Oxford Dendrochronology Laboratory
Report 2012/24

THE TREE-RING DATING OF BLAEN GLASGWM UCHAF, PENMACHNO, BETWS-Y-COED CONWY (NGR SH 766 495)

Summary

Eight samples were taken from both halves of this cottage. The primary phase of construction was represented by a cruck blade and purlins which retained complete sapwood and were found to have been fashioned from trees that were felled in autumn 1518 and during the following winter. This suggests construction of both halves of the cottage in **1519**, or shortly after. The roof was raised and reconstructed, and a packing rafter and purlins were found to have been made from trees felled in winter 1619/20 and spring 1621, suggesting that this work took place in **1621** or shortly after.

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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.

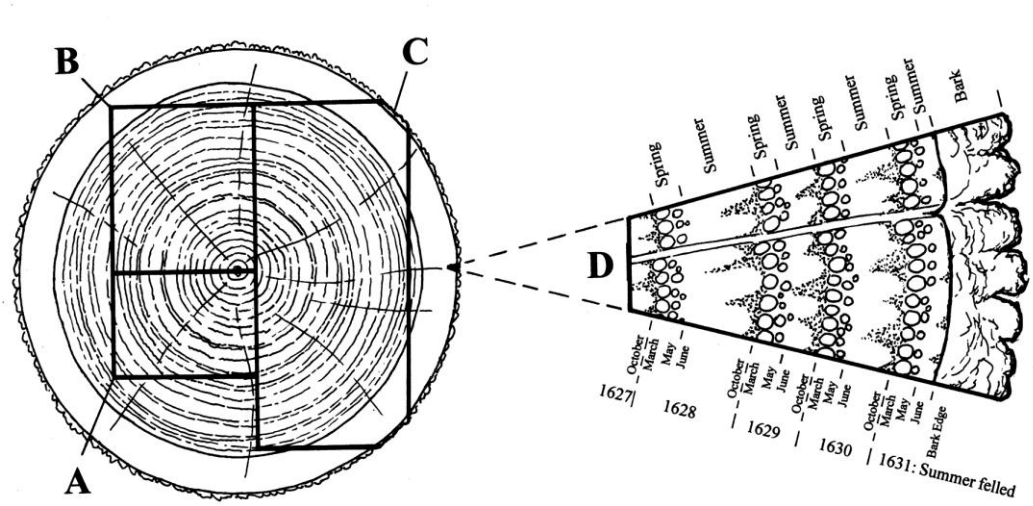
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence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

BLAEN GLASGWM UCHAF

This is an upland farmhouse of late medieval origin. The house is downslope sited, rubble walled, and retains two cruck trusses with lapped blades. The crucks defined a four-bay range, presumably a peasant hall-house with single-bayed hall. The inserted fireplace has created a house of lobby-entry type with the large fireplace heating the former hall with *crog-loft* beyond. The former doorway into the cross-passage has been converted to a window. The C17th roof raising is probably contemporary with the inserted fireplace. Blaenglasgwm was part of the Gwydir estate in the early C17th. Plan and

description in RCAHMW, *Caernarvonshire Inventory, Volume I: East* (1956), p.174, mon. 620 and fig. 169, plate 63. NPRN 26032. 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 **bgu**. 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

[N.B. Another property close by (Plas Glasgwm) produced a site chronology **GLASGWM1**, which is why the site chronologies presented here start at **GLASGWM2**.]

Basic information about the samples and their origins are shown in Table 1. A total of ten samples was taken from eight timbers. These were spread about the building in that the roof appeared to have been reconstructed at some point with some elements re-used. A second sample was taken from the north cruck blade in the eastern half of the house which had complete sapwood, the first sample having been abraded. There two matched (t = 4.9 with 36 years overlap) were combined together to form the same-timber mean **bgu1**. Two samples were also taken from the westernmost north upper purlin where the distorted and fractured timber structure made sampling difficult. It was not possible to conclusively cross-match the two radii, therefore both were used individually in the subsequent analysis.

