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Oxford Dendrochronology Laboratory
Report 2018/28

# THE DENDROCHRONOLOGICAL DATING OF TIMBERS FROM THE BARN LLWYNDU FARM, LLANBER, MERIONETH

**(SH 600 185)**


## Summary

The barn appears to have a reset roof, but may well have re-used timbers from the original build. Access on this visit was restricted to the north side. One cruck blade had 88 rings including complete sapwood, but exhibited sudden growth-rate changes, and was not dated. Of the remaining seven samples, one timber, a cruck fillet on the east truss, was from a tree felled in summer 1480, earlier than the other timbers. The tiebeam on the east truss, and a timber at the west end of the barn appear to have come from the same tree, and three other timbers form a coherent group, although there are different felling dates, including Winter 1548/49 and Spring 1571. A beam from the east end appears to have been from a tree felled much later, in the late seventeenth-century, and this may represent the last re-roofing period.



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A report commissioned by the Discovering Old Welsh Houses Group in collaboration with the Royal Commission on the Ancient and Historic Monuments Wales (RCAHMW)

**The Dendrochronological Dating of Timbers from the barn at Llwyndu Farm, Llanber, Merioneth (SH 600 185)**

## 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.

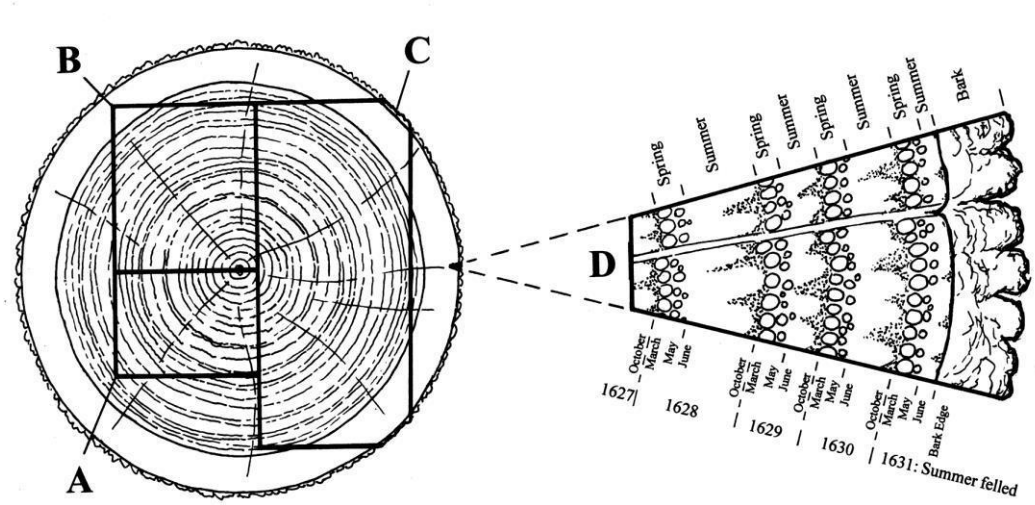
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation 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 1997, 42)

## The Barn

The barn is Listed as probably C17th, a low rubble building with boulder foundations and an undulating, heavily grouted slate roof. There is an upper loading bay to the east gable and a ventilation slit in the west gable apex. There is a four-bay interior with three remaining cruck blades on two trusses. The purlins are thought to be of a later date and are various dimensions., some obviously re-used.

## SAMPLING

Eight samples were taken from timbers in the roof during August 2018. Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled with the prefix **lydu**, and taken away for subsequent analysis, where they were glued to laths.

The samples 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 programs by Ian Tyers (Tyers 2004).

