TE	AD1366	AD1571	7.06	82	Temple Elfande - Capel - Surrey (Moir 2003a)
SHERE-RN	AD1362	AD1485	6.72	82	Rookery Nook - Shere - Surrey (Moir 2004c)
HORSM-CB	AD1397	AD1499	6.72	54	15 Causeway - Horsham - W Sussex (Moir 2013)
RUSPR-AV	AD1382	AD1580	6.18	69	Averys - Rusper - West Sussex (Moir 2003b)

KEY: **Bold** = indicates a composite reference chronology consisting of multiple site chronologies. # = components of CHARL-32.

Figure 3: Plot of site chronologies STYNG-BH (blue) and CRANL-VH from Village Hospital - Cranleigh - Surrey (black), which cross-match together with a *t*-value of 10.8



Note: The ring width (mm) is plotted on a (y axis) logarithmic scale using a common axis for both samples.

INTERPRETATION

Felling Dates

The sapwood allowance used to calculate the felling dates now discussed is presented in **Table 3**, and the bar diagram (see **Figure 4**) helps to demonstrate the findings visually.

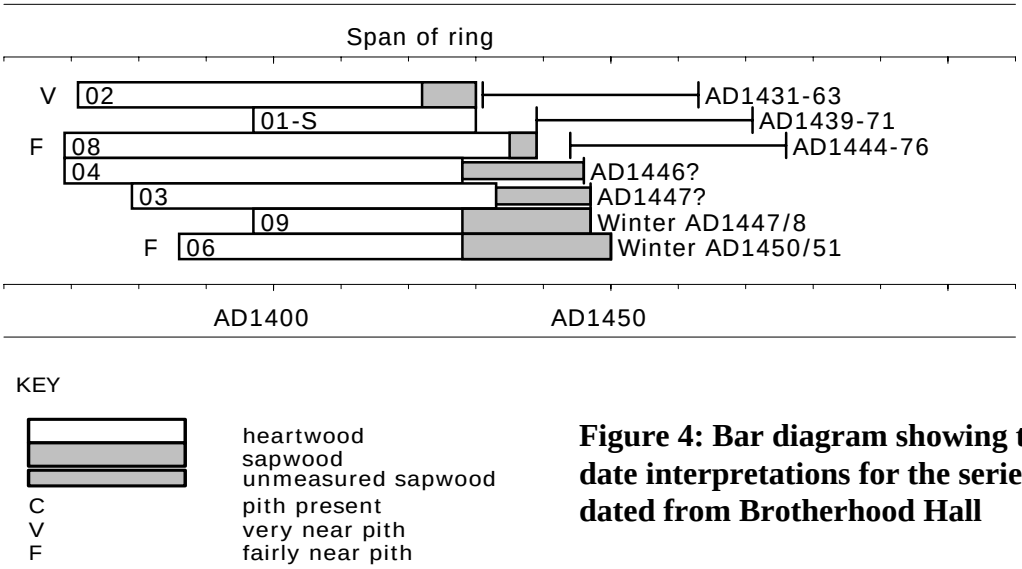


Figure 4: Bar diagram showing the date interpretations for the series dated from Brotherhood Hall

Brotherhood Hall produces two precise felling dates and two probably precise felling dates. Under the microscope, full sapwood on samples SYBH09 and SYBH06 occurs with the complete development of the final ring, indicating that the source trees were felled in the winters of AD 1447/8 and AD 1450/51, respectively. Samples SYBH04 and SYBH03 were probably felled in AD 1446 and AD 1447, respectively. The felling-date ranges produced from three other samples dated are compatible with these precise fellings, and together this provides strong evidence to indicate that construction occurred in AD 1451, or soon after.

The fellings which pre-date the AD 1450/51 date are likely to indicate that some stockpiling of timbers occurred. The stockpiling of some timbers might be expected for a building of this size, and the earlier felling dates should not detract from the interpretation of a single phase of construction, albeit protracted over a few years.

Timber analysis

All the timbers sampled were oak and either boxed heartwood or quarter converted. Only one of the largest structural timbers (in this instance, a post) was sampled, and this had an age

of *c*. 85 years. This compares closely with the age of the other trees dated in the build, which have an average age of 80 years.

The high cross-matching against other reference chronologies established locally (see **Table 2**) indicates the timbers are likely to have come from a local source(s).

CONCLUSIONS

Seven of the nine timbers sampled are matched together to form an 82-year site chronology which is dated to span AD 1369 to AD 1450. Timbers probably felled in AD 1446 and AD 1447, together with timbers felled in the winters of AD 1447/8 and AD 1450/51 provide good evidence that construction of the building is likely to have occurred in AD 1451, or soon after.

The four-year range of felling dates suggests that there was some stockpiling of timbers and the build may have been protracted over a few years, which might be expected for a building of this large size. The average age of the tress felled for construction was *c*. 80 years and high cross-matching with local reference chronologies suggest these were sourced locally.

