Oxford Dendrochronology Laboratory
Report 2010/62

THE TREE-RING DATING OF THE TUDOR ROSE 32 CASTLE STREET, BEAUMARIS, ANGLESEY (NGR SH 605 760)

Summary

Three phases of construction were sampled here. The rear range consists of a high-quality open hall with carved bosses from which eleven timbers were sampled, and despite many having more than 50 rings, none were conclusively dated. However, two beams from the inserted floor below produced a precise felling date of spring 1549. A total of nine timbers from the front range were sampled, and two dated, one was found to have been felled shortly after 1480, and the other from the winter of 1485/6. No suitable timbers from the projecting porch were found, and therefore this area was not sampled. All of the timbers dated from this site were found to be from north-west Wales.

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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).

32 CASTLE STREET (Adapted from a report by David Longley)

The building known as Tudor Rose comprises a hall-house on a north-south alignment and a southern wing of two storeys, perpendicular to the hall. The date of construction is not known and it is possible that the wing was a secondary feature. Nevertheless, the hall and wing together were standing during the second half of the fifteenth century. The house was timber-framed in the early phase and several components of its construction have survived despite a later stone-clad revamp. During the later sixteenth or, perhaps, early seventeenth century, the hall was provided with an upper floor and the traditional open hearth was replaced by a chimney stack against the north gable of the hall. There are indications of the former presence of rooms on two storeys beyond the present north end, now lost.

SAMPLING

Sampling took place in January and September 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 **angd.** 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).

Many of the sampled timbers are shown in Figures 1-5.

