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Oxford Dendrochronology Laboratory
Report 2017/06

THE DENDROCHRONOLOGICAL DATING OF TIMBERS FROM GREENHILL FARM, BRYN CELYN, HOLYWELL, FLINTSHIRE

(SJ 188 768)

Summary

Timbers were sampled from principal posts on the ground floor, a ground floor screen and ceiling, a first floor screen and two purlins in the rear range. Two series from the ground floor screen matched each other, but contained a sudden decline in growth two thirds of the way through the series, and these could not be dated. Two other series also exhibited sudden growth declines, and could not be dated. Five series did however match each other, representing the ground floor ceiling, a post, the first floor screen and the purlins, all appearing to have come from trees likely to have been felled at the same time. Two retained complete sapwood, and were felled in winter 1600/01, making **1601** the most likely year of construction, which may also have taken place within a year or two after this date.

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The Dendrochronological Dating of Timbers from Greenhill Farm, Bryn Celyn, Holywell, Flintshire. (SJ 188 768)

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. These include chronologies made by colleagues in other countries, most notably areas such as modern Poland, which have proved to be the source of many boards used in the construction of doors and chests, and for oil paintings before the widespread use of canvas.

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.

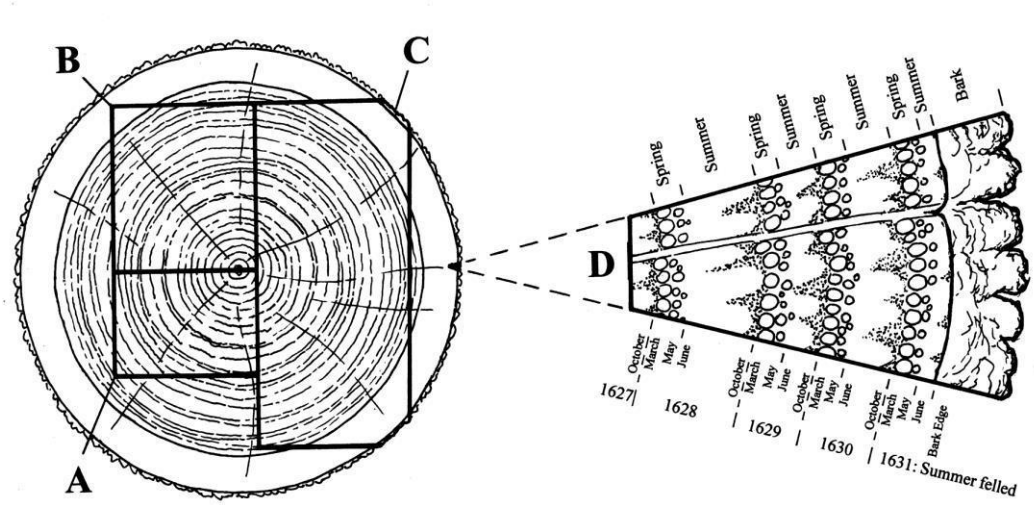
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation 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 in oak studies. Higher values are usually found with matching pine sequences. 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)

Greenhill Farm

Described in Coflein only as - 16th - 17th century timber-framed hall-house with later alterations.
The ground floor has a screen still in place and a moulded ceiling beam, whilst a screen remains at first floor level. It was unclear whether the rear wing was contemporaneous or not.