Next, all samples were compared with each other and two purlins were found to have originated from the same parent tree: **bgu2** and **bgu6** (t = 10.2 with 43 years overlap). These were then combined to form the same-tree mean **bgu26** which was also used in the subsequent analysis. This was then found to match with another purlin, sample **bgu3** (t = 5.2 with 50 years overlap), and was combined to form the 51-year site master **GLASGWM2**. Despite the low ring count, this was found to match with the reference chronologies, spanning the years 1468-1518 (Table 3a). The site master did not match with either of the two cruck blades, but one of these, **bgu5**, dated individually to span the years 1423-1517 (Table 3b). The second cruck blade (**bgu1**) failed to date conclusively.

The dated cruck blade retained complete sapwood and was found to have been felled in the late summer or autumn of 1518. All three of the dated purlins also retained bark edge and all were found to have been felled in the winter of 1518/19. As the dated samples were distributed between the two halves of the house, it can be concluded that the building was originally constructed in 1519 or very shortly afterwards.

Three additional samples were found to match each other (Table 2): a packing rafter from the eastern cruck truss (**bgu4**) and two purlins from the western half of the house (**bgu7** and **bgu8b**). There were combined to form the 170-ring site master **GLASGWM3** which dated, spanning the years 1451-1620 (Table 3c). Two of the timbers retained complete sapwood, although the sapwood rings on both were exceptionally narrow. The packing rafter was found to be felled in the winter of 1619/1620, whilst a

purlin was felled in the spring of 1621. One further purlin with incomplete sapwood gave a felling date range of 1609-25. This would suggest that the roof was raised and reconstructed in both halves of the cottage during or shortly after 1621.

The relative positions of overlap of the dated timbers are shown, along with their felling dates, in Figure 1.

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Table 1: Details of samples taken from Blaen Glasgwm Uchaf, 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
Primary Phase									
bgu1a	*North cruck, east truss*	undated	-	*22*	*71*	*2.34*	*1.50*	*0.27*	-
bgu1b	*ditto*	undated	-	*14¼C*	*37*	*1.19*	*0.69*	*0.24*	-
bgu1	Mean of **bgu1a** and **bgu1b**	undated	-	19¼C	72	2.29	1.51	0.26	unknown
bgu2	North lower purlin, bay 1	1468-1518	1500	18C	51	1.94	1.16	0.29	Winter 1518/19
* **bgu3**	North upper purlin, bay 1	1469-1518	1494	24C	50	1.39	0.77	0.18	Winter 1518/19
bgu5	North cruck, west truss	1423-1517	1494	23½C	95	1.11	0.83	0.30	Autumn 1518
bgu6	North lower purlin, bay 3	1476-1518	1503	15C	43	1.65	0.89	0.24	Winter 1518/19
* **bgu26**	Same tree mean of **bgu2** and **bgu6**	1468-1518	1501	17C	51	1.94	1.11	0.26	Winter 1518/19
* = included in Site Master **GLASGWM2**		**1468-1518**			**51**	**1.69**	**0.93**	**0.20**	
Roof Reconstruction Phase									
† **bgu4**	Packing rafter north side, east truss	1451-1619	1580	39C	169	0.63	0.59	0.24	Winter 1619/20
† **bgu7**	North upper purlin, bay 3	1470-1620	1575	45¼C	151	0.72	0.58	0.22	Spring 1621
bgu8a	North upper purlin, bay 4	undated	-	25	117	0.51	0.23	0.28	-
† **bgu8b**	*ditto*	1475-1608	1588	20	134	0.66	0.48	0.26	1609–29
† = included in Site Master **GLASGWM3**		**1451-1620**			**170**	**0.77**	**0.62**	**0.19**	

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 dated samples included in **GLASGWM3**

