Tree Ring Dating

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Oxford Dendrochronology Laboratory
Report 2016/08

THE DENDROCHRONOLOGICAL DATING OF TIMBERS FROM BRYN DINAS, TYWYN, MERIONETH (NGR SN 635 986)

Summary

Two sampling visits to this property yielded a number of samples, the ring-width series of many of which were rather short. A single timber, a collar, from the primary cruck phase of the building had a likely felling date range of **1511-41**, though caution needs to be applied in assigning this date range to the whole phase, based on a single timber. Three timbers from the inserted floor to the east of the central chimney dated, with a likely felling date range of **1581–86** being derived for this feature.

Author: Dr M. C. Bridge FSA
Oxford Dendrochronology Laboratory
Mill Farm
Mapledurham
Oxfordshire
RG4 7TX

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The Dendrochronological Dating of Timbers from Bryn Dinas, Tywyn, Merioneth (SN 635 986)

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.

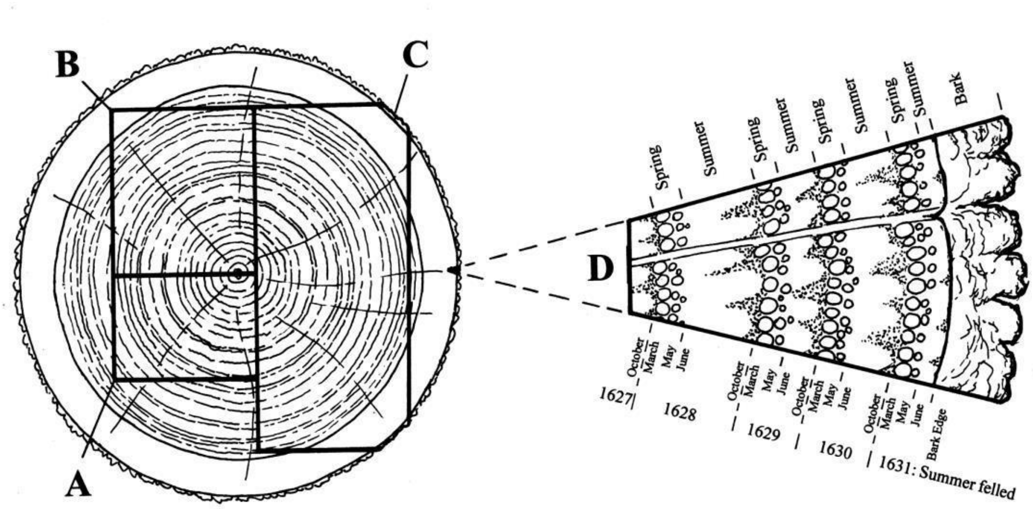
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation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

BRYN DINAS (notes by Richard Suggett)

Bryndinas is a downslope-sited, stoned-walled, three-unit cruck-framed hall-house of gentry type. The two-bay hall, set between rather narrow inner and outer bays, has a refined central truss with a boss (cut back). In a second phase, the fireplace was inserted against the central truss and the hall ceiling with curved stops and bar inserted. The house was undergoing repairs in 2014 and 2016 when sampled.
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. 450, 483 (fig. 10.25). Coflein (RCAHMW's on-line database) entry: NPRN 41593. R.F.Suggett/RCAHMW/November 2014.

Further survey work was carried out on behalf of the Snowdonia National Park by Ian Brooks (2015-16), who kindly provided the drawings used as a base for the sample location figures used in this report.

SAMPLING

Samples were originally taken in June 2014 as part of a programme funded by 'Dating Old Welsh Houses' arranged by Margaret Dunn. That sampling session was cut short when it was found that one cruck was hollow, and there were concerns about the structural integrity of the building. The site was revisited in January 2016, at which time extensive repairs were being undertaken to stabilise the building, and the dendrochronology was now being funded by the Snowdonia National Park, who were also having an historical survey being carried out by Ian Brooks.