SAMPLING

Samples were taken in December 2016. The locations of the samples are described in Table 1. Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled (prefix **grnh**) and were polished with progressively finer grits down to 800 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. Measurements and subsequent analysis were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

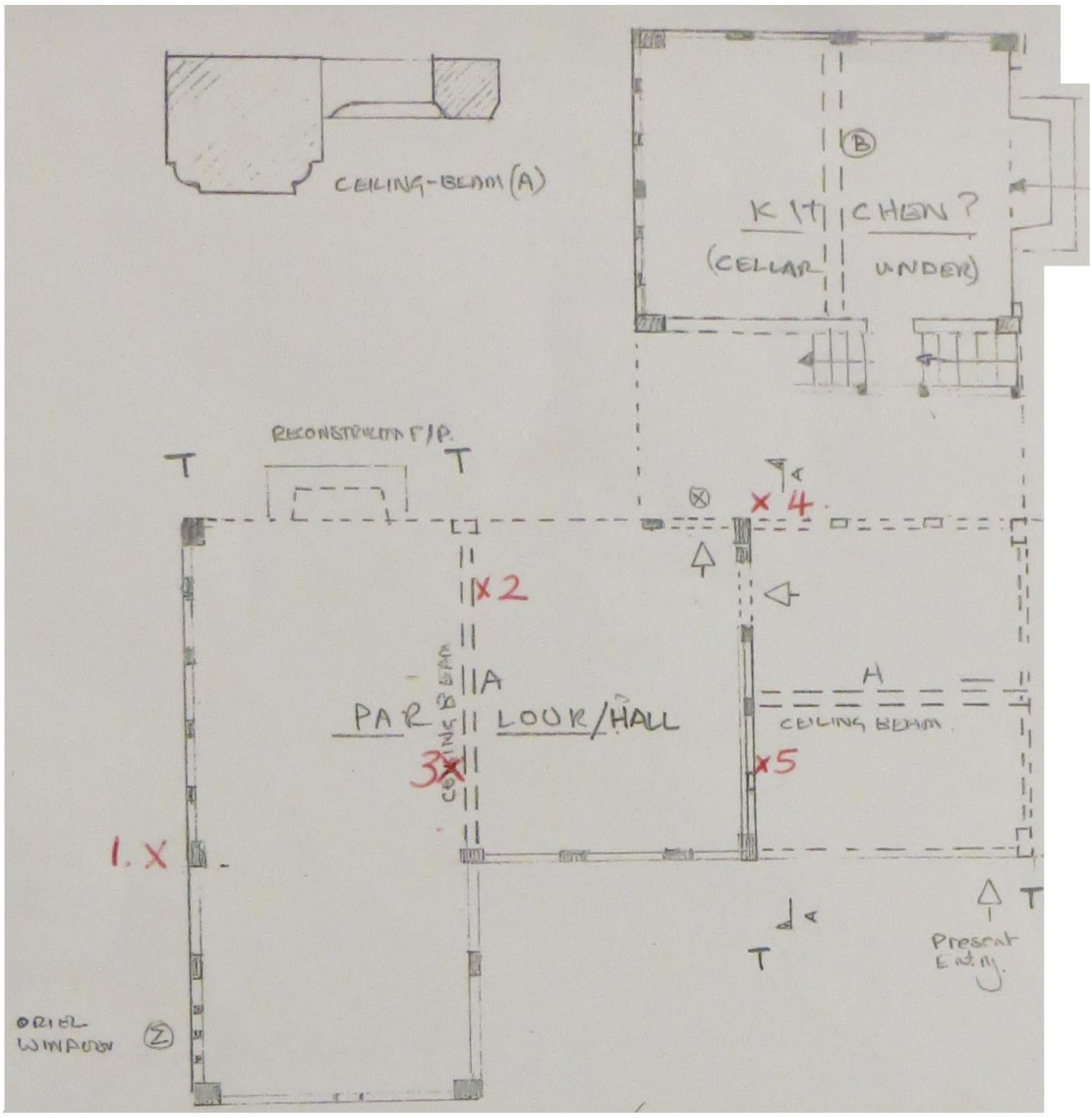


Figure 1: Plan of the ground floor with positions of samples marked (Margaret Barr)

