Oxford Dendrochronology Laboratory
Report 2014/5

THE TREE-RING DATING OF BERAIN, LLANNEFYDD CONWY (NGR SJ 007 697)

Summary

An 85-year long site chronology was made from three timbers, a purlin in the hammerbeam roof, a principal rafter from the side extension roof, and a ceiling beam from the ground floor. All appeared to represent a single phase of building, and one retained complete sapwood, coming from a tree felled in **winter 1553/54**. Construction seems most likely therefore in 1554, or within a year or two after this date.

Author: Dr M. C. Bridge FSA
Oxford Dendrochronology Laboratory
Mill Farm
Mapledurham
Oxfordshire
RG4 7TX

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BACKGROUND TO DENDROCHRONOLOGY

The basis of dendrochronological dating is that trees of the same species, growing at the same time, in similar habitats, produce similar ring-width patterns. These patterns of varying ring-widths are unique to the period of growth. Each tree naturally has its own pattern superimposed on the basic 'signal', resulting from genetic variations in the response to external stimuli, the changing competitive regime between trees, damage, disease, management etc.

In much of Britain the major influence on the growth of a species like oak is, however, the weather conditions experienced from season to season. By taking several contemporaneous samples from a building or other timber structure, it is often possible to cross-match the ring-width patterns, and by averaging the values for the sequences, maximise the common signal between trees. The resulting 'site chronology' may then be compared with existing 'master' or 'reference' chronologies.

This process can be done by a trained dendrochronologist using plots of the ring-widths and comparing them visually, which also serves as a check on measuring procedures. It is essentially a statistical process, and therefore requires sufficiently long sequences for one to be confident in the results. There is no defined minimum length of a tree-ring series that can be confidently cross-matched, but as a working hypothesis most dendrochronologists use series longer than at least fifty years.

The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation to the variation in the data, and is an established statistical technique for looking at the significance of matching between two datasets that has been adopted by dendrochronologists. The values of '*t*' which give an acceptable match have been the subject of some debate; originally values above 3.5 being regarded as acceptable (given at least 100 years of overlapping rings) but now 4.0 is often taken as the base value. It is possible for a random set of numbers to give an apparently acceptable statistical match against a single reference curve – although the visual analysis of plots of the two series usually shows the trained eye the reality of this match. When a series of ring-widths gives strong statistical matches in the same position against a number of independent chronologies the series becomes dated with an extremely high level of confidence.

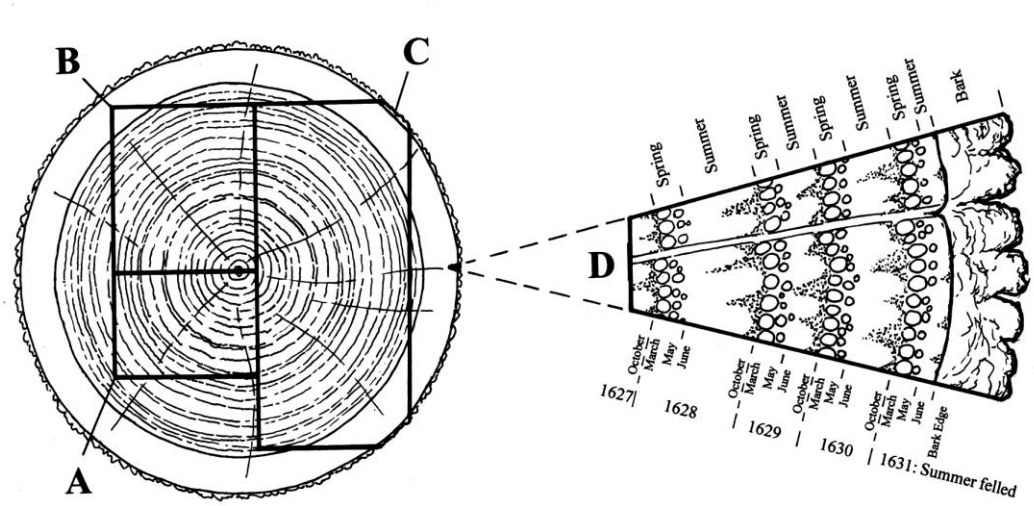
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence of unknown date to this reference material.

It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal

resulting from widespread influences such as the weather. However, a single sequence can be successfully dated, particularly if it has a long ring sequence.

Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are less useful for dating by this technique.

When interpreting the information derived from the dating exercise it is important to take into account such factors as the presence or absence of sapwood on the sample(s), which indicates the outer margins of the tree. Where no sapwood is present it may not be possible to determine how much wood has been removed, and one can therefore only give a date after which the original tree must have been felled. Where the bark is still present on the timber, the year, and even the time of year of felling can be determined. In the case of incomplete sapwood, one can estimate the number of rings likely to have been on the timber by relating it to populations of living and historical timbers to give a statistically valid range of years within which the tree was felled. For this region the estimate used is that 95% of oaks will have a sapwood ring number in the range 11 – 41 (Miles 1997).



Section of tree with conversion methods showing three types of sapwood retention resulting in **A** *terminus post quem*, **B** a felling date range, and **C** a precise felling date. Enlarged area **D** shows the outermost rings of the sapwood with growing seasons (Miles 1997, 42)

BERAIN

Berain is an early example of dual domestic planning ('the unit system'). An early storeyed house has been built against a hall-house giving an L-plan range. Both buildings are stone-built but with high-quality carpentry internally. The hallhouse has a three-bay hall with a hammer-beam roof; one of only ten or so examples in Wales , all or most dating from the sixteenth century. The storeyed house is of Snowdonian type with roll-moulded beams and decorative doorheads. The addition of the storeyed house coincided with the construction of the lateral fireplace in the hall with roll-moulded mantelbeam,

and probably with the flooring over of the open hall. Structurally there are two principal phases but they may be quite close chronologically as the hammer-beam roof does not appear to be smoke-blackened. R.F. Suggett/RCAHMW/March 2014. Entry from Coflein (RCAHMW's on-line database): NPRN 26789.

SAMPLING

Sampling took place in February 2014. All the samples were of oak (*Quercus* spp.). Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were numbered using the prefix **brin**. The samples were removed for further preparation and analysis. Cores were mounted on wooden laths and then these were polished using progressively finer grits down to 400 to allow the measurement of ring-widths to the nearest 0.01 mm. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer. The ring-width series were compared on an IBM compatible computer for statistical cross-matching using a variant of the Belfast CROS program (Baillie and Pilcher 1973). A version of this and other programmes were written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker. Subsequent analyses were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1. Cross-matching among the samples revealed that there was a strong match between samples **01** and **05** (Table 2), these possibly even being from the same tree. Both are collars, one from the main range of the hammerbeam roof, the other from the small roof to the side (a bedroom). Unfortunately, the series did not date, probably as they exhibit some regular growth changes, possibly resulting from management of the tree(s). Three other series matched well (Table 2) – a purlin from the main hammerbeam roof, a principal rafter from the side (bedroom) roof, and an axial beam in the ground floor kitchen. These were meaned together to form an 85-year site chronology, **BERAIN**, which was subsequently dated to the period 1469–1553. No other samples could be matched.

The principal rafter from the side extension retained complete sapwood, but the outer rings were very narrow indeed, and individual rings could not be distinguished. The ground floor ceiling beam also retained complete sapwood, and was found to have come from a tree felled in **winter 1553/54**. The other two dated series have similar date ranges, suggesting that they were most likely all felled at about the same time. The likely date of construction of this wing of the house is therefore 1554, or within a year or two after this date.

Only two samples were taken from the other wing of the house, which mostly had very fast-grown timbers. Neither of these dated.

Table 1: Details of samples taken from Berain, Llannefydd.

Sample number	Timber and position	Date of series	H/S boundary date	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens	Felling date range
North wing with hammerbeam roof and side bedroom									
brin01	Collar to south-west end truss (T4)	-	-	5 +21CNM	105	1.66	0.80	0.18	-
brin02	North-west principal rafter (T4)		-	25C	40	2.81	1.05	0.26	-
*** brin03**	North-west purlin bay T3 – T4	1469-1542	1535	7	74	1.79	0.98	0.23	1546-76
*** brin04**	North principal rafter, side wing	1488-1542	1532	10 +6NM	55	1.95	1.24	0.34	1549–59
brin05	Collar to central truss, side wing	-	-	H/S	94	2.12	1.06	0.23	-
brin06	North prin rafter, central truss, side wing (bedroom)	-	-	-	54	2.63	1.42	0.22	-
*** brin07**	Main ceiling beam, kitchen	1472-1553	1532	21C	82	2.37	1.10	0.31	Winter 1553/54
* = component of site master **BERAIN**		**1469-1553**			**85**	**2.13**	**0.94**	**0.24**	
South-east wing									
brin08	6th joist from east side	-	-	-	<40	NM	-	-	-
brin09	Axial beam in living room	-	-	2	<40	NM	-	-	-

