Oxford Dendrochronology Laboratory
Report 2007/16

Tree-ring Analysis of Timbers from Plas Tan y Bwlch , Snowdonia National Park Study Centre

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Summary:

MAENTWROG, Plas Tan y Bwlch: Rear East Wing (SH 655 406)

Rear East wing (re-used timbers) *Felling date ranges:* **1525-55** and **1536-61**
Floor beam 1516(2); Cill beam 1535(15); Floor joist (1503). *Site Master* 1411-1535 PTYB
(*t* = 7.8 CEFNCAR1; 7.7 WPGASQ04; 7.4 GWYDWN; 6.17 PENGWERN).

The three timbers used for this study were found re-used as lintels in the rear east wing of Plas Tan y Bwlch. The timbers matched together to form a 125-ring site master PTYB, which dated, spanning the years 1411-1535. Best matches were with a variety of master reference chronologies from North Wales, Northern Ireland and Cumbria. None of the timbers retained complete sapwood, but produced two felling date ranges of 1525-55 and 1536-61.

Date sampled: 2006

Owner & Commissioner: Snowdonia National Park

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TREE RING DATING AT PLAS TAN Y BWLCH, MAENTRWOG, GWYNEDD

Description of building

Plas Tan y Bwlch, Maentwrog, Gwynedd (SH 655 406) is a large mansion house, now used as the Snowdonia National Park Study Centre. The structural development of the house is complex, with many stages of re-building and enlargement. The present layout and facades are mainly due to major phases of building work carried out in the second half of the 19th century, but the main block incorporates an earlier probably mid-18th century house. This had an imposing three storey frontage and a rear wing also of three stories. The broad outlines of the later development of the house, from 1777 onwards, can be reconstructed with some confidence from a series of engravings, paintings and early photographs but evidence for the early house and its development is limited.

During the insertion of a lift shaft in 2005 several re-used oak timbers were recovered from lintels in blocked openings in all three floors of the rear east wing. Although the timbers were in what is now an internal wall, they had been used as window lintels, showing that this wall was originally the outside wall of the 18th century house. These timbers had first been used as the cill beam of a post and panel partition and as floor joists and so provided an opportunity for dating a pre-18th century phase of the building. The first house on this site has previously been thought to have been erected by Evan Evans in the early 17th century.

Sampling

All the samples were of oak, from structural timbers which had been cut down and re-used as lintels. The timbers were removed intact for the insertion of the lift shaft, so it was possible to record them and to cut two complete slices through each, to include the maximum number of sapwood rings (Figs. 1 and 2). One set of samples was submitted for dendrochronological measurement and one set is retained in the Plas Tan y Bwlch collection.

ptyb1 is a 2m length from a substantial beam, either for a floor or possibly used as a wall plate, 385mm x 130mm. It has rectangular notches for joists, along one side only, which are 190mm wide by 80mm high and only 70mm deep. Their spacing is rather irregular, on centres from 380 to 450mm.

ptyb2 is a 700mm length of a cill beam from a post and panel partition, which was only partly recovered. This has overall dimensions of 185 by 135mm. Neither of the recesses for the posts are complete, but they would appear to have been slightly larger than the 350mm wide panel.

ptyb3 is a 1.5m length of a floor joist, 150 x 120mm overall, with sloping chamfers on 450mm centres, probably the seatings for secondary floor joists, though there are no nail or peg holes. There is a deep 75mm square mortice on the bottom side, probably from a vertical stile. This timber had been heavily lime-washed.

How Dendrochronology Works

Dendrochronology has over the past 20 years become one of the leading and most accurate scientific dating methods. Whilst not always successful, when it does work, it is precise, often to the season of the year. Tree-ring dating is well known for its use in dating historic buildings and archaeological timbers to this degree of precision. However more ancillary objects such as doors, furniture, panel paintings, and wooden boards in medieval book-bindings can sometimes be successfully dated.

The science of dendrochronology is based on a combination of biology and statistics. Fundamental to understanding how dendrochronology works is the phenomenon of tree growth. Essentially, trees grow through the addition of both elongation and radial increments. The elongation takes place at the terminal portions of the shoots, branches, and roots, while the radial increment is added by the cambium, the zone of living cells between the wood and the bark. In general terms, a tree can be best simplified by describing it as a cone, with a new layer being added to the outside each year in temperate zones, making it wider and taller.