ACKNOWLEDGEMENTS

I would like to thank George Barker and the other Steyning Grammar School Old Boys for commissioning this analysis. I am grateful to Joanne Burroughs and Stephen Diplock for arranging access to the school and George Barker, Janet Pennington, Phil Daventry, Michael Moore and Derrick Gilpin for their kind assistance on the sampling day.

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Table 3: Summary of dendrochronological analysis

Sample	Timber and Position	Timber Conversion	Timber Dimensions (mm)	Rings	Sapwood	Average Growth Rate (mm/yr)	Sequence Date Range	Felling Date	Rings to Pith		Age Estimate
SYBH01-S	NW rail - G to H	C2	170 x 0	34	+HS	1.23	AD1397-AD1430	AD1439-71	>	15	69
SYBH02	Post G	A2	0 x 260	60	8	3.07	AD1371-AD1430	AD1431-63		5	85
SYBH03	NW rafter - 1st SW of truss G	C2	100 x 150	55	+14+?B	1.70	AD1379-AD1433	AD1447?	>	15	84
SYBH04	SE rafter - truss G	C2	100 x 150	60	+18+?B	1.79	AD1369-AD1428	AD1446?	>	15	93
SYBH05-S	NW rafter - 1st NE of truss F	C2	100 x 155	35	+HS	1.58				5	58
SYBH06	SE rafter - 3rd SW of truss D	C2	100 x 140	65	22+Bw	1.63	AD1386-AD1450	Winter AD1450/51		10	75
SYBH07-S	Crown post - truss D	A2	180 x 190	36	+HS	2.60				10	64
SYBH08	NW wallplate - C to D	A2	190 x 0	71	4	1.86	AD1369-AD1439	AD1444-76		10	92
SYBH09	NW stud - C to D	A2	195 x 0	51	19+Bw	1.36	AD1397-AD1447	Winter AD1447/8	>	15	66

KEY	
+	= additional information not measured on the core
(+)	= unmeasured heartwood rings at the beginning or end of the core
HS	= heartwood/sapwood boundary
?B	= probable bark
¼B	= spring bark
½B	= summer bark
Bw	= winter bark
A2	= boxed heartwood & trimmed
B2	= halved & trimmed
C2	= quartered & trimmed
E2	= tangential & trimmed

Note: Timber dimensions were generally taken at the core sample location and are not necessarily the maximum dimensions of the timber

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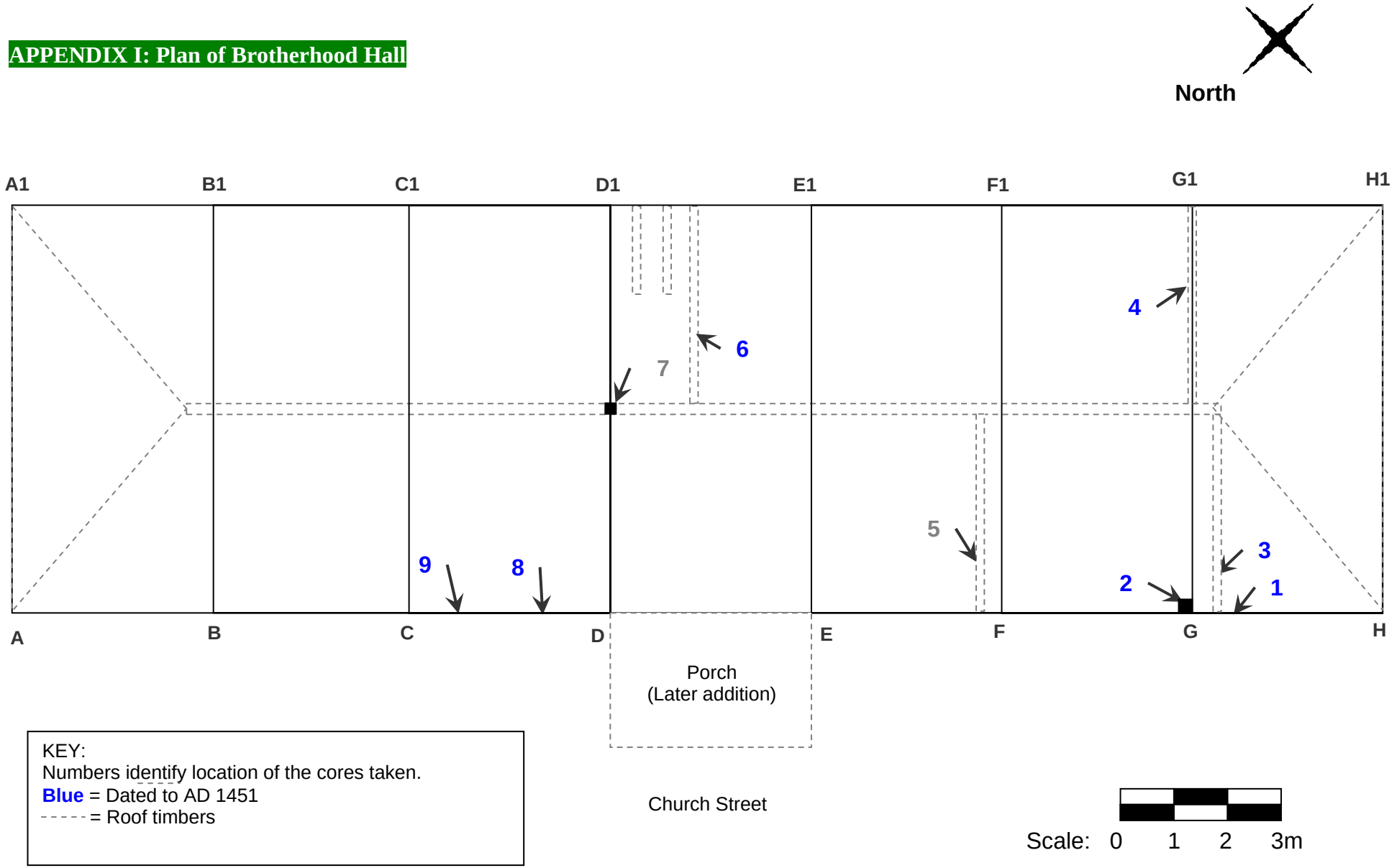
APPENDIX I: Plan of Brotherhood Hall



