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Oxford Dendrochronology Laboratory
Report 2016/14

THE DENDROCHRONOLOGICAL DATING OF TIMBERS FROM CAE'R MARCH, LLANFACHRETH, MERIONETH (NGR SH 761 219)

Summary

Five timbers from the primary construction phase matched each other. One tiebeam was from a tree felled in spring 1515, but three other timbers were from trees each felled in winter 1541/42, with a fourth missing the outer few rings, but almost certainly felled at the same time. This makes the most likely date of construction **1542**, or within a year or two after this date.

Three timbers from the inserted floor matched each other and were combined to make a second site chronology. They showed rapid growth declines at two places during their lifetimes, and had very narrow outer rings. These timbers, along with a fireplace lintel, failed to date.

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The Dendrochronological Dating of Timbers from Cae'r March, Llanfachreth, Merioneth (SH 761 219)

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.

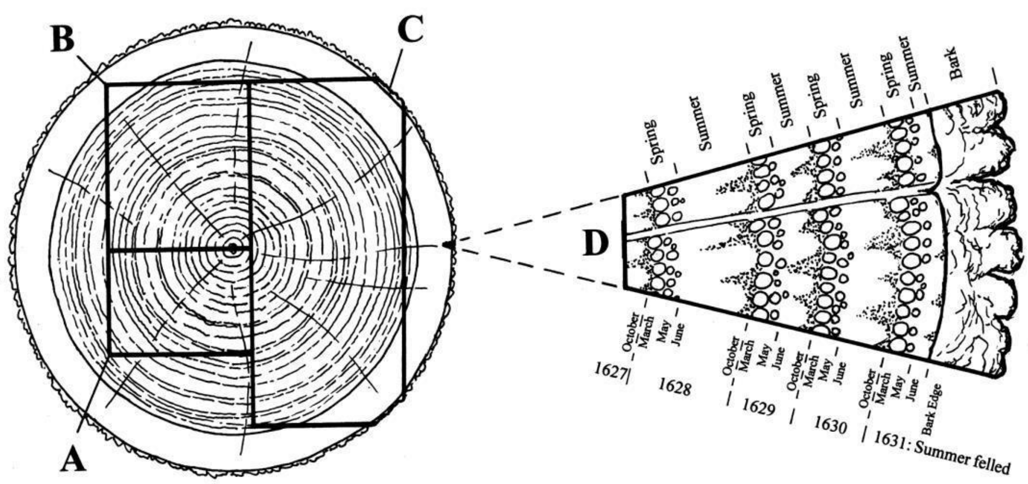
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation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

CAE'R MARCH

Cae'r-march is illustrated in Peter Smith's *Houses of the Welsh Countryside* (2nd ed., 1988), fig. 90b (cutaway) and 95b (plan), as an early storeyed house of two-unit plan with lateral chimney. At Cae'r-march the hall was directly entered alongside the lateral chimney (now reconstructed) with secondary rooms at the upper end of the hall. By contrast the Snowdonian houses of the district invariably have twin outer rooms beyond the passage rather than twin inner-rooms, as at Cae'r-march. The first floor, now without evidence for division, seems to have been unheated. Cae'r-march may represent an early experiment with the storeyed house plan, or it may perhaps have been the parlour wing of a former principal house now rebuilt as the present farmhouse. At any rate, the tree-ring date confirms that this early storeyed range was built just before the earliest tree-ring dated storeyed houses of Snowdonian type. Period detail includes the post-and-panel partition at the upper end of the hall with shaped (double ogee) door-heads and the collar-beam trusses with wall-posts. R.F. Suggett/RCAHMW/March 2016. Extract from Coflein (NPRN 96032).

SAMPLES

Samples were of oak (*Quercus* spp.). Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled (prefix **crmc**) 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. Cross-matching between the samples from the primary phase is shown in Table 2a. The five timbers match each other and were combined into a 137-year site chronology, **CAERMCH1**, which was subsequently dated to the period 1405–1541, the strongest matches being shown in Table 3. The relative positions of overlap and felling dates are also shown in Fig 1. A tiebeam was found to have been converted from a tree felled in spring 1515, but three other timbers were from trees felled in winter 1541/42, and a fourth lost the outermost rings, but was almost certainly felled at the same time. Construction of this primary phase is therefore most likely to have occurred in **1542**, or within a year or two after this date.

Three timbers from the inserted floor phase matched each other (Table 2b) and were combined into a second 172-year long site chronology, **CAERMCH2**. Fig 2 shows the relative positions of overlap of the timbers, and Fig 3 shows a plot of the resulting ring width master curve. It will be seen that there are at least two sudden growth declines, and that the outer 70+ rings are very narrow. This site master failed to date when compared with the available dated reference material. Similarly, the fireplace lintel, which yielded a 67-year long chronology, also failed to date.

ACKNOWLEDGEMENTS

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Table 1: Details of samples taken from Cae'r March, Llanfachreth, Merioneth (trusses numbered from the east end)

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 (first floor)									
* **crmc01**	North post, truss 2	1405-1541	1513	27C	137	1.46	0.77	0.23	Winter 1541/42
* **crmc02**	South post, truss 2	1453-1541	1518	23C	89	1.59	0.60	0.25	Winter 1541/42
* **crmc03**	Tiebeam, truss 4	1415-1514	1490	24¼C	100	1.53	0.79	0.19	Spring 1515
* **crmc04**	South principal rafter, truss 4	1433-1513	1505	8 (+26NM)	81	2.39	1.02	0.26	1539–44
* **crmc05**	Collar, truss 4	1474-1541	1514	27C	68	1.45	0.97	0.23	Winter 1541/42
* = included in site master **CAERMCH1**		**1405-1541**			**137**	**1.77**	**0.77**	**0.17**	
Floor insertion									
∫ **crmc11**	East end beam	-	-	39C	118	0.96	0.71	0.26	-
∫ **crmc12**	Transverse beam, screen head, truss 2	-	-	46C	164	0.94	0.60	0.23	-
∫ **crmc13**	Middle transverse beam	-	-	-	130	1.24	0.79	0.25	-
Fireplace lintel									
crmc14	Fireplace lintel	-	-		67	0.87	0.83	0.26	-
∫ = included in site master **CAERMCH2**		-	-		**172**	**1.08**	**0.70**	**0.22**	

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 2a: Cross-matching between the individual components of **CAERMCH1** (*t*-values of 3.5 and above are significant)

	***t* - values**			
Sample	**crmc02**	**crmc03**	**crmc04**	**crmc05**
crmc01	7.7	2.1	4.1	2.6
crmc02		3.2	4.6	4.2
crmc03			4.9	3.5
crmc04				4.3

Table 2b: Cross-matching between the individual components of **CAERMCH2** (*t*-values of 3.5 and above are significant)

	***t* - values**	
Sample	**crmc12**	**crmc13**
crmc11	7.2	7.6
crmc12		9.0

Table 3: Dating evidence for the site master **CAERMCH1** **AD 1405–1541** against dated reference chronologies

County or region	*Chronology name*	*Reference*	*File name*	*Spanning*	*Overlap (yrs)*	*t-value*
Regional Chronologies						
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404–1981	137	7.6
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	137	6.7
Site Chronologies						
Denbighshire	Ucheldref Rhug, Corwen	(Miles *et al* 2010)	DENBY4	1373–1597	137	8.6
Caernarvonshire	Dylasau Isaf	(Miles *et al* 2011)	DYLASAU1	1412–1592	130	8.5
Montgomeryshire	Royal House, Machynlleth	(Miles *et al* 2004)	ROYALHS3	1427–1575	115	8.2
Shropshire	St Swithin's Church, Clunby	(Tyers 2000)	CLUNBY	1239–1494	90	7.6
Herefordshire	Pikes Farm, Michaelchurch, Escley	(Miles *et al* 2006)	MLCHRCH2	1342–1590	137	7.6
Merioneth	Gwernbraichdwr, Llandderfel	(ODL unpublished data)	GWRNBRDW	1404–1585	137	7.6
Merioneth	Tyddyn Sais, Trawsfynydd	(ODL unpublished data)	TYDDSAIS	1405–1527	123	7.3
Merioneth	Plas y Dduallt, Maentwrog	(Miles *et al* 2011)	GWYNEDD5	1355–1604	137	7.3
Denbighshire	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	137	7.2

