Oxford Dendrochronology Laboratory
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THE TREE-RING DATING OF LLANNERCHYFELIN, ROWEN, CONWY (NGR SH 759 722)

Summary
Samples were taken from the roof, first floor beams and ground floor beam. Felling dates were obtained for a ground floor axial beam (**Winter 1568/69**) and a first floor beam (**Winter 1578/79**) with the remaining dated timbers having likely felling date ranges that make the later date most likely for construction, and implying that the ground floor beam may have been stock-piled for around ten years before use.

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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.

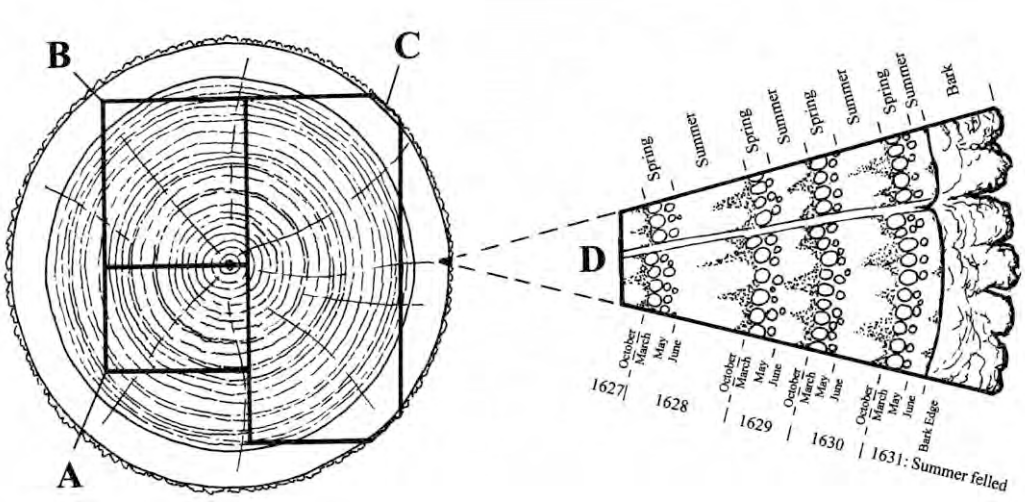
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence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

LLANNERCHYFELIN

Llannerchyfelin is a fully-storeyed Snowdonian house with added back kitchen. The plan is characteristic with a passage between hall and screened outer rooms. The fireplace stair has been superseded by a stair in the cross-passage, probably contemporary with the rear wing. Llannerchyfelin has a full complement of generally fast-grown timber detail: massive fireplace beam, stop-chamfered beams, and post-and-panel partition. The screen is reed-moulded with a Tudor-headed doorway blocked by the inserted stair. The principal chamber over the hall has a fireplace beam has a curved stops with

fillets. The trusses are of collar-beam type with raking struts in the main range, and with a lapped and arched collar-beam truss over the wing. There is some suggestion of a cog-loft over one attic bay. Plan and description in RCAHMW, *An Inventory of . . . Caernarvonshire, Volume I: East* (1956), pp. 25, fig. 43. NPRN 26709.

SAMPLING

Sampling took place in January 2012. 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 **lyf**. 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.

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1, and illustrated in Figure 1. Two samples could not be dated. Cross-matching between the dated samples was relatively poor (Table 2) but when combined into a 160-year long site chronology, **LLANNFEL,** this matched well with dated reference material, the best results being shown in Table 3. Figure 2 shows the relative positions of overlap and felling dates of the dated timbers.

Two timbers retained complete sapwood, one having come from a tree felled ten years before the other. The main axial beam at ground floor level was found to have come from a tree felled in Winter 1568/69, and it did not match the other samples well. The axial beam from the first floor ceiling was found to have been felled in Winter 1578/79, with other timbers having likely felling dates which incorporate this year. It seems likely therefore that the house was constructed in 1579, or within a year or two after this date, a decade or so before Smith suggested, but that it incorporated at least one stock-piled timber.