The locations of the samples are described in Table 1, many being shown in Figs 1-3. Core samples were extracted using a 15mm diameter borer attached to an electric drill. They were labelled (prefix **bds**) and 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 DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Details of the samples are given in Table 1. Several samples were found to have short ring series, and two were not even measured as the series were too short. Several others were shorter than would normally be measured, but it was hoped the replication at the site might allow them to be matched. Sample **08** was a repeat of the original sample **04**, but was found to be much less distorted and was used in preference (although comparison of the plots of both showed reasonable agreement).

Cross-matching was found between three timbers from the inserted floor in the room to the east of the chimney (Table 2), and these were combined into a working site master, **bds11108**, which was dated independently. A fourth series, from the collar of truss 3 matched this series (t = 4.9 with 42 years overlap). Given that this was from a different phase, and the overlap was rather short, this series was also dated independently, the strongest matches being shown in Table 3a. This series was then combined with the working site master **bds11108**, to form a site master sequence, **BRYNDNAS**, the dating evidence for which is given in Table 3b.

There is thus a single dated timber from the primary cruck phase of the building, giving a likely felling date range of **1511–41**. Clearly there is a danger in dating a whole phase on the basis of a single timber, which may be a repair, or a stockpiles or re-used timber, but the result seems not unreasonable as a representative of this primary phase of building.

The inserted floor to the east of the central chimney had one timber with complete sapwood, but this had extremely narrow rings and the sapwood rings could not be measured with certainty. The number of rings was however determined to within 5 years, allowing a narrow felling date range of **1581–86** to be determined, with a second timber having a likely felling date range encompassing this range (Fig 4).

ACKNOWLEDGEMENTS

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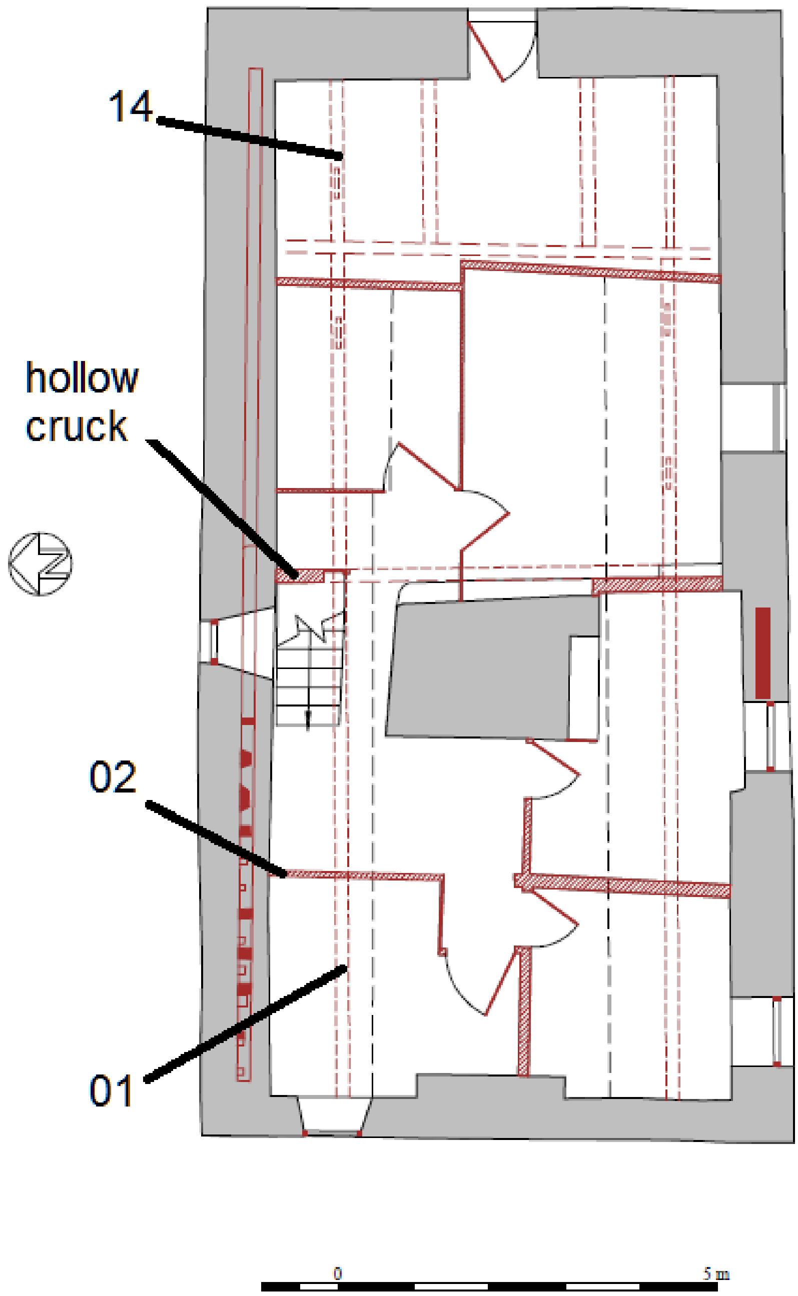

