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Oxford Dendrochronology Laboratory
Report 2011/**

THE DENDROCHRONOLOGICAL INVESTIGATION OF MATHAN HOUSE, STRYD PENLAN PWLLHELI GWYNEDD (NGR SH 374 352)

Draft 13/10/11

Summary
Eleven samples were taken from this building, eight from the main range roof, and three from the south-west extension to the roof. Eight samples matched each other, six from the main roof and two from the extension, suggesting that the two roofs are contemporaneous. These eight sequences were combined into a 93-year long site chronology. This however failed to match against a range of dated reference material, and for the present remains undated.

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

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A report commissioned by The North West Wales Dendrochronology Project in partnership with The Royal Commission on the Ancient and Historical Monuments in Wales (RCAHMW).

The Dendrochronological Investigation of Mathan House, Stryd Penlan, Pwllheli, Gwynedd

(NGR SH 374 352)

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.

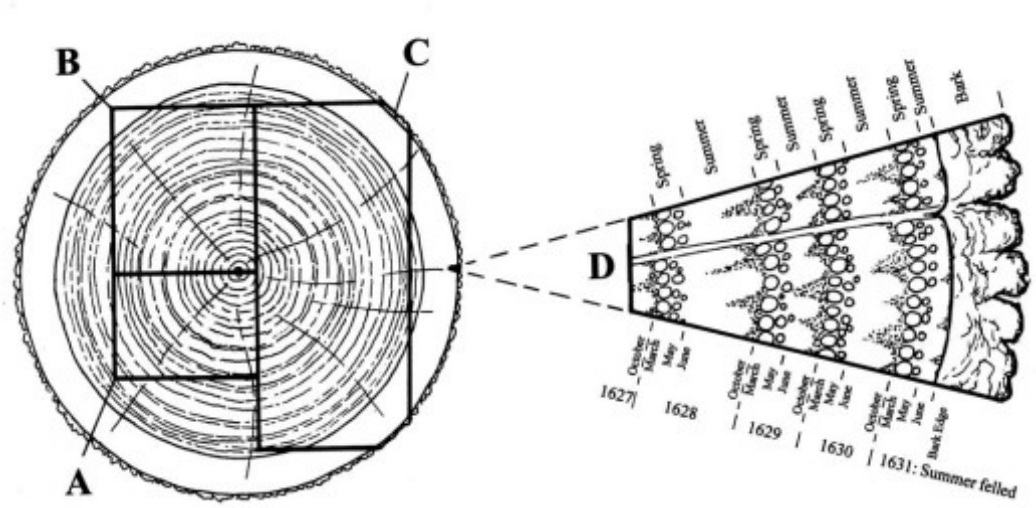
One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence 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 1997a, 42)

MATHAN HOUSE

To be inserted
The main roof has two rows of purlins, the south-west roof is a single-purlin roof.

SAMPLING

Sampling took place in July 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 **pmh**. 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.

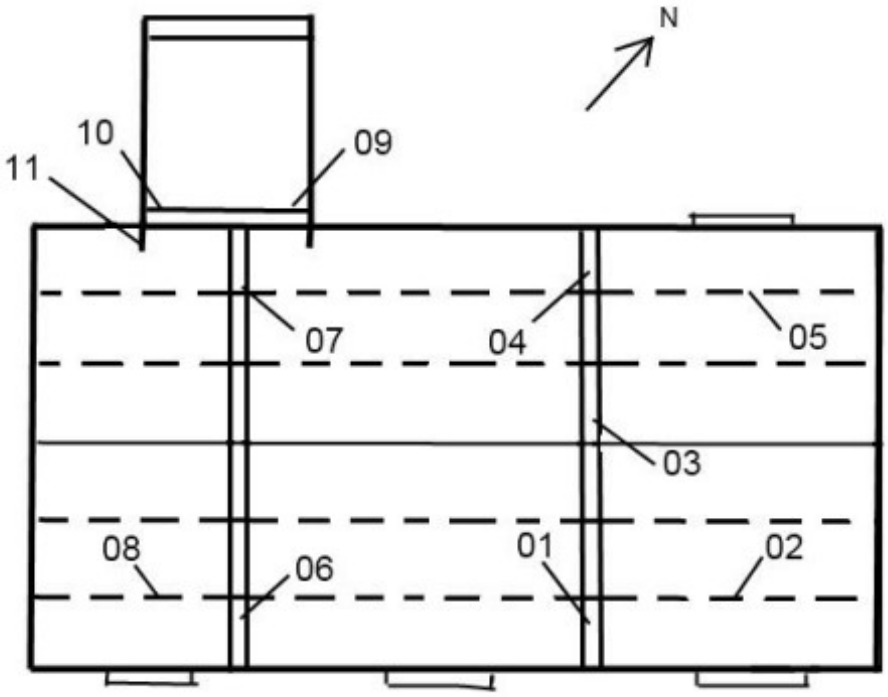


Figure 1: Sketch-plan of Mathan House roof showing the approximate positions of timbers sampled

RESULTS AND DISCUSSION

Basic information about the samples and their origins are shown in Table 1, and illustrated in Figure 1. Sample **07** was found to have a knot in it and only the outer rings were measured, denoted as **07o**. Eight of the series were found to cross-match with each other (Table 2), including six from the main roof and

two from the south-west rood adjoining it. The remaining three series did not give satisfactory matches against the others, nor did they date independently. The matching sequences were combined to form a 93-year site master, **MATHAN1**. This failed to give replicated acceptable matches against independent dated reference material, and remains undated. Three samples in the site master retained complete sapwood. As shown by the relative positions of overlap (Figure 2), these were from trees felled over a ten year period. This is an unusual situation, and may represent a collection of samples from several sources.

