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Oxford Dendrochronology Laboratory
Report 2023/24

THE DENDROCHRONOLOGICAL DATING OF HAFOD YR AFR, CYNWYD DENBIGHSHIRE (MERIONETH)

(SJ 06680 42370)

Summary

Two crucks from the primary phase have a combined likely felling date range of 1522–52, while a beam in the service range has a heartwood/sapwood boundary date of 1522, suggesting a slightly later felling date range of 1533–1563. However, there is no evidence that the house ever functioned as an open hall, being floored very rapidly with a large chimney at one end.

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October 2023

The Dendrochronological Dating of Hafod yr Afr, Cynwyd, Denbighshire (Merioneth) (SJ 06680 42370)

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.

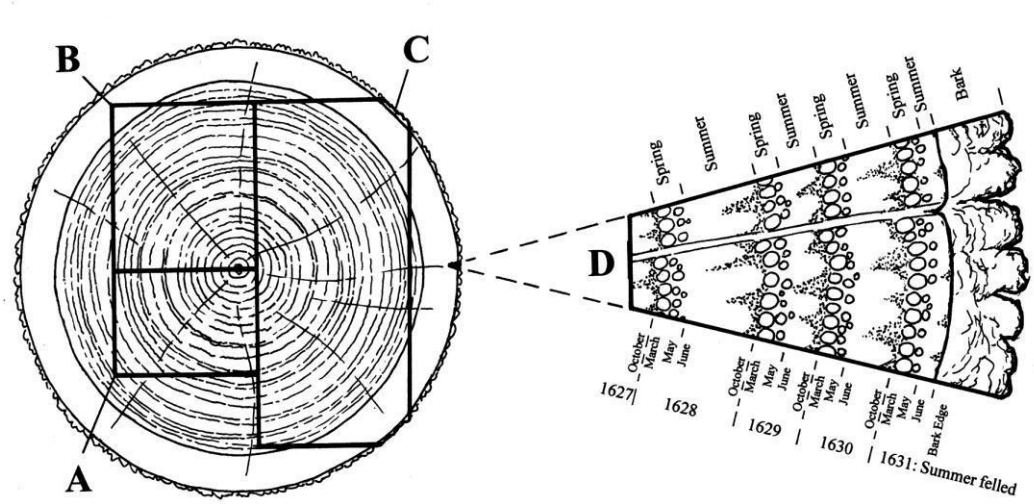
The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation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

Hafod yr Afr (NPRN 28477)

Hafod yr Afr is a farmhouse near Cynwyd in the Upper Dee Valley, in the historic county of Merioneth, North-East Wales.

The house evolved over a number of phases, with the earliest dating to the mid-16th century. At this time, the house was constructed as a cruck hall house with a two-bay central hall with service and parlour bays to either end. The house appears to have never functioned as an open hall; evidence suggests it was floored, almost immediately, into a storeyed dwelling, with a large chimney constructed at the lower end of the house. By 1800, the house had undergone significant change, with the two downhill bays converted into a double-fronted house, with up-hill byre.

It was recorded in on the Crucks (map 12), Cusping in roof trusses (map 20), and Ornate open roofs (map 43) in *Houses of the Welsh Countryside* (Smith, 1988).

SAMPLING

Sampling took place in June 2023. Samples were labelled (prefix **hya**) 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), with additional software written by Dr Chris Bridge.

RESULTS AND DISCUSSION

Details of the samples are given in Table 1. Three of the series measured dated independently (Tables 3 a,b,c) but did not match each other well (Table 2). Plots of the series (Fig 1) do however show broad similarities in growth, and they were combined into a single 134-year long site chronology, which dated well against a range of sites from both Wales and England (particularly nearby Shropshire). The matching positions and likely felling date ranges are shown in Figure 2.

Two crucks from the primary phase have a combined likely felling date range of 1522–52, while a beam in the service range has a heartwood/sapwood boundary date of 1522, suggesting a slightly later felling date range of 1533–1563.

ACKNOWLEDGEMENTS

This study was commissioned by Discovering Old Welsh Houses group. We are very grateful to the owners of the individual dwellings for support during fieldwork and to martin Cherry for making the arrangements.

We thank our fellow dendrochronologists for permission to use their data.