Fig 1: Sketch drawings of timbers from Plas Tan y Bwlch, showing sample locations (Scale 1:10)

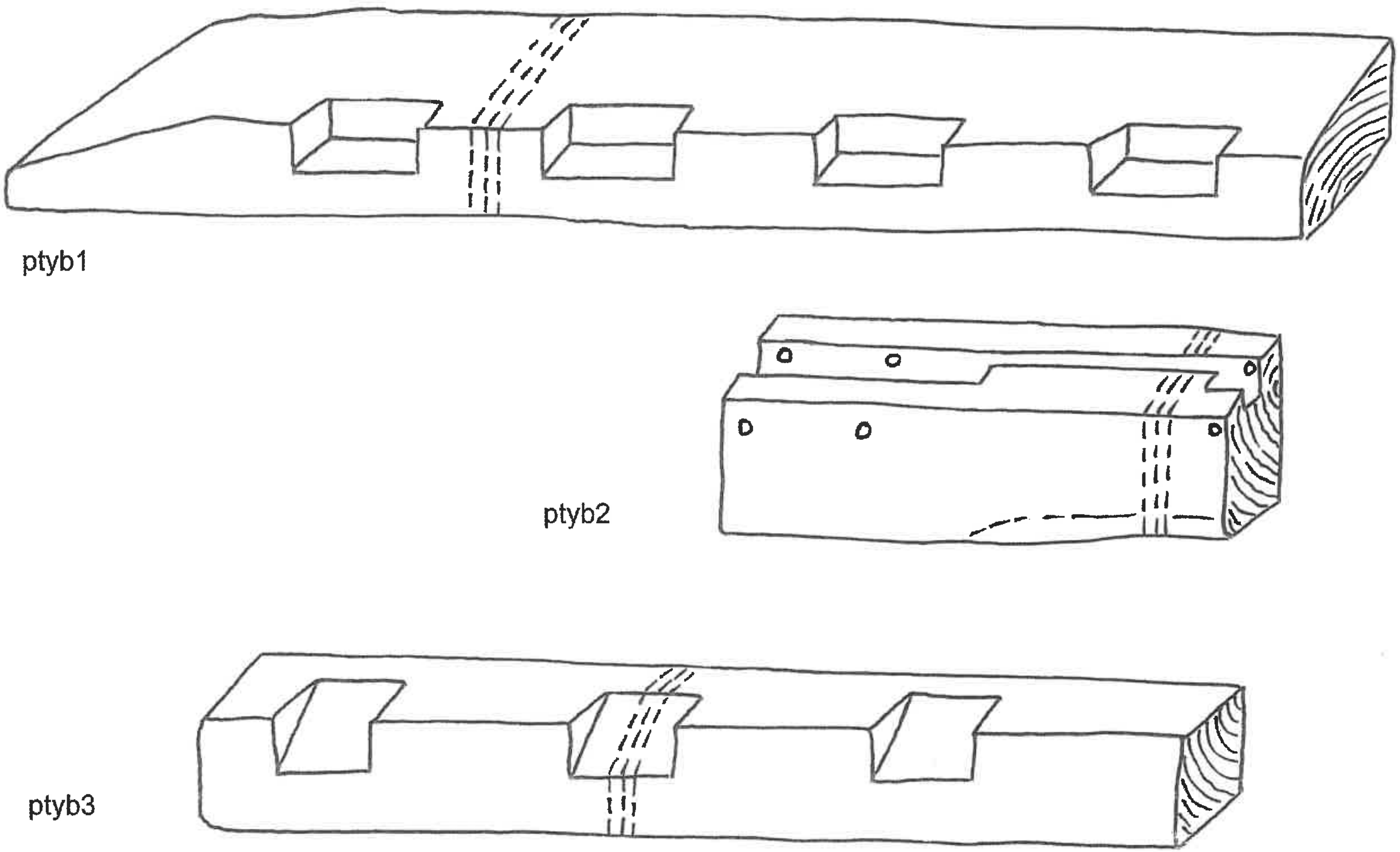


Fig 1: Cut sections of timbers from Plas Tan y Bwlch, (Scale 1:2)

