Oxford Dendrochronology Laboratory
Report 2011/01

THE TREE-RING DATING OF TY CERRIG, LLANFWROG, DENBIGHSHIRE (NGR SJ 114 576)

Summary

Three purlins and four crucks were sampled. Two of the purlins were considered to have come from the same parent tree. The new series formed from these two purlins cross-matched the third purlin and two crucks, forming a 97-year site chronology dated to the years 1404–1500. The earliest part of this sequence was represented by a single tree with a narrow band of rings, and editing out the first 16 rings to form an 81-year site chronology greatly improved the level of cross-matching with the reference material. Three of the dated timbers retained complete sapwood. One cruck was found to have been felled in the spring of 1500, whilst a front lower purlin was felled in the spring of the following year, 1501. The front upper purlin dated to the winter of 1500/01, and as the rear upper purlin from the same bay was found to have originated from the same parent tree, then it has been possible to ascribe the same felling date to this timber as well. Another cruck had no sapwood surviving, but a felling date range of 1483-1513, which is entirely consistent with the 1500 and 1501 felling dates. This clustering of dated would suggest that Ty Cerrig was most likely constructed during **1501**.

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February 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).

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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.

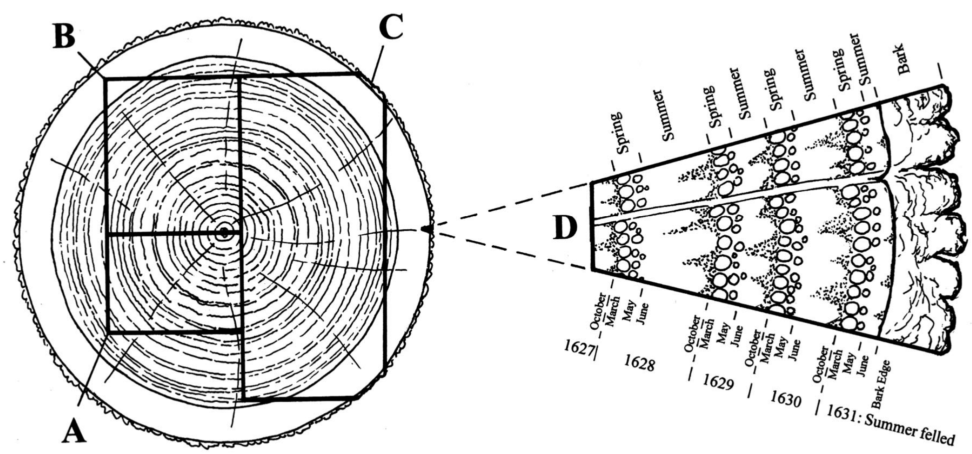
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation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

TY CERRIG, LLANFWROG

A remarkably complete cottage-farmhouse of late-medieval origin. The late-medieval house was cruckframed with full crucks defining four bays. The cruck-trusses are windbraced and heavily smoke-blackened, especially at the lower end. Analysis of the crucks suggests that the house was a peasant hallhouse, i.e. the arrangement of the bays was outer room, passage, single-bayed hall, inner room. The

back of the cruck blade (T3) suggests that Tŷ-cerrig was originally timber framed. The name Tŷ-cerrig refers to the siting of the house on a rocky outcrop.
In a second phase a fireplace was inserted in the wide passage bay, latterly adapted as a back-to-back fireplace. The timber walls were replaced in stone and a lobby-entrance plan created. The house remained essentially single-storeyed with a tall Denbighshire chimney and was latterly thatched. (RFS/RCAHMW/APRIL 2011)

SAMPLING

Sampling took place in January 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 **denh**. 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 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

Basic information about the samples and their origins are shown in Table 1.

Seven timbers were sampled which included three purlins and four crucks. Two of the purlins, **denh1** and **denh2**, were found to match together sufficiently well (t=10.7 with 73 ring overlap) to be considered to have originated from the same tree, and were therefore combined to form the same-tree mean **denh12**. Other matches are shown in Table 2.

