DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS FROM THE ROCK INN, CHIDDINGSTONE, SEVENOAKS, KENT, ENGLAND.

Tree-Ring Services Report: TNRO/16/11

Dr Andy Moir

Tree-Ring Services
Plough House, 49 High Street,
Hungerford, Berkshire, RG17 0NE
Email: enquiries@tree-ring.co.uk
www.tree-ring.co.uk

DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS FROM THE ROCK INN, CHIDDINGSTONE, SEVENOAKS, KENT, ENGLAND

Dr Andy Moir

Tree-Ring Services Report: TNRO/16/11

SUMMARY

This three-bay, two-and-a-half-storey building is a lateral chimney house with an unusual plan. It had a two-bay hall from the beginning but this was floored over, rather than being open to the roof in the medieval style. The roof is of clasped-purlin construction with queen struts and curved windbraces. It is gabled to the front but was originally hipped to the rear. The gabled front has an end jetty. The walls have jowled posts and curved down braces. It has a high level of decoration with ogee braces in the first floor partitions and chamfered beams in all the rooms including the attic. There is evidence for a garderobe. The rear (north) wall has a large inglenook chimney and there is a chimney on the east end.

Eleven of the twelve samples taken from The Rock Inn dated. Seven samples match together to form a 137-year site chronology which spans AD 1383 to AD 1519. Two precise felling dates in the winter of AD 1519/20, together with two samples probably felled within two years of this date and four compatible felling-date ranges, provide good evidence to indicate that construction likely occurred in AD 1520, or soon after.

A later date range of AD 1545-77 for the inglenook bressumer is a surprise and leaves unanswered the question as to how the large ground floor room was originally heated. Further archaeological examination is recommended.

The rafters involved in the change from hip to gable at the east end were felled in the winter of AD 1571/2, which shows that the work is likely to have occurred in AD 1572, or soon after.

The trees used in construction are likely to have come from a local source.

KEYWORDS

Dendrochronology, 16th Century, Standing building, Kent, Chiddingstone.

Figures

Tables

Photos

INTRODUCTION

There is an increasing interest in Britain's past as evinced by such television programmes as "Time Team" and "The House Detectives", which both promote and respond to this interest. More and more people wish to know precisely when ancient buildings were constructed in order to better understand the history of the land in which we live. However, although there is some ability to date a building on stylistic grounds, a precise date is rarely known except when there is a date-stone or documentary evidence.

The advent of dendrochronology (tree-ring dating) is changing 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. Small cores of wood taken from the structural timbers of a building 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.

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

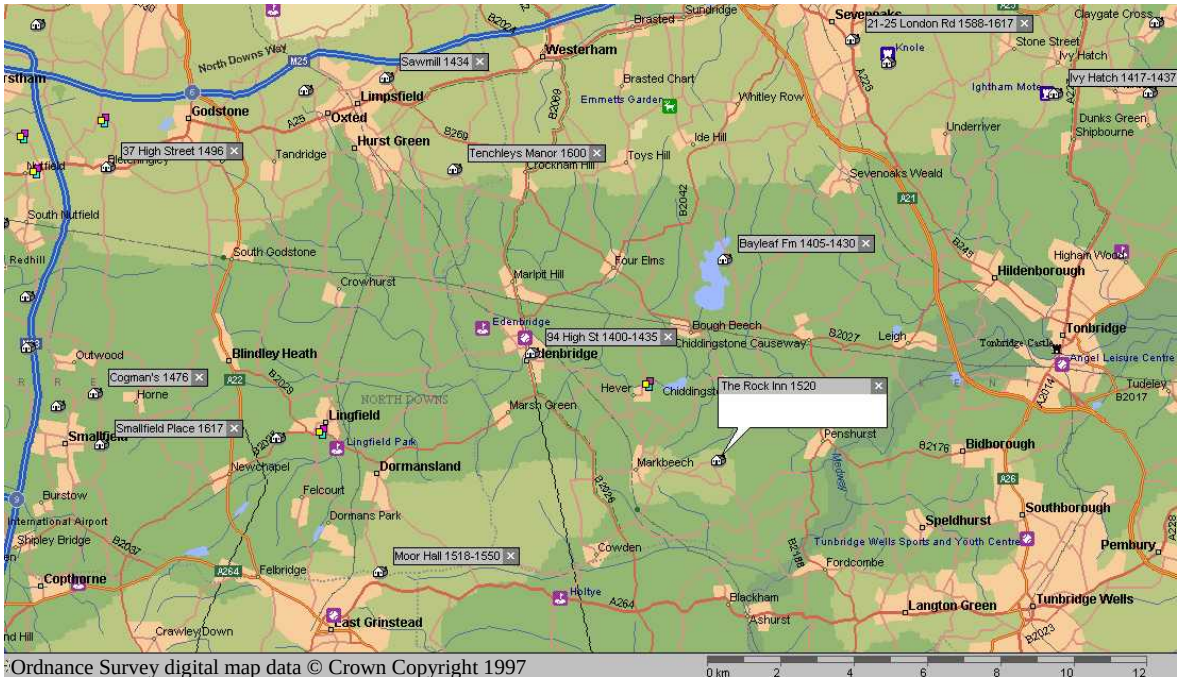
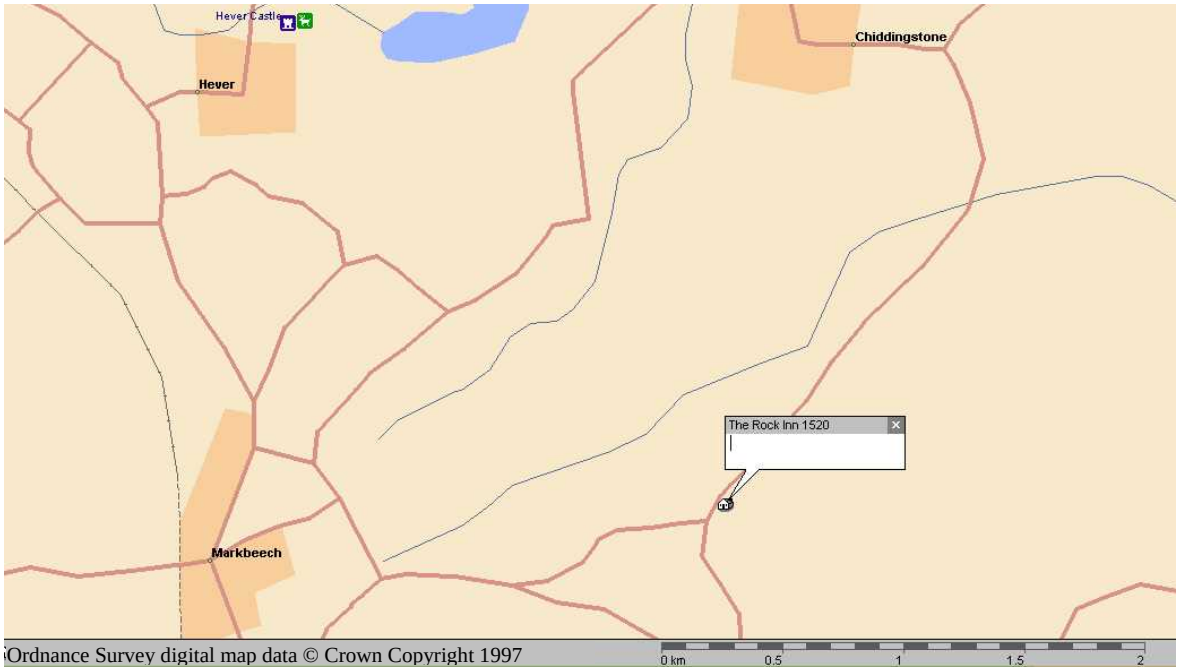