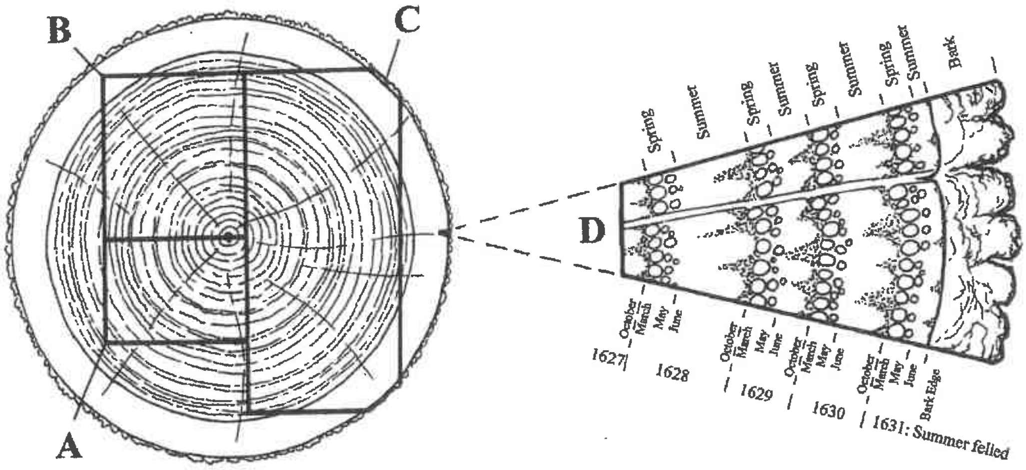
ptyb1

ptyb2

ptyb3

An annual ring is composed of the growth which takes place during the spring and summer until about November when the leaves are shed and the tree becomes dormant for the winter period. For the European oak (*Quercus robur* and *Q. petraea*), as well as many other species, the annual ring is composed of two distinct parts - the spring growth or early wood, and the summer growth, or late wood. Early wood is composed of large vessels formed during the period of shoot growth which takes place between March and May, which is before the establishment of any significant leaf growth, and is produced by using most of the energy and raw materials laid down the previous year. Then, there is an abrupt change at the time of leaf expansion around May or June when hormonal activity dictates a change in the quality of the xylem and the summer, or late wood is formed. Here the wood becomes increasingly fibrous and contains much smaller vessels. Trees with this type of growth pattern are known as ring-porous, and are distinguished by the contrast between the open, light-coloured early wood vessels and the dense, darker-coloured late wood.

Dendrochronology utilises the variation in the width of the annual rings as influenced by climatic conditions common to a large area, as opposed to other more local factors such as woodland competition and insect attack. It is these climate-induced variations in ring widths that allow calendar dates to be ascribed to an undated timber when compared to a firmly-dated sequence. If a tree section is complete to the bark edge, then when dated a precise date of felling can be determined. The felling date will be precise to the season of the year, depending on the degree of formation of the outermost ring. Therefore, a tree with bark which has the spring vessels formed but no summer growth can be said to be felled in the spring, although it is not possible to say in which particular month the tree was felled.



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)

Another important dimension to dendrochronological studies is the presence of sapwood. This is the band of growth rings immediately beneath the bark and comprises the living growth rings which transport the sap from the roots to the leaves. This sapwood band is distinguished from the heartwood by the prominent features of colour change and the blocking of the spring vessels with tyloses, the waste products of the tree's growth. The heartwood is generally darker in colour, and the spring vessels are blocked with tyloses. The heartwood is dead tissue, whereas the sapwood is living, although the only really living, growing, cells are in the cambium, immediately beneath the bark. In European oak (*Quercus robur* sp), the difference in colour is generally matched by the change in the spring vessels. Generally the sapwood retains stored food and is therefore attractive to insect and fungal attack once the tree is felled and therefore is often removed during conversion.

Sapwood in European oaks tends to be of a relatively constant width and/or number of rings. By determining what this range is with an empirically or statistically-derived estimate is a valuable aspect in the interpretation of tree-ring dates where the bark edge is not present (Miles 1997). The narrower this range of sapwood rings, the more precise the estimated felling date range will be.

Methodology: The Dating Process

All timbers sampled were of oak (*Quercus* spp.) as described above.

The dry samples were sanded on a linisher, or bench-mounted belt sander, using 60 to 1200 grit abrasive paper, and were cleaned with compressed air to allow the ring boundaries to be clearly distinguished. They were then measured under a x10/x30 microscope using a travelling stage electronically displaying displacement to a precision of 0.01mm. Thus each ring or year is represented by its measurement which is arranged as a series of ring-width indices within a data set, with the earliest ring being placed at the beginning of the series, and the latest or outermost ring concluding the data set.