Figure 1: Drawing of the first floor, showing the approximate locations of samples taken for dendrochronology, adapted from a drawing by Ian Brooks

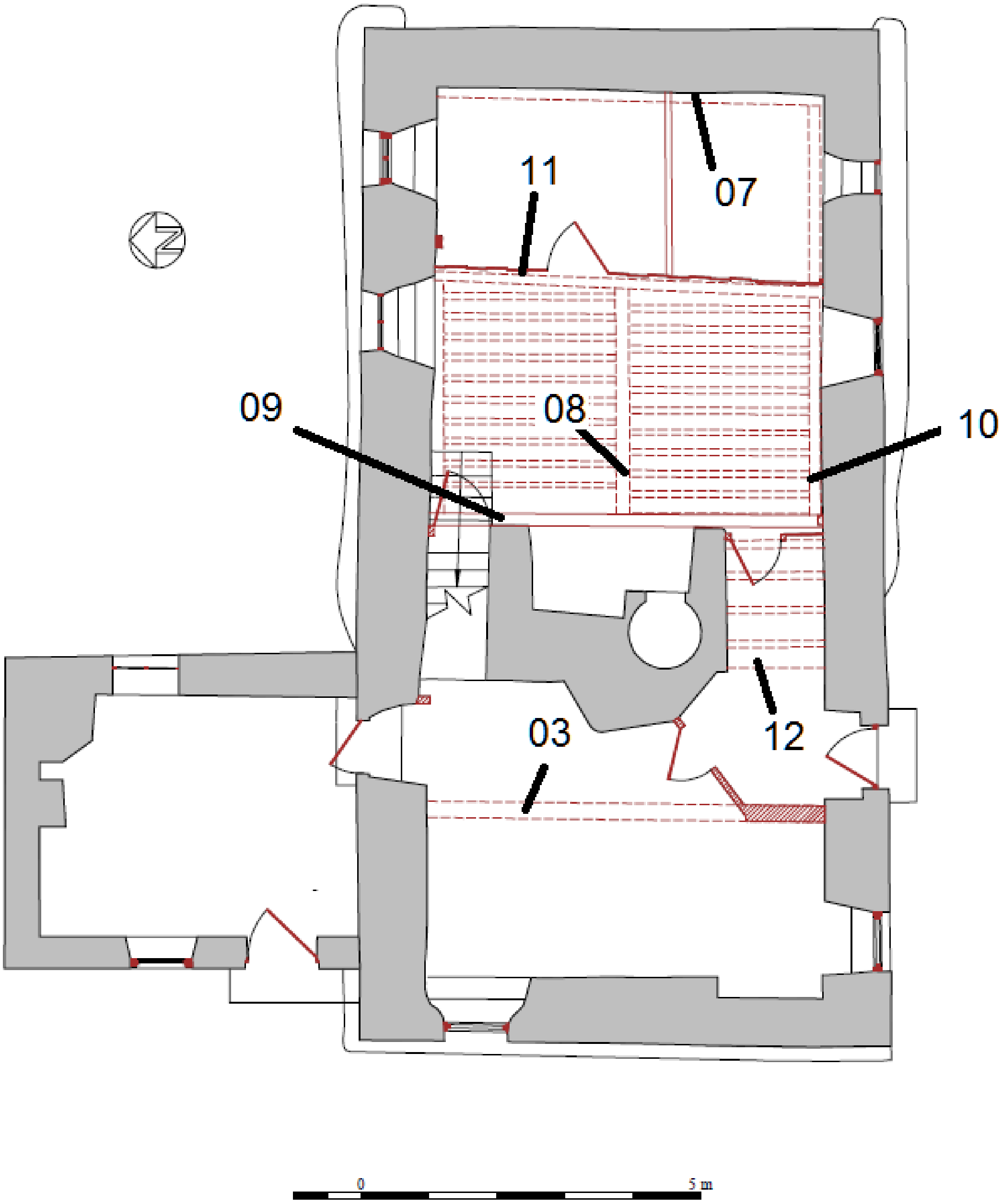

Figure 2: Drawing of the ground floor, showing the approximate locations