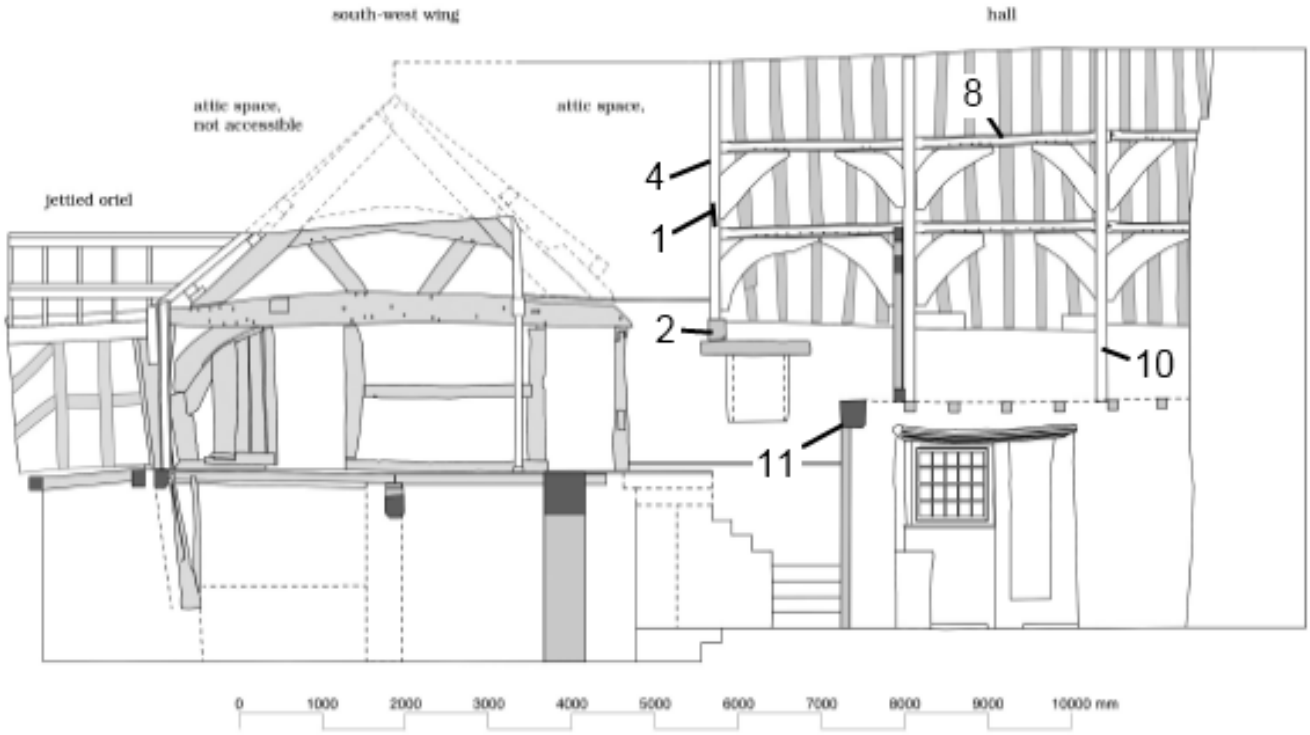

Figure 1: West side internal elevation showing some the timbers sampled for dendrochronology (adapted from original drawings by David Longley)

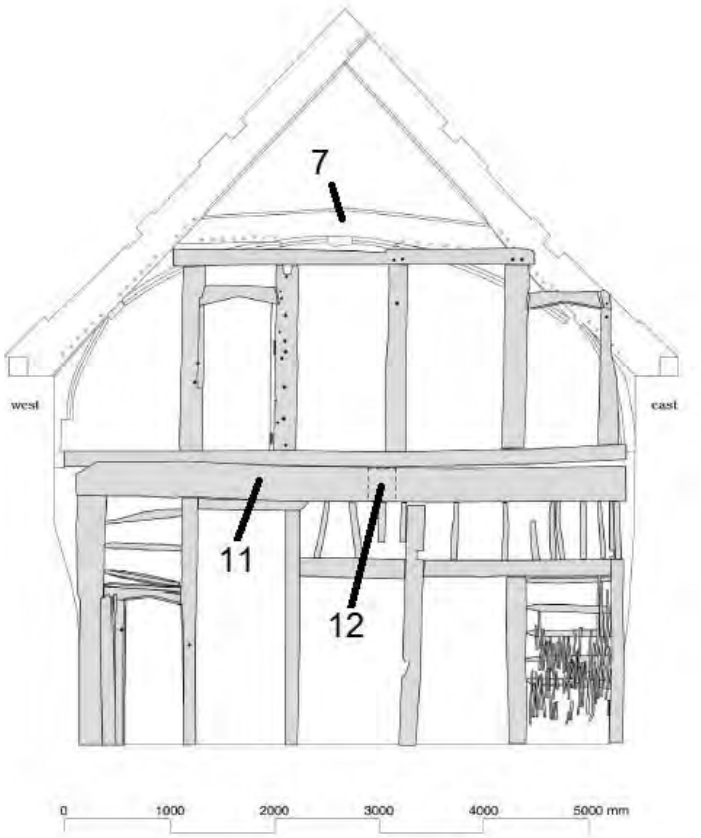

Figure 2: Cross-section drawing showing some the timbers sampled for dendrochronology (adapted from original drawings by David Longley)

