Oxford Dendrochronology Laboratory
Report 2012/27

THE TREE-RING DATING OF PLAS GLASGWM, PENMACHNO, BETWS-Y-COED CONWY (NGR SH 774 504)

Summary
Six timbers were sampled for dendrochronological analysis, two from the kitchen ceiling, and four from the roof. Two roof samples were dated, one being from a tree felled in **winter 1570/71** and the other in **spring 1573**. This strongly suggests that construction of the property took place in 1573 or shortly after. The remaining four sample series matched each other, and were combined into a site master chronology, but this remains undated, although it may be contemporaneous with the dated material.

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A report commissioned by The North West Wales Dendrochronology Project in partnership with The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

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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.

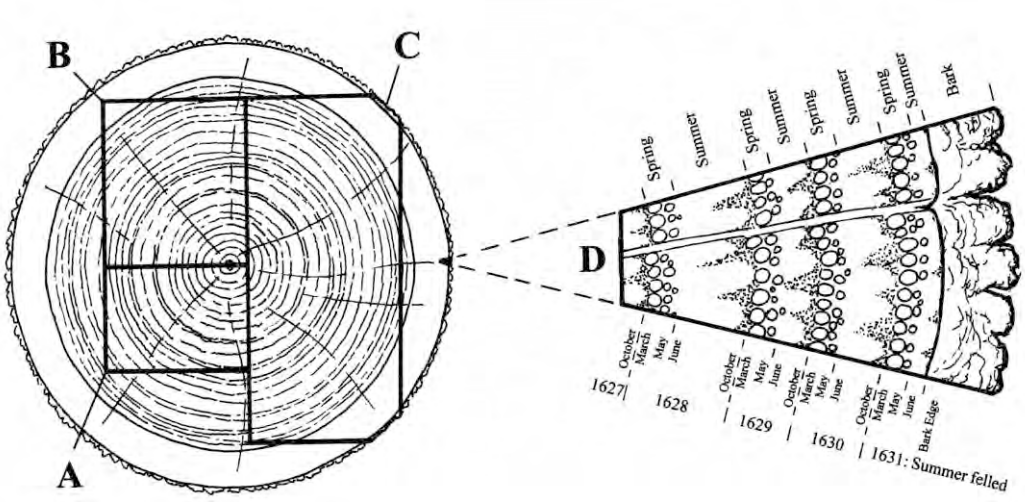
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence 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 1997a).



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)

PLAS GLASGWM

Plas Glasgwm is a substantial multi-period farmhouse of L-plan with the earlier house re-fronted *c*.1800. A lean-to dairy and service range with water-wheel has infilled the remaining space between older and newer ranges. The later house presents a hipped main front of central entry type with elaborate porch, and has a lateral fireplace with ogee stops (of uncertain date) heating the best kitchen. The earlier house, now the back kitchen, was of Snowdonian type. The large projecting end fireplace (without stair but with oven projection) survives along with chamfered beams with curved

stops. The bolted truss appears C19th but the earlier purlins and rafters have been reused. Dendrochronology showed that these dated from the later C16th. Noted in RCAHMW, *Caernarvonshire Inventory, Volume I: East* (1956), p.175, mon. 626. NPRN 16743. RFS/RCAHMW/July 2012.

SAMPLING

Sampling took place in January 2012. 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 **pgm**. 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. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer allowing the measurement of ring-widths to the nearest 0.01 mm using programs written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker. DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004) was also used.

RESULTS AND DISCUSSION

Details of the samples and their locations are given in Table 1. Cross-matching between the samples revealed that three samples matched each other well(Table 2) and a fourth could be added to these to be formed into a site master chronology, **GLASGWM1,** the components of which were from trees felled over a two-year period. This however failed to give satisfactory matches to the dated reference material, and remains, for now, undated. Two individual samples could be dated. Series **pgm4**, from one of the purlins, matched very well against the dated reference material (Table 3a) and was found to have been made from a tree felled in **Spring 1573**. Series **pgm6**, from a common rafter, gave rather poor matches with the database (Table 3b) that would not have been acceptable on their own, but it did cross-match with the dated sample **pgm4,** both statistically (t = 4.0 with 82 years overlap) and visually, confirming its dating to 1489–1570, being from a tree felled in **Winter 1570/71**.