Figure 2: Site location map



The Rock Inn (NGR: TQ 4973 4313).

The following descriptive paragraphs about the building have been drawn from those kindly provided by Rod Wild of the Domestic Buildings Research Group (Surrey):

> The Rock Inn is in the Kentish Weald in Chiddingstone Hoath, a small collection of houses a little south of the village of Chiddingstone. It is a three-bay, two-and-a-half-storey, lateral chimney house with an unusual plan. It had a two-bay hall from the beginning but this was floored over, rather than being open to the roof in the medieval style. Two-bay halls were common in the 15th century but they were open

to the roof. Then when chimneys arrived, halls were built floored over but were of one bay only. They are more commonly referred to as 'hearth rooms'. So, with its double-sized hearth room, the Rock Inn does not have a domestic plan. Furthermore, it has a high level of decoration with ogee braces in the first floor partitions and chamfered beams in all the rooms including the attic. There is evidence for a garderobe, which is unusual at this level of building. It seems likely that it was built to be an inn from the beginning, perhaps serving drove roads nearby. The situation adds to the case, as it is by the roadside at a junction and next to Spokeshave Cottage, a bigger and older house that would normally have more space around it.

The roof is of clasped-purlin construction with queen struts and curved windbraces. It is gabled to the front but was originally hipped to the rear. The gabled front has an end jetty, a Kentish feature and perhaps not expected for a chimney house. The walls have jowled posts and curved down braces. The previously estimated date was late 16th century.

The chimney on the rear wall has a large inglenook. Later, the rear hip was gabled out. The end chimney and the outshot were added at some time.

The dendrochronology shows that the large inglenook chimney was not first build and raises the question as to how the building was originally heated (see Interpretation, page 17).

Photo 1: The Rock Inn – south-west aspect

Photo 2: The Rock Inn – south aspect

Objective of the Analysis

The main objective of this analysis was to provide dendrochronological evidence to date the primary phase of construction and also the chimney phases.

Dendrochronological Assessment

The Rock Inn was visited on the 29th June 2011 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. Sufficient suitable timbers were identified in the primary phase for sampling to proceed. The inglenook bressumers and rafters in the gable roof contained sufficient rings for analysis, but the end chimney bressumer was unsuitable. Mortises for a mullion window were identified in a head rail, but it was unclear whether the timber had been re-used and therefore this timber was additionally sampled.

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 3: 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 4**. 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 4: 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.

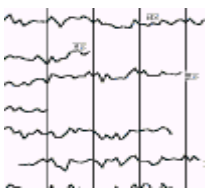
Cross-correlation algorithms are then employed to search for the positions where tree-ring series correlate and therefore possibly match. All statistical correlations are reported as *t*-values derived from the original CROS73 algorithm (Baillie and Pilcher 1973). A value of 3.5 or over is usually indicative 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.