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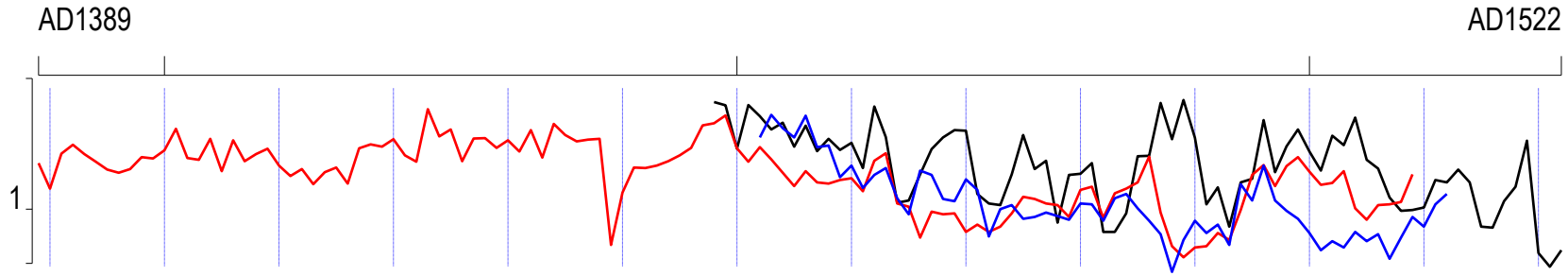

Figure 1: Plots of the three dated samples against each other, showing the large variation in growth patterns, *x*-axis time (yrs), *y*-axis ring width (mm) on a logarithmic scale

Table 1: Details of samples from Hafod yr Afr, Cynwyd

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 (AD)
hya01i	Transverse beam in kitchen (inner rings)	-	-	h/s	77	1.64	0.72	0.21	-
hya01ii	Transverse beam in kitchen (outer rings)	-	-	32¼C	32	1.00	0.30	0.22	-
hya02i	Bressumer in kitchen (inner rings)	-	-	-	50	1.64	0.62	0.23	-
hya02ii	Bressumer in kitchen (outer rings)	-	-	21(+1NM)	85	1.34	0.45	0.23	-
hya03i	Longitudinal beam, service wing (inner rings)	-	-	-	35	2.64	1.20	0.32	-
hya03ii	Longitudinal beam, service wing (outer rings)	1448–1522		h/s	75	1.84	0.81	0.31	1533–63
hya04	South cruck, truss B	1389–1509		h/s	121	1.61	0.58	0.18	1520–50
hya05	North cruck, truss A	1452–1512		h/s	61	1.19	0.58	0.20	1523–53
hya543	Mean of **05**, **04**, **03**	**1389–1522**			**134**	**1.67**	**0.57**	**0.21**	

Key: h/s bdry = heartwood/sapwood boundary; NM = not measured; C = complete sapwood, felled the following winter; ¼C = complete sapwood, felled the following spring; std devn = standard deviation; mean sens = mean sensitivity

Table 2: Cross-matching between the dated samples

	***t*-value**	
Sample no	**hya04**	**hya05**
hya03ii	3.3	3.4
hya04		2.9

Table 3a: Strongest matches for series hya03ii with outer ring corresponding to 1522

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Site Chronologies						
Montgomeryshire	Rhos-fawr-isaf, Meifod	Miles *et al* 2005	RHOSFAWR	1430–1576	75	6.4
Denbighshire	Ty Mawr, Druid, Corwen	Miles *et al* 2010	DENBY1	1440–1583	75	6.3
Denbighshire	Ucheldref Rhug, Corwen	Miles *et al* 2010	DENBY4	1373–1597	75	6.0
Denbighshire	Hendre barn, Gwyddelwern	Bridge *et al* 2019	HENDREBN	1433–1534	75	5.9

Table 3b: Strongest matches for series hya04 with outer ring corresponding to 1509

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Site Chronologies						
Merioneth	Bodloesygad, Ffestiniog	Miles *et al* 2012	BODLSYGD	1368–1560	121	6.2
Caernarvonshire	Blaen Glasgwm Uchaf, Penmachno	Bridge *et al* 2013	GLASGWM3	1451–1620	59	5.9
Denbighshire	Branas-Uchaf, Llandrillo	Miles *et al* 2010	DENBY6	1388–1763	121	5.3
Anglesey	60 Castle Street, Beaumaris	Miles *et al* 2011	ANGK	1391–1515	119	5.2