This mean was then compared with the other samples from the site and was found to match another purlin (**denh3**), and two crucks (**denh4** and **denh5**). These were then combined to form the 97-ring site master **DENBY7x**. This was then compared with the reference chronologies and was found to match, spanning the years 1404–1500. The early years of this chronology were represented by a single tree with a narrow band of rings at the start of the sequence. Removing the first 16 rings, reducing the site master (**DENBY7**) to the years 1420–1500, significantly increases the cross-matching with reference material (Table 3b).

Three of the dated timbers retained complete sapwood. The rear cruck to Truss 1 (**denh4**) was found to have been felled in the spring of 1500, whilst the front lower purlin in bay 1 (**denh3**) was felled in the spring of the following year, 1501. The front upper purlin (**denh2**) dated to the winter of 1500/1501, and as the rear upper purlin (**denh1**) from the same bay was found to have originated from the same parent tree, then it has been possible to ascribe the same felling date to this timber as well. The front cruck to Truss 2 (**denh5**) did not have sapwood surviving, but a felling date range of 1483-1513 is entirely consistent with the 1500 and 1501 felling dates. This clustering of dated would suggest that Ty Cerrig was most likely constructed during 1501. The relative cross-matching and interpreted felling dates are shown in Figure 1.

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Table 1: Details of samples taken from Ty Cerrig, Llanfwrog.

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
denh1	Rear (west) upper purlin, bay 1-2	1427-1499	1479	20	73	1.21	0.75	0.19	(winter 1500/01)
denh2	Front (east) upper purlin, bay 1-2	1427-1500	1485	15C	74	1.76	1.00	0.21	Winter 1500/01
* **denh3**	Front (east) lower purlin, bay 1-2	1462-1500	1494	6¼C	39	2.97	1.04	0.26	Spring 1501
* **denh4**	Rear (west) cruck T1	1426-1499	1475	24¼C	74	2.31	1.09	0.24	Spring 1500
* **denh5**	Front (east) cruck T2	1404-1472	1472	H/S	69	2.13	1.09	0.28	1483–1513
denh6	Front (east) cruck T2	undated	-	23C	74	2.59	1.36	0.28	unknown
denh7	Front (east) cruck T3	undated	-	16¼C	41	2.30	0.97	0.29	unknown
* **denh12**	Same tree mean **denh1** + **denh2**	1427-1500	1482	18C	74	1.49	0.85	0.20	Winter 1500/01
* = included in Site Master **DENBY7x**		**1404–1500**			**97**	**2.08**	**0.96**	**0.24**	

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured.

Table 2: Cross-matching between dated samples (**denh1** *v* **denh2**, $t = 10.7$ with 73 years overlap)

	***t*-values**		
Series	**denh3**	**denh4**	**denh5**
denh12	4.3	6.5	4.4
denh3		3.4	1.9
denh4			7.0

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Table 3a: Dating evidence for the site master **DENBY7x AD 1404–1500** against dated reference chronologies, regional chronologies in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Shropshire	Church Farm, Ditton Priors	(Miles *et al* 2004)	DITTON5	1437-1578	64	7.4
Wales	Llwyn Llandrinio Montgomeryshire	(Miles *et al* 2003)	LLWYN	1413-1551	88	6.8
Wales	George and Dragon, Beaumaris	(Miles *et al* 2010)	ANGLSY1	1437-1540	64	6.4
Wales	Neuadd Cynhinfa Pontrobert	(Miles and Haddon-Reece 1996)	neu1	1438-1506	63	6.3
Wales	Lower Cill, Berriew, Montgomeryshire	(Miles *et al* 2006)	BERRIEW	1428-1583	73	5.7
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411-1571	90	5.6
Shropshire	Dutch Cottage, Clunbury	(Miles *et al* 2006)	DUTCHCOT	1424-1549	77	5.6
Shropshire	Abcott Manor, Clungunford	(Miles and Worthington 2002)	CGFA	1422-1545	79	5.5
Wales	Old Market Hall, Llanidloes	(Miles *et al* 2003)	LNYDLOS1	1424-1589	77	5.5
Somerset	The Knapp, Tivington	(Miles *et al* 2004)	THEKNAPP	1445-1508	56	5.4
Wales	Nannerth-Ganol Rhayader	(Miles and Haddon-Reece 1996)	nan2	1454-1554	47	5.3
Wales	Ffinnant, Llansantffraid-ym-Machain	(Miles *et al* 2010)	FFINNANT	1437-1609	64	5.3
Herefordshire	Forbury Chapel, Leominster	(Arnold, Laxton and Litton 2003)	HFCASQ01	1432-1520	69	5.1
Wales	Trefrechan barn	(Miles *et al* 2004)	TREFECHN	1423-1606	78	5.1