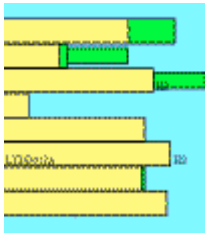
Tree-ring analysis is used to support suggestions of same-tree groups between samples based on a combination of information. Timbers derived from the same tree are generally expected to have *t*-values over 10, although lower *t*-values may be produced when different radii measured from the same tree 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



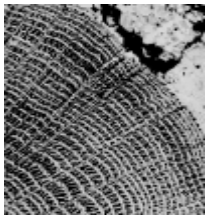
The process of cross-matching compares all tree-ring series against one another and those found to cross-match satisfactorily together are combined to create an average series. The site mean(s) and individual ring series which remain unmatched with the site mean are then tested against a range of established 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

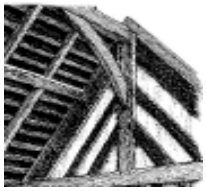


Where bark is missing from oak samples, as long as either sapwood or the heartwood/sapwood boundary have been identified, an estimated felling-date range can be calculated using the maximum and minimum number of sapwood rings that were likely to have been present. Sapwood estimates have varied over time 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 6**. 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 1999a). 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.

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

Twelve core samples were taken from The Rock Inn on the 29th June 2011. The main timber trusses were labelled alphabetically from A in the south-west corner to D1 in the north-east corner. Sampling locations are indicated on a sketch plan of the building (see **Appendix I**) and the locations of cores taken are shown in the photographs below.

Photo 5: Core TNRO01

Photo 6: Cores TNRO02 (left) & TNRO03 (right)

Photo 7: Cores TNRO04 (right), TNRO05 (middle) & TNRO06 (left)

Photo 8: Core TNRO07-S

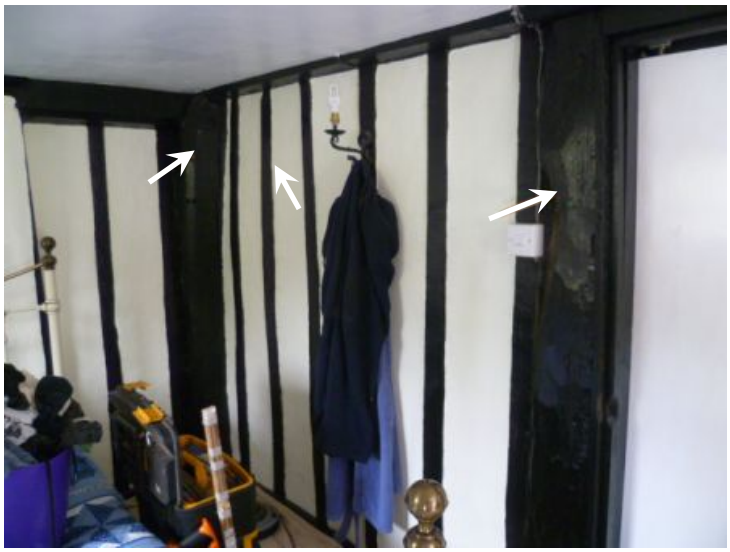


Photo 9: Cores TNRO08 (left) & TNRO09-S (right)

Photo 10: Cores TNRO10 (left) & TNRO11 (right)

Photo 11: Core TNRO12-S

All the samples analysed were confirmed as oak (*Quercus* spp). Seven samples were taken from where the sapwood appeared complete. The sapwood broke off from samples TNRO04 and TNRO07-S during sampling, but no rings were thought to be lost. Three series containing less than 50 rings were identified by the suffix '-S', i.e., TNRO07-S, TNRO09-S and TNRO12-S. All twelve series were of sufficient length to be considered for cross-matching and seven were found to match together (see **Table 1**).

Table 1: Cross-matching between series from primary phase timbers at The Rock Inn

Filenames	Start date	End date	TNRO02	TNRO03	TNRO04	TNRO07-S	TNRO08	TNRO09-S
TNRO01	AD1383	AD1519	4.02	5.92	4.12	5.44	7.62	4.49
TNRO02	AD1431	AD1497		-	3.89	5.98	-	5.37
TNRO03	AD1409	AD1493			6.48	4.26	-	-
TNRO04	AD1453	AD1507				4.89	-	-
TNRO07-S	AD1452	AD1496					3.55	3.79
TNRO08	AD1462	AD1519						5.02
TNRO09-S	AD1447	AD1492						

KEY: - = *t*-values less than 3.50. \ = overlap < 30 years.

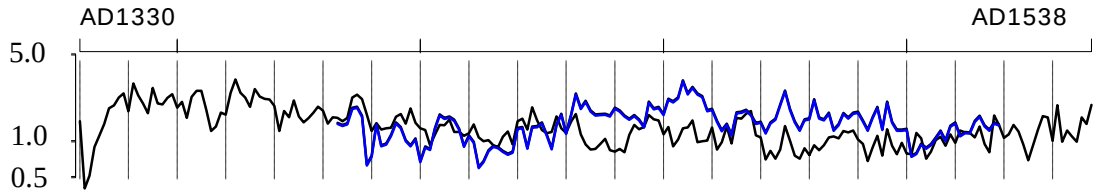
Series TNRO01, TNRO02, TNRO03, TNRO04, TNRO07-S, TNRO08 and TNRO09-S were combined to form a 137-year site chronology named CHIDS-R1. This site chronology was found to produce consistently high *t*-values against reference chronologies (**Table 2**) and to visually cross-match (**Figure 3**), with the first ring of the series at AD 1383 and the final ring of the series at AD 1519.