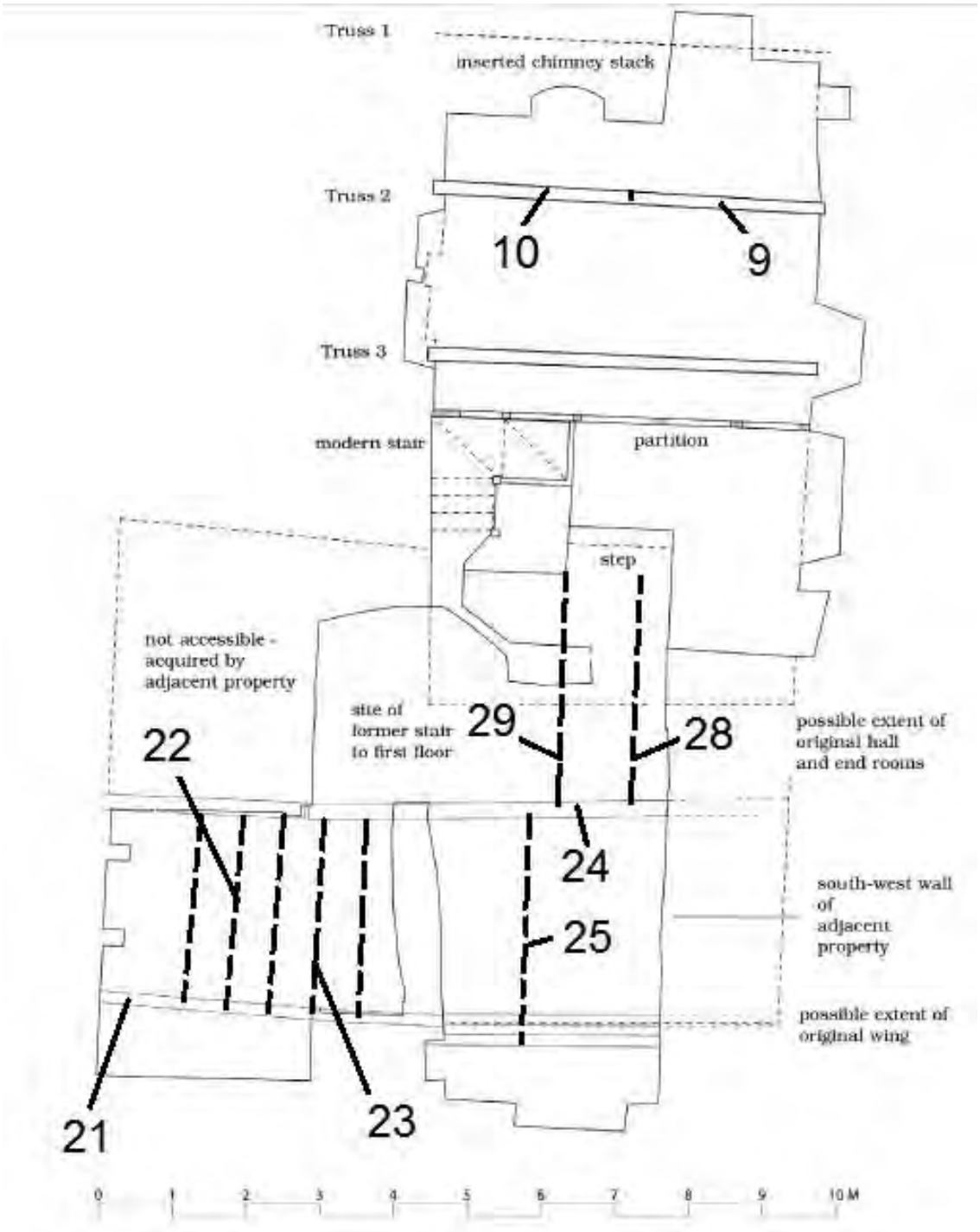

Figure 3: Plan of the ground floor hall and wing, showing some the timbers sampled for dendrochronology (adapted from original drawings by David Longley)

