Oxford Dendrochronology Laboratory
Report 2011/**

THE TREE-RING DATING OF CAE CANOL MAWR, FFESTINIOG GWYNEDD (NGR SH 720 439)

Draft as at 17/10/11

Summary

Two principal rafters were found to have been derived from the same tree. In all four roof timbers and a fireplace lintel were dated. One roof timber retained complete sapwood and was felled in spring 1530, whilst the fireplace lintel was from a tree felled in winter 1531/32. Construction is therefore likely to have been completed in **1532**, or within a year or two after this date.

Author: Dr M. C. Bridge FSA
Oxford Dendrochronology Laboratory
Mill Farm
Mapledurham
Oxfordshire
RG4 7TX

October 2011

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).

The Tree-Ring Dating of Cae Canol Mawr, Ffestiniog, Gwynedd
(NGR SH 720 439)

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.

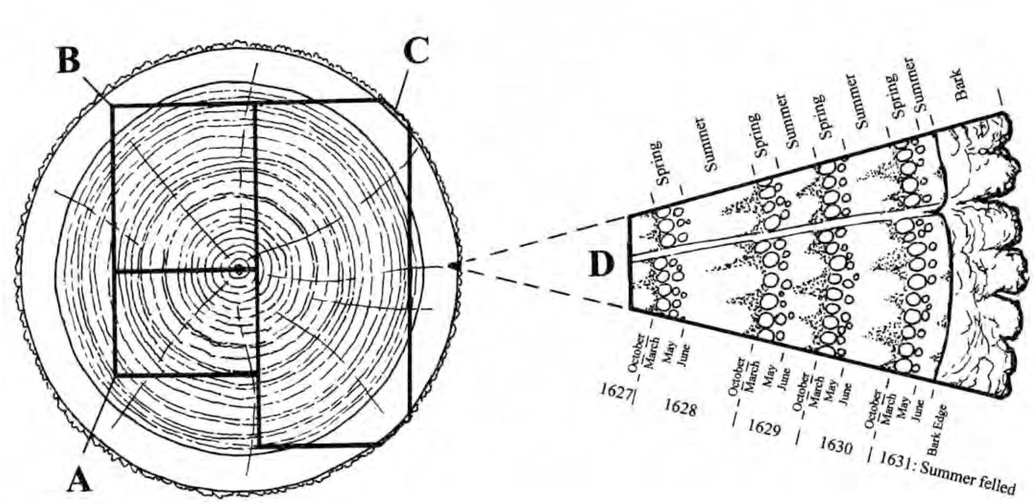
It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal

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).

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)

CAE CANOL MAWR

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 **ccm**. 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.

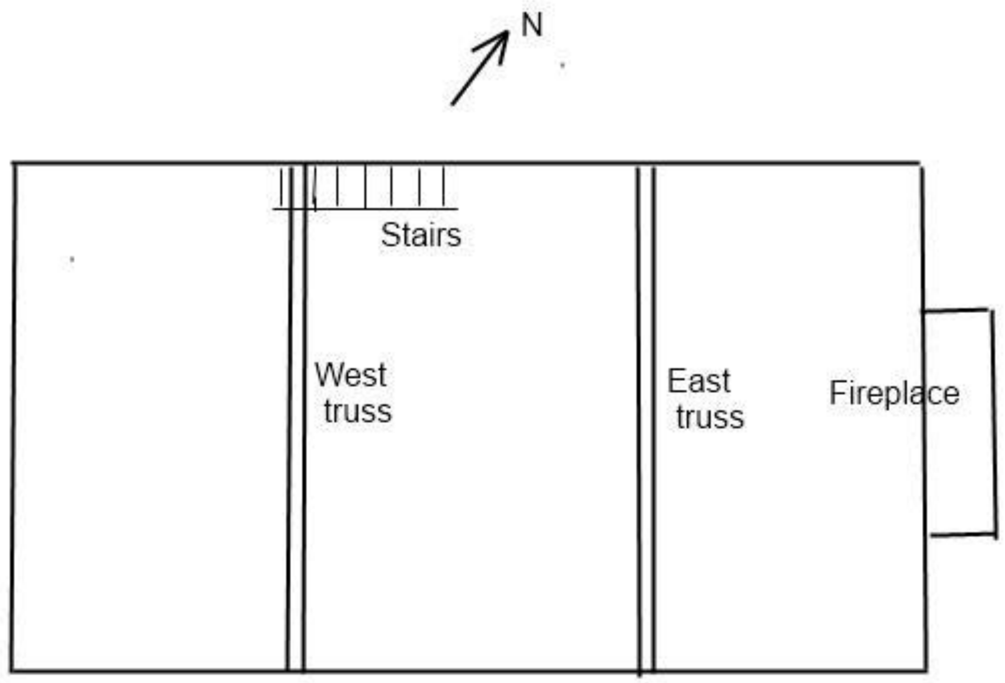


Figure 1: Sketch-plan of the upper floor of Cae Canol Mawr, Ffestiniog, showing the positions of trusses sampled