of samples taken for dendrochronology, adapted from a drawing by Ian Brooks

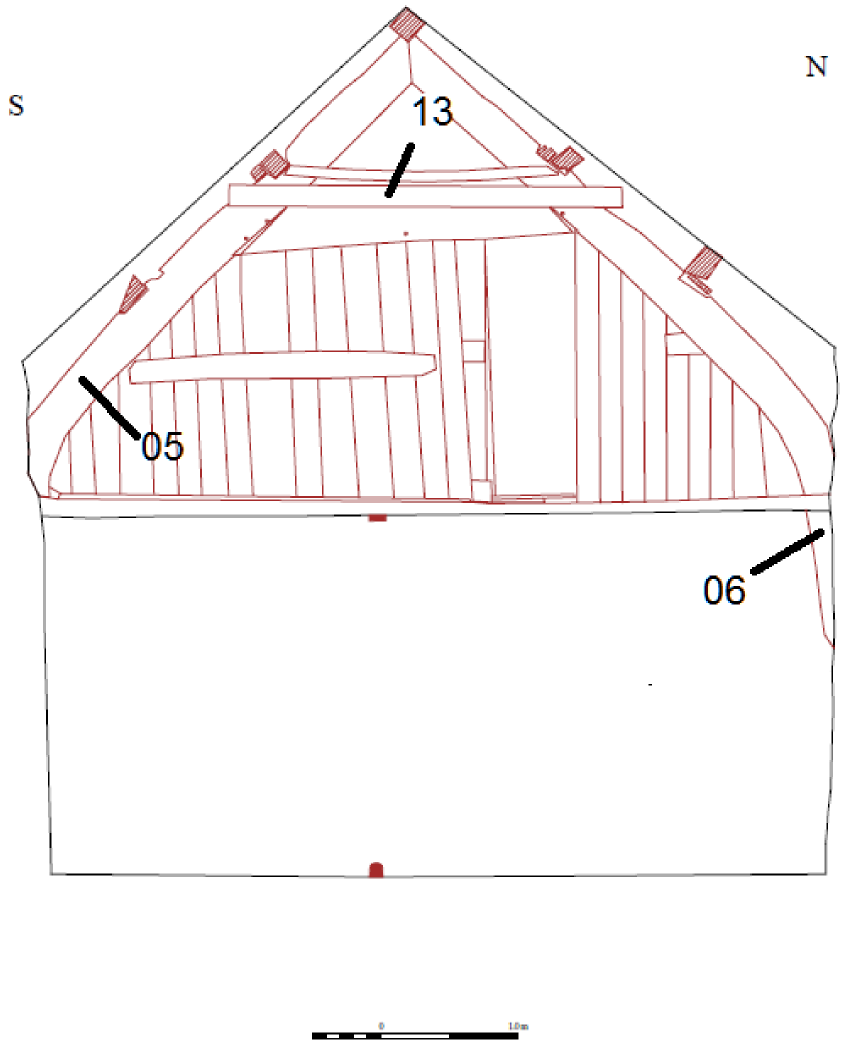

Figure 3: Drawing of Truss 3, showing the approximate locations of samples taken for dendrochronology, adapted from a drawing by Ian Brooks

