Tree Ring Dating

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Oxford Dendrochronology Laboratory
Report 2016/10

THE DENDROCHRONOLOGICAL DATING OF TIMBERS FROM ESGAIR OLWYN, LLANDECWYN, MERIONETH (NGR SH 619 345)

Summary

A number of the series collected showed periods of exceptionally slow growth, with individual rings at times being impossible to distinguish. Some of the trees may have been close to death when felled. When the series were edited into the parts that were considered properly resolved, a 158-year long site chronology was produced with matched very well with local chronologies, dating it to the period 1437–1594. Two trees were found to have been felled in winter 1594/95 and summer 1595 respectively, suggesting construction of the building in **1595**, or within a year or two after this date, slightly earlier than had been suggested on stylistic grounds.

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The Dendrochronological Dating of Timbers from Esgair Olwyn, Llandecwyn, Merioneth (SH 617 345)

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.

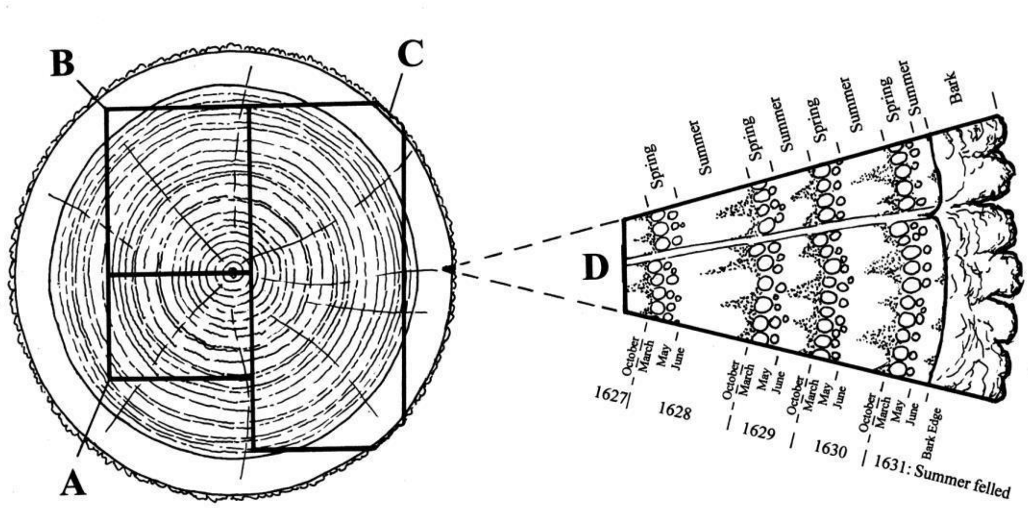
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation 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 1997a, 42)

ESGAIR OLWYN (notes by Peter Thompson)

Esgair Olwyn is a fine example of a stone-built storeyed house of three bays in the classic Snowdonia style. Latterly it has been used as a barn. The doorways have flat-headed lintels, and the window openings have been altered. The ground floor now has no internal walls, but it was once divided by a cross-passage to give a hall and two service rooms. The ceiling has stop-chamfered beams and joists. A floor beam at the lower end is morticed to accept a plank and muntin screen with twin doorways, but the screen has now gone. The other end has a typical gable end fireplace with large bresummer and winding stair at fireside to the first floor. There are no extant internal walls. Only part of original roof survives but this shows a good pair of oak A-frame trusses of principal rafters with unusual lapped and notched collar beams with the principal rafters resting on short section wall plates. Chimney removed and purlins and rafters replaced with modern softwood and covered with corrugated iron in later reroofing.

First floor gable external entry doorway is of interest but possibly later. The down-slope siting suggests an early building.

While the house may have been considered an example of the house built later in the 17th century, a 1623 Crown Rental for Ardudwy of chief tenants has an entry for 'William John pro Eskaire Olwyn 2/6' which suggests the date may be somewhat earlier*. The evidence of the building is not conclusive and it may be that a Crown chief tenant was in occupation at the beginning of the 17th century.

* Parry, R, An Ardudwy Crown Rental 1623, Journal of the Merioneth Historical and Record Society, Vol XV, 2009, Part IV, 365-389.