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1, and illustrated in Figure 1. Two samples were taken from **04**, the collar to the west truss. The two series overlapped each other and were combined to form a single series used in subsequent analysis. Cross-matching between the samples (Table 2) showed that samples **02** and **03** had almost certainly been derived from the same tree (t = 17.4) and these were combined to form a single series **ccm23m**, used in subsequent analysis. This is interesting as the two principal rafters come from different trusses, whereas it is often the case that two parts of the same tree are used in the same truss. None of the three samples from the ground floor screen on the west side of the partition by the south door matched each other, neither did any of these series date independently. The five matching series were combined into a 115-year site chronology, **CAECANLM**. This was subsequently dated to the period 1417-1531, the strongest matches being shown in Table 3. The relative positions of overlap of the samples are shown, along with their felling date ranges, or actual felling dates, in Figure 2.

The roof timber retaining complete sapwood was from a tree felled in spring 1530, whereas the fireplace lintel was from a tree felled in winter 1531/32, suggesting that construction is likely to have been completed in **1532**, or within a year of two after this date.

ACKNOWLEDGEMENTS

This study was commissioned by Margaret Dunn of the North-West Wales Dendrochronology Project. I am grateful to the owner, Tom Lorenz, for allowing access to his building during a busy work schedule, and to Richard Suggett of the Royal Commission on Ancient and Historic Monuments of Wales who assisted in the interpretation on site, and provided useful background information.

REFERENCES

Arnold, A. J., Howard, R. E. and Litton, C. D. (2004) *Tree-ring analysis of timbers from Dacre Hall, Lanercost Priory, Brampton, near Carlisle, Cumbria*, **Centre for Archaeology Rep**, 48/2004.

Baillie, M.G.L. and Pilcher, J.R. (1973) *A simple cross-dating program for tree-ring research*. **Tree Ring Bulletin**, 33, 7-14.

Bridge, M. C. (1988) The dendrochronological dating of buildings in southern England, **Medieval Archaeology**, 32, 166-174.

English Heritage (1998) *Guidelines on producing and interpreting dendrochronological dates,* **English Heritage, London.**

Miles, D. (1997) The interpretation, presentation, and use of tree-ring dates, **Vernacular Architecture**, 28, 40-56.

Miles, D. H. and Worthington, M. J. (1999) Tree-ring dates, **Vernacular Architecture**, 30, 98-113.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2003) Tree-ring dates, **Vernacular Architecture**, 34, 109-113.

Miles, D. H., Worthington, M. J. and Bridge, M. C. (2006) Tree-ring dates, **Vernacular Architecture**, 37, 118-132.

Miles, D. H., Worthington, M. J., Bridge, M. C., Suggett, R. and Dunn, M. (2010) Tree-ring dates, **Vernacular Architecture**, 41, 110-118.

Miles, D. H., Bridge, M. C., Suggett, R. and Dunn, M. (2011) Tree-ring dates, **Vernacular Architecture**, 42, in press.

Miles, D. H., Bridge, M. C., Suggett, R. and Dunn, M. (2012) Tree-ring dates, **Vernacular Architecture**, 43, in prep.

Tyers, I. (2004) *Dendro for Windows Program Guide 3rd edn*, **ARCUS Report,** 500b**.**

Table 1: Details of samples taken from Cae Canol Mawr, 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
* ccm01	South principal rafter, west truss	1454-1524	1517	7	71	1.90	0.95	0.34	1528–1538
ccm02	North principal rafter, west truss	1427-1529	1504	25¼C	103	1.54	0.58	0.20	Spring 1530
ccm03	North principal rafter, east truss	1432-1501	1501	H/S + 15NM	70	1.67	0.56	0.22	Spring 1530
* ccm23m	Mean of **02** and **03**	1427-1529	1503	26¼C	103	1.55	0.60	0.20	Spring 1530
ccm04a	Collar, west truss	*1417-1502*	*1502*	*H/S*	*86*	*1.48*	*0.72*	*0.27*	
ccm04b	*ditto*	*1452-1488*	-	-	*37*	*0.57*	*0.14*	*0.25*	
* ccm04	Mean of **04a** and **04b**	1417-1502	1502	H/S	86	1.27	0.68	0.25	1513–1543
ccm05	Tie inserted next to east truss	-	-	15C	54	2.10	0.99	0.25	-
ccm06	Grd flr stud in west partition	-	-	2	50	2.35	1.65	0.28	-
ccm07	Grd flr N door jamb nr south door	-	-	-	<40	NM	-	-	-
* ccm08	Fireplace lintel, east end	1421-1531	1500	31C	111	1.70	0.88	0.26	Winter 1531/32
* = included in Site Master **CAECANLM**		**1417-1531**			**115**	**1.59**	**0.60**	**0.21**	

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	**ccm02**	**ccm03**	**ccm04**	**ccm08**
ccm01	5.0	4.9	4.0	2.6
ccm02		17.4	6.2	3.1
ccm03			6.1	3.5
ccm04				4.2

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).