	***t*-values**	
Sample	**bgu7**	**bgu8b**
bgu4	6.6	5.1
bgu7		4.5

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Table 3a: Dating evidence for the site master **GLASGWM2** **AD 1468–1518** 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	51	7.4
Wales	Plas Mawr House	(Miles and Haddon-Reece 1996)	PLASMWR1	1428-1556	51	7.3
Warwickshire	Ufton Fields	(Miles and Bridge forthcoming)	UFTNFLDS	1270-1588	51	6.8
Wales	Dylasau Isaf, Caernarfonshire	(Miles *et al* 2011)	DYLASAU1	1412-1592	51	6.5
Wales	Old Market Hall, Llanidloes	(Miles *et al* 2003)	LNYDLOS1	1424-1589	51	6.3
Wales	Lower Cill, Berriew	(Miles *et al* 2006)	BERRIEW	1428-1583	51	6.2
Suffolk	Otley Hall	(Bridge 2001)	OTYHALL1	1415-1587	51	6.1
Co Durham	Durham Cathedral	(Arnold *et al* 2007)	DURPSQ01	1431-1683	51	6.1
Wales	Bryngwylan, Abergele, Conwy	(Miles *et al* forthcoming)	BRYNGWYL	1430-1586	51	6.1
Wales	Bennar, Penmachno, Conwy	(Miles *et al* forthcoming)	BENNAR	1441-1563	51	5.9
Ireland	Belfast Master Chronology	(Baillie 1977)	**BELFAST**	1001-1970	51	5.9
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411-1571	51	5.9
W Midlands	Oak House, West Bromwich	(Arnold and Howard 2009)	OAKHSQ02	1456-1599	51	5.8
Shropshire	Buildwas Abbey	(Miles 2002)	BUILDWS2	1374-1547	51	5.8
Wales	Kerry Church	(Miles *et al* 2011)	KERRY	1402-1567	51	5.7

Table 3b: Dating evidence for the site sequence **bgu5** **AD 1423–1517** 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:*
Cumbria	Dacre Hall	(Arnold *et al* 2004)	LCPASQ02	977-1256	82	6.0
Wales	60 Castle Street, Beaumaris	(Miles *et al* 2011)	ANGK	1391-1515	93	5.8
Wales	Bodloesygad, Ffestiniog	(Miles *et al* forthcoming)	BODLSYGD	1368-1560	95	5.7
Wales	Bryn yr Odyn, Gwynedd	(Miles *et al* 2010)	BRYNRDYN	1388-1586	95	5.3
Wales	Cwm Farm, Cwm Cynfal	(Miles *et al* forthcoming)	CWMFM1	1364-1567	95	5.3
Wales	Pengwern Old Hall	(Miles *et al* 2003)	PENGWERN	1353-1521	95	5.2
Wales	Ty-draw Llanarmon	(Miles *et al* 2003)	TYDRAW1	1407-1476	54	4.9
Yorkshire	Harome Manor, Ryedale	(Miles and Worthington 1999)	RYEDALE1	1391-1569	95	4.9
Durham	Low Harperley	(Howard *et al* 2006)	LWHBSQ01	1356-1604	95	4.8
Wales	Bwthyn Cae-glas, Llanfrothen	(Miles *et al* 2006)	BDGLRT7	1386-1547	95	4.7