Table 1: Details of samples taken from Bryn Dinas, Tywyn (trusses numbered west to east)

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
bds01	North purlin in west bay	-	-	15	55	1.63	0.58	0.30	-
bds02	North cruck, truss 1	-	-	31C	131	0.98	0.64	0.26	-
bds03	Inserted floor beam in west grd flr room	-	-	41C	105	1.07	0.44	**0.25**	-
bds04	W-E central beam inserted floor	-	-	H/S	60	2.03	0.64	0.26	-
bds05	South cruck, truss 3	-	-	H/S	64	2.18	1.32	0.29	-
bds06	North cruck, truss 3	-	-	H/S	59	2.45	1.70	0.25	-
bds07	East end ceiling beam, ground floor	-	-	9	38	2.74	0.73	0.28	-
***bds08**	W-E central beam inserted floor (same as **04**)	1505-1564	1558	6	60	1.98	1.00	0.27	1569–99
bds09	Ceiling beam over fireplace	-	-	24 (+6NM)	58	1.15	0.86	0.28	-
***bds10**	South ceiling beam	1494-1538	-	-	45	1.34	0.42	0.20	after 1549
***bds11**	East ceiling beam	1459-1556	1556	H/S (+25NM)	98	1.40	0.60	0.34	1581–86
bds12	Partition beam in passage, into chimney	-	-	-	<38	NM	-	-	-
***bds13**	Collar, truss 3	1452-1500	1500	H/S	49	2.82	0.84	0.24	1511–41
bds14	Lower north purlin in east end bay	-	-	H/S	<38	NM	-	-	-
* = included in site master **BRYNDNAS**		**1452-1564**			**113**	**1.82**	**0.58**	**0.26**	

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 the dated samples (values of *t* over 3.5 are significant)

	***t*-values**	
Sample	**bds10**	**bds11**
bds08	1.9	5.2
bds10		4.3

NB – bds11109 matches **13** with *t* = 4.9 (42 years overlap)

Table 3a: Dating evidence for the site sequence **bds13** **AD 1452–1500** against dated reference chronologies

County or region	*Chronology name*	*Reference*	*File name*	*Spanning*	*Overlap (yrs)*	*t-value*
Regional Chronologies						
Shropshire	Clungunford Master Chronology	(Miles 2002 unpubl)	**CLNGNFRD**	1273–1653	49	6.4
Wales/borders	Hillside oaks	(Siebenlist-Kerner 1978)	**GIERTZ**	1341–1636	49	5.4
Site Chronologies						
Radnorshire	Old Impton Norton	(Miles and Worthington 1998)	OLDIMTN2	1415–1542	49	7.8
Merioneth	Cefn Caer Pennal	(Miles and Worthington 1999)	CEFNCAR1	1404–1525	49	7.7
Shropshire	Stokesay Castle	(Miles and Worthington 1997)	STOKE4	1449–1640	49	7.4
Shropshire	Brook House, Lydbury North	(Miles *et al* 2007)	LYDBURY2	1412-1596	49	7.0
Montgomeryshire	Royal House, Machynlleth	(Miles *et al* 2004)	ROYALHS1	1363–1560	49	6.8
Herefordshire	Forbury Chapel, Leominster	(Arnold *et al* 2003)	HFCASQ01	1432–1520	49	6.7
Caernarvonshire	Y Gesail Gyfarch, Dolbenmaen	(Miles *et al* 2006)	BDGLRT6	1384–1609	49	6.5
Devon	Cricklepit Mill, Exeter	(Hillam 1993)	EXCPM8	1432–1526	49	6.4