The principle behind tree-ring dating is a simple one: the seasonal variations in climate-induced growth as reflected in the varying width of a series of measured annual rings is compared with other, previously dated ring sequences to allow precise dates to be ascribed to each ring. When an undated sample or site sequence is compared against a dated sequence, known as a reference chronology, an indication of how good the match is must be determined. Although it is almost impossible to define a visual match, computer comparisons can be accurately quantified. Whilst it may not be the best statistical indicator, Student's (a pseudonym for W S Gosset) *t*-value has been widely used amongst British dendrochronologists. The cross-correlation algorithms most commonly used and published are derived from Baillie and Pilcher's CROS programme (Baillie and Pilcher 1973), although a faster version (Munro 1984) giving slightly different t-values is sometimes used for indicative purposes.

Generally, *t*-values over 3.5 should be considered to be significant, although in reality it is common to find demonstrably spurious t-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, or higher, and for these to be well replicated from different, independent chronologies with local and regional chronologies well represented. Users of dates also need to assess their validity critically. They should not have great faith in a date supported by a handful of *t*-values of 3's with one or two 4's, nor should they be entirely satisfied with a single high match of 5 or 6. Examples of spurious *t*-values in excess of 7 have been noted, so it is essential that matches with reference chronologies be well replicated, and that this is confirmed with visual matches between the two graphs. Matches with *t*-values of 10 or more between individual sequences usually signify having originated from the same parent tree.

In reality, the probability of a particular date being valid is itself a statistical measure depending on the *t*-values. Consideration must also be given to the length of the sequence being dated as well as those of the reference chronologies. A sample with 30 or 40 years growth is likely to match with high *t*-values at varying positions, whereas a sample with 100 consecutive rings is much more likely to match significantly at only one unique position. Samples with ring counts as low as 50 may occasionally be dated, but only if the matches are very strong, clear and well replicated, with no other significant matching positions. This is essential for intra-site matching when dealing with such short sequences. Consideration should also be given to evaluating the reference chronology against which the samples have been matched: those with well-replicated components which are geographically near to the sampling site are given more weight than an individual site or sample from the opposite end of the country.

It is general practice to cross-match samples from within the same phase to each other first, combining them into a site master, before comparing with the reference chronologies. This has the advantage of averaging out the 'noise' of individual trees and is much more likely to obtain higher *t*-values and stronger visual matches. After measurement, the ring-width series for each sample is plotted as a graph of width against year on log-linear graph paper. The graphs of each of the samples in the phase under study are then compared visually at the positions indicated by the computer matching and, if found satisfactory and consistent, are averaged to form a mean curve for the site or phase. This mean curve and any unmatched individual sequences are compared against dated reference chronologies to obtain an absolute calendar date for each sequence. Sometimes, especially in urban situations, timbers may have come from different sources and fail to match each other, thus making the compilation of a site master difficult. In this situation samples must then be compared individually with the reference chronologies.

Therefore, when cross-matching samples with each other or against reference chronologies, a combination of both visual matching and a process of qualified statistical comparison by computer is used. 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.

Ascribing and Interpreting Felling Dates

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. For samples which have sapwood complete to the underside of, or including bark, this process is relatively straight forward. Depending on the completeness of the final ring, i.e. if it has only the early wood formed, or the latewood, a *precise felling date and season* can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an *estimated felling date range* can be given for each sample. The number of sapwood rings can be estimated by using a statistically derived sapwood estimate with a given confidence limit. A review of the geographical distribution of dated sapwood data from historic building timbers has shown that a 95% range of 11-41 rings is most appropriate for Wales (Miles 1997), which will be used here. If no sapwood or heartwood/sapwood boundary survives, then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or *felled after* date.

Some caution must be used in interpreting solitary precise felling dates. Many instances have been noted where timbers used in the same structural phase have been felled one, two, or more years apart. Whenever possible, a *group* of precise felling dates should be used as a more reliable indication of the *construction period*. It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure under study. However, it is common practice to build timber-framed structures with green or unseasoned timber and that construction usually took place within twelve months of felling (Miles 2006).

Details of Dendrochronological Analysis

The results of the dendrochronological analysis for the building under study are presented in a number of detailed tables. The most useful of these is the summary **Table 1**. This gives most of the salient results of the dendrochronological process, and includes details for each sample, its location, and its felling date or date range, if successfully tree-ring dated. This last column is of particular interest to the end user, as it gives the actual year and season when the tree was felled, if bark is present, or an estimated felling date range if the sapwood is incomplete. Occasionally it will be noted that the felling date ranges may not coincide with the precise felling dates. This is nothing to be overly concerned about so long as these are not too far apart. It must be remembered that the estimated felling date ranges are calculated at a 95% confidence level, which means that statistically one sample in 20 will have felling dates which actually fall *outside* the predicted range.