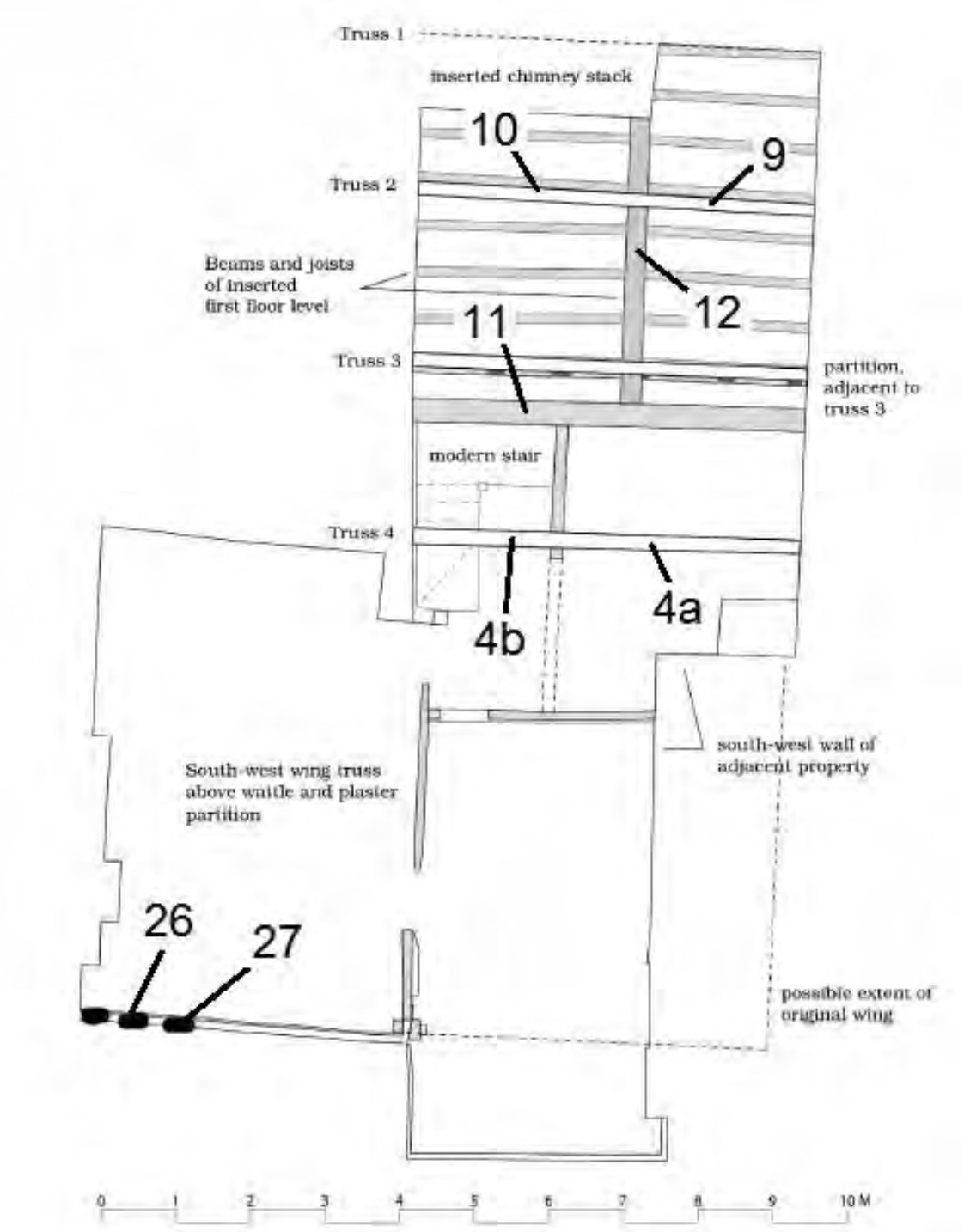

Figure 4: Plan of the first floor hall and wing, showing some the timbers sampled for dendrochronology (adapted from original drawings by David Longley)

