Oxford Dendrochronology Laboratory
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THE DENDROCHRONOLOGICAL INVESTIGATION OF PLAS PENMYNYDD, LLANGEFNI, ANGLESEY (NGR SH 496 752)

Summary

Six timbers in the roof and one ground floor ceiling beam were sampled, all of which were thought to date to a known building phase of 1576. Matches were found between three timbers (two from the roof and the ceiling beam), all of which were felled in the same year, but none of the series were dated. All series exhibited high sensitivity (year-to-year ring width variation).

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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 1997a).

PLAS PENMYNEDD

An interesting property associated with Owain Tudur (Owen Tudor), grandfather to Henry VII. Much of the current building is thought to relate to 1576 or later, though some timbers at ground floor level at the west end may date from an earlier period. The roof comprises four trusses.

SAMPLING

Sampling took place in August 2010. 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 **pmd**. 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. Measurements and subsequent analysis were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

RESULTS AND DISCUSSION

Details of the samples and their locations are given in Table 1. The series are all quite sensitive (i.e. they show high year-to-year ring width variation). Cross-matching individual series resulted in one good match between all the possible pairs of series, **pmd1** and **pmd2** (t = 5.9 with 72 years overlap). The combined mean formed from these two samples (**pmd21m**) matches against **pmd7** (t = 5.1 with 116 years overlap). A working site master **pmd127** failed to give acceptable consistent matching against references chronologies, as did all the individual series measured at this site, and the samples therefore remain undated. The relative positions of overlap of the three samples, shown in Figure 1, show that they were all felled in the same year, proving that the main central beam in the main ground floor room is of the same date as the roof timbers in this part of the house.

It is perhaps not surprising that such sensitive series do not date. The trees must have grown in a site with an unusual micro-environment. It may be that as more sites on Anglesey are dated, it will be possible to date these samples in the future.

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Table 1: Details of samples taken from Plas Penmynedd, Llangefni, Anglesey. Trusses numbered from the East end

Sample number	Timber and position	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens
pmd01	S principal rafter, truss 1	23 (+8NM)	72	1.35	0.56	0.26
pmd02	N principal rafter, truss 3	25?C	122	1.21	0.73	0.26
pmd03	S principal rafter, truss 3	5	47	1.22	0.67	0.31
pmd04	Tiebeam, truss 1	1	79	1.83	1.13	0.33
pmd05	Tiebeam, truss 2	16?C	33	2.71	1.26	0.48
pmd06	Tiebeam, truss 3	7	97	1.49	0.40	0.19
pmd07	Central ceiling beam, main GFlr room	39½C	116	1.16	0.70	0.26
pmd127	Mean of **01** + **02** + **07**	-	122	1.29	0.65	0.22

Key: H/S bdry = heartwood/sapwood boundary - last heartwood ring date; std devn = standard deviation; mean sens = mean sensitivity; C = bark edge present, winter felled; ½ C = bark edge, felled the following winter; NM = not measured.

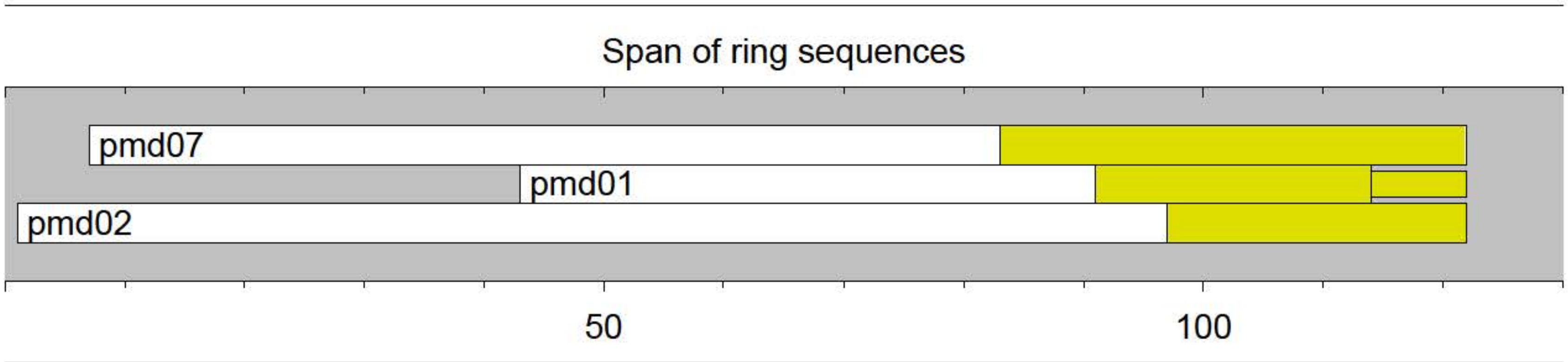

Figure 1: Bar diagram showing the relative positions of overlap of the three matched series, showing that they all have the same felling date