SAMPLES

Samples (taken by DM) were of oak (*Quercus* spp.). Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled (prefix **esg**) 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. As can be seen from the values in the column representing mean sensitivity, the year-to-year fluctuation in sing width was very high, and several of the samples showed areas with very narrow rings, often impossible to resolve into annual sequences. A number of series were edited therefore into shorter series with approximate numbers of additional rings estimated (e.g. **02e** and **05e**). Several of the trees must have been near death when felled, or may have even died, when cut down. Despite the difficulties in cross-matching the series (Table 2), a robust site master chronology was derived from the measurable parts of the sequences (see Fig 1) and this 158-year long chronology matched very well with a number of local chronologies, as well as some from further afield (Table 3).

Two felling dates were derived, one timber being felled in winter 1594/95, and the other in Summer 1595. The other timbers were probably felled in the same period, although some look as if they could normally be thought to have been felled earlier – this is probably the result of unusually large numbers of sapwood rings being present in what often looked like dying trees.

The felling information suggests construction of this building in 1595, or within a year of two after this date. This date is slightly earlier than had been proposed on stylistic grounds.

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Table 1: Details of samples taken from Esgair Olwyn

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
* **esg01**	Rear left-hand principal rafter	1501-1594	1570	24C	94	1.72	0.80	0.23	Winter 1594/95
* **esg02e**	Front left-hand principal rafter	1451-1518	-	-	68 (+*c*37)	1.94	0.82	0.31	after 1556
* **esg03**	Collar, left-hand truss	1483-1594	1575	19½C	112	1.92	0.76	0.32	Summer 1595
* **esg04**	Rear right-hand principal rafter	1437-1546	-	-	110	1.31	0.58	0.24	after 1557
* **esg05e**	Front right-hand principal rafter	1450-1535	1535	H/S +*c*40	86	1.15	0.57	0.24	after 1575
* **esg06**	Collar right-hand truss	1448-1564	1564	H/S +5	117	1.39	0.63	0.32	1575–1605
esg07ai	Rear right-hand pad			-	*NM*	-	-	-	-
esg07aii	*ditto*	*1503-1578*	*1564*	*14 +c17*	*77*	*0.91*	*0.28*	*0.25*	-
esg07bi	*ditto*	-	-	-	*30*	*1.04*	*0.43*	*0.27*	-
esg07bii	*ditto*	*1501-1559*	-	-	*59*	*0.90*	*0.25*	*0.27*	-
esg07biii	*ditto*	-	-	*6*	*13*	*1.07*	*0.40*	*0.24*	-
esg07biv	*ditto*	-	-	*29¼C*	*29*	*0.97*	*0.31*	*0.26*	-
* **esg07**	Mean of cross-matched parts of **07**	1501-1578	1564	14 +*c*17	78	0.90	0.28	0.26	1592–1605
esg08a	Left-hand transverse beam	-	-	9 +*c*28	90	2.04	1.42	0.30	-
* **esg08b**	*ditto*	1494-1558	1548	10 +*c*28	65	1.33	0.81	0.28	1586–96
* = included in site master **ESGAIR**		**1437-1594**			**158**	**1.36**	**0.44**	**0.21**	

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

Table 2: Cross-matching between the dated samples (values of *t* over 3.5 are significant, negative values shown as 0)

***t*-values**							
Sample	**esg02e**	**esg03**	**esg04**	**esg05e**	**esg06**	**esg07**	**esg08b**
esg01	*	2.8	3.8	1.7	5.0	3.6	4.5
esg02e		3.8	5.1	4.9	0	*	*
esg03			5.9	5.6	4.3	2.6	2.5
esg04				9.5	2.0	3.3	3.4
esg05e					0.3	*	3.6
esg06						4.9	4.4
esg07							2.5

* = overlap too short to calculate value

Table 3: Dating evidence for the site master **ESGAIR** **AD 1437–1594** against dated reference chronologies