Table 3b: Dating evidence for the site master **DENBY7 AD 1420–1500** against dated reference chronologies, regional chronologies in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Shropshire	Church Farm, Ditton Priors	(Miles *et al* 2004)	DITTON5	1437-1578	64	7.7
Wales	Llwyn Llandrinio Montgomeryshire	(Miles *et al* 2003)	LLWYN	1413-1551	81	7.2
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411-1571	81	6.9
Wales	Welsh Master Chronology	(Miles 1997)	**WALES97**	404-1981	81	6.6
Wales	George and Dragon, Beaumaris	(Miles *et al* 2010)	ANGLSY1	1437-1540	64	6.5
Wales	Plas Mawr House	(Miles and Haddon-Reece 1996)	PLASMWR2	1360-1578	81	6.5
Wales	Neuadd Cynhinfa Pontrobert	(Miles and Haddon-Reece 1996)	neu1	1438-1506	63	6.5
Wales	Ucheldref Rhug, Corwen	(Miles *et al* 2010)	DENBY4	1373-1597	81	6.4
Shropshire	Chapel Cottage, Ditton Priors	(Miles *et al* 2004)	DITTON2	1404-1544	81	6.3
Wales	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388-1763	81	6.2

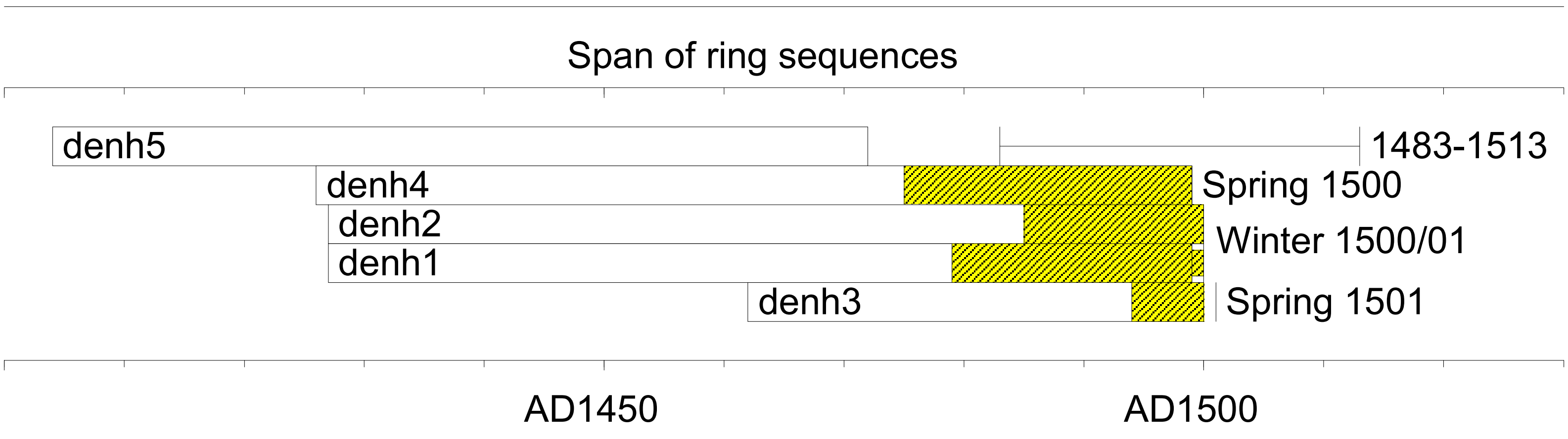

Figure 1: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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ACKNOWLEDGEMENTS

The dating was commissioned by Margaret Dunn of the North-West Wales Dendrochronology Project. We are grateful to the owners Dr and Mrs Lyne for allowing access to their house, and to Richard Suggett from the Welsh Royal Commission who assisted in the interpretation on site and provided useful background material. Matt Hurford assisted on site during the sampling.

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