Oxford Dendrochronology Laboratory
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THE TREE-RING DATING OF BODLOESYGAD, FFESTINIOG GWYNEDD (NGR SH 710 411)

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Summary
Seven timbers from the roof and ground floor ceiling beams matched each other and produced a site master chronology covering the years 1368–1560. One timber retained complete sapwood, having been felled in spring 1561. The other timbers with the heartwood-sapwood boundary present have likely felling date ranges incorporating this date, and it seems likely therefore that construction took place in **1561**, or within a year or two after this date.

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The Tree-Ring Dating of Bodloesygad, Ffestiniog, Gwynedd
(NGR SH 710 411)

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.

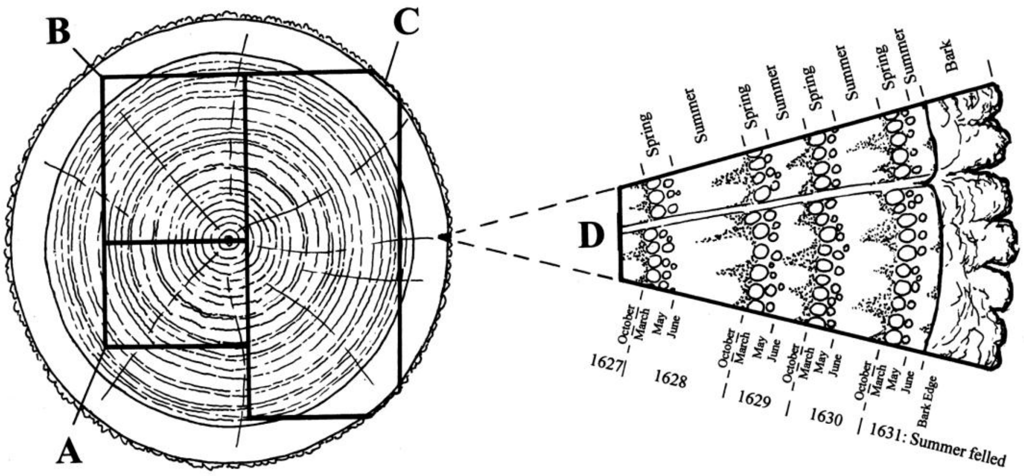
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation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

BODLOESYGAD

To be inserted

SAMPLING

Sampling took place in August 2011. 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 **blg**. 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 DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004), which was also used for subsequent analysis, along with other programs written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker.

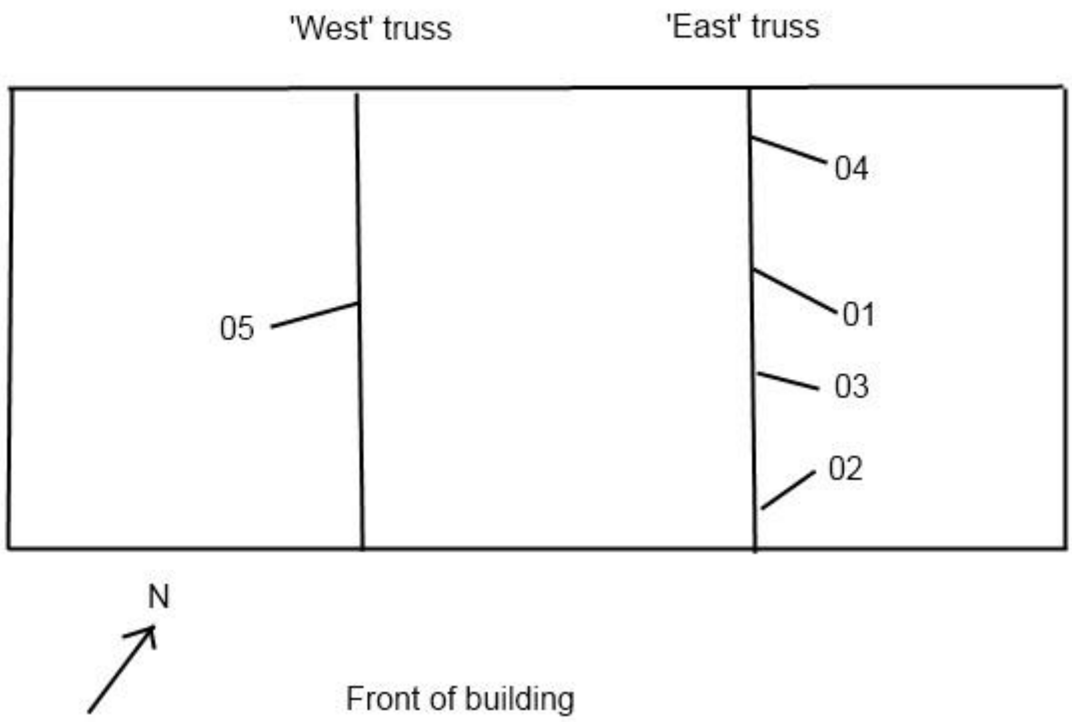


Figure 1: Sketch-plan of Bodloesygad, Ffestiniog, showing the approximate positions of timbers sampled