Table 2: Dating evidence for site chronology CHIDS-R1 against reference chronologies

CHIDS-R1 dated AD 1383 TO AD 1519					
File	**Start Date**	**End Date**	***t*-value**	**Overlap (yr.)**	**Reference chronology**
CHARL-32	AD1233	AD1727	9.39	137	Charlwood Parish - Surrey (Moir 2004a)
CHARL-LD*	AD1336	AD1496	8.33	114	Little Dolby - Charlwood - Surrey (Moir 2003f)
COOLHAM	AD1416	AD1548	7.88	104	Coolham Barn - Billingshurst - West Sussex (Moir 2002a)
CHARL-GB*	AD1330	AD1538	7.86	137	Greenings Farm Barn - Charlwood - Surrey (Moir 2004b)
WITLY-LB	AD1389	AD1521	7.82	131	Littlebrook Farm - Witley - Surrey (Moir 2005b)
KENT	AD1158	AD1540	7.20	137	Kent county chronology (Laxton and Litton 1989)
BLETC-PF	AD1393	AD1546	7.17	127	Place Farm - Bletchingley - Surrey (Moir 2009)
NWDGT-NX	AD1396	AD1524	7.15	124	St Peters Church - Newdigate - Surrey (Moir 2003c)
RUSPR-AV	AD1382	AD1580	7.06	137	Averys - Rusper - West Sussex (Moir 2003d)
CHARL-G1*	AD1387	AD1538	6.94	133	Greenings - Charlwood - Surrey (Moir 2004c)
CHARL-PA*	AD1338	AD1548	6.91	137	Pagewood Hse - Charlwood - Surrey (Moir 2003g)
OXTED-B1	AD1353	AD1593	6.88	137	South range - Barrow Green Court - Oxted - Surrey (Moir 2008)

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

Figure 3: Plot of site chronologies CHIDS-R1 (blue) and CHARL-GB from Greenings Farm Barn - Charlwood - Surrey (black), which cross-match together with a *t*-value of 7.86



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

Series TNRO10 and TNRO11 cross-match with a *t*-value of 8.31 and were combined to form a 64-year site mean series called CHIDS-R2. Series CHIDS-R2 was found to produce

consistently high *t*-values, with the first ring of the series at AD 1508 and the final ring of the series at AD 1571 (**Table 3**).

Table 3: Dating evidence for site chronology CHIDS-R2 against reference chronologies.

CHIDS-R2 dated AD 1508 TO AD 1571					
File	**Start Date**	**End Date**	***t*-value**	**Overlap (yr.)**	**Reference chronology**
COOLHAM	AD1416	AD1548	9.95	41	Coolham Barn - Billingshurst - West Sussex (Moir 2002a)
PSHRT-SB	AD1515	AD1616	8.62	57	Swaylands Barn - Penshurst - Kent (Arnold *et al.* 2001)
OXTED-B1	AD1353	AD1593	8.11	64	South range - Barrow Green Court - Oxted - Surrey (Moir 2008)
GUILD-27	AD1278	AD1638	8.04	64	Guildford area - Surrey Frosbury report (Moir 2007b)
STORR-P1	AD1353	AD1579	7.92	64	Parham Hse - Storrington - West Sussex (Moir 2007a)
OCKLY-BW	AD1517	AD1607	7.46	55	Black and While Cottage - Ockley - Surrey (Moir 2003a)
CAPEL-TE	AD1366	AD1571	7.11	64	Temple Elfande - Capel - Surrey (Moir 2003b)
CHARL-32	AD1233	AD1727	7.07	64	Charlwood Parish - Surrey (Moir 2004a)
WHSLY-OC	AD1355	AD1562	7.05	55	Old Cottage - West Horsley - Surrey (Moir 2005d)
WCHLT-N4	AD1463	AD1605	6.91	64	Nynetimber Fm Bn - West Chiltington - W Sussex (Arnold *et al.* 2010)
BETCH-MC	AD1489	AD1588	6.83	64	Manor Cottage - Betchworth - Surrey (Moir 2005c)
SMALL-PL	AD1451	AD1616	6.46	64	Smallfield Place - Smallfield - Surrey (Moir 2006b)

KEY: **Bold** = indicates a composite reference chronology consisting of multiple site chronologies.

The remaining unmatched series were next individually compared against our data base of reference chronologies. Series TNRO05 was found to produce consistently high *t*-values, with the first ring of the series at AD 1438 and the final ring of the series at AD 1499 (**Table 4**).

Table 4: Dating evidence for series TNRO05 against reference chronologies.

TNRO05 dated AD 1438 TO AD 1499					
File	**Start Date**	**End Date**	***t*-value**	**Overlap (yr.)**	**Reference chronology**
WITLY-LB	AD1389	AD1521	5.18	62	Littlebrook Farm - Witley - Surrey (Moir 2005b)
SHEPHERD	AD1423	AD1602	5.14	62	Shepherd Cottage - Bordon - Hampshire (Moir 2002b)
PEMBGE_B	AD1360	AD1550	4.78	62	Bell Frame - St Marys - Pembridge - Herefordshire (Tyers 1999b)
WHANGER	AD1338	AD1550	4.76	62	Westerhanger Castle - Nr Folkstone - Kent (Howard *et al.* 2001)

EAST_MID	AD882	AD1981	4.65	62	East Midlands (Laxton and Litton 1988)
CHARL-LD	AD1336	AD1496	4.57	59	Little Dolby - Charlwood - Surrey (Moir 2003f)
GEORGE	AD1350	AD1487	4.55	50	The George Hotel - Odiham - Hampshire (Haddon-Reece and Miles 1995)
BROMFLD1	AD1414	AD1520	4.51	62	Church - Broomfield - Taunton - Somerset (Miles 2005)
STONEPT1	AD1389	AD1497	4.44	60	Stonepitts Manor - Seal - Kent (Howard *et al.* 2003)
ROMSEY	AD1362	AD1496	4.38	59	Romsey Abbey - Hampshire (Hillam and Groves 1994)
IFELD-OP	AD1392	AD1574	4.36	62	Old Plough Cottage - Ifield - West Sussex (Moir 2004e)
COOLHAM	AD1416	AD1548	4.34	62	Coolham Barn - Billingshurst - West Sussex (Moir 2002a)

KEY: **Bold** = indicates a composite reference chronology consisting of multiple site chronologies.

Series TNRO06 was found to produce consistently high *t*-values, with the first ring of the series at AD 1480 and the final ring of the series at AD 1540 (**Table 5**).

Table 5: Dating evidence for series TNRO06 against reference chronologies.

TNRO06 dated AD 1480 TO AD 1540					
File	**Start Date**	**End Date**	***t*-value**	**Overlap (yr.)**	**Reference chronology**
STORR-P1	AD1353	AD1579	7.61	61	Parham Hse – Storrington - West Sussex (Moir 2007a)
BLETC-PF	AD1393	AD1546	6.69	61	Place Farm – Bletchingley - Surrey (Moir 2009)
WALMER	AD1396	AD1523	6.36	44	Walmer Castle - Kent (Howard *et al.* 1997)
WVT9	AD1364	AD1602	5.78	61	White House – Vowchurch - Herefordshire (Nayling 1999)
GODAL-20	AD1282	AD1626	5.63	61	Godalming Area- Surrey (Moir 2006a) THRI/02/06
BRUCE4	AD1421	AD1544	5.60	61	Bruce Castle – Tottenham - G London (Bridge 1998)
CAPEL-10	AD1246	AD1624	5.46	61	Capel Parish - Surrey (Moir 2004d)
IFELD-OP	AD1392	AD1574	5.41	61	Old Plough Cottage – Ifield - West Sussex (Moir 2004e)
CAPEL-CH	AD1382	AD1553	5.38	61	Clock Hse - Capel - Surrey (Moir 2003e)
STLENBL1	AD1433	AD1550	5.37	61	Barn - St Leonard's Grange - Bealieu - Hampshire (Bridge 2005)
GODAL-CS*	AD1440	AD1556	5.32	61	3 Church St - Godalming - Surrey (Moir 2005a)
RUSPR-AV	AD1382	AD1580	5.31	61	Averys - Rusper - West Sussex (Moir 2003d)

KEY: **Bold** = indicates a composite reference chronology consisting of multiple site chronologies. * = Component of the GODAL-20 chronology.

Series TNRO12-S failed to cross-match when compared against our database of reference chronologies, and therefore remains undated at this time.

Table 6: 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
TNRO01	Joist - 5th north of C-D	C2	110 x 160	137	24+Bw	1.00	AD1383-AD1519	Winter AD1519/20	>	15	152
TNRO02	Transverse beam - truss C	A2	280 x 200	67	+HS+13	1.73	AD1431-AD1497	AD1510-38	>	10	**90**
TNRO03	Post C1	B2	210 x 280	85	1	1.37	AD1409-AD1493	AD1501-33	>	15	**123**
TNRO04	Spine beam - bay B	B2	180 x 310	55	15+10+?B	1.59	AD1453-AD1507	*c*. AD1517	>	15	70
TNRO05	Head rail - B1-C1 [prossibly re-used]	B2	200 x 120	62	+HS+7	2.01	AD1438-AD1499	AD1508-40		10	83
TNRO06	Bressumer - bay A	A2	360 x 300	61	4+1	1.59	AD1480-AD1540	AD1545-77	>	15	93
TNRO07-S	Post - truss A	C2	190 x 0	45	+HS+23	2.46	AD1452-AD1496	*c*. AD1519		10	**55**
TNRO08	Post B1	A2	0 x 0	58	26+Bw	1.31	AD1462-AD1519	Winter AD1519/20	>	15	**73**
TNRO09-S	Door post - truss B	?C	170 x 180	46	1	2.57	AD1447-AD1492	AD1500-32	>	15	61
TNRO10	North rafter - 3rd west of truss D	C2	75 x 100	61	23+Bw	1.82	AD1511-AD1571	Winter AD1571/2	>	15	76
TNRO11	South rafter - 3rd west of truss	C2	180 x 80	64	23+Bw	1.69	AD1508-AD1571	Winter AD1571/2	>	15	79
TNRO12-S	South queen post - truss C	C2	170 x 90	48	25+¼B	1.51				10	58

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
Bold	= main structural timbers used to calculate mean age

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

INTERPRETATION

Felling Dates

The sapwood allowance used to calculate the felling dates now discussed is presented in **Table 6**, and the bar diagram (see **Figure 4**) helps to demonstrate the findings visually.

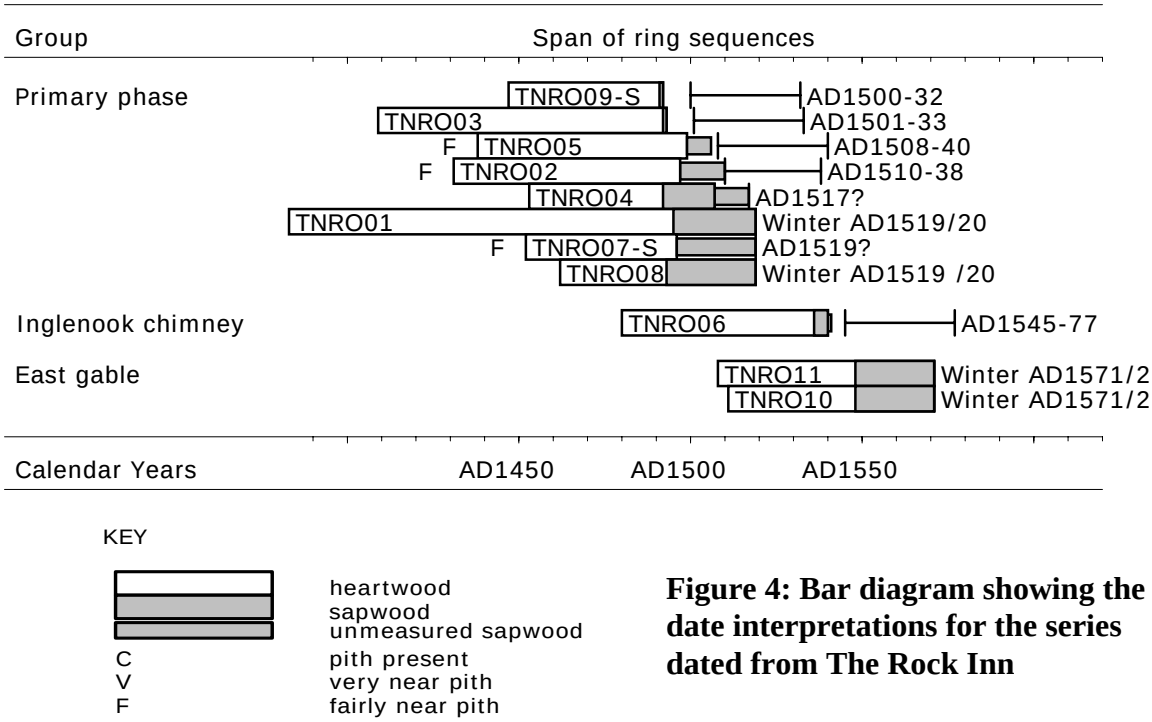


Figure 4: Bar diagram showing the date interpretations for the series dated from The Rock Inn

The primary phase of the Rock Inn produces two precise felling dates and two likely precise felling dates. Under the microscope, full sapwood on samples TNRO01 and TNRO08 occurs with the complete development of the final ring, indicating that the source trees were felled in the winter of AD 1519/20. Samples TNRO04 and TNRO07-S are likely to have been felled near this time in AD 1517 and AD 1519, respectively. The felling-date ranges of the four other dated samples span these precise felling dates. Together this provides good evidence to indicate that construction likely occurred in AD 1520, or soon after. The dating of a joist in bay C - D and the spine beam in bay B - C confirm the archaeological interpretation that both bays were floored from the beginning. Despite its lack of cross-matching with the other samples, the dating of sample TNRO05 identifies the timber as likely to be the same date and, rather than being evidence for re-use, the mortises observed identify the original position of a mullion window.

The date of AD 1520 is substantially earlier than the late 16th century date previously estimated. A chimney would not be expected at the earlier date. The felling date range of AD 1545–77 from the inglenook bressumer does indeed show that it was added later. There must have been an earlier form of heating. As an inn, a detached kitchen is probable and these rarely survive. The chambers could have had braziers. The hearth room may have had an early timber-framed chimney, sometimes called a smoke hood, probably in the same position as the later inglenook: but the AD 1520 date is early, even for a transitional arrangement such as this, so how the large hearth room was heated is not understood. Further archaeological examination is recommended.

Full sapwood on samples TNRO10 and TNRO11 from the east gable occurs with the complete development of the final ring. This indicates that the source trees were felled in the winter of AD 1571/2, and shows that the change from hip to gable is therefore likely to have occurred in AD 1572, or soon after. This would have made the eastern attic chamber much more habitable. It might have coincided with the building of the end chimney at this point, but the current chimney looks too slender to date from this period.

Timber analysis

All the timbers sampled were oak. Using the largest structural timbers (in this instance, one transverse beam and three posts), the average age of the source trees used in the construction is 85 years.

Cross-matching against individual buildings and area reference chronologies is sufficiently high to indicate that the dated timbers probably came from relatively local sources.

CONCLUSIONS

Eleven of the twelve samples taken from The Rock Inn dated. Seven samples match together to form a 137-year site chronology which spans AD 1383 to AD 1519. Two precise felling dates in the winter of AD 1519/20, together with two samples probably felled within two years of this date and four compatible felling date ranges, provide good evidence to indicate that construction likely occurred in AD 1520, or soon after.

The later date range of AD 1545-77 for the inglenook bressumer is a surprise and leaves unanswered the question as to how the large ground floor room was originally heated. Further archaeological examination is recommended.

The rafters involved in the change from hip to gable at the east end were felled in the winter of AD 1571/2, which indicates the work was likely undertaken in AD 1572, or soon after.

ACKNOWLEDGEMENTS

I would like to thank the owner, Mr John Coldman, for funding this analysis, and the landlords Matt and Laura for allowing access. I am particularly grateful to Rod Wild of the Domestic Buildings Research Group (Surrey) for the building description and useful discussion, and Bob Golds of the Wealden Buildings Study Group for the organization of the visit.

REFERENCES

Alcock, N W, Barley, M W, Dixon, P W, and Meeson, R A, 1996 *Recording timber-framed buildings: an illustrated glossary*, York (CBA).

Arnold, A J, Howard, R E, and Bridge, M C, 2010 *Nyetimber Farm Barns, Gay Street, West Chiltington, Near Pulborough, West Sussex: Tree-ring analysis of timbers.*, English Heritage, Research Department Report Series, **36/2010**

Arnold, A J, Howard, R E, Laxton, R R, and Litton, C D, 2001 *Tree-ring analysis of timbers from Swaylands Barn, Penshurst, Kent*, English Heritage, Centre for Archaeol Rep, **36/2001**

Baillie, M G L, 1982 *Tree-ring dating and archaeology*, London (Croom-Helm).

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

Bridge, M C, 1998 *Tree-ring analysis of timbers from the basement, Bruce Castle, Tottenham, London* , English Heritage, Anc Mon Lab Rep, **21/98**

Bridge, M C, 2005 *Tree-ring analysis of timbers from the Barn at St Leonard's Grange, Beaulieu, Hampshire*, English Heritage, Centre for Archaeol Rep, **62/2005**

Brunskill, R W, 2000 *Vernacular Architecture: an illustrated handbook*, London (Faber and Faber).

English Heritage, 2001 *Timber Dendrochronology of Roof Timbers at Lincoln Cathedral*, London (James & James (Science Publishers) Ltd).

Haddon-Reece, D and Miles, D H, 1995 List 64 - Tree-Ring Dates - Part 2, *Vernacular Architect*, **26**

Haddon-Reece, D, Miles, D H, and Munby, J T, 1990 List 38 - Tree-Ring Dates from the Ancient Monuments Laboratory, HBMC, *Vernacular Architect*, **21**, 46-50.

Harris, R, 1978 *Discovering timber-framed buildings*, Princess Risborough (Shire Publications).

Hillam, J, 1998 *Dendrochronology: Guidelines on producing and interpreting dendrochronological dates*, London (English Heritage).

Hillam, J and Groves, C, 1994 *Tree-ring analysis of oak timbers from the Bell Tower of the Abbey Church of St Mary and St Ethelfaeda, Romsey, Hampshire*, English Heritage, Anc Mon Lab Rep, **24/94**

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, **S333**, 165-85.

Howard, R E, Laxton, R R, and Litton, C D, 1997 *Tree-ring analysis of timbers from the Keep of Walmer Castle, Walmer, Kent*, English Heritage, Anc Mon Lab Rep, **75/97**

Howard, R E, Laxton, R R, and Litton, C D, 2001 *Tree-ring analysis of timbers from Westenhanger Castle, Stone Street, Westenhanger, near Folkestone, Kent*, English Heritage, Centre for Archaeol Rep, **85/2001**

Howard, R E, Litton, C D, and Arnold, A J, 2003 *Tree-ring analysis of timbers from Stonepitts Manor, Seal, Kent*, English Heritage, Centre for Archaeol Rep,

Laxton, R R and Litton, C D, 1988 *An East Midlands master tree-ring chronology and its use for dating vernacular buildings*, University of Nottingham, Dept of Classical and Archaeol Studies, Publication Monograph Ser, **3**

Laxton, R R and Litton, C D, 1989 Construction of a Kent Master Dendrochronological Sequence for Oak, AD 1158 to 1540, *Med Archaeol*, **33**, 90-8.

Miles, D H, 1997 The interpretation, presentation, and use of tree-ring dates, *Vernacular Architect*, **28**, 40-56.

Miles, D H, 2005 *The Tree-Ring Dating of the Church of St Mary and All Saints, Broomfield, Taunton, Somerset*, English Heritage, Centre for Archaeol Rep, **28/2005**

Mills, C M, 1988 Dendrochronology: the long and short of it, in *Science and archaeology* (eds E A Slater, and J O Tate), Glasgow, BAR Int Ser, **196**, 549-65.

Moir, A K, 2002a *Dendrochronological analysis of timbers from Coolham Barn, Coolham, West Sussex, England*, Tree-Ring Services, Tree-Ring Services, Dendro Rep, **CBBI/30/02**

Moir, A K, 2002b *Dendrochronological analysis of timbers from Shepherds Cottage, Holleywater Road, Nr. Bordon, Hampshire, England*, Tree-Ring Services, Dendro Rep, **SCHW/33/02**

Moir, A K, 2003a *Dendrochronological analysis of oak timbers from Black and White Cottage, Ockley, Surrey, England* , Tree-Ring Services, Dendro Rep, **OCBW/33/03**

Moir, A K, 2003b *Dendrochronological analysis of oak timbers from Temple Elfande, Capel, Surrey, England*, Tree-Ring Services, Dendro Rep, **CATE/28/03**

Moir, A K, 2003c *Dendrochronological analysis of oak timbers from the Church of St Peter, Newdigate, Surrey, England*, Tree-Ring Services, Dendro Rep, **NDNX/29/03**

Moir, A K, 2003d *Dendrochronological analysis of timbers from Averys, Horsham Road, Rusper, England.*, Tree-Ring Services, Dendro Rep, **RUAV/02/03**

Moir, A K, 2003e *Dendrochronological analysis of timbers from Clock House, Horsham Road, Capel, Surrey, England.*, Tree-Ring Services, Dendro Rep, **CACH/01/03**

Moir, A K, 2003f *Dendrochronological analysis of timbers from Little Dolby, Charlwood, Surrey, England*, Tree-Ring Services, Dendro Rep, **CHLD/07/03**

Moir, A K, 2003g *Dendrochronological analysis of timbers from Pagewood House, Charlwood, Surrey, England*, Tree-Ring Services, Dendro Rep, **CHPA/11/03**

Moir, A K, 2004a *Dendrochronological analysis of oak timbers from Charlwood Place Farm, Charlwood, Surrey, England* , Tree-Ring Services, Dendro Rep, **CHPF/09/04**

Moir, A K, 2004b *Dendrochronological analysis of oak timbers from Greenings Farm Barn, Charlwood, Surrey, England*, Tree-Ring Services, Dendro Rep, **CHGB/07/04**

Moir, A K, 2004c *Dendrochronological analysis of oak timbers from Greenings, Charlwood, Surrey, England*, Tree-Ring Services, Dendro Rep, **CHGB/08/04**

Moir, A K, 2004d *Dendrochronological analysis of oak timbers from Ketleas, Capel, Surrey, England.*, Tree-Ring Services, Dendro Rep, **CAKE/04/04**

Moir, A K, 2004e *Dendrochronological analysis of two additional oak timbers from Old Plough Cottage, Ifield, West Sussex, England*, Tree-Ring Services, Dendro Rep, **IFOP/11/04**

Moir, A K, 2005a *Dendrochronological analysis of oak timbers from 3 Church Street, Godalming, Surrey, England*, Tree-Ring Services, Dendro Rep, **GOCS/04/05**

Moir, A K, 2005b *Dendrochronological analysis of oak timbers from Littlebrook Farm, Witley, Surrey, England*, Tree-Ring Services, Dendro Rep, **WILB/35/05**

Moir, A K, 2005c *Dendrochronological analysis of oak timbers from Manor Cottage, Betchworth, Surrey, England*, Tree-Ring Services, Dendro Rep, **CCKG/15/05**

Moir, A K, 2005d *Dendrochronological analysis of oak timbers from Old Cottage, West Horsley, Surrey, England*, Tree-Ring Services, Dendro Rep, **WHOC/27/05**

Moir, A K, 2006a *Dendrochronological analysis of oak timbers from Ridgeway Farm, Thursley, Surrey, England*, Tree-Ring Services, Dendro Rep, **THRI/02/06**

Moir, A K, 2006b *Dendrochronological analysis of oak timbers from Smallfield Place, Smallfield, Surrey, England*, Tree-Ring Services, Dendro Rep, **SMSP/05/06**

Moir, A K, 2007a *Dendrochronological analysis of oak timbers from Parham House, Storrington, near Pulborough, West Sussex, England*, Tree-Ring Services, Dendro Rep, **PAPA/01/07**

Moir, A K, 2007b *Dendrochronological analysis of oak timbers from the Porch and Scullery of Frosbury Farmhouse, Worplesdon, Surrey, England*, Tree-Ring Services, Dendro Rep, **FRWO/15/07**

Moir, A K, 2008 *Dendrochronological analysis of oak timbers from Barrow Green Court, Oxted, Surrey, England*, Tree-Ring Services, Dendro Rep, **OXBG/01/08**

Moir, A K, 2009 *Dendrochronological analysis of oak timbers from Place Farm, Place Farm Road, Bletchingley, Surrey, England.*, Tree-Ring Services, Dendro Rep, **BLPF/12/09**

Nayling, N, 1999 *Tree-ring analysis of timbers from The White House, Vowchurch, Herefordshire*, English Heritage, Anc Mon Lab Rep, **73/99**

Pearson, S, 1994 *The Medieval Houses of Kent, An Historical Analysis*, London (RCHME).

Rackham, O, 1990 *Trees and woodland in the British Landscape*, London (J M Dent & Sons Ltd).

Roberts, E, 2003 *Hampshire Houses 1250 - 1700: Their dating & Development*, (Hampshire County Council).

Tyers, I, 1998 *Tree-ring analysis and wood identification on timbers excavated on the Magistrates Court Site, Kingston upon Hull, East Yorkshire*, ARCUS Rep, **410**

Tyers, I, 1999a *Dendro for Windows Program Guide 2nd Edition*, ARCUS Rep, **500**

Tyers, I, 1999b *Tree-ring analysis of the bell tower of the Church of St Mary, Penbridge, Herefordshire*, English Heritage, Anc Mon Lab Rep, **1/9**