Table 3: Dating evidence for the site master **CAECANLM AD 1417–1531** 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	105	8.4
Wales	Bryn yr Odyn, Gwynedd	(Miles *et al* 2010)	BRYNRDYN	1388-1586	115	7.5
Wales	Dyffryn Mymbyr, Llandegai	(Miles *et al* 2011)	DYFMYM	1383-1531	115	6.4
Wales	Hafodruffydd-uchaf, Beddglert	(Miles *et al* 2006)	BDGLRT20	1416-1523	107	5.9
Wales	Cwm Farm, Cwm Cynfal	(Miles *et al* 2012)	CWMFM1	1364-1567	115	5.8
Wales	Cae'nycoed-uchaf, Maentwrog	(Miles *et al* 2006)	BDGLRT17	1407-1592	115	5.8
Herefordshire	King's Arms, Michaelchurch, Escley	(Miles *et al* 2006)	MLCHRCH4	1370-1497	81	5.7
Wales	Cefn Caer Pennal	(Miles & Worthington 1999)	CEFNCAR1	1404-1525	109	5.6
Wales	Plas y Dduallt, Maentwrog	(Miles *et al* 2011)	GWYNEDD5	1355-1604	115	5.4
Wales	Bodloesygad, Ffestiniog	(Miles *et al* 2012)	BODLSYGD	1368-1560	115	5.4
Wales	Parc Llanfrothen	(Miles *et al* 2006)	BDGLRT22	1386-1669	115	5.3
Cumbria	Dacre Hall	(Arnold *et al* 2004)	LCPASQ01	1350-1504	88	5.2
Wales	Plas ym Mhenrhos, Penrhos	(Miles *et al* 2012)	PLASMNRS	1413-1607	115	5.1
Wales	Bodwrda, Aberdaron	(Miles *et al* 2010)	LYNA	1384-1527	111	5.0

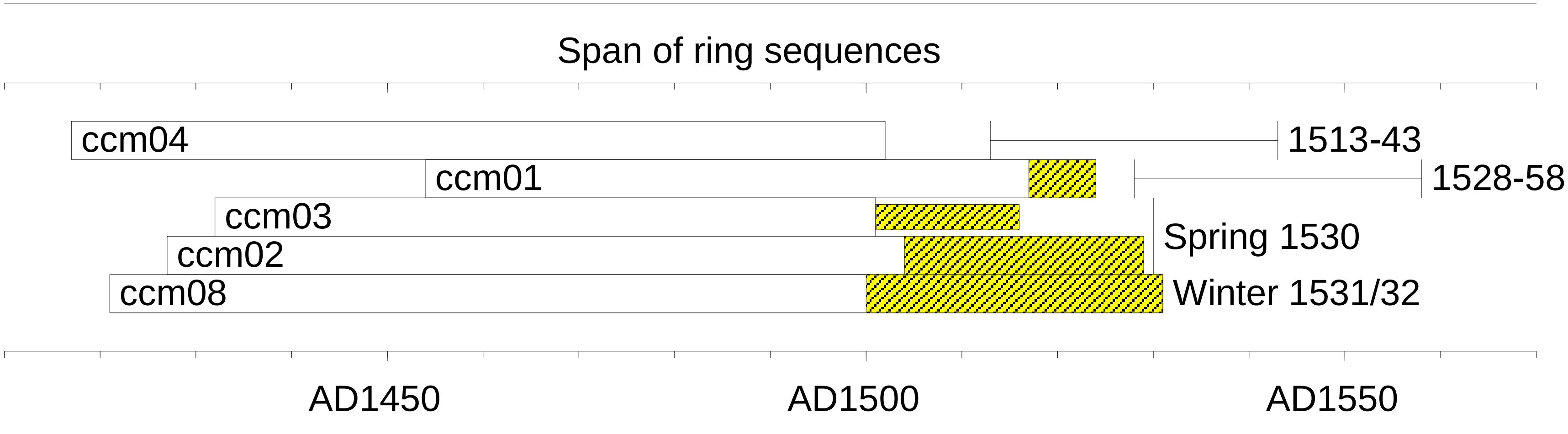


Figure 2: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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).

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).