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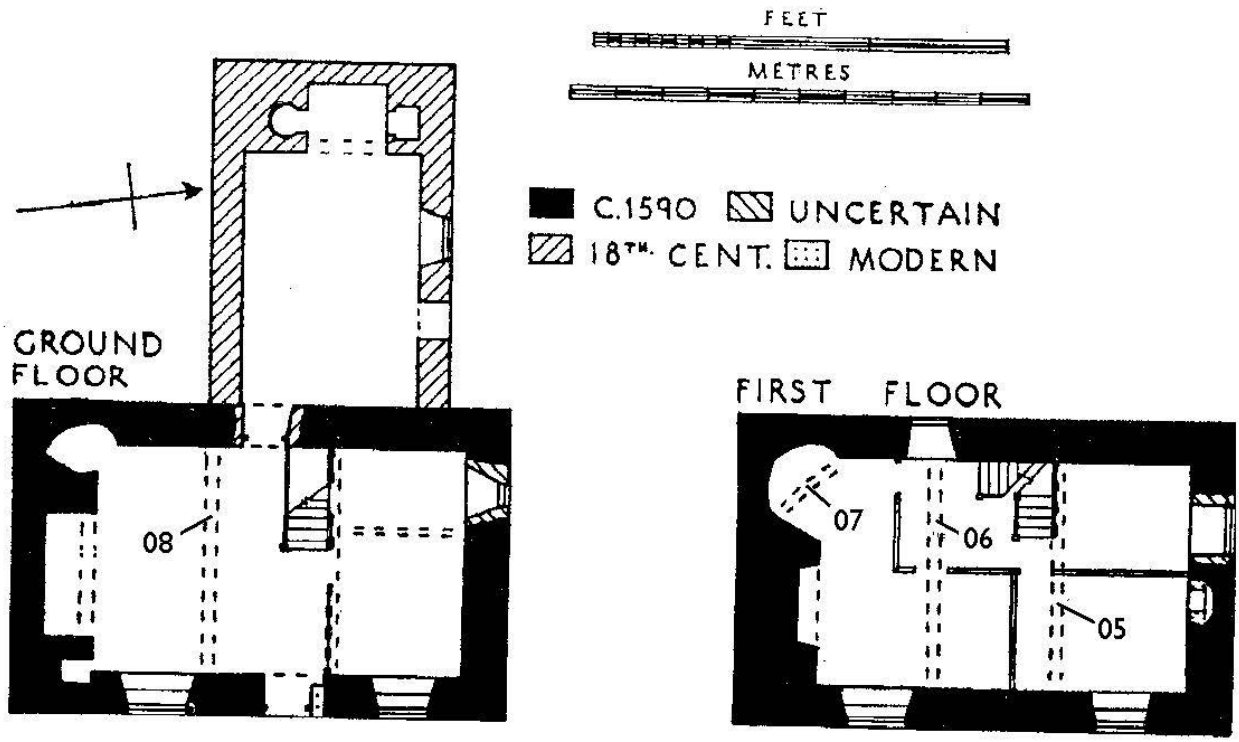

Figure 1: Plan of the ground and first floors, showing where samples were taken for dendrochronology. Adapted from an original in RCAHMW, *An Inventory of . . . Caernarvonshire, Volume I: East* (1956).

Table 1: Details of samples taken from Llannerchyfelin, Rowen, Conwy.

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
* lyf01	East principal rafter to north truss	1440–1563	1563	h/s	124	1.26	1.07	0.28	1574-1604
lyf02	West vertical strut to north truss	undated	-	h/s	67	1.59	1.23	0.28	-
* lyf03	West vertical strut to south truss	1443–1559	1559	h/s	117	0.97	0.53	0.27	1570–1610
lyf04i	Lower east purlin, to south of south truss	*undated*	-	-	*55*	*1.16*	*0.63*	*0.33*	-
lyf04ii	*ditto*	*undated*	-	*18*	*30*	*0.92*	*0.36*	*0.24*	-
* lyf05	Axial beam, first floor bedroom	1444–1578	1542	36C	135	1.33	1.01	0.28	Winter 1578/79
* lyf06	Beam over hall, first floor	1432–1539	1539	h/s	108	1.59	0.96	0.32	1550–1590
* lyf07	Curved beam in bathroom	1433–1563	1557	6	131	1.72	1.29	0.28	1568–1608
lyf08a	Axial beam in ground floor main room	*1423–1529*	*1529*	*h/s*	*107*	*1.72*	*0.70*	*0.28*	-
lyf08b	*ditto*	*1419–1568*	*1530*	*38C*	*150*	*1.35*	*0.91*	*0.27*	-
* lyf08	Mean of **08a** and **08b**	1419–1568	1530	38C	150	1.35	0.85	0.27	Winter 1568/69
*** = included in Site Master LLANNFEL**		**1419–1578**	**-**	**-**	**160**	**1.33**	**0.73**	**0.21**	**-**

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, winter felled; ¼C = complete sapwood, felled the following spring; ½C = complete sapwood, felled the following summer; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured; ∫ = only 2-3mm lost to bark edge.