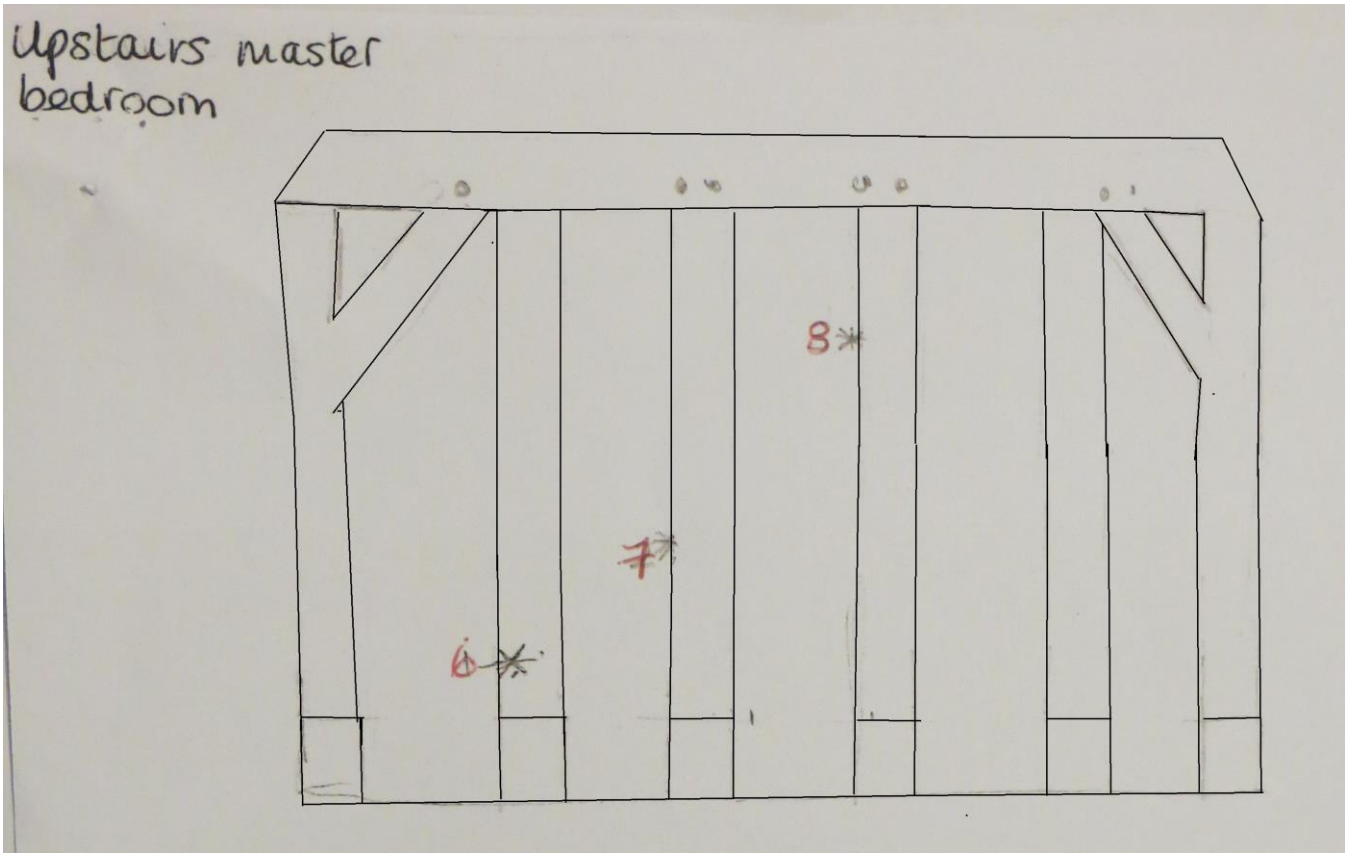


Figure 2: Field sketch of the screen in the first floor showing timbers sampled (after Margaret Barr)

RESULTS AND DISCUSSION

Details of the samples are given in Table 1, with filed sketches (Figs 1 & 2) giving approximate locations of the timbers sampled. Some of the ring series were quite short. A split in the core from **02** meant that it was measured as two separate pieces, the dates of which were later resolved by cross-matching with the other dated timbers. Two cores were taken from **04**, which retained complete sapwood, the first having few rings, but both were eventually dated. Sample **08** split along a medullary ray, giving two overlapping samples which were combined to give a single series representing the timber. Samples **05** and **06** matched each other (t = 4.6 with 56 years overlap), but the resulting series contains a sudden growth rate decline, and could not be dated.