These results suggest that the house was constructed in 1573 or shortly afterwards, using at least one timber that had been stockpiled previously. The wide-ranging matching against the reference material suggests that the timber may have been brought in from outside the immediately local area.

Figure 1a shows the relative positions of overlap of the two dated series, whilst Figure 1b shows the matching positions of the undated material, showing that felling took place over a period of two years. These timbers would be expected to be contemporaneous with the dated timbers, and some weak matching was found that would support this idea, but the matches obtained were not strong enough, nor replicated sufficiently to allow its independent dating.

ACKNOWLEDGEMENTS

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Table 1: Details of samples taken from Plas Glasgwm, Penmachno, Betws-y-Coed Conwy.

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
pgm1	Transverse beam in the kitchen	-	-	15C	95	2.09	0.54	0.20	unknown
pgm2	Ceiling joist adjacent to **pgm1**	-	-	19½C	68	1.62	0.78	0.23	unknown
pgm3	Lower NW purlin	-	-	21C	68	1.77	0.82	0.23	unknown
pgm4	Lower SW purlin	1472-1572	1551	21¼C	101	1.64	0.42	0.19	Spring 1573
pgm5	Upper NW purlin	-	-	7C	59	1.85	0.72	0.22	unknown
pgm6	4th common rafter from chimney, E side	1489-1570	1546	24C	82	1.17	0.41	0.22	Winter 1570/71

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, winter felled; ¼C = complete sapwood, felled the following spring; ½C = complete sapwood, felled the following autumn; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured

Table 2: Cross-matching between the components of site chronology GLASGWM1.

	t-values		
Sample	**pgm2**	**pgm3**	**pgm5**
pgm1	5.6	4.6	5.5
pgm2		2.9	2.5
pgm3			5.7

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Table 3a: Dating evidence for the site sequence **pgm4** AD 1472–1572, against dated reference chronologies.
Regional multi-site chronologies are shown in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	101	8.8
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881-1745	101	7.5
North England	Northern England Master	(Hillam and Groves 1994)	**NORTH**	440-1742	101	7.0
Wales	Bryndrynaenog Beguildy	(Miles and Haddon-Reece 1996)	bry2	1414-1614	101	6.9
North Yorkshire	Thorpe Prebend House	(Boswijk 1998)	RIPONWW	1408-1583	101	6.9
Shropshire	Lydbury North mean	(Miles *et al* 2007)	**LYDBURY**	1363-1658	101	6.7
Somerset	Somerset Master Chronology	(Miles 2004)	**SOMRST04**	770-1979	101	6.4
Shropshire	Clungunford Master Chronology	(Miles 2002 unpubl)	**CLNGNFRD**	1273-1653	101	6.4
Shropshire	Old Hall Farm, All Stretton	(Miles and Haddon-Reece 1996)	OLDHLLFM	1379-1630	101	6.2
Wales/borders	Hillside oaks	(Siebenlist-Kerner 1978)	**GIERTZ**	1341-1636	101	6.2
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882-1981	101	6.1
Northumberland	Dilston Castle, Corbridge	(Howard *et al* 2003)	DSTASQ01	1402-1611	101	6.1
Shropshire	Dutch Cottage, Clunbury	(Miles *et al* 2006)	DUTCHCOT	1424-1549	78	6.0
Herefordshire	Mynde, Dewchurch	(Nayling 2001)	MYNDEt10	1392-1619	101	6.0
Shropshire	Habberley Mill	(Miles *et al* 2003)	HBBRLYML	1355-1575	101	6.0

Table 3b: Dating evidence for the site sequence **pgm6** AD 1489–1570, against dated reference chronologies.
Regional multi-site chronologies are shown in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Plas Mawr House	(Miles 1997c)	PLASMAWR	1360-1578	82	5.4
North Yorkshire	Thorpe Prebend House	(Boswijk 1998)	RIPONWW	1408-1583	82	5.3
Yorkshire	Markenfield Hall	(Howard *et al* 2002)	MFKASQ01	1388-1589	82	5.3
Wales	Blaen-y-cwm, Pennant Melangell	(Miles *et al* 2005)	BLNYCWM1	1435-1587	82	4.6
Derbyshire	Bentley Hall, Hungry Bentley	(Arnold and Howard 2009)	HBNASQ01	1444-1675	82	4.2
Wales	Ty Mawr, Wybrnant	(Miles *et al* 2011)	WYB	1437-1564	76	4.1
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	82	4.0
Shropshire	Chapel Cottage, Ditton Priors	(Miles *et al* 2004)	DITTON2	1404-1544	56	4.1

