Oxford Dendrochronology Laboratory
Report 2014/31

THE TREE-RING DATING OF RHYDYWERNEN, LLANFOR, MERIONETH (NGR SH 972 407)

Summary
Five timbers from the primary phase roof matched each other and were found to have come from trees felled in winter 1530/31, making construction likely in **1531**, or within a year or two after this date. A beam from the inserted floor could not be satisfactorily dated.

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A report commissioned by Dating Old Welsh Houses Project in partnership with
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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.

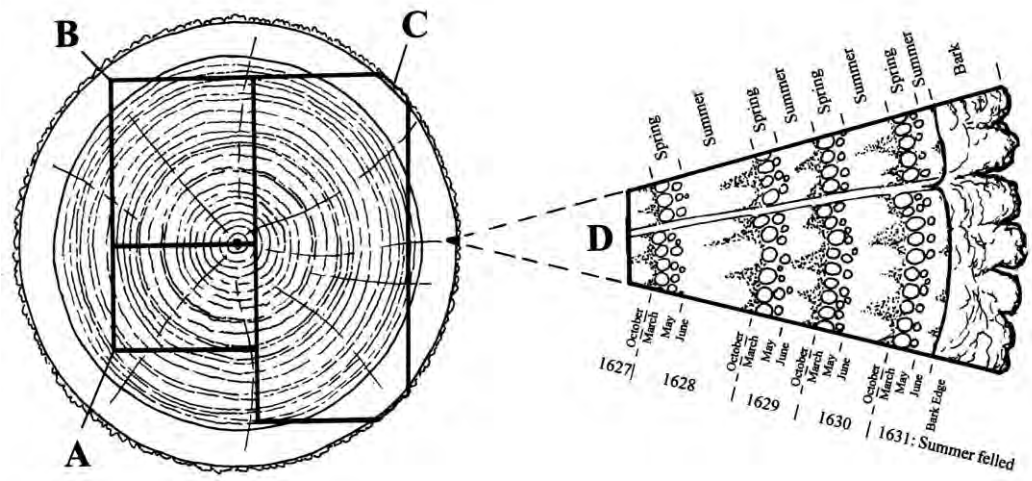
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence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

RHYDYWERNEN (notes by Richard Suggett)

Rhydywernen is a late-medieval hall-house of classic three-unit plan, cruck-framed, and downslope-sited. A two-bay hall with central archbraced truss with cusped struts is set between inner and outer bays. At the upper end of the hall there is a two-door post-and-panel partition with Tudor doorheads. In a second phase, a fireplace was constructed in the passage bay and a ceiling inserted into the hall. The beams relate to the stone walls and these probably replace timber walls. The felling dates of 1530/31 show that Rhydywernen belongs to the last phase of cruck-framed hall-house construction, but the status

of the builder is unclear. The inserted ceiling was sampled but did not date. RCAHMW survey. Plan and account in Peter Smith, 'Houses c. 1415 – c. 1642', *History of Merioneth, Vol. II: The Middle Ages*, ed. J & Ll. Beverley Smith (Cardiff, 2001), pp. 451, 485 (fig. 10.27a). Coflein (RCAHMW's on-line database) entry: NPRN 28721. R.F.Suggett/RCAHMW/November 2014.

SAMPLING

Sampling took place in June 2014. 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 **rdrn**. Locations of samples 1 – 6 are shown in the field notes reproduced as an appendix. 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. The ring-width series were compared on an IBM compatible computer for statistical cross-matching using a variant of the Belfast CROS program (Baillie and Pilcher 1973). A version of this and other programmes were written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker. Subsequent analyses 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. There was significant cross-matching between samples 1, 2, 3, 5 and 6 (Table 2), but the sequence for sample 4, whilst it looked superficially as if it matched these other samples, could not be resolved, and remains undated. The five matching sequences were meaned to produce a 128-year site master chronology, **RHYDYWRN**, which was subsequently dated to the period 1403-1530. The strongest matches are shown in Table 3, and the relative positions of overlap are illustrated in Fig 1, along with the felling dates. It is clear that the timbers were felled as a batch in winter 1530/31, making construction most likely in **1531**, or within a year or two after this date.

The single long sequence derived from a timber in the inserted floor had very narrow rings in the outer decades, and could not be satisfactorily dated.

ACKNOWLEDGEMENTS

This study was commissioned by Margaret Dunn of the charity Dating Old Welsh Houses in collaboration with Richard Suggett of the Royal Commission on Ancient and Historic Monuments of Wales who provided useful background information. Martin Cherry provided transport to the site, made notes, and assisted with the sampling. We thank the owner, Mr J. Jones, for allowing the work to take place. We thank our fellow dendrochronologists for permission to use their data.

Table 1: Details of samples taken from Rhydywernen, Llanfor.