It will also be noticed that often the precise felling dates will vary within several years of each other. Unless there is supporting archaeological evidence suggesting different phases, all this would indicate is either stockpiling of timber, or of trees which have been felled or died at varying times but not cut up until the commencement of the particular building operations in question. When presented with varying precise felling dates, one should always take the *latest* date for the structure under study, and it is likely that construction will have been completed for ordinary vernacular buildings within twelve or eighteen months from this latest felling date (Miles 1997).

Table 2 gives an indication of the statistical reliability of the match between one sequence and another. This shows the *t*-value over the number of years overlap for each combination of samples in a matrix table. It should be born in mind that *t*-values with less than 80 rings overlap may not truly reflect the same degree of match and that spurious matches may produce similar values.

First, multiple radii have been cross-matched with each other and combined to form same-timber means. These are then compared with other samples from the site and any which are found to have originated from the same parent tree are again similarly combined. Finally, all samples, including all same timber and same tree means are combined to form one or more site masters. Again, the cross-matching is shown as a matrix table of *t*-values over the number of years overlaps. Reference should always be made to **Table 1** to clearly identify which components have been combined.

Table 3 shows the degree of cross-matching between the site master(s) with a selection of reference chronologies. This shows the county or region from which the reference chronology originated, the common chronology name together with who compiled the chronology with publication reference and the years covered by the reference chronology. The years overlap of the reference chronology and the site master being compared are also shown together with the resulting *t*-value. It should be appreciated that well replicated regional reference chronologies, which are shown in **bold**, will often produce better matches than with individual site masters or indeed individual sample sequences.

Tables 4 and 5 give the ring width data for the PTYB site master and for the individual samples.

Publication of all dated sites are published in *Vernacular Architecture* annually, and the entry, if available, is shown on the summary page of the report. This does not give as much technical data for the samples dated, but does give the *t*-value matches against the relevant chronologies, provide a short descriptive paragraph for each building or phase dated, and gives a useful short summary of samples dated. These summaries are also listed on the web-site maintained by the Laboratory, which can be accessed at www.dendrochronology.com. The Oxford Dendrochronology Laboratory retains copyright of this report, but the commissioner of the report has the right to use the report for his/her own use so long as the authorship is quoted. Primary data and the resulting site master(s) used in the analysis is available from the Laboratory on request by the commissioner and bona fide researchers. The samples form part of the Laboratory archives.

Summary of Dating

The three timbers from Plas Tan y Bwlch matched together to form a 125-ring site master PTYB, which dated, spanning the years 1411-1535. Best matches were with a variety of master reference chronologies from North Wales, Northern Ireland and Cumbria. None of the timbers retained complete sapwood, but produced two felling date ranges of 1525-55 (ptyb1) and 1536-61 (ptyb2). In the latter case the sample retained what appeared to be almost complete sapwood, with little lost to the bark edge, and so the likely felling date could be in the early part of this range.

Interpretation

The dendrochronological results suggest that all three timbers are from a single phase of construction which was probably shortly after the felling of the timbers in the mid-16th century. This is considerably earlier than expected and it suggests that the timbers may have derived from a structure built by Robert ap Ievan ap Iorwerth, who died *circa.* 1568 (Hughes 1989, 6).

There is no indication of where this structure was located but the topography of the site suggests that it was probably on the same alignment as the present east frontage, giving a hall building of some 18m by 6m. However, it is also possible that these timbers could have derived from a structure elsewhere on the estate.

Acknowledgements

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Table 1: Summary of Tree-Ring Dating

SNOWDONIA NATIONAL PARK

PLAS TAN Y BWLCH

Sample number & type		Timber and position	Dates AD spanning	H/S bdry	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens mm	Felling seasons and dates/date ranges (AD)
Timbers Re-used as Lintels in East Wing										
ptyb1	s	Floor beam	1442-1516	1514	2	75	2.48	0.74	0.278	1525-55
ptyb2	s	Cill beam for in-and-out partition	1426-1535	1530	15	110	1.51	0.69	0.218	1536-61
ptyb3	s	Floor joist	1411-1503			93	1.77	0.70	0.212	After 1514
PTYB		**Mean of ptyb1 + ptyb2 + ptyb3**	**1411-1535**			**125**	**1.84**	**0.65**	**0.211**	