Table 3c: Strongest matches for series hya05 with outer ring corresponding to 1512

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Site Chronologies						
Denbighshire	Hendre barn, Gwyddelwern	Bridge *et al* 2019	HENDREBN	1433–1534	61	7.8
Merioneth	Cae'r March, Llanfachreth	Bridge *et al* 2016	CAERMCH1	1405–1541	61	6.2
Montgomeryshire	Trefrechan barn	Miles *et al* 2004	TREFECHN	1423–1606	61	5.9
Caernarvonshire	Blaen Glasgwm Uchaf, Penmachno	Bridge *et al* 2013	GLASGWM3	1451–1620	61	5.9

Table 3d: Dating evidence for the site chronology **HYA543 AD 1389–1522** against dated reference chronologies

County or region:	*Chronology name:*	*Reference*	*File name:*	*Spanning*	*Overlap: (yrs)*	*t-value:*
Site Chronologies						
Denbighshire	Bryngwylan, Abergele, Conwy	Bridge *et al* 2013	BRYNGWYL	1430–1586	93	7.3
Montgomeryshire	Rhos-fawr-isaf, Meifod	Miles *et al* 2005	RHOSFAWR	1430–1576	93	7.0
Devon	Royal Clarence Hotel, Exeter	Arnold *et al* 2020	EXTMSQ01	1337–1636	134	7.0
Denbighshire	Rose and Crown, Gwyddelwern	Miles and Worthington 2000	GWYDWN	1411–1571	112	6.9
Shropshire	Brookgate Farm	Miles and Haddon-Reece 1993	BROOKGT	1362–1611	134	6.7
Denbighshire	Branas-Uchaf, Llandrillo	Miles *et al* 2010	DENBY6	1388–1763	134	6.6
Cheshire	Combermere Abbey, Whitchurch	Howard *et al* 2003	CBMASQ01	1371–1564	134	6.6
Shropshire	Ightfield Hall barn, Whitchurch	Groves 1997	IGHTFELD	1341–1566	134	6.6
Shropshire	Church Farm, Ditton Priors	Miles *et al* 2004	DITTON5	1437–1578	86	6.6
Flintshire	Chirk Castle, Wrexham	Bridge *et al* 2020	CHIRK18	1379–1796	134	6.5

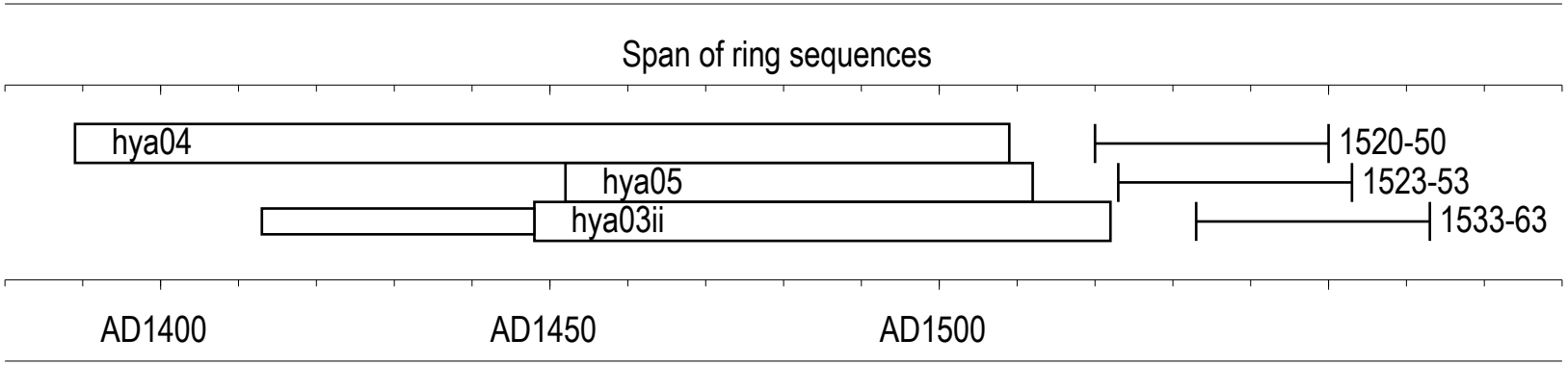

Figure 2: Bar diagram showing the relative positions of the dated timbers and their likely felling date ranges