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Oxford Dendrochronology Laboratory
Report 2017/07

THE DENDROCHRONOLOGICAL DATING OF TIMBERS FROM EFENECHTYD FARM, GLYNDYFRDWY, CORWEN

(SJ 166 434)

Summary

At first glance this appears to be a relatively simple building, with a north-south front wing and an E-W rear wing, possibly of different age, as they seem not to mesh completely with each other. The dendro dating suggests that the rear E-W range may be slightly older, with one purlin being from a tree felled in spring 1602, and other purlins appearing to be of similar age. The front N-S range is dated by only the principal rafters of the central truss, which appear to be made from a single tree, most likely felled in the period 1616–46, the other timbers mostly having too few rings for dating. The ground floor ceiling beam in the eastern room of the rear E-W range has a likely felling date range later still (1623–53), or it could be coeval with the front range. Careful fabric analysis may throw more light on the relationships between the various elements of this property.

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A report commissioned by the Discovering Old Welsh Houses Group in collaboration with the Royal Commission on the Ancient and Historic Monuments Wales (RCAHMW)

The Dendrochronological Dating of Timbers from Efenechtyd Farmhouse, Gelndyfrdwy, Denbighshire (SJ 166 434)

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.

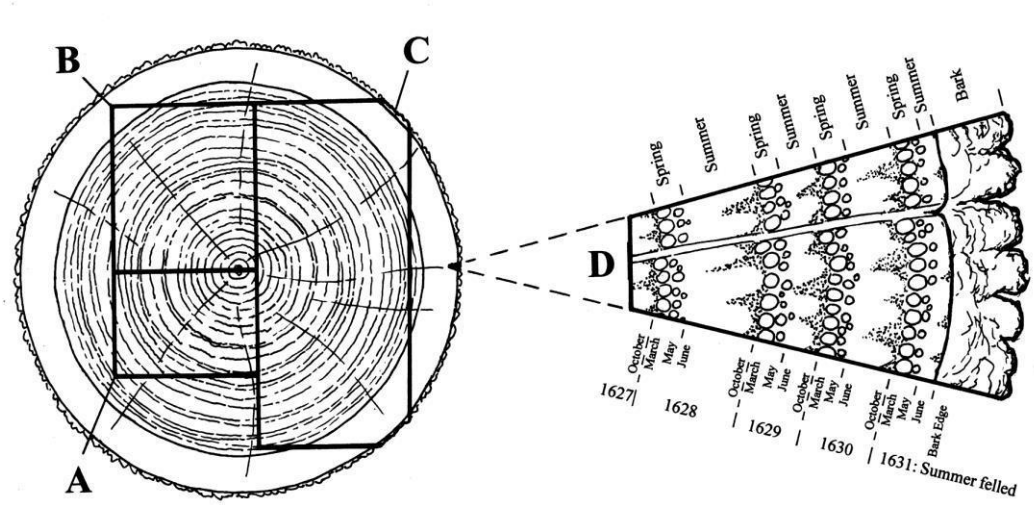
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation 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)

Efenechtyd

Listed as a late C16th asymmetrical stone farmhouse with alterations and additions. The first floor is noted as having an arch-braced truss. The RCAHMW for Denbighshire suggests it may be of the C17th, with a completely modernised interior.

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 **eytd**) and were polished with 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. Measurements and subsequent analysis were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Details of the samples are given in Table 1. Two timbers (03 and 09) had rapid growth rate changes and were not suitable for dating. Cross-matching between the remaining samples (Table 2) strongly suggests that the two principal rafters in the front N-S range were fashioned from a single tree, and samples **02** and **01** were combined into a single series for subsequent analysis. Similarly **06** and **07** the purlins at the west end of the rear E-W range appear to have been made from a single tree, and their series were also combined for subsequent analysis. Fig 1. Shows the relative positions of overlap of the dated timbers, and suggests that the rear range may be slightly older than the front range – with one tree having been felled in spring 1602. The principal rafters of the front range arch-braced truss appear to have come from a tree felled later (1616-46). The purlin at the top of the stairs to the north of the front bedroom was thought to be part of the N-S range, but dating suggests it is more likely associated with the rear range.

One complication is that a ceiling beam in the east room of the rear range was from a tree felled either later, or possibly at the same time as those in the front range (1623–53). A number of unusual features were noted in the way this ceiling respects the north wall, and it may be an alteration, or an inserted floor. Closer fabric analysis is required at this site to work out the complex relationships between various elements.

The site master sequence formed from the five series gives very strong matching with other chronologies (Table 3).

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Table 1: Details of samples taken from Efenechtyd.

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
eytd01	East principal rafter, front N-S range	1481-1611	1605	6	131	1.20	0.38	0.19	
eytd02	West principal rafter, front N-S range	1456-1552	-	-	97	1.47	0.70	0.20	
eytd03	W door jamb, 1st flr partition N-S range	-	-	H/S	65	0.91	0.59	0.22	-
* **eytd04**	Upper west purlin at top of stairs	1482-1560	1554	6	79	1.26	0.57	0.19	1565–95
* **eytd05**	N lower purlin, east rear room	1510-1601	1584	17¼C	92	1.32	0.40	0.18	Spring 1602
eytd06	SW purlin, rear range	1488-1579	1579	H/S	92	1.47	0.47	0.20	1590–1620
eytd07a	NW purlin, rear range	*1504-1580*	-	-	*77*	*0.87*	*0.49*	*0.18*	
eytd07b	*ditto*	*1455-1540*	-	-	*86*	*1.49*	*0.48*	*0.21*	
eytd07	Mean of **07a** and **07b**	1455-1580	-	-	126	1.20	0.62	0.19	1591–1621
* **eytd08**	W ceiling beam in east rear Grd Flr room	1530-1612	1612	H/S	83	1.53	0.65	0.19	1623–53
eytd09	S post of central rear range truss	-	-	-	75	1.91	1.33	0.26	-
* **eytd21m**	Mean of **01** and **02**	1456-1611	1605	6	156	1.39	0.56	0.19	1616–46
* **eytd76m**	Mean of **06** and **07**	1455-1580	1580	H/S	126	1.38	0.54	0.19	1591–1621
* = included in site master **EFNCHTYD**		1455-1612			158	1.44	0.44	0.16	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; ½ C = complete sapwood, felled the following spring; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured.

Table 2: Cross-matching between the dated samples from Efenechtyd included in the site master

	t-values					
Sample	**eytd02**	**eytd04**	**eytd05**	**eytd06**	**eytd07**	**eytd08**
etyd01	9.4	0.2	4.4	3.5	3.5	3.8
eytd02		0.1	2.9	3.9	5.7	*
eytd04			1.4	2.0	2.5	0.3
eytd05				6.8	6.6	4.0
eytd06					9.0	4.6
eytd07						2.9

* = overlap too short to produce meaningful value

Table 3: Dating evidence for the site chronology **EFNCHTYD AD 1455–1612** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Regional Chronologies						
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	158	9.0
England	Southern Central England	(Wilson *et al* 2012)	**SCENG**	663–2009	158	8.5
London	London Master Chronology	(Tyers pers comm)	**LONDON**	413–1728	158	8.4
Site Chronologies						
Denbighshire	Caerfallen, Ruthin	(Bridge *et al* 2015)	CAERFLLN	1415–1559	105	10.5
Shropshire	8-10 High Street, Bishop's Castle	(Miles and Bridge 2011)	BCSC	1422–1508	54	9.2
Radnorshire	Old Impton Norton	(Miles and Worthington 1998)	OLDIMTN2	1415–1542	88	9.1
Denbighshire	Glas Hirfryn,	(Bridge *et al* 2014)	GHN	1404–1557	103	8.9
Montgomeryshire	Rhos-fawr-isaf, Meifod	(Miles *et al* 2005)	RHOSFAWR	1430–1576	122	8.8
Breconshire	Hay Castle gate	(Miles *et al* 2008)	HAYGATE1	1445–1603	149	8.8
Radnorshire	Llansantfraidd	(Miles and Worthington 2002)	TUHWNT	1400–1647	158	8.5
Shropshire	Habberley Hall	(Miles and Haddon-Reece 1995)	HABBERLY	1386–1554	100	8.5
Gloucestershire	26 Westgate Street, Gloucester	(Howard *et al* 1998)	GLOBSQ01	1399–1622	158	8.1
Worcestershire	Plowstall Farmhouse, Bayton	(Miles *et al* 2008)	BAYTONPF	1410–1570	116	7.8
Denbighshire	Hafod Bilston, Llandegla	ODL 2017 as yet unpublished	HFDBLSTN	1455–1637	158	7.8
Shropshire	Reader's House, Ludlow	(Bridge and Miles 2011)	READERS1	1406–1615	158	7.6
Shropshire	Fulway Cottage	(Miles and Haddon-Reece 1994)	FULWAY	1397–1639	158	7.5