Key: *, †, § = sample included in site-master; c = core; mc = micro-core; s = slice/section; g = graticule; p = photograph; ¼C, ½C, C = bark edge present, partial or complete ring: ¼C = spring (last partial ring not measured), ½C = summer/autumn (last partial ring not measured), or C = winter felling (ring measured); H/S bdry = heartwood/sapwood boundary - last heartwood ring date; std devn = standard deviation; mean sens = mean sensitivity

Explanation of terms used in Table 1

The summary table gives most of the salient results of the dendrochronological process. For ease in quickly referring to various types of information, these have all been presented in Table 1. The information includes the following categories:

Sample number: Generally, each site is given a two or three letter identifying prefix code, after which each timber is given an individual number. If a timber is sampled twice, or if two timbers were noted at time of sampling as having clearly originated from the same tree, then they are given suffixes '**a**', '**b**', etc. Where a core sample has broken, with no clear overlap between segments, these are differentiated by a further suffix '**1**', '**2**', etc.

Type shows whether the sample was from a core 'c', or a section or slice from a timber's'. Sometimes photographs are used 'p', or timbers measured *in situ* with a graticule 'g'.

Timber and position column details each timber sampled along with a location reference. This will usually refer to a bay or truss number, or relate to compass points or to a reference drawing.

Dates AD spanning gives the first and last measured ring dates of the sequence (if dated),

H/S bdry is the date of the heartwood/sapwood transition or boundary (if present). This date is critical in determining an estimated felling date range if the sapwood is not complete to the bark edge.

Sapwood complement gives the number of sapwood rings. The tree starts growing in the spring during which time the earlywood is produced, also known also as spring growth. This consists of between one and three decreasing spring vessels and is noted as *Spring* felling and is indicated by a ¼ C after the number of sapwood ring count. . Sometimes this can be more accurately pin-pointed to very early spring when just a few spring vessels are visible. After the spring growing season, the latewood or summer growth commences, and is differentiated from the proceeding spring growth by the dense band of tissue. This summer growth continues until just before the leaves drop, in about October. Trees felled during this period are noted as *summer* felled (½ C), but it is difficult to be too precise, as the width of the latewood can be variable, and it can be difficult to distinguish whether a tree stopped growing in autumn or *winter*. When the summer growth band is clearly complete, then the tree would have been felled during the dormant winter period, as shown by a single C. Sometimes a sample will clearly have complete sapwood, but due either to slight abrasion at the point of coring, or extremely narrow growth rings, it is impossible to determine the season of felling.

Number of rings: The total number of measured rings present on the samples analysed.

Mean ring width: This, simply put, is the sum total of all the individual ring widths, divided by the number of rings, giving an average ring width for the series.

Mean sensitivity: A statistic measuring the mean percentage, or relative, change from each measured yearly ring value to the next; that is, the average relative difference from one ring width to the next, calculated by dividing the absolute value of the differences between each pair of measurements by the average of the paired measurements, then averaging the quotients for all pairs in the tree-ring series (Fritts 1976). Sensitivity is a dendrochronological term referring to the presence of ring-width variability in the radial direction within a tree which indicates the growth response of a particular tree is "sensitive" to variations in climate, as opposed to complacency.

Standard deviation: The mean scatter of a population of numbers from the population mean. The square root of the variance, which is itself the square of the mean scatter of a statistical population of numbers from the population mean. (Fritts 1976).

Felling seasons and dates/date ranges is probably the most important column of the summary table. Here the actual felling dates and seasons are given for each dated sample (if complete sapwood is present). Sometimes it will be noticed that often the precise felling dates will vary within several years of each other. Unless there is supporting archaeological evidence suggesting different phases, all this would indicate is either stockpiling of timber, or of trees which have been felled or died at varying times but not cut up until the commencement of the particular building operations in question. When presented with varying precise felling dates, one should always take the *latest* date for the structure under study, and it is likely that construction will have been completed for ordinary vernacular buildings within twelve or eighteen months from this latest felling date (Miles 2006).

Felling date ranges are produced using an empirical estimates using the appropriate estimate (Miles 1997). However, these can sometimes be reduced using a new sapwood estimation methodology which uses the mean ring width, number of heartwood rings, known H/S boundary date, and the number of surviving sapwood rings, if present (Miles 2006). These are used after the empirical range and are shown in brackets (OxCal followed by date range). Combined felling date ranges for a phase of building is shown at the end of the phase to which it relates.