Table 2: Cross-matching between the dated samples

	t-values				
Sample	**lyf03**	**lyf05**	**lyf06**	**lyf07**	**lyf08**
lyf01	6.5	3.0	1.7	4.0	2.7
lyf03		1.4	1.5	2.4	2.6
lyf05			2.5	2.2	4.3
lyf06				5.5	3.8
lyf07					2.9

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Table 3: Dating evidence for the site master **LLANNFEL AD 1419–1578** against dated reference chronologies.
Regional multi-site chronologies are shown in **bold**

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Plas Mawr House	(Miles 1997b)	PLASMAWR	1360-1578	160	8.3
Wales	George and Dragon, Beaumaris	(Miles *et al* 2010)	ANGLSY1	1437-1540	104	8.2
Shropshire	Ightfield Hall barn, Whitchurch	(Groves 1997)	IGHTFELD	1341-1566	148	8.2
Wales	Peniarth-Uchaf Meifod	(Miles and Haddon-Reece 1996)	PENIARTH	1385-1550	132	8.1
Wales	Cefn Caer Pennal	(Miles and Worthington 1999)	CEFNCAR1	1404-1525	107	7.6
Shropshire	Abcott Manor, Clungunford	(Miles and Worthington 2002)	CGFA	1422-1545	124	7.4
Wales	Llwyn Llandrinio, Montgomeryshire	(Miles *et al* 2003)	LLWYN	1413-1551	133	7.2
Cheshire	Combermere Abbey, Whitchurch	(Howard *et al* 2003)	CBMASQ01	1371-1564	146	7.0
Shropshire	Upper Lake, Westbury	(Miles and Worthington 2000)	UPRLAKE	1418-1546	128	7.0
Wales	Plas Coch, Anglesey	(Miles *et al* 2011)	PLASCOCH	1402-1591	160	6.8
Cumbria	Wetheral Priory	(Arnold *et al* 2004)	WPGASQ04	1410-1511	93	6.7
Hampshire	High Street, Whitchurch	(Miles unpublished)	WHGHWHIT	1416-1596	160	6.6
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411-1571	153	6.6
Warwickshire	Gorcott Hall	(Nayling 2006)	GORC_T17	1385-1531	113	6.5
Wales	Tyn Celyn	(Miles *et al* 2004)	TYNCELYN	1375-1524	106	6.5

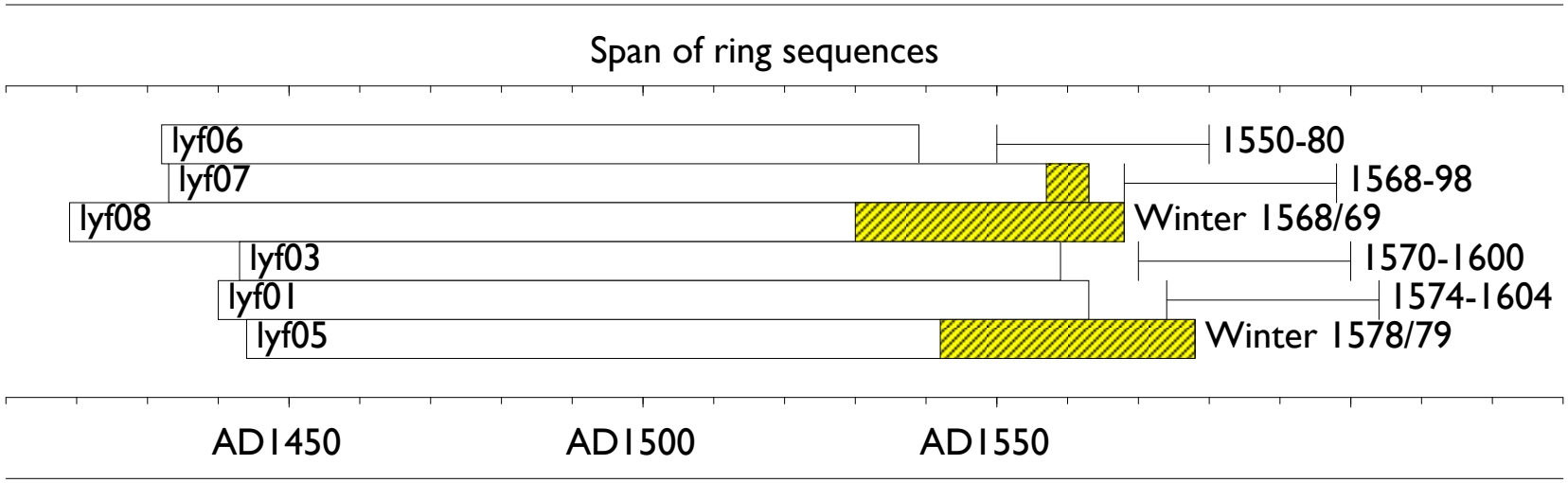

Figure 2: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings