Oxford Dendrochronology Laboratory
Report 2011/13

THE TREE-RING DATING OF DYLASAU-ISAF, BETWS-Y-COED CAERNARFONSHIRE (NGR SH 8218 5259)

Summary

Three phases were sampled, the main east-west range, the kitchen block, and a single timber in the detached storied block. The samples from the kitchen block and the detached storied block failed to date, despite a long site master being obtained for the kitchen. Seven timbers from the main block matched together well. Two timbers were felled *c*1570 and in winter 1587/88, and probably represent stockpiled timbers, whilst four timbers were found to have been felled in winter 1592/93, with a fifth timber having a likely felling date range incorporating this date. It seems most likely therefore that construction of the main range took place in **1593**, or within a year or two after this date.

Authors: Dr D. H. W. Miles FSA and Dr M. C. Bridge FSA
Oxford Dendrochronology Laboratory
Mill Farm
Mapledurham
Oxfordshire
RG4 7TX

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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.

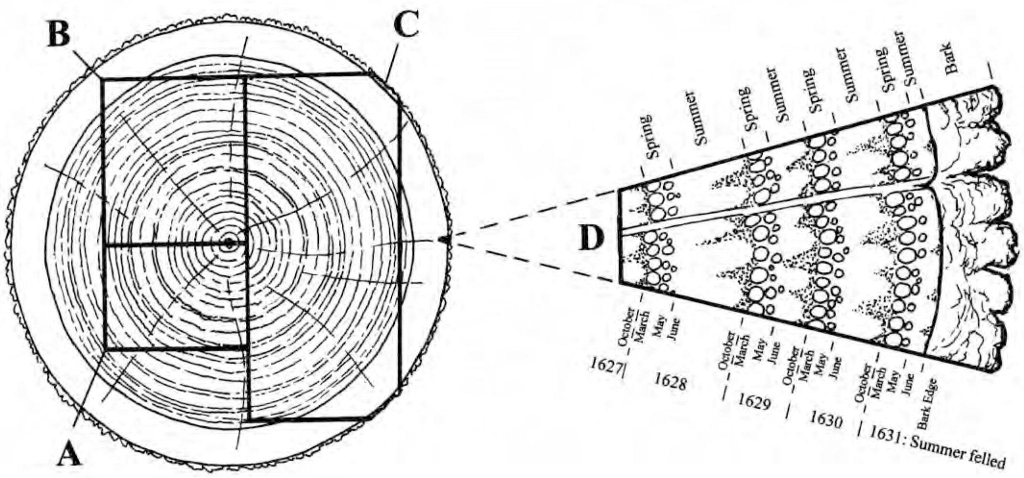
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation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

DYLASAU-ISAF

Dylasau-isaf (sometimes Dulasau-isaf) has a classic north-west Wales unit-system arrangement. There are two storeyed houses of Snowdonian type set corner-to-corner. The principal house has the characteristic regional plan with large hall and twin outer rooms (parlour and service) on either side of the central entrance. An added rear kitchen wing has an C18th inscription on the fireplace beam: *T. P.*

Esqr. 1735. The secondary and smaller house (now used as a store) has a two-unit plan with projecting end chimney heating the hall. The first floor is now approached by a stone stair which, with the tall end chimney, gives the house a tower-like appearance. However the dwelling is a diminutive version of a Snowdonian house and the present external stair obscures the original plan.

Tree-ring dating showed that the principal house was built at the end of the C16th, probably c. 1593, but the added kitchen wing failed to date. Further sampling of the secondary house (considered by the *Caernarvonshire Inventory* to be the older house) is needed. Plan and account in RCAHMW, *Caernarvonshire Inventory, Volume I: East* (1956), pp. 172-3. (RFS/RCAHMW/May 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 **dyla**. 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.

RESULTS AND DISCUSSION

Details of the samples, and their locations, are given in Table 1 and illustrated in Figs 1 and 2. The seven timbers sampled from the main range all matched together despite exceptionally narrow rings in the outer segments of the cores. Two samples were taken from one purlin (**dyla16a** and **dyla16b**) as the first core broke up into segments and the second core ensured no rings were missing; they matched each other (t = 19.5 with 118 years overlap) and were combined to form the same-timber mean **dyla16**. Whilst some timbers matched poorly with some of the others, the dating was confirmed by independently cross-matching with the reference chronologies independently which confirmed the low matches with some samples. Therefore all seven timbers were combined to form the 181-year site master **DYLASAU1**. This dated well, spanning the years 1412-1592. Six of the timbers retained complete sapwood, although one timber (**dyla14**) had been sandblasted, resulting in some uncertainty in the felling season for this timber. Two of the transverse beams (**dyla11** and **dyla12**), a tiebeam (**dyla15**), and a purlin (**dyla16**) were all felled in the winter of 1592/93, suggesting that construction took place during 1593. Two other timbers with what appeared to be complete sapwood (**dyla13** and **dyla14**) with felling dates of winter 1587/8 and *circa* 1570 respectively. These earlier felling dates do not represent earlier work, but instead are either stock-piled timbers or windfalls. Indeed the outermost rings of some of the timbers are so narrow it is quite possible they might have died standing up. One further timber, a purlin (**dyla17**) produced a felling date range of 1583-1613. A bar diagram summarising these dates is found as Figure 3.

Of the three timbers sampled from the kitchen wing, two were sampled twice to obtain maximum sapwood rings. The two samples from the south transverse beam under the north wall (**dyla21a** and **dyla21b**) matched each other (t = 5.0 with 72 years overlap) and were combined to form the 127-ring mean **dyla21**. The two samples from one of the muntins of the plank and muntin partition upstairs broke into two segments each due to the groove of the plank bisecting the line of the core, with no overlap between the two segments. The two longer segments of the two samples, **dyla23a1** and **dyla23b1**, matched each other (t = 17.1 with 112 years overlap) and were combined to form the 122-year sequence **dyla23**. This sequence finished at least 29 rings from the bark edge by taking into account the detached segment **dyla23b2**. Unfortunately none of these samples, or sample **dyla22** taken from another muntin with bark edge, matched each other or dated individually. They also failed to match any of the other timbers from the main E-W range. Therefore, this wing must remain undated at the moment. However, there might be some potential in the roof timbers to this range which were not sampled due to the roof space having just been insulated with lambs' wool insulation making access treacherous. If further work on this building was considered essential, then it would be possible to remove the insulation to gain access to the ceiling timbers to allow safe access to the roof timbers.

The detached storied block adjacent to the south-east corner of the main range had only one timber sampled, a ceiling joist. This was sampled twice due to the orientation of the rings being difficult to assess. The two sequences matched each other (t = 10.3 with 55 years overlap) were combined to form the same-timber mean **dyla1** with 81 rings and heartwood/sapwood boundary. This however failed to date with any of the other timbers sampled from the site, or with the reference chronologies individually. The reason only one timber was sampled was due primarily to the fact that the ground floor of the building was filled with many years accumulation of rubbish and most of the ceiling was covered with sheet material. The upper floors of the building were in a state of collapse and would require making safe before sampling could be undertaken. A brief assessment revealed that a roof timber appeared to have some sapwood, whereas many of the visible timbers had no sapwood or heartwood/sapwood boundaries, making interpretation of any dating difficult. However, the building was of interest and should proper sampling be undertaken, then the rubbish should be cleared out, plywood removed from the ceiling joists, and scaffold boards placed over the unsafe floors to allow reasonable access to the upper timbers.

Table 1: Details of samples taken from Dylasau-isaf, Betws-y-Coed.

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
Detached storied block									
dyla01a	2nd joist from E side, ground floor			-	*76*	*1.07*	*0.46*	*0.25*	
dyla01b	*ditto*			H/S	*60*	*1.10*	*0.47*	*0.22*	
dyla01	Mean of **dyla01a** + **dyla01b**	undated	-	H/S	81	1.08	0.47	0.25	unknown
Main E-W Range (GF = ground floor, FF = first floor)									
* **dyla11**	1st transverse beam from W, GF	1443-1592	1557	35C	150	1.26	0.97	0.20	Winter 1592/93
* **dyla12**	2nd transverse beam from W, GF	1454-1592	1554	38C	139	1.14	0.77	0.25	Winter 1592/93
* **dyla13**	3rd transverse beam from W, GF	1422-1587	1548	39C	166	1.26	0.91	0.22	Winter 1587/88
* **dyla14**	4th transverse beam from W, GF	1412-1569	1526	43C?	158	1.11	0.71	0.21	*c*1570
* **dyla15**	1st tiebeam from W, FF	1421-1592	1540	52C	172	0.92	0.58	0.21	Winter 1592/93
dyla16a	Lower S purlin, 2nd bay from E	*1464-1592*	*1578*	*14C*	*129*	*1.23*	*0.39*	*0.23*	
dyla16b	*ditto*	*1475-1592*	*1578*	*14C*	*118*	*1.17*	*0.35*	*0.23*	
* **dyla16**	Mean of **dyla16a** + **dyla16b**	1464-1592	1578	14C	129	1.22	0.37	0.22	Winter 1592/93
* **dyla17**	Upper N purlin, E bay	1433-1572	1572	H/S	140	0.90	0.44	0.17	1583-1613
* = included in *Site Master* **DYLASAU1**		**1412–1592**			**181**	**1.25**	**0.69**	**0.15**	
Kitchen Wing									
dyla21a	S transverse beam under N wall			*24*	*122*	*1.73*	*1.00*	*0.31*	
dyla21b	*ditto*			*39C*	*77*	*0.99*	*0.78*	*0.27*	
dyla21	Mean of **dyla21a** + **dyla21b**	undated	-	-	127	1.63	1.03	0.27	unknown
dyla22	1st muntin E of post, FF	undated	-	24C	114	1.00	0.66	0.25	unknown
dyla23a1	1st muntin W of post, FF			*H/S*	*116*	*0.74*	*0.30*	*0.19*	
dyla23a2	*ditto*			*+25C*	*25*	*0.67*	*0.24*	*0.20*	
dyla23b1	*ditto*			*H/S*	*118*	*0.71*	*0.29*	*0.22*	
dyla23b2	*ditto*			*+29C*	*29*	*0.66*	*0.23*	*0.27*	
dyla23	Mean of **dyla23a1** + **dyla23b1**	undated	-	H/S	122	0.72	0.29	0.20	unknown

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, winter felled; std devn = standard deviation; mean sens = mean sensitivity.

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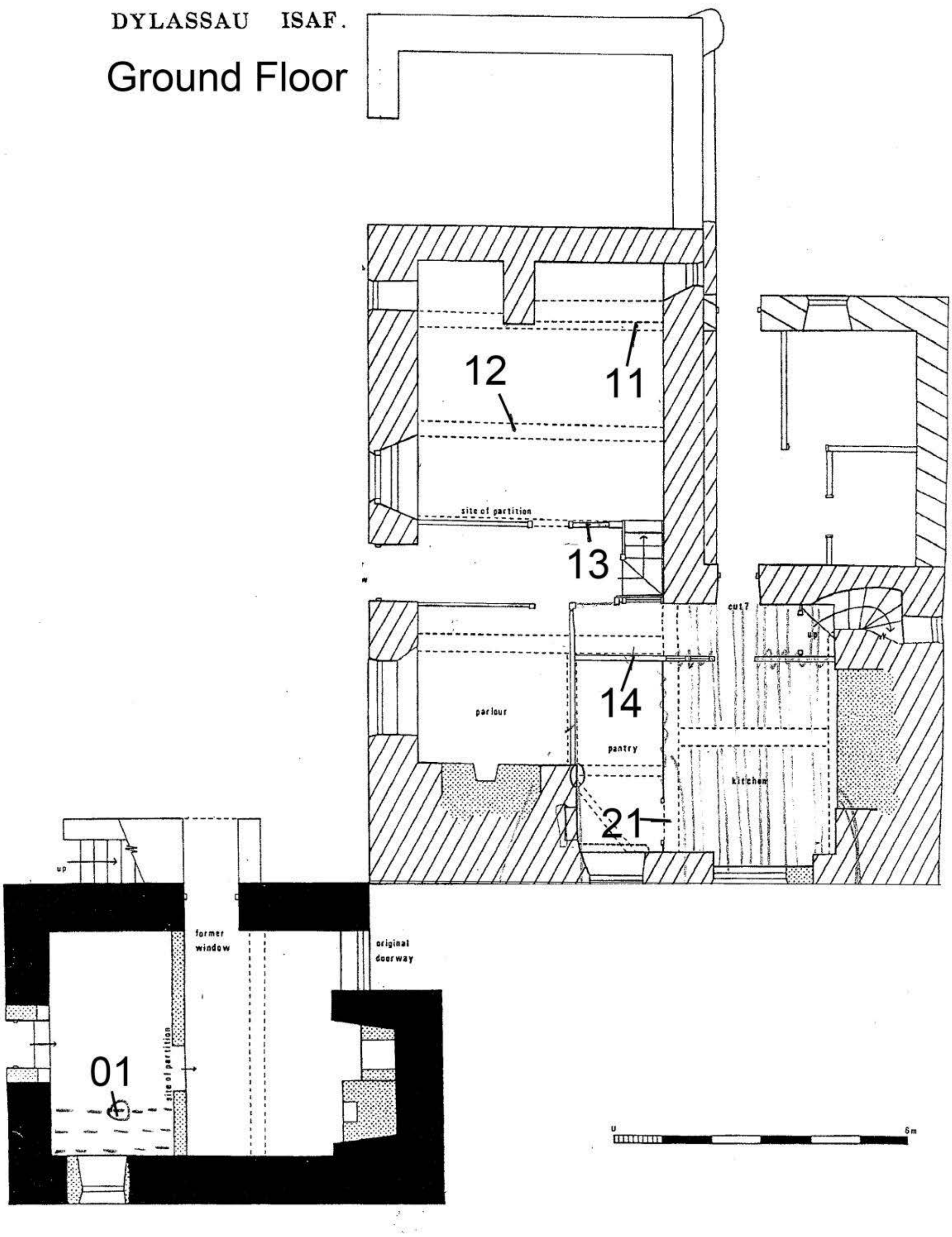

Figure 1: Plan of the Ground Floor of the property showing the timbers sampled (adapted from drawings supplied)

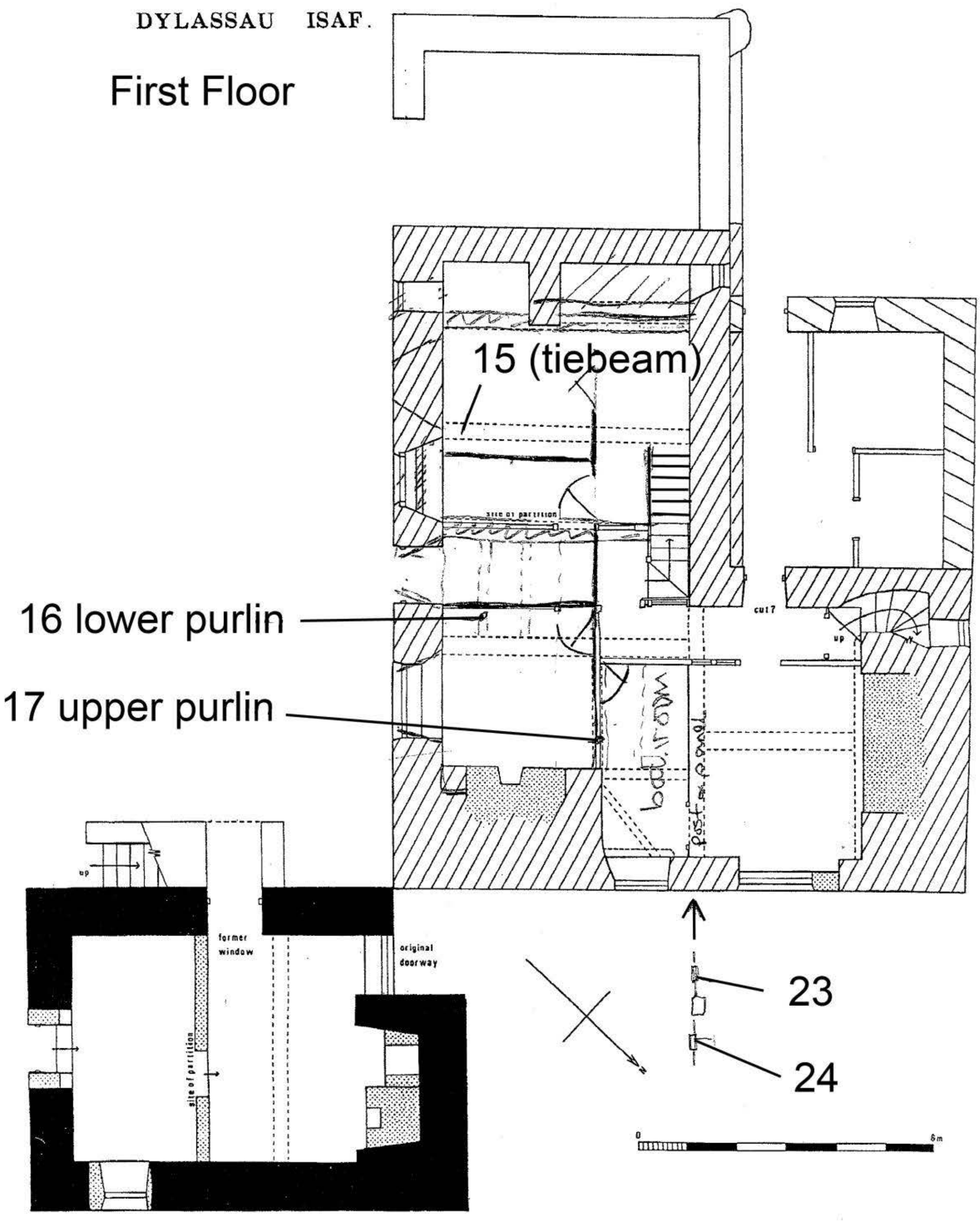

Figure 2: Plan of the First Floor of the property showing the timbers sampled (adapted from drawings supplied)