Table 2: Matrix of *t*-values and overlaps for the site master

Components of site master **PTYB**

Sample: *Last ring date AD:*	**ptyb2** 1535	**ptyb3** 1503
ptyb1	2.38 75	6.85 62
	ptyb2	3.17 78

Table 3: Dating of site master **PTYB** (1411-1535) against reference chronologies at 1535

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
Wales	Y Gesail Gyfarch, Dolbenmaen	(Miles *et al* 2006)	BDGLRT6	1384-1609	125	4.93
Wales	Ffridd-isaf, Betws Garmon	(Miles *et al* 2006)	BDGLRT1	1423-1599	113	5.80
Wales	Beddgelert, Snowdonia	(Nayling *pers comm*)	BEDD_T6	1302-1529	119	6.04
Wales	St Idloes Church, Llanidloes	(Miles *et al* 2003)	LNYDLOS2	1384-1593	125	6.17
Wales	Ty-mawr, Nantmor	(Miles *et al* 2006)	BDGLRT3	1425-1528	104	6.19
Wales	Pengwern Old Hall, Ffestiniog	(Miles *et al* 2003)	PENGWERN	1353-1521	111	6.17
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881-1745	125	6.42
Lancashire	Worden Old Hall, Chorley	(Bridge 2003)	OLDWORD2	1415-1531	117	7.14
Wales	Royal House, Machynlleth	(Miles *et al* 2004)	ROYALHS1	1363-1560	125	7.16
Wales	Bwthyn Cae-glas, Llanfrothen	(Miles *et al* 2006)	BDGLRT7	1386-1547	125	7.21
Northern Ireland	Belfast Master Chronology	(Baillie 1977)	**BELFAST**	1001-1970	125	7.31
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411-1571	125	7.44
Cumbria	Wetheral Priory Gatehouse	(Arnold *et al* 2004)	WPGASQ04	1410-1511	101	7.71
Wales	Cefn Caer Pennel	(Miles and Worthington 1999)	CEFNCAR1	1404-1525	115	7.84

Table 4: Ring width data for site master **PTYB**, AD 1411 – 1535. Plas Tan y Bwlch, Maentwrog, Gwynedd - reused timbers from rear E wing. Mean of samples **ptyb1** + **ptyb2** + **ptyb3**, 125 rings starting data AD 1411

Ring widths (0.01mm)

162	216	254	171	210	221	283	302	122	402
331	239	250	189	241	376	228	284	305	290
289	311	272	262	269	197	204	185	134	153
188	188	262	282	259	175	170	190	185	134
175	179	159	248	169	222	196	234	193	253
241	148	219	126	155	225	259	222	166	133
116	82	101	154	220	235	183	149	157	113
139	97	151	170	191	187	212	182	189	182
147	153	111	166	208	226	202	179	139	170
158	153	149	197	208	258	149	195	171	156
262	166	162	195	173	179	109	101	147	122
140	129	132	99	99	85	91	88	62	73
65	48	91	97	81					

Number of samples in master

1	1	1	1	1	1	1	1	1	1
1	1	1	1	1	2	2	2	2	2
2	2	2	2	2	2	2	2	2	2
2	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3
3	3	3	2	2	2	2	2	2	2
2	2	2	2	2	2	1	1	1	1
1	1	1	1	1	1	1	1	1	1
1	1	1	1	1					

Table 5: Ring width data for ptyb1, ptyb2 and ptyb3. Ring widths at 0.01mm.

ptyb1 75 rings, including 2 sapwood rings <1442-1516>

243 336 402 307 204 203 222 167 106 183
181 136 296 199 281 251 293 236 277 319
168 276 149 146 282 349 247 176 133 122
082 130 170 304 339 268 225 272 145 205
142 251 273 287 285 291 290 358 295 190
263 151 294 373 353 397 313 219 308 263
253 210 266 271 404 226 282 232 227 383
213 200 285 238 263

ptyb2 110 rings, including 15 sapwood rings (nearly complete) <1426-1535>

427 241 322 363 305 297 348 296 241 274
160 184 160 104 134 159 110 219 201 220
177 161 125 186 170 160 151 184 225 141
180 174 221 184 297 205 125 172 106 173
182 192 173 124 080 093 082 091 139 213
212 176 125 089 102 124 084 106 124 164
171 211 160 134 160 153 103 120 127 156
207 110 104 100 078 086 107 112 128 144
111 072 108 110 084 140 119 123 104 107
094 109 101 147 122 140 129 132 099 099
085 091 088 062 073 065 048 091 097 081