APPENDIX II: Raw ring-width data

Ring widths (0.01mm), starting with innermost measured ring

SYBH01-S

121	172	123	112	107	86	115	188	147	161
121	113	143	157	162	158	89	81	90	101
81	128	95	148	115	112	157	135	125	107
83	128	137	99						

SYBH02

476	334	357	432	277	298	285	454	433	532
374	471	343	305	338	447	461	399	473	269
381	303	407	317	720	694	822	1466	674	280
248	156	257	287	296	229	237	175	195	170
169	156	102	94	110	114	80	196	111	156
119	84	137	157	130	72	72	101	125	86

SYBH03

226	212	183	217	161	178	189	251	260	245
203	134	157	137	166	218	179	149	150	163
197	140	174	114	146	195	139	222	156	171
203	209	172	122	110	119	120	147	116	169
149	164	214	120	169	170	129	122	98	215
218	154	171	207	155					

SYBH04

265	209	188	137	175	178	157	170	183	166
223	236	199	217	204	169	188	291	267	285
174	166	170	230	170	183	149	188	179	155
150	216	191	153	219	218	219	190	123	156
204	208	221	182	145	139	185	172	175	190
162	169	140	119	155	133	105	75	67	104

SYBH05-S

457	390	471	371	300	277	257	187	159	141
92	90	39	41	41	26	28	25	17	21
23	34	51	68	85	105	140	162	199	149
144	205	261	225	240					

SYBH06

714	546	431	285	146	142	143	209	188	165
127	98	124	119	83	89	69	130	178	169
157	162	121	136	138	149	110	109	104	113
128	107	159	141	175	162	133	194	129	117
101	117	174	158	104	157	160	139	132	146
133	195	144	119	159	156	163	134	150	151
162	165	147	157	145					

SYBH07-S

372	349	326	276	250	369	234	200	329	329
334	322	447	219	188	192	220	305	267	206
207	236	297	171	229	182	134	198	146	215
219	207	368	326	185	295				

SYBH08

288	216	139	151	165	163	220	187	171	147
223	250	197	275	232	203	216	261	249	277
194	148	109	133	178	191	202	202	150	200
236	171	169	129	203	267	180	191	165	181
224	198	221	163	144	136	163	124	148	283
172	224	168	149	216	189	110	116	89	212
193	122	150	233	136	122	165	187	234	200
154									

SYBH09

154	181	202	172	170	155	190	275	184	244
121	130	236	192	195	119	135	121	149	124
169	210	146	208	179	139	193	185	136	101
86	140	126	117	111	125	82	83	80	77
78	68	89	97	73	66	54	72	70	61
71									

APPENDIX III: Mean ring-width data

Title : Brotherhood Hall - Steyning - West Sussex [STYNG-BH]
Ring-width QUSP data of 82 years length
Dated AD1369 to AD1450
7 timbers raw data mean
Unit of Measurement 0.01mm
Average ring width 185.39 Sensitivity 0.17

AD1369									276	212
	267	207	232	257	218	218	213	255	276	307
	238	295	235	213	232	392	356	327	265	172
	191	189	226	219	283	272	239	351	243	167
AD1401	164	123	180	229	190	199	155	149	191	181
	184	144	119	113	132	130	125	190	139	177
	156	122	174	156	121	99	87	153	159	113
	147	181	128	112	130	132	169	137	120	128
	114	114	94	111	110	111	118	147	157	145