## RESULTS AND DISCUSSION

The locations and details of the samples are described in Table 1. One sample (**03**) was found to have rapid growth rate changes, and could not be dated. Of the remaining timbers, two matched so strongly (Table 2) that they are almost certainly from the same tree – these being a cut-off tie and a beam across the west end of the barn. These two were combined for further analysis, and were found to match two of the purlins. They seem to form a coherent group with good internal matches, suggesting a similar source, but have different felling dates, one being felled in winter 1548/49, one in spring 1571, with the others having feeling date ranges encompassing 1571. They were combined into a single site chronology, **LWYNDU2**, which dated well, the best results being shown in Table 3a, with the relative positions of overlap being shown in Fig 1.

The cruck fillet, on the north side of the east truss, dated independently (Table 3b), but also matched **LLWYNDU2** ($t$ = 4.2 with 58 years overlap). It is much earlier, having come from a tree felled in summer 1480.

Sample **06**, a beam at the east end of the barn also dated independently (Table 3c) and is much later – having a felling date range of 1668–98. The matches for this are interesting, appearing at first to be of Irish origin, matching several Irish sites, and a site in Anglesey attributed to having Irish timber. It also gives matches to coastal Welsh sites and to sites in Somerset, suggesting a general Irish Sea peripheral affinity, and prompts thoughts about this as a 'region' which may be explored elsewhere.

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**Table 1:** Details of samples taken from the barn at Llwyndu Farm, Llanaber.

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| * **lydu01** | Lower N purlin, bay 1 | 1422–1548 | 1530 | 18C | 127 | 1.35 | 0.59 | 0.21 | Winter 1548/49 |
| * **lydu02** | Lower N purlin, bay 2 | 1445–1538 | 1538 | H/S | 94 | 1.33 | 0.47 | 0.23 | 1549–79 |
| **lydu03** | N cruck blade, east truss | undated | - | 22C | 88 | 1.16 | 0.73 | 0.24 | - |
| **lydu04** | Cut tiebeam, east truss | 1442–1536 | 1536 | H/S | 95 | 1.35 | 0.58 | 0.23 | 1552–82 [1] |
| * **lydu05** | Lower N purlin, bay 3 | 1462–1570 | 1541 | 29¼C | 109 | 1.07 | 0.30 | 0.21 | Spring 1571 |
| **lydu06** | Beam at east end, bay 4 | 1544–1660 | 1657 | 3 | 117 | 1.28 | 0.48 | 0.19 | 1668–98 |
| **lydu07** | Cruck fillet, north, east truss | 1421–1479 | 1452 | 17½C | 59 | 1.64 | 0.47 | 0.25 | Summer 1480 |
| **lydu08** | Beam at west end, bay 1 | 1446–1545 | 1545 | H/S | 100 | 1.02 | 0.44 | 0.22 | 1552–82 [1] |
| * **lydu84m** | Mean of **04** and **08** | 1442–1545 | 1541 | Mean H/S | 104 | 1.18 | 0.56 | 0.23 | 1552–82 |
| * = included in site master **LLWYNDU2** | | **1422–1570** | | | **149** | **1.25** | **0.48** | **0.19** | |

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; ¼C = complete sapwood, felled the following spring; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured. [1] based on mean H/S date for two timbers.

**Table 2:** Cross-matching between the dated samples in site master **LLWYNDU2**
(the orange highlighted cell indicates same tree couple)

| ***t* - values** | | | | |
|---|---|---|---|---|
| **Sample** | **lydu02** | **lydu04** | **lydu05** | **lydu08** |
| **lydu01** | 6.0 | 4.5 | 4.5 | 4.6 |
| **lydu02** | | 5.1 | 7.0 | 4.1 |
| **lydu04** | | | 2.6 | 14.5 |
| **lydu05** | | | | 3.6 |