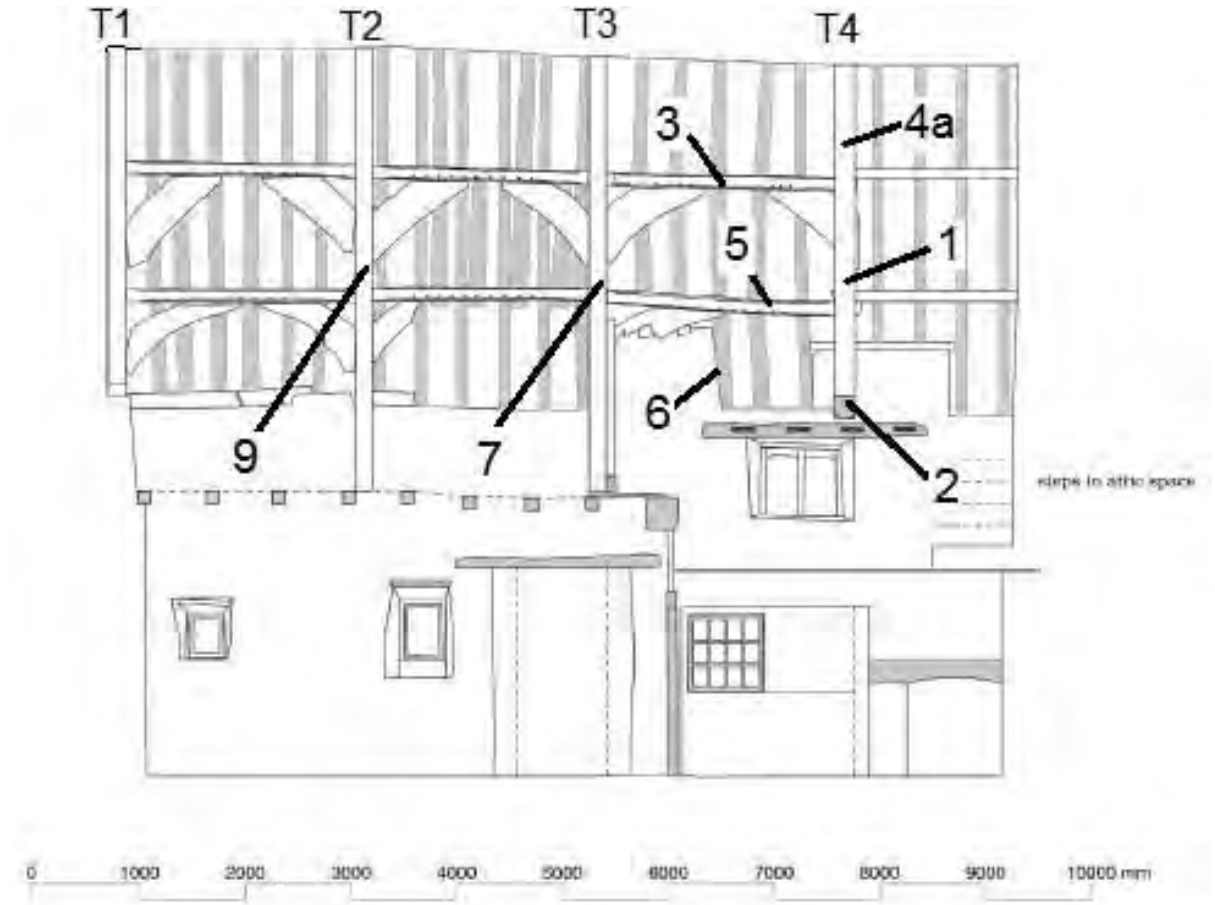

Figure 5: East side internal elevation showing some the timbers sampled for dendrochronology (adapted from original drawings by David Longley)

RESULTS AND DISCUSSION

Details of the samples and their locations are given in Table 1. Little cross-matching was found between the tree ring series, especially from the rear open hall roof. Four samples with reasonable ring sequences were sampled from the hall roof during January 2010, but no success was had in dating these, therefore a further seven timbers were sampled in the following September. Two principal rafters from Truss 4 were sampled: **angd4a** from the east principal rafter sampled in January, and **angd4b** from the west principal, sampled in September. Although the two timbers matched together with a *t*-value of only 5.6, they were combined to form the same-tree mean **angd4** on the physical evidence of the timbers themselves, both being cut from the same tree halved. Two principal rafters were also sampled from Truss 2, **angd9a** and **angd9b**, from the east principal rafter, and **angd10** from the west principal. Despite samples **angd9a** and **angd9b** were from the same timber, they failed to match sufficiently well to allow them to be combined to form a same-timber mean. Despite the two principal rafters probably originating from the same tree as in Truss 4, the dendrochronological match was so poor that they could not be combined.