Cross-matching of the remaining series (Table 2) resulted in six of the timbers being combined into a 91-year site master chronology, **GRNHLLFM**, which was subsequently dated to the period 1510-1600 (the strongest matches being shown in Table 3). The relative positions of matching are illustrated in Fig. 3. Two timbers retained complete sapwood, and were from trees felled in winter 1600/01, making the most likely date of construction 1601, or within a year or two after this date. The study also reveals that the rear wing was contemporaneous with the main body of the house.

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Table 1: Details of samples taken from Greenhill Farm, Bryn Celyn, Holywell.

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
grnh01	South east corner post	-			57	1.85	1.11	0.22	
* ***grnh02i***	Moulded ceiling beam	1511-1546			*36*	*2.80*	*0.93*	*0.26*	
* ***grnh02ii***	*ditto*	1548-1596			*49*	*1.37*	*0.25*	*0.16*	
grnh03	East principal post	-			39	3.29	1.96	0.24	
grnh04a	West principal post	*1563-1600*	*26C*		*38*	*1.44*	*0.41*	*0.15*	
grnh04b	*ditto*	*1555-1600*	*27C*		*46*	*1.50*	*0.30*	*0.17*	
* **grnh04**	Mean of **04a** and **04b**	1555-1600	27C		46	1.49	0.33	0.17	
grnh05	Screen middle stud	-			56	1.60	0.93	0.35	
grnh06	Screen, west stud	-			61	1.49	0.48	0.29	
* **grnh07**	First Flr screen, 2nd stud from west	1514-1595			82	1.66	0.59	0.21	
grnh08i	First Flr screen, 3rd stud from west	*1510-1572*			*63*	*1.32*	*0.80*	*0.22*	
grnh08ii	*ditto*	*1564-1600*			*37*	*1.03*	*0.25*	*0.19*	
* **grnh08**	Mean of **08i** and **08ii**	1510-1600			91	1.25	0.68	0.21	
* **grnh09**	North purlin in rear wing	1531-1599			69	1.77	0.56	0.21	
* **grnh10**	South purlin in rear wing	1515-1586			72	2.39	0.92	0.18	
* = included in site master **GRNHLLFM**		**1510-1600**			**91**	**1.84**	**0.68**	**0.16**	

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

05 and **06** match each other (t = 4.6 with 56 years overlap), but the resulting series contains a sudden growth rate decline, and could not be dated

Table 2: Cross-matching between the dated samples (*t*-values above 3.5 are significant)

	***t*-values**				
Sample	**grnh04**	**grnh07**	**grnh08**	**grnh09**	**grnh10**
grnh02i	*	2.9	2.2	*	1.9
grnh02ii	4.8	4.7	2.4	2.0	*
grnh04		5.9	4.9	2.4	*
grnh07			6.0	2.5	3.8
grnh08				2.8	4.6
grnh09					5.6

* = overlap less than 40 year, not calculated

Table 3: Dating evidence for the site chronology **GRNHLLFM AD 1510–1600** against dated reference chronologies