Table 3c: Dating evidence for the site master **GLASGWM3** **AD 1451–1620** 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	Dylasau Isaf, Caernarfonshire	(Miles *et al* 2011)	DYLASAU1	1412-1592	142	6.2
Wales	Dyffryn Mymbyr, Llandegai	(Miles et al 2011)	DYFMYM	1383-1531	81	5.8
Wales	Ffridd-isaf, Betws Garmon	(Miles *et al* 2006)	BDGLRT1	1423-1599	149	5.7
Wales	Bennar, Penmachno, Conwy	(Miles *et al* forthcoming)	BENNAR	1441-1563	113	5.7
Wales	Gelli, Llanfrothen	(Miles *et al* 2006)	BDGLRT8	1391-1662	170	5.6
Wales	Bangor Town Hall	(Miles *et al* 2010)	BANGOR	1412-1545	95	5.4
Wales	Cefn Caer Pennal	(Miles and Worthington 1999)	CEFNCAR2	1491-1659	130	5.3
Wales	Dugoed, Penmachno	(Miles *et al* 2011)	DUGOED	1397-1593	143	5.2
Wales	Ucheldref Rhug, Corwen	(Miles *et al* 2010)	DENBY4	1373-1597	147	5.2
Wales	Penhyddgan, Buan	(Miles *et al* 2010)	lyne4	1453-1571	119	5.2
Lancashire	Turton Tower, Blackburn	(Arnold and Howard 2008)	TRTASQ01	1483-1665	138	5.1
Shropshire	Chapel Cottage, Ditton Priors	(Miles *et al* 2004)	DITTON2	1404-1544	94	5.1
Wales	Llwyn Llandrinio, Montgomeryshire	(Miles *et al* 2003)	LLWYN	1413-1551	101	5.1
Wales	Old Market Hall, Llanidloes	(Miles *et al* 2003)	LNYDLOS1	1424-1589	139	5.1
Devon	Holcombe Court, Holcombe Rogus	(Miles and Bridge forthcoming)	HOLCOMBE	1349-1536	86	5.0

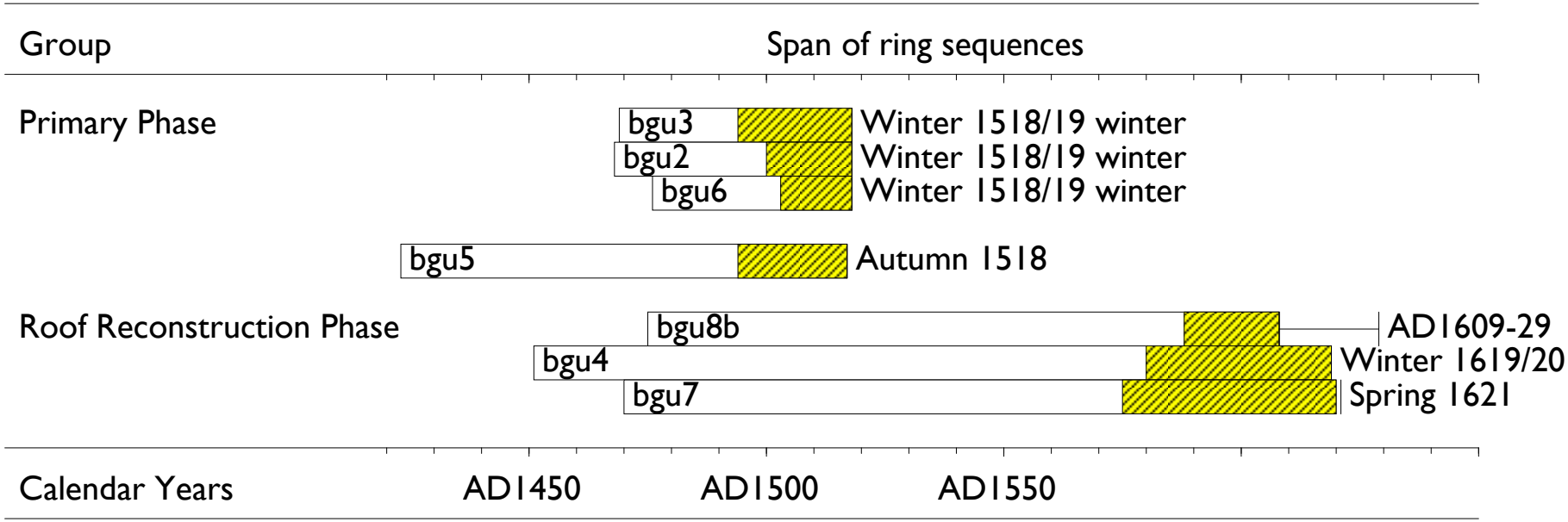

Figure 1: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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