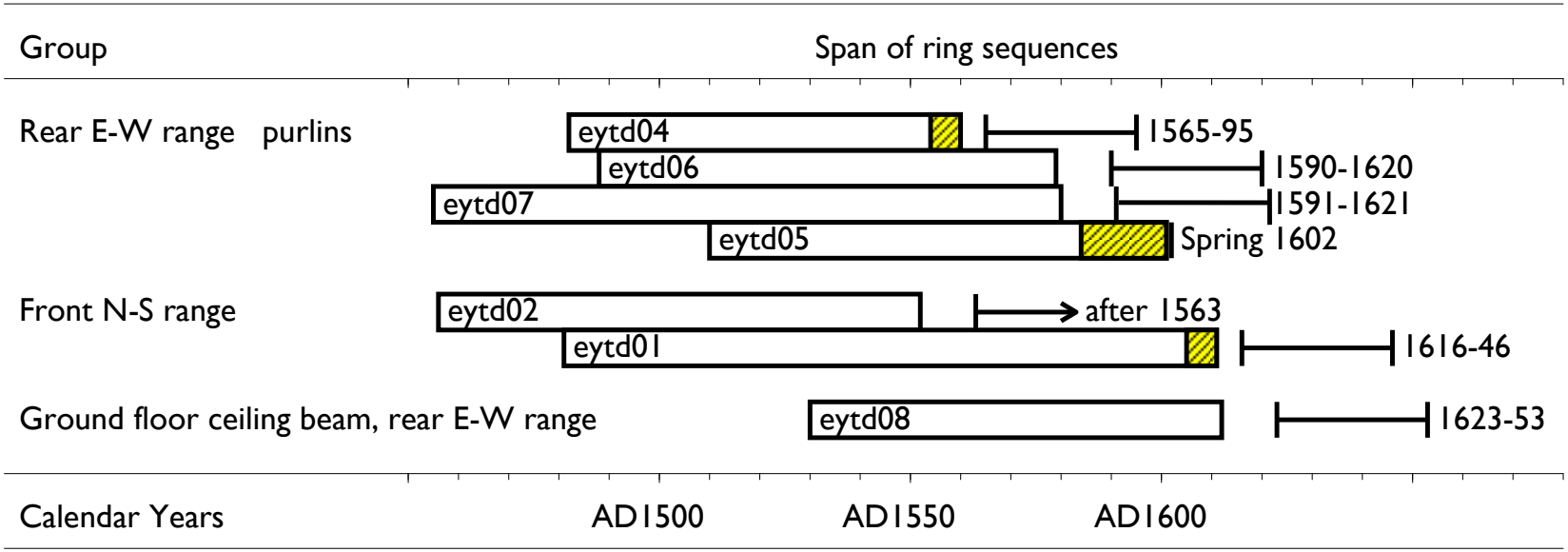

Figure 1: Bar diagram showing the relative positions of overlap of the dated samples, with their actual or likely felling dates / date ranges. White sections represent heartwood rings and yellow hatched sections represent sapwood, narrow bars represent additional unmeasured rings.