County or region:	***Chronology name:***	***Reference***	***File name:***	***Spanning***	***Overlap: (yrs)***	***t-value:***
Regional Chronologies						
England	Southern Central England	(Wilson et al 2012)	**SCENG**	663–2009	91	9.5
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	91	9.1
Wales/borders	Hillside oaks	(Siebenlist-Kerner 1978)	**GIERTZ**	1341–1636	91	8.8
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882–1981	91	8.7
Site Chronologies						
Worcestershire	Granary, Meadow Farm, Redditch	(Miles *et al* 2007)	REDGRAN	1402–1597	88	8.0
Shropshire	Clungunford Farm	(Miles and Worthington 2002)	CGFB	1273–1628	91	7.8
Shropshire	Church Farm, Ditton Priors	(Miles *et al* 2004)	DITTON5	1437–1578	69	7.7
Warwickshire	Astley Castle	(Howard *et al* 1997)	ASTCSQ01	1495–1627	91	7.5
Worcestershire	Meadow Farm, Redditch	(Miles *et al* 2007)	REDDITCH	1442–1602	91	7.4
Shropshire	Church Farm, Clungunford	(Miles and Worthington 2002)	CGFD	1443–1597	88	7.4
Breconshire	The Three Tuns, Hay on Wye	(Bridge *et al* 2016)	HAY3TUNS	1386–1652	91	7.3
Warwickshire	Wellesborne Granary	(Miles and Haddon-Reece 1996)	WELLSBRN	1431–1639	91	7.3
Worcestershire	Hartlebury Castle Saloon Roof	(Tyers 2008)	HARTSALN	1339–1608	91	7.2

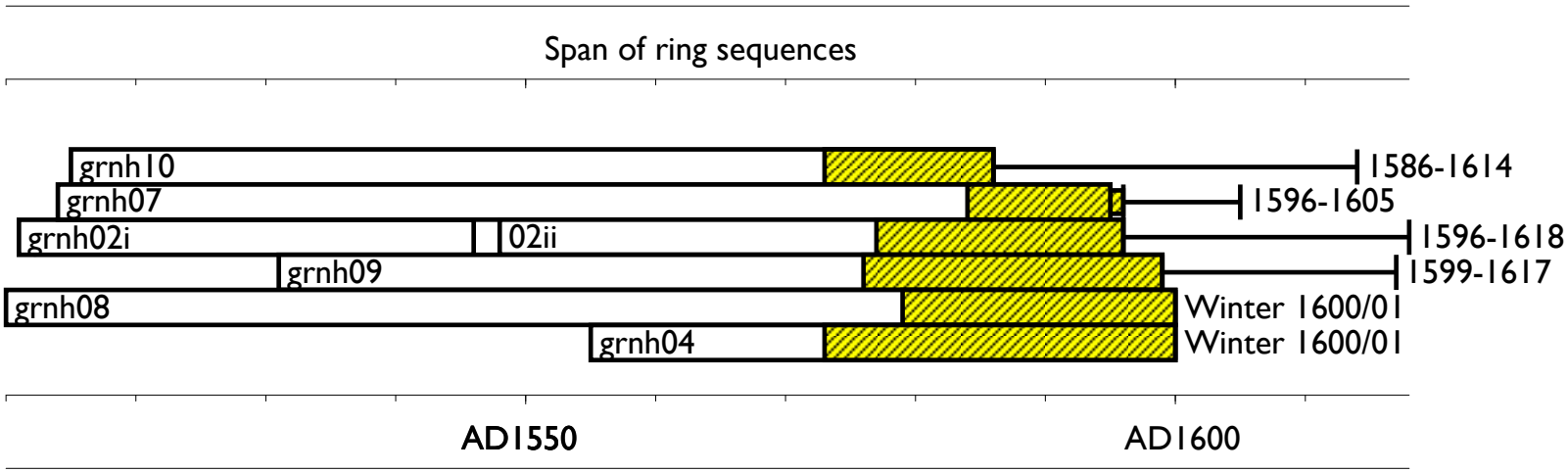

Figure 3: Bar diagram showing the relative positions of overlap of the dated samples, with their actual or likely felling dates / date ranges. White sections represent heartwood rings and yellow hatched sections represent sapwood, narrow bars represent additional unmeasured rings.