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Table 1: Details of samples taken from Mathan House (site north is taken as the right hand side of the house).

Sample number	Timber and position	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens	Felling date range (relative years)
* **pmh01**	East principal rafter, N truss	26C	88	1.28	0.63	0.23	Winter 93/94
pmh02	North-east lower purlin	10	76	1.52	0.42	0.20	-
* **pmh03**	Collar, N truss	19C	82	1.27	0.62	0.26	Winter 85/86
pmh04	West principal rafter, north truss	10C	88	1.51	0.41	0.22	-
* **pmh05**	North-west lower purlin	H/S	72	1.46	0.82	0.25	83-113
* **pmh06**	East principal rafter, south truss	C	60+20NM	1.55	0.41	0.29	Winter 95/96
* **pmh07o**	West principal rafter, south truss	H/S	36	0.91	0.37	0.36	81-111
* **pmh08**	South-east lower purlin	H/S	68	1.56	1.02	0.26	85-115
South-west extension to main roof							
* **pmh09**	North principal rafter, east truss	H/S	62+17NM	1.11	0.51	0.25	88-111
pmh10	South principal rafter, east truss	14	44	1.43	0.35	0.22	-
pmh11i	South purlin	-	*31*	*0.83*	*0.39*	*0.32*	
pmh11ii	*ditto*	*2*	*34*	*0.96*	*0.29*	*0.24*	
* **pmh11**	Mean of **11a** and **11b**	2	58	0.91	0.36	0.29	86-116
* = included in Site Master **MATHAN1**			**93**	**1.37**	**0.67**	**0.19**	**-**

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; C = complete sapwood, winter felled; std devn = standard deviation; mean sens = mean sensitivity; NM = not measured;

Table 2: Cross-matching between the roof samples

	***t*-values**						
Sample	**pmh03**	**pmh05**	**pmh06**	**pmh07o**	**pmh08**	**pmh09**	**pmh11**
pmh01	5.6	3.4	4.0	2.6	4.7	3.1	1.6
pmh03		4.5	8.2	3.8	4.1	5.8	4.2
pmh05			6.3	4.4	3.2	3.6	3.3
pmh06				6.6	3.5	6.8	4.6
pmh07o					2.7	3.1	4.3
pmh08						3.8	2.2
pmh09							3.7

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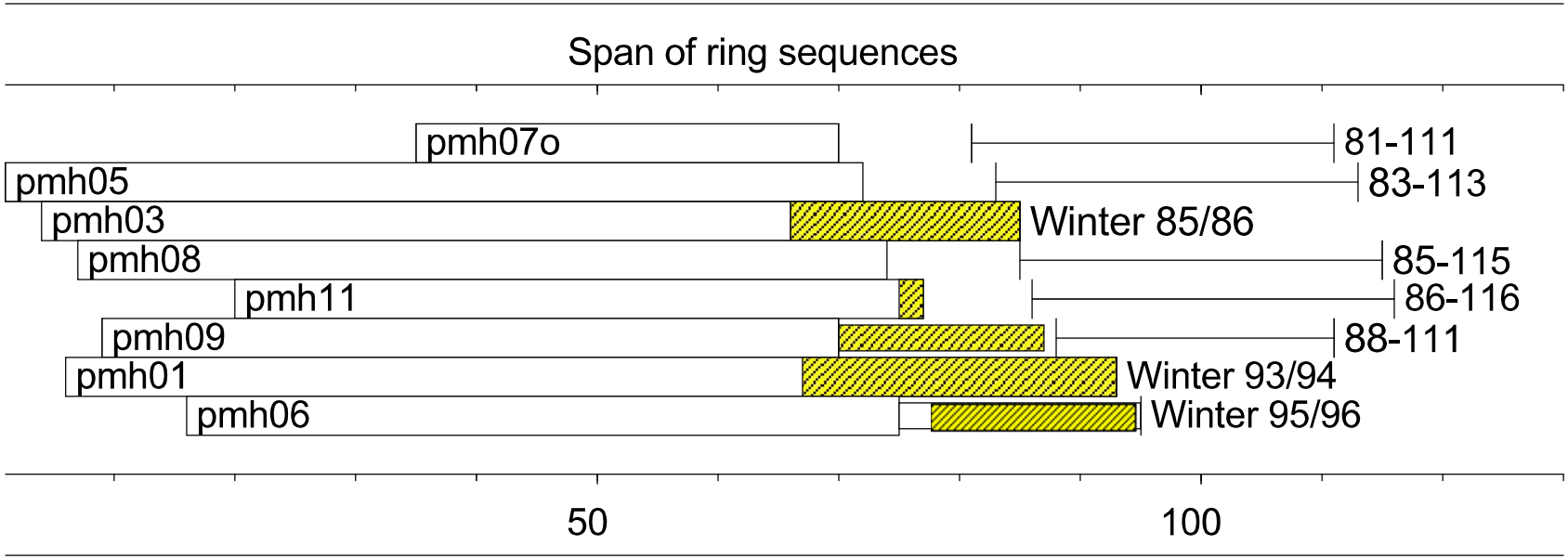

Figure 2: Bar diagram showing the relative positions of overlap of the dated series, along with their interpreted likely felling date ranges. Hatched yellow sections represent sapwood rings, and narrow sections of bar represent additional unmeasured rings