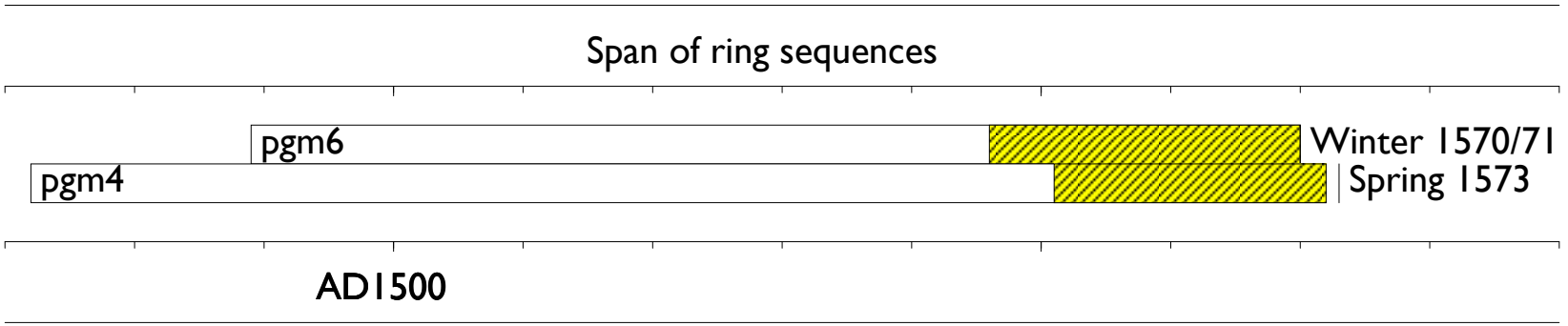

Figure 1a: Bar diagram showing the relative positions of overlap of the dated series, along with their felling dates. Hatched yellow sections represent sapwood rings.

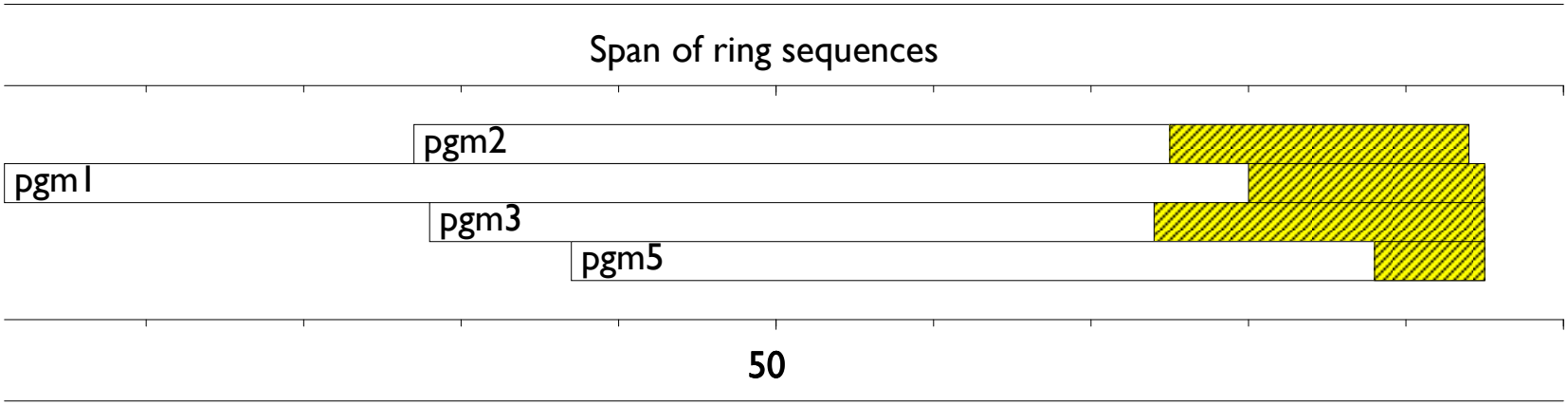

Figure 1b: Bar diagram showing the relative positions of overlap of the undated series forming the site chronology GLASGWM1. Hatched yellow sections represent sapwood rings.

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