The inserted floor had two main timbers sampled which did match reasonably well, with **angd11** and **angd12** matching with a t = 4.5 and 106 years overlap, and were combined to form the site master **ANGLSY3a.** This dated, spanning the years 1420–1548, the strongest matches being shown in Table 2a.

A total of nine timbers from the front range were sampled. Despite most having complete sapwood and reasonably ring counts, very few matched together or dated. Three timbers were found to match well together: **angd22** and **angd23** (t = 8.9 with 56 years overlap), **angd22** and **angd25** (t = 5.6 with 55 years overlap), and **angd23** with **angd25** (t = 7.2 with 55 years overlap), all three of which were combined to form the mean **angd2235**, which failed to date. However, two other timbers, **angd24** from the eastern axial beam, and **angd27** from the front window jamb upstairs in the western bay matched with a t = 5.0 with 92 years overlap. These were combined to form the second site master **ANGLSY3b** which was dated to span the years 1383–1485, the strongest matches for which are given in Table 2b. No other samples were dated. The relative positions of overlap of the dated series are shown in Figure 7.

Disappointingly therefore, no samples from the hall range dated. However, two beams from the inserted floor produced a precise felling date of **spring 1549**. This main beam had been reputed to have been taken from Beaumaris Castle, but the dendrochronology has shown, together with the carpentry, that it had been cut specially for its present location.

A total of nine timbers from the front range were sampled, and two dated, one was found to have been felled shortly after 1480, and the other from the **winter of 1485/6**. All of the timbers dated from this site were found to be from north-west Wales. Another legend is that the other timbers had been reused from a 12th century house from Llanfaes, two miles from Beaumaris, but again the tree-ring dating and carpentry has shown that this is highly unlikely.

Figure 6: Carved rose decoration

ACKNOWLEDGEMENTS

Margaret Dunn and Richard Suggett both provided assistance on site and provided background information on the building. David Longley kindly supplied a copy of his survey of this property for the project, and Gareth Ogwen-Jones delivered and collected a scaffold tower. We would also thank our fellow dendrochronologists for permission to use their data.

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Table 1: Details of samples taken from The Tudor Rose, 32 Castle Street, Beaumaris, Anglesey.

Sample number	Timber and position	Dates AD spanning	H/S bdry	Sapwood complement	No of rings	Mean width mm	Std devn mm	Mean sens	Felling seasons and dates/date ranges (AD)
Hall Range									
angd1	Collar, truss 4	unknown	-	17C	112	1.67	0.74	0.23	
angd2	Tiebeam, truss 4	unknown	-	19C	67	2.24	0.88	0.26	
angd3	Upper east purlin, bay 3-4	unknown	-	3	50	1.54	0.67	0.23	
angd4a	East principal rafter, truss 4	unknown	-	H/S	70	2.37	0.88	0.23	
angd4b	West principal rafter, truss 4	unknown	-	H/S	50	2.11	0.49	0.16	
angd4	Mean of **angd4a** and **angd4b**	unknown	-	H/S	71	2.29	0.72	0.20	
angd5	Lower east purlin, bay 3-4	unknown	-	9	45	1.64	0.40	0.23	
angd6	Middle east rafter, bay 3-4	unknown	-	H/S?	52	1.66	0.74	0.18	
angd7	Collar, truss 3	unknown	-	4	45	4.34	0.73	0.16	
angd8a	West upper purlin, bay 2-3	unknown	-	-	55	2.22	0.88	0.26	
angd8b	*Ditto*	unknown	-	H/S	47	2.39	1.10	0.28	
angd8	Mean of **angd8a** and **angd8b**	unknown	-	H/S	60	2.20	0.95	0.27	
angd9a	East principal rafter, truss 2	unknown	-	17C	65	2.87	1.30	0.24	
angd9b	*Ditto*	unknown	-	24C	47	1.69	0.66	0.19	
angd10	West principal rafter, truss 2	unknown	-	24C?	70	2.34	1.09	0.24	
Inserted floor to Hall									
angd11	Front transverse beam	1422-1548	1527	21¼C	127	1.58	1.05	0.18	Spring 1549
angd12	Longitudinal beam	1420-1527	1525	2	108	1.30	0.78	0.21	1539–1569
anglsy3a	Mean of **angd11** and **angd12**	**1420-1548**		-	**129**	**1.41**	**0.84**	**0.17**	