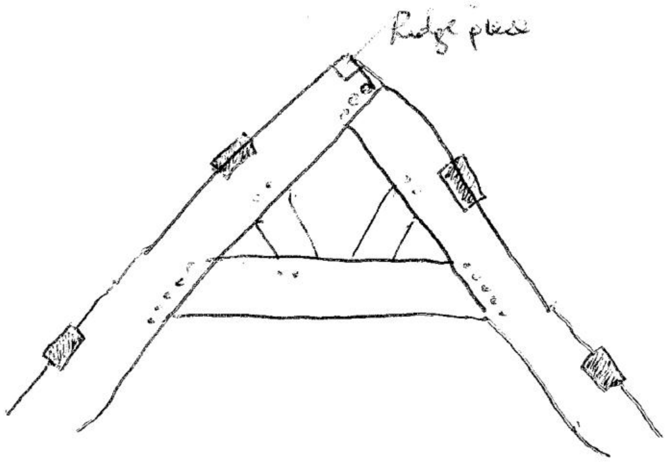


Figure 2: Sketch of the east truss (the west truss has no struts and a higher collar)

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1, and illustrated in Figure 1. Sample **04** was found to have very distorted growth rings and the measured series did not match any of the other series. The remaining seven samples all matched each other (Table 2). It was noted on site that knot patterns in the principal rafters of the west truss showed that they had both been derived from the same tree. The two samples from the principal rafters of the east truss (**02** and **03**) matched each other very well (*t*= 10.8) and may indicate that these too were formed from the same parent tree. If meaned together and used for the final site master chronology, the resulting chronology was marginally less well matched to the dated reference material than a site master formed from all the individual series however, and so the two series were kept separate in subsequent analyses. The east ceiling beam above the doorway, next to the fireplace was found on coring to contain several fissures, and only a longer inner section was retained, hence the designation **08i**, to indicate that further rings were present on the timber itself. The 193-year site master chronology, **BODLSYGD**, was dated to the period 1368–1560, the best matches being shown in Table 3. The relative positions of overlap of the dated series are shown in Figure 3. Only one timber retained complete sapwood, and this was found to have been felled in spring **1561**. The other timbers which retained the heartwood-sapwood boundary have likely felling date ranges that incorporate this date. It seems likely therefore that construction took place in **1561** or within a year or two after this date.

Table 1: Details of samples taken from Bodloesygad, Ffestiniog.

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
* blg01	Collar, east truss	1418-1515	-	-	98	1.50	0.83	0.32	after 1526
* blg02	South principal rafter, east truss	1404-1500	-	-	97	1.48	0.64	0.27	after 1511
* blg03	South strut, east truss	1399-1508	-	-	110	1.29	0.87	0.26	after 1519
blg04	South principal rafter, west truss	-	-	H/S+21NM	64	0.68	0.30	0.24	-
* blg05	Collar, west truss	1378-1517	1517	H/S	140	1.12	0.75	0.23	1528–1558
* blg06	Fireplace lintel, w end, 1st floor	1380-1540	1540	H/S	161	1.01	0.73	0.23	1551–1581
* blg07	Ceiling beam, living room	1386-1560	1522	38¼C	175	1.32	0.77	0.24	Spring 1561
* blg08i	East ceiling beam by fireplace	1368-1435	-	-	68	1.73	0.57	0.21	after 1446
* = included in Site Master	**BODLSYGD**	**1368-1560**			**193**	**1.25**	**0.69**	**0.20**	

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;

Table 2: Cross-matching between the dated samples

t-values						
Sample	**blg02**	**blg03**	**blg05**	**blg06**	**blg07**	**blg08**
blg01	5.2	4.9	1.0	6.8	6.0	-
blg02		10.8	3.6	7.2	8.2	5.3
blg03			4.2	8.0	9.7	3.7
blg05				2.2	4.2	2.7
blg06					6.6	5.3
blg07						6.7

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Table 3: Dating evidence for the site master **BODLSYGD AD 1368–1560** against dated reference chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Pengwern Old Hall	(Miles *et al* 2003)	PENGWERN	1353-1521	154	10.1
Wales	Cwm Farm, Cwm Cynfal	(Miles *et al* 2012)	CWMFM1	1364-1567	193	10.0
Wales	Bodwrda, Aberdaron	(Miles *et al* 2010)	LYNA	1384-1527	144	9.2
Wales	60 Castle Street, Beaumaris	(Miles *et al* 2011)	ANGK	1391-1515	125	8.1
Wales	Bryn yr Odyn, Gwynedd	(Miles *et al* 2010)	BRYNRDYN	1388-1586	173	8.1
Wales	Plas y Dduallt, Maentwrog	(Miles *et al* 2011)	GWYNEDD5	1355-1604	193	7.7
Cumbria	Dacre Hall	(Arnold *et al* 2004)	LCPASQ01	1350-1504	137	7.7
Wales	Parliament House	(Miles *et al* 2004)	PARLMNT1	1306-1451	84	7.7
Wales	Pant-glas-uchaf, Clynnog	(Miles *et al* 2006)	BDGLRT14	1413-1573	148	6.6
Wales	St Gwyddelan's Church, Dolwyddelan	(Miles *et al* 2011)	STGWYD	1360-1467	100	6.6
Wales	Gelli, Llanfrothen	(Miles *et al* 2006)	BDGLRT8	1391-1662	170	6.4
Herefordshire	Farmer's Club, Hereford	(Tyers 1996)	HEREFC	1313-1617	193	6.1
Wales	Clenennau, Dolbenmaen	(Miles *et al* 2006)	BDGLRT10	1406-1570	155	6.1

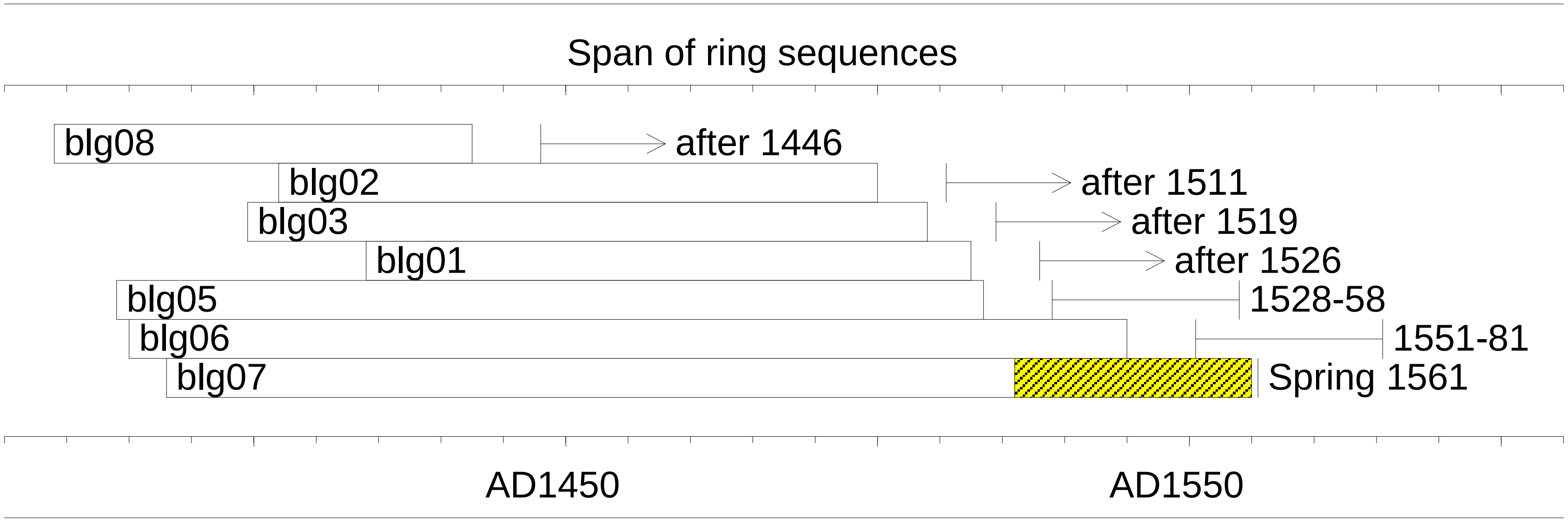

Figure 3: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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