**Table 3a:** Dating evidence for the site chronology **LLWYNDU2** **AD 1422–1570** against dated reference chronologies

| ***County or region:*** | ***Chronology name:*** | ***Reference*** | ***File name:*** | ***Spanning*** | ***Overlap: (yrs)*** | ***t-value:*** |
|---|---|---|---|---|---|---|
| **Site Chronologies** | | | | | | |
| Merioneth | Plas y Dduallt, Maentwrog | (Miles *et al* 2011) | GWYNEDD5 | 1355–1604 | 149 | 8.8 |
| Merioneth | Llwyndu Farmhouse and Dower House | (Miles *et al* 2008) | LLWYNDU | 1404–1592 | 149 | 8.0 |
| Merioneth | Esgair Olwyn, Llandecwyn | (Bridge *et al* 2016) | ESGAIR | 1437–1594 | 134 | 7.5 |
| Caernarvonshire | Plas ym Mhenrhos, Penrhos | (Miles *et al* 2012) | PLASMNRS | 1413–1607 | 149 | 7.4 |
| Anglesey | Tudor Rose, Beaumaris | (Miles *et al* 2010) | ANGLSY3a | 1420–1548 | 127 | 7.1 |
| Montgomeryshire | Royal House, Machynlleth | (Miles *et al* 2004) | ROYALHS1 | 1363–1560 | 139 | 6.9 |
| Caernarvonshire | Pant-glas-uchaf, Clynnog | (Miles *et al* 2007) | BDGLRT14 | 1413–1573 | 149 | 6.9 |
| Caernarvonshire | Clenennau, Dolbenmaen | (Miles *et al* 2007) | BDGLRT10 | 1406–1570 | 149 | 6.8 |
| Denbighshire | Ty Mawr, Wybrnant | (Miles *et al* 2011) | WYB | 1437–1564 | 128 | 6.7 |
| Shropshire | Oldfields Farm | (Miles and Haddon-Reece 1994) | OLDFIELD | 1404–1572 | 149 | 6.1 |
| Gloucestershire | Odda's Chapel, Deerhurst | (Bridge 2001) | ODDA | 1352–1593 | 149 | 6.1 |

**Table 3b:** Dating evidence for the site sequence **lydu07** **AD 1421–1479** against dated reference chronologies

| *County or region:* | *Chronology name:* | *Reference* | *File name:* | *Spanning* | *Overlap: (yrs)* | *t-value:* |
|---|---|---|---|---|---|---|
| **Site Chronologies** | | | | | | |
| Glamorgan | Sker House, Porthcawl | (Miles and Worthington 2000) | SKERHS2 | 1435–1553 | 45 | 7.4 |
| Merioneth | Llwyndu Farmhouse and Dower House | (Miles *et al* 2008) | LLWYNDU | 1404–1592 | 59 | 6.1 |
| Caernarvonshire | St Brothen's Church, Llanfrothen | (Miles *et al* 2007) | BDGLRT16 | 1410–1495 | 59 | 5.6 |
| Caernarvonshire | Ty Mawr, Criccieth | (Miles *et al* 2010) | gwyg2 | 1431–1516 | 49 | 5.0 |
| Cardiganshire | St Padarn's Church, Llanbadarn Fawr | (Miles *et al* 2011) | STPADRNS | 1416–1489 | 59 | 4.9 |
| Worcestershire | Bailiff's House, Bewdley | (Fletcher 1980) | BEWDLEY2 | 1430–1600 | 50 | 4.9 |