Table 3b: Dating evidence for the site sequence **BRYNDNAS** **AD 1452–1564** against dated reference chronologies

County or region	*Chronology name*	*Reference*	*File name*	*Spanning*	*Overlap (yrs)*	*t-value*
Regional Chronologies						
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404–1981	113	5.4
Site Chronologies						
Merioneth	Cefn Caer Pennal	(Miles and Worthington 1999)	CEFNCAR1	1404–1525	74	8.0
Montgomeryshire	Royal House, Machynlleth	(Miles *et al* 2004)	ROYALHS1	1363–1560	109	7.4
Caernarvonshire	Y Gesail Gyfarch, Dolbenmaen	(Miles *et al* 2006)	BDGLRT6	1384–1609	113	6.6
Merioneth	Plas y Dduallt, Maentwrog	(Miles *et al* 2011)	GWYNEDD5	1355–1604	113	6.3
Merioneth	Cwrt Plas yn Dre	(Bridge *et al* 2013)	CWRTPLAS	1397–1508	57	6.0
Merioneth	Bron y Foel Isaf, Gwynedd	(Miles *et al* 2012)	BRONFOEL	1438–1578	113	5.8
Denbighshire	Coed-y-Foel, Derwen	(Bridge *et al* forthcoming)	COEDYFL	1436–1511	60	5.8
Shropshire	Stokesay Castle	(Miles and Worthington 1997)	STOKE4	1449–1640	113	5.7
Caernarvonshire	Parc, Llanfrothen	(Miles *et al* 2007)	BDGLRT22	1386–1669	113	5.6

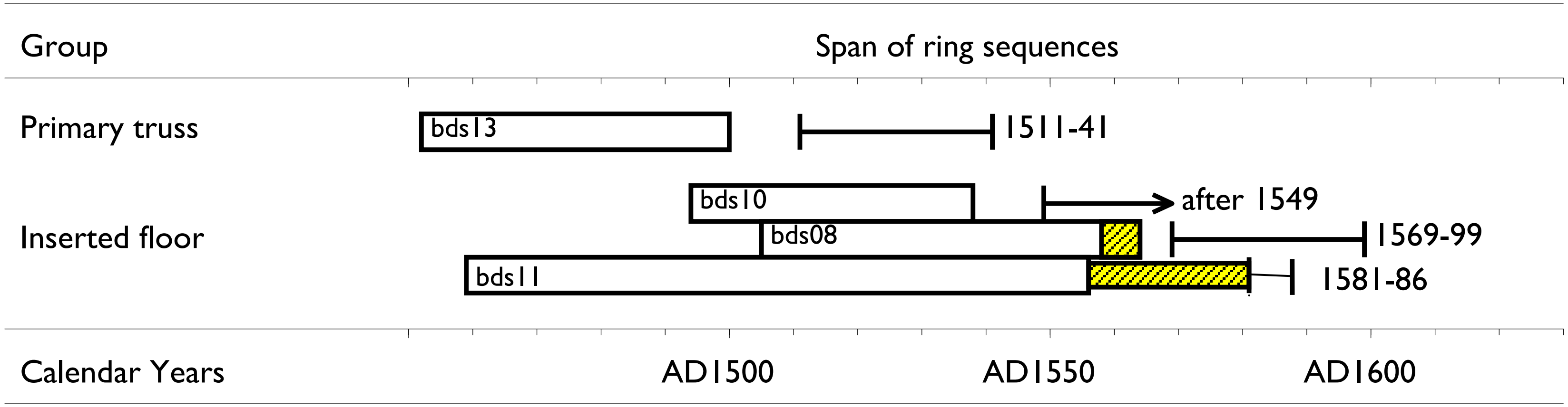

Figure 4: Bar diagram showing the relative positions of overlap of the dated timbers. White bars represent heartwood rings, yellow hatched sections represent sapwood, narrow sections represent additional unmeasured rings.