Table 2: Cross-matching between dated samples in the Site Master **DYLASAU1**

	t-values					
Sample	**dyla12**	**dyla13**	**dyla14**	**dyla15**	**dyla16**	**dyla17**
dyla11	2.7	2.2	2.0	5.1	1.9	3.9
dyla12		3.9	4.2	3.8	1.7	2.5
dyla13			0.3	4.2	3.0	1.9
dyla14				1.9	0.5	2.5
dyla15					3.4	5.4
dyla16						7.9

Table 3: Dating evidence for the site master **DYLASAU1** **AD 1412–1592** against dated reference chronologies, regional chronologies in **bold**

County or region:	***Chronology name:***	***Short publication reference:***	***File name:***	***Spanning:***	***Overlap (yrs):***	***t-value:***
Shropshire	Lydbury North mean	(Miles *et al* 2007)	LYDBURY	1363-1658	181	9.2
Wales	St Idloes Church, Llanidloes	(Miles *et al* 2003)	LNYDLOS2	1384-1593	181	9.0
Shropshire	Clungunford Master Chronology	(Miles 2002 unpubl)	CLNGNFRD	1273-1653	181	8.9
Wales	Ty Mawr, Druid, Corwen	(Miles and Bridge 2010)	DENBY1	1440-1583	144	8.6
Wales	Branas-Uchaf, Llandrillo	(Miles and Bridge 2010)	DENBY6	1388-1763	181	8.2
Gt Manchester	Hall I' Th' Wood, Bolton	(Groves 1999)	BOLTON	1467-1569	103	8.2
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	181	8.0
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881-1745	181	7.9

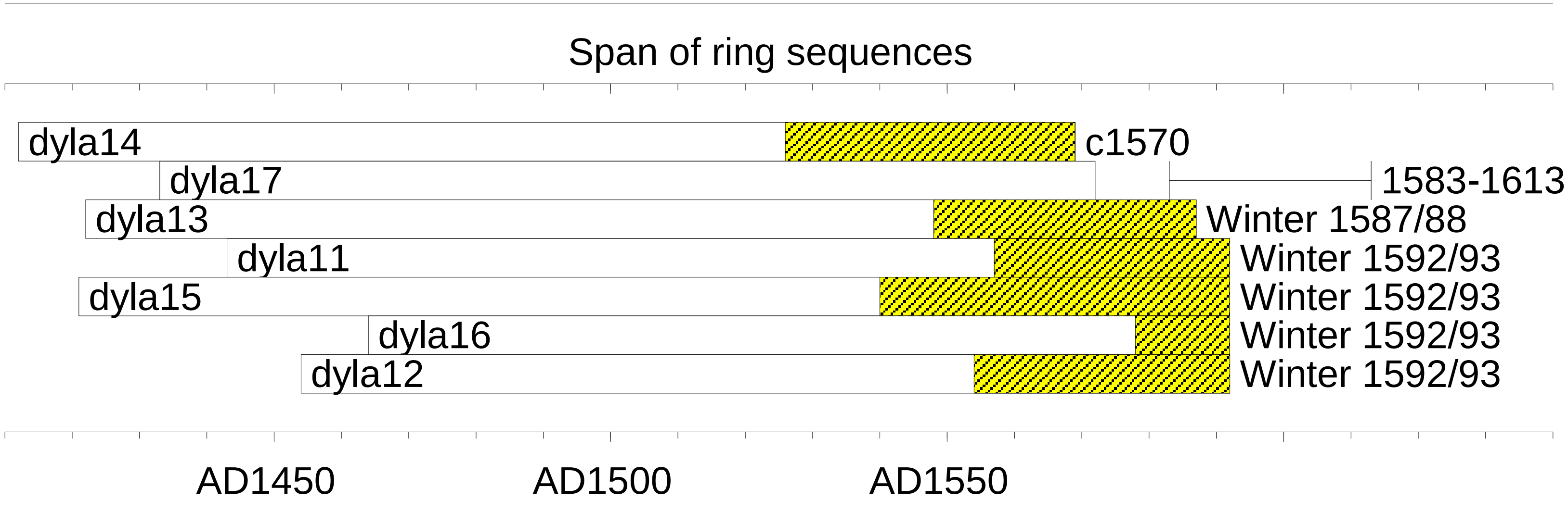

Figure 3: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings.

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