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									
*** rdrn1**	South cruck, truss C-C	1418-1530	1492	38C	113	1.77	1.16	0.24	Winter 1530/31
*** rdrn2**	Upper south purlin, over lower end	1418-1530	1498	32C	113	1.25	0.77	0.19	Winter 1530/31
*** rdrn3**	Lower north purlin, over lower end	1420-1530	1510	20C	111	1.61	0.84	0.24	Winter 1530/31
rdrn4	North cruck, truss B-B	-	-	*21*	*c*105	*2.14*	*1.29*	*0.26*	-
*** rdrn5**	Upper north purlin, over Hall	1450-1525	1512	13 (+ up to 6)	76	2.05	0.72	0.21	1525–31
*** rdrn6**	Collar, truss A-A	1403-1530	1506	24C	128	1.23	0.65	0.24	Winter 1530/31
***** = included in site master **RHYDYWRN**		**1403-1530**			**128**	**1.64**	**0.63**	**0.19**	
Inserted floor									
rdrn11	Inserted floor, half beam	-	-	36¼C	119	1.22	0.95	0.23	-

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, felled the following winter; ¼C = complete sapwood, felled the following spring; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured;

Table 2: Cross-matching between the samples (values over 3.5 are significant)

	***t*-values**			
Sample	**rdrn2**	**rdrn3**	**rdrn5**	**rdrn6**
rdrn1	5.2	3.6	3.0	6.8
rdrn2		3.7	2.5	4.8
rdrn3			6.9	5.4
rdrn5				4.9

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Table 3: Dating evidence for the site master **RHYDYWRN** **AD 1403–1530** against dated reference chronologies, regional chronologies in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Regional chronologies						
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404–1981	128	9.0
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881–1745	128	8.0
Wales/borders	Hillside oaks	(Siebenlist-Kerner 1978)	**GIERTZ**	1341–1636	128	7.8
Individual site chronologies						
Shropshire	Oswestry Old Grammar School	(Miles *et al* 2008)	OSWTRYOG	1356–1552	128	9.6
Shropshire	Whittington Castle	(Miles *et al* 2004)	WHITNGTN	1351–1628	128	8.9
Denbighshire	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388–1763	128	8.7
Denbighshire	Ucheldref Rhug, Corwen	(Miles *et al* 2010)	DENBY4	1373–1597	128	7.9
Shropshire	Church Farm, Ditton Priors	(Miles *et al* 2004)	DITTON5	1437–1578	94	7.8
Herefordshire	Church House, Allensmore	(Miles *et al* 2006)	CHAM	1357–1551	128	7.5
Merioneth	Ty Cerrig, Llandower	(new ODL data, unpublished)	TYCERRIG	1373–1633	128	7.4
Montgomeryshire	Royal House, Machynlleth	(Miles *et al* 2004)	ROYALHS1	1363–1560	128	7.3
Caernarvonshire	Derwyn-bach, Dolbenmaen	(Miles *et al* 2006)	BDGLRT15	1385–1548	128	7.3
Cornwall	Trerice, Kestle Mill	(Hurford *et al* 2009)	TRCESQ01	1394–1562	128	7.2
Shropshire	Aston Eyre, gatehouse	(Miles and Worthington 1998)	ASTNEYR3	1357–1612	128	7.2