**Table 3c:** Dating evidence for the site sequence **lydu06** **AD 1544–1660** against dated reference chronologies

| *County or region:* | *Chronology name:* | *Reference* | *File name:* | *Spanning* | *Overlap: (yrs)* | *t-value:* |
|---|---|---|---|---|---|---|
| **Regional Chronologies** | | | | | | |
| Ireland | Belfast Master Chronology | (Baillie 1977) | **BELFAST** | 1001–1970 | 117 | 7.5 |
| **Site Chronologies** | | | | | | |
| Devon | Church of St Nectan, Hartland | (Arnold and Howard 2013) | NECPSQ01 | 1440–1697 | 117 | 7.1 |
| Ireland* | 48 Castle Street, Beaumaris | (Miles *et al* 2010) | ANGLSY4 | 1468–1618 | 75 | 7.0 |
| Somerset | Church of St Mary the Virgin | (Tyers and Wilson 1999) | YATTON 2 | 1564–1691 | 97 | 6.2 |
| Ireland | Pottagh, Co Londonderry | (D Brown, pers comm) | POTTAGH | 1433–1665 | 117 | 6.1 |
| Ireland | Castle Dargan, Co Sligo | (D Brown, pers comm) | CaDARGAN | 1531-1682 | 117 | 6.1 |
| Caernarvonshire | Parc, Llanfrothen | (Miles *et al* 2007) | BDGLRT22 | 1386–1669 | 117 | 6.1 |
| Denbighshire | Pant-glas-isaf, Llanynys | (Miles *et al* 2003) | LLANYNYS | 1538–1674 | 117 | 5.9 |
| Somerset | 8 Market Place, Shepton Mallet | (Miles and Worthington 2002) | SHPTNMLT | 1518–1677 | 117 | 5.8 |
| Denbighshire | Nantclwyd House, Ruthin | (Miles *et al* 2005) | NHRE | 1563–1662 | 98 | 5.7 |

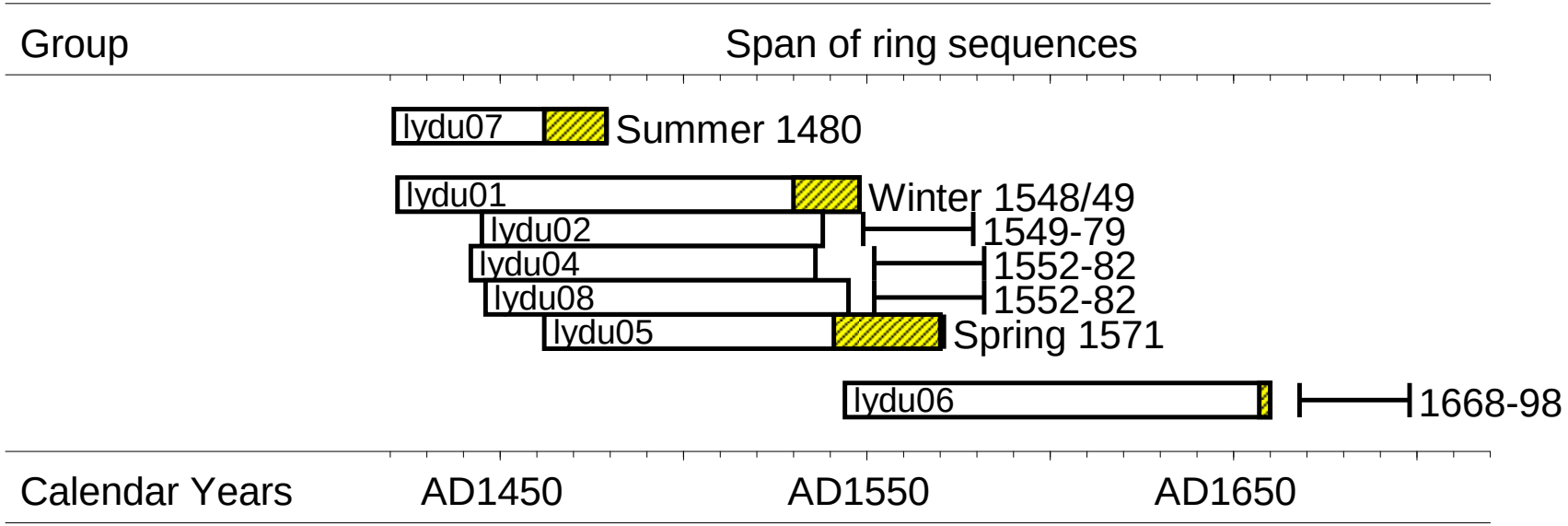


**Figure 1:** Bar diagram showing the relative positions of overlap of the dated samples, with their actual or likely felling dates / date ranges. White sections represent heartwood rings and yellow hatched sections represent sapwood.