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured;

Table 2: Cross-matching between samples

	***t*-values**		
Sample	**brin05**	**brin04**	**brin07**
brin01	8.3	-	-
brin03	-	3.5	6.2
brin04	-	-	5.2

Table 3: Dating evidence for the site master **BERAIN** **AD 1469–1553** against dated reference chronologies, regional chronologies in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Plas Mawr House	(Miles and Haddon-Reece 1996)	PLASMWR2	1360–1578	85	7.7
Warwickshire	Baddesley Clinton	(Miles and Worthington 2002)	BADESLY3	1423–1577	85	7.4
Worcestershire	Seechem Manor, Alvechurch	(Miles and Haddon-Reece 1995)	SEECHEM2	1388–1595	85	6.6
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411–1571	85	6.5
Wales	Tyn Celyn	(Miles *et al* 2004)	TYNCELYN	1375–1524	56	6.5
Shropshire	Church Farm, Ditton Priors	(Miles *et al* 2004)	DITTON5	1437–1578	85	6.5
Lancashire	Turton Tower, Blackburn	(Arnold and Howard 2008)	TRTASQ01	1483–1665	71	6.3
Lancashire	Worden Old Hall, Chorley	(Bridge 2003)	OLDWORD2	1415–1531	63	6.3
Wiltshire	Gable End, Upper Chute	(Miles and Worthington 1998)	CHUTE	1471–1575	83	6.3
Wales	Ty Mawr, Druid, Corwen	(Miles *et al* 2010)	DENBY1	1440–1583	85	6.2
Northamptonshire	Dower House, Fawsley Park	(Howard *et al* 1999)	FAWSLEY1	1427–1575	85	6.1
Wales	Ystumcolwyn Barn, Meifod	(Miles *et al* 2005)	YSTUM1	1416–1558	85	6.0
Wales	St Idloes Church, Llanidloes	(Miles *et al* 2003)	LNYDLOS2	1384–1593	85	5.9

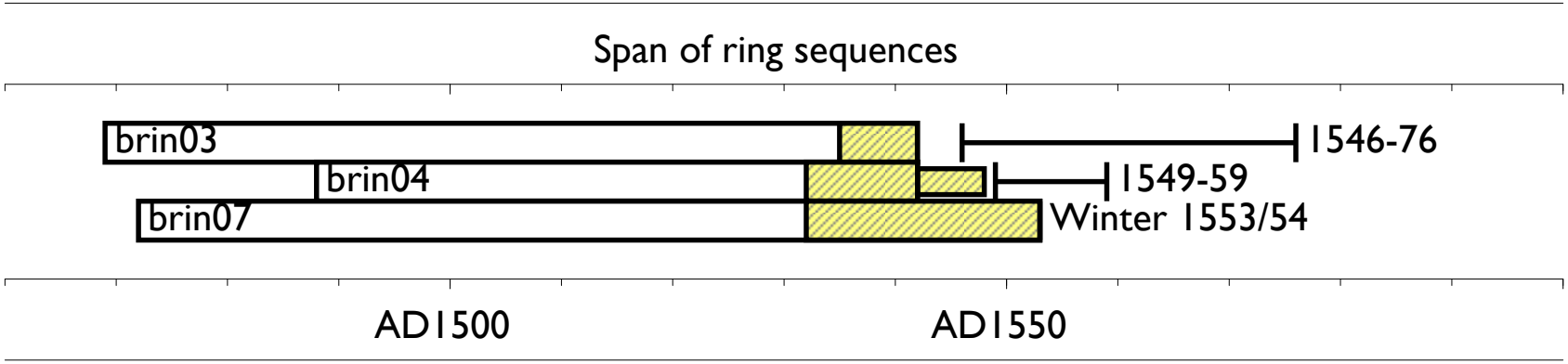


Figure 1: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely, or actual, felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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