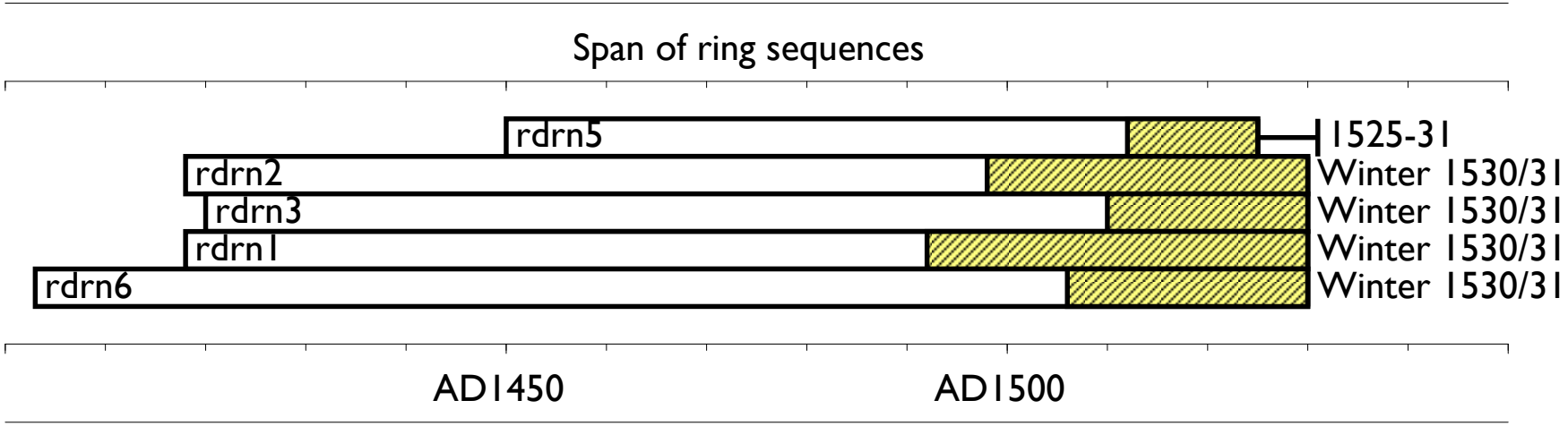

Figure 1: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely, or actual, felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings

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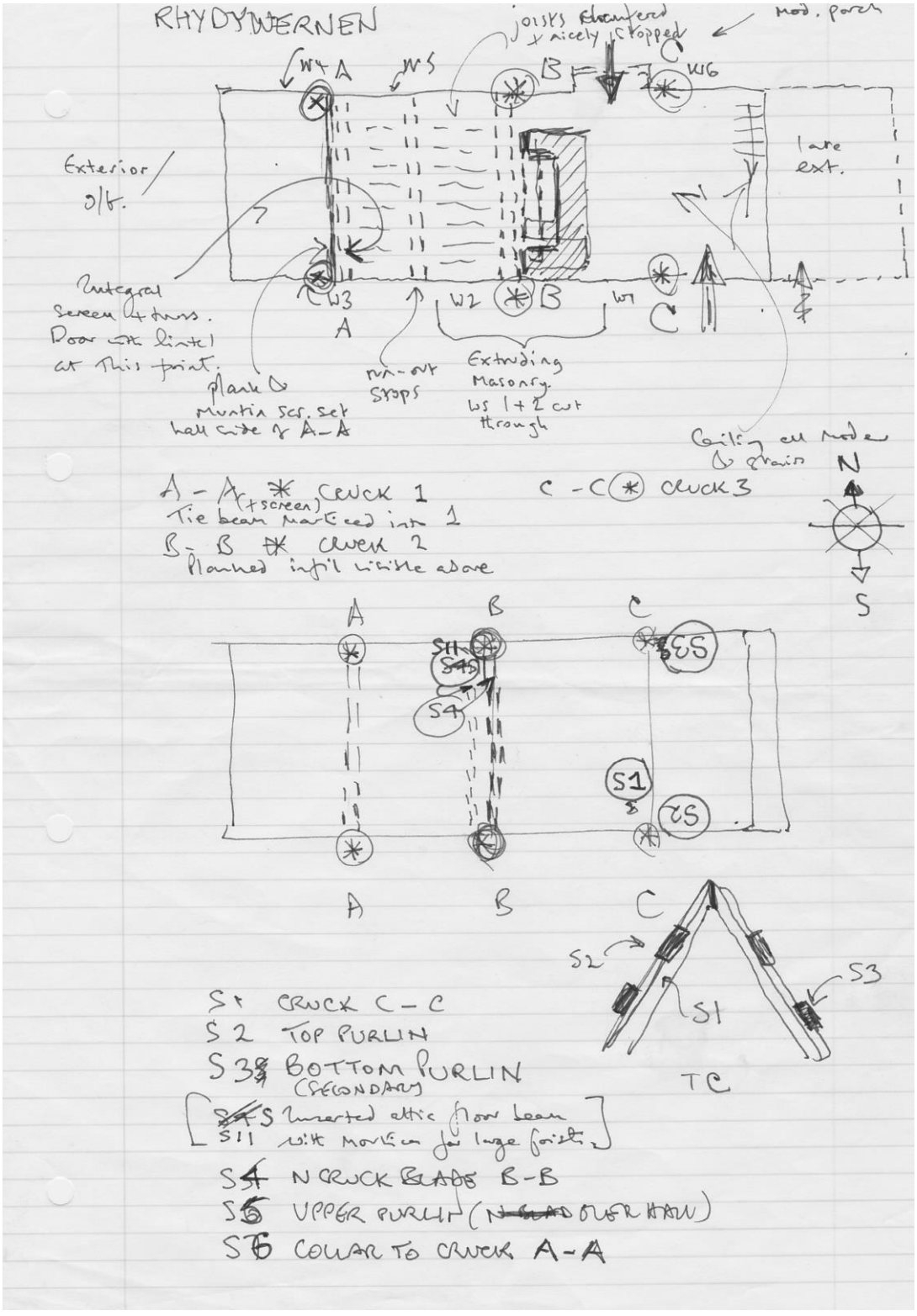
Appendix



Field notes made by Martin Cherry giving indications of the timbers sampled for dendrochronology