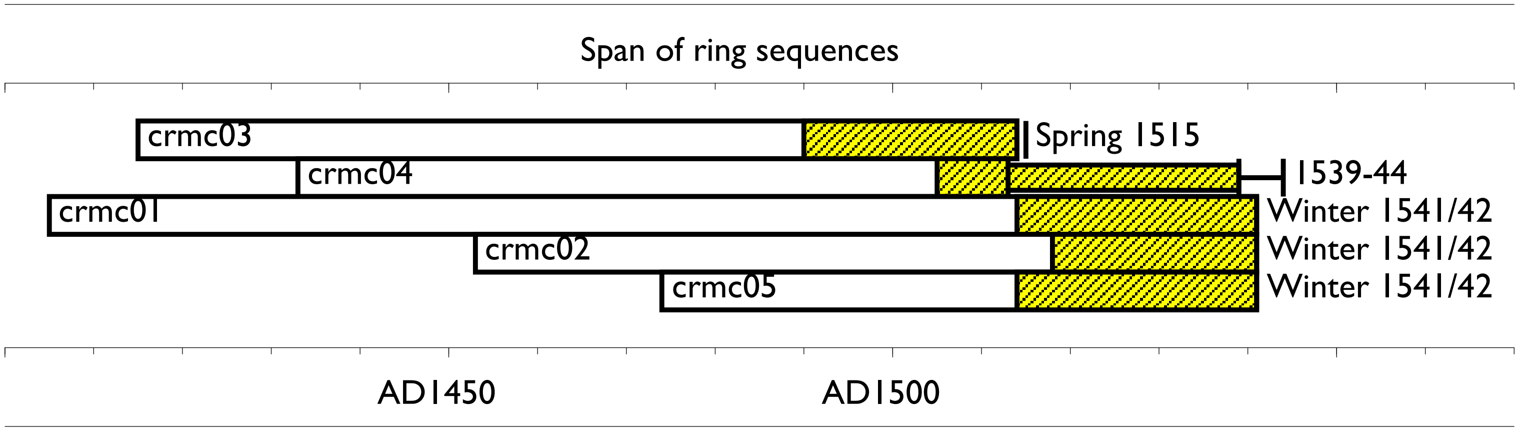

Figure 1: Bar diagram showing the relative positions of overlap of the dated timbers. White bars represent heartwood rings, yellow hatched sections represent sapwood, narrow sections represent additional unmeasured/undated rings.

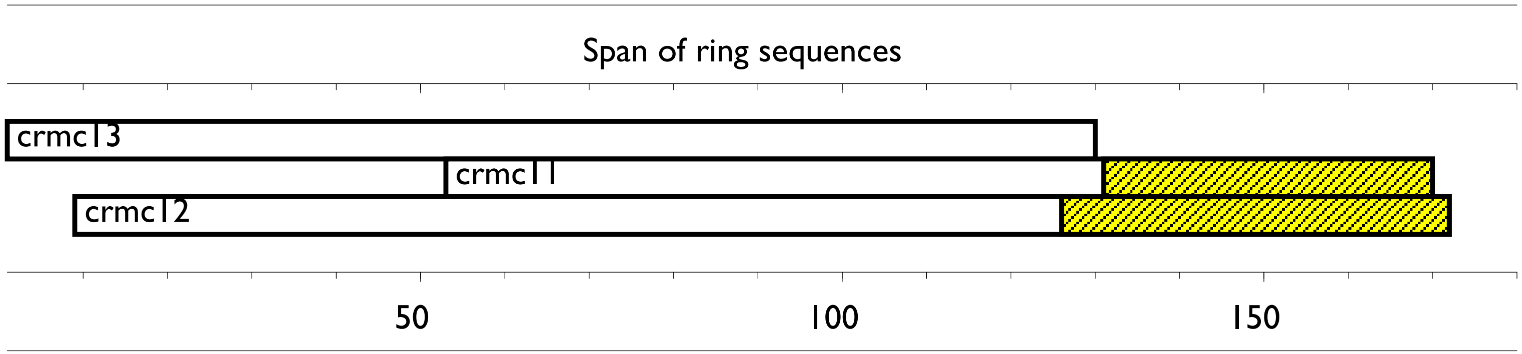

Figure 2: Bar diagram showing the relative positions of overlap of the undated timbers. White bars represent heartwood rings, yellow hatched sections represent sapwood, narrow sections represent additional unmeasured/undated rings.

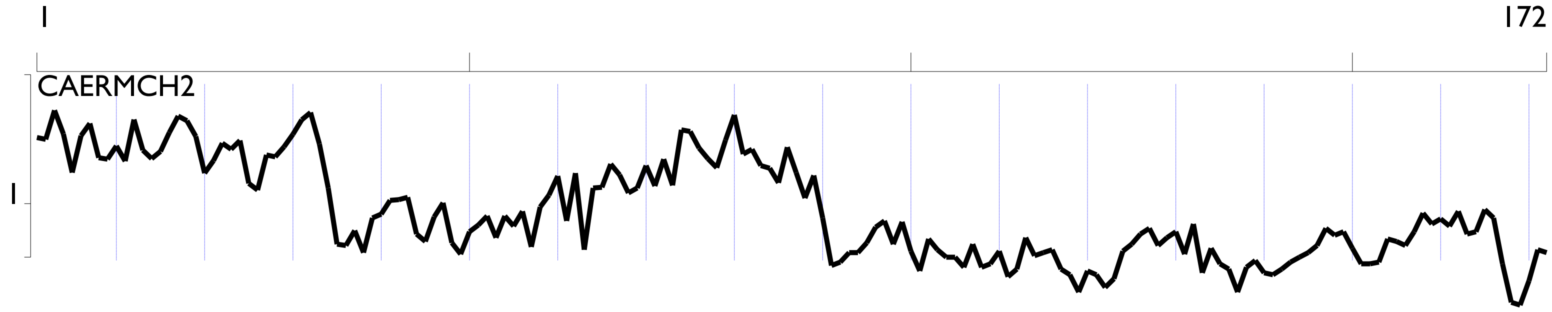

Figure 3: Plot of the site master **CAERMCH2**, showing its unusual growth pattern, with at least two sudden decreases in growth rate, and the very narrow nature of the outer rings (the *y*-axis in ring-width in mm on a logarithmic scale)