County or region	*Chronology name*	*Reference*	*File name*	*Spanning*	*Overlap (yrs)*	*t-value*
Regional Chronologies						
Wales	Welsh Master Chronology	(Miles 1997)	**WALES97**	404–1981	158	8.9
Northern England	Northern England Master	(Hillam and Groves 1994)	**NORTH**	440–1742	158	8.8
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	158	8.5
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882–1981	158	8.1
Site Chronologies						
Caernarvonshire	Clenennau, Dolbenmaen	(Miles *et al* 2007)	BDGLRT10	1406–1570	134	9.2
Caernarvonshire	Plas ym Mhenrhos, Penrhos	(Miles *et al* 2012)	PLASMNRS	1413–1607	158	8.8
Merioneth	Plas y Dduallt, Maentwrog	(Miles *et al* 2011)	GWYNEDD5	1355–1604	158	8.8
Cumbria	Dandra Garth, Garsdale	(Arnold and Howard 2014)	DNDRSQ01	1373–1635	158	8.8
Montgomeryshire	Trefrechan barn	(Miles *et al* 2004)	TREFECHN	1423–1606	158	8.8
Anglesey	Tudor Rose, Beaumaris	(Miles *et al* 2010)	ANGLSY3a	1420–1548	112	8.2
Denbighshire	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	158	8.2
Shropshire	Abcott Manor, Clungunford	(Miles and Worthington 2002)	CGFA	1422–1545	109	8.2
Montgomeryshire	Llwyn Llandrinio	(Miles *et al* 2003)	LLWYN	1413–1551	115	8.1

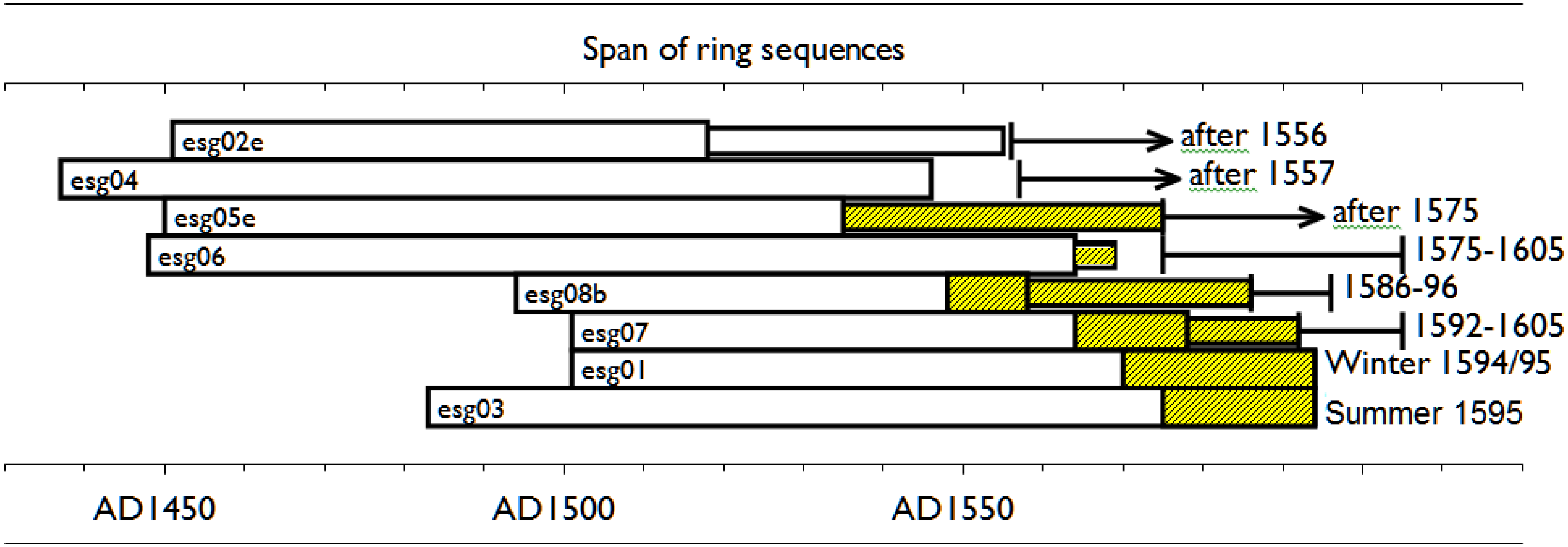

Figure 1: Bar diagram showing the relative positions of overlap of the dated timbers. White bars represent heartwood rings, yellow hatched sections represent sapwood, narrow sections represent additional unmeasured/undated rings