ptyb3 93 rings, including pith but no sapwood <1411-1503>

162 216 254 171 210 221 283 302 122 402
331 239 250 189 241 324 215 246 247 274
281 274 247 283 263 233 223 210 164 171
217 211 230 244 249 143 145 224 201 127
183 206 156 223 168 204 163 187 160 185
199 152 210 122 145 212 235 247 197 185
133 082 081 153 142 154 106 098 110 092
088 065 096 113 121 105 133 096 076 090
098 092 062 076 096 119 100 119 097 123
125 099 126

TREE RING DATING AT PLAS TAN Y BWLCH, MAENTRWOG, GWYNEDD

(1) INTRODUCTION AND OBJECTIVES

Plas Tan y Bwlch, Maentwrog, Gwynedd (SH 655 406) is a large mansion house, now used as the Snowdonia National Park Study Centre. The structural development of the house is complex, with many stages of re-building and enlargement. The present layout and facades are mainly due to major phases of building work carried out in the second half of the 19th century, but the main block incorporates an earlier probably mid-18th century house. This had an imposing three storey frontage and a rear wing also of three stories. The broad outlines of the later development of the house, from 1777 onwards, can be reconstructed with some confidence from a series of engravings, paintings and early photographs but evidence for the early house and its development is limited.

During the insertion of a lift shaft in 2005 several re-used oak timbers were recovered from window lintels in all three floors of what is now an internal wall, but which was originally the outside wall of the 18th century house. These timbers had first been used as the cill beam of a post and panel partition and as floor joists and so provided an opportunity for dating a pre-18th century phase of the building. The first house on this site has previously been thought to have been erected by Evan Evans in the early 17th century.

(2) SAMPLING

All the samples were of oak, from structural timbers which had been cut down and re-used as lintels. The timbers were removed intact for the insertion of the lift shaft, so it was possible to record them and to cut complete slices through each one for dendrochronological purposes.

ptyb1 is a 2m length from a substantial beam, probably used as a wall plate, 385mm x 130mm. It has rectangular notches for floor joists, along one side only, which are 190mm wide by 80mm high and only 70mm deep. Their spacing is rather irregular, on centres from 380 to 450mm.

ptyb2 is a 700mm length of a cill beam from a post and panel partition, which was only partly recovered. This has overall dimensions of 185 by 135mm. Neither of the recesses for the post or panel are complete, but they would appear to have been of similar width.

ptyb3 is a 1.5m length of a floor joist, 150 x 120mm overall, with sloping chamfers on 450mm centres, probably the seatings for secondary floor joists. There is a deep 75mm square mortice on the bottom side, probably from a vertical stile. This timber had been heavily lime-washed.

(3) METHODOLOGY

(4) PRELIMINARY RESULTS

ptyb1: 75 rings spanning the years 1442 - 1516, with 2 sapwood rings, giving a felling date range of 1525 - 1555

ptyb2: 110 rings spanning the years 1426 - 1535, with 15 sapwood rings, giving a felling date of 1536 - 1561. As this sample retained what appeared to be almost complete sapwood, with little lost to the bark edge, the likely felling date should be in the early part of this range.

ptyb3: 93 rings spanning the years 1411 - 1504, with no sapwood rings or HW/SW boundary, so only a terminus post quem of after 1514 can be given for this timber.

These results suggest that all three timbers were contemporary and were felled in 1536 or shortly afterwards.

(5) CONCLUSIONS

The dendrochronological results suggest that all three timbers are from a single phase of construction which was probably shortly after the felling of the timbers in the late 1530's. This is considerably earlier than expected and it suggests that the timbers derive from a structure built by Robert ap Ievan ap Iorwerth, who died circa. 1568 (Hughes 1989, 6).

There is no indication of where this structure was located but the topography of the site suggests that it could probably have been on the same alignment as the present east frontage, giving a building some 18m by 6m. However, it is also possible that these timbers could have derived from a structure elsewhere on the estate.

(6) ACKNOWLEDGEMENTS

(7) REFERENCES

Hughes, G., *House on a Hill: a history of Plas Tan y Bwlch and the Maentwrog valley.* Friends of Tan y Bwlch, 1989.