Continued overleaf

Table 1 continued:

Front Range									
angd21	Jetty plate, west side	unknown	-	6	53	2.50	0.65	0.15	
angd22	Jetty joist, south side	unknown	-	16C	56	2.47	1.03	0.23	
angd23	Jetty joist, south side	unknown	-	16C	60	2.62	1.26	0.24	
angd24	Axial beam, east side	1383-1477	1439	38 +3C NM	95	1.26	0.39	0.21	Shortly after 1480
angd25	Jetty joist, south side	unknown	-	16C	55	2.50	1.29	0.25	
angd26	2nd upper stud from west	unknown	-	25C	61	1.19	0.56	0.25	
angd27	3rd upper stud from west	1386-1485	1454	31C	100	1.35	0.51	0.22	Winter 1485/86
angd28a1	2nd joist from east, north bay	unknown	-	-	70	0.59	0.20	0.18	
angd28a2	*Ditto*	unknown	-	-	129	0.74	0.23	0.24	
angd28a3	*Ditto*	unknown	-	8 +26 NM	93	0.75	0.21	0.18	
angd29	4th joist from east, north bay	unknown	-	-	116	1.15	0.35	0.18	
angd2235	Mean of **angd 22 + 23 + 25**	unknown	-		60	2.64	1.23	0.20	
anglsy3b	**Mean of angd 24 + 27**	**1383-1485**			**103**	**1.31**	**0.39**	**0.19**	

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; NM = not measured

Table 2a. Dating evidence for series **anglsy3a** 1420–1548 against regional (**bold**) and individual site chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Wales	Rose and Crown, Gwydwn	(Miles and Worthington 2000)	GWYDWN	1411-1571	129	8.8
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	129	8.2
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881-1745	129	7.6
Cheshire	Combermere Abbey, Whitchurch	(Howard *et al* 2003)	CBMASQ01	1371-1564	129	7.5
Wales	Branas-Uchaf, Llandrillo	(Miles *et al* 2010)	DENBY6	1388-1763	129	7.5
Wales	Cefn Caer Pennel	(Miles and Worthington 1999)	CEFNCAR1	1404-1525	106	7.5
Yorkshire	Yorkshire Buildings Chronology	(Hillam pers comm)	YORKMED	1320-1696	129	7.3
Wales	Llwyn Llandrinio Montgomeryshire	(Miles *et al* 2003)	LLWYN	1413-1551	129	7.2
Wales	Old Market Hall, Llanidloes	(Miles *et al* 2003)	LNYDLOS1	1424-1589	125	7.2
East Midlands	East Midlands Master	(Laxton and Litton 1988)	**EASTMID**	882-1981	129	7.1

Table 2b. Dating evidence for series **anglsy3b** 1383–1485 against regional (**bold**) and individual site chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Yorkshire	Nostell Priory	(Tyers 1998)	NOSTELL1	1263-1536	103	7.8
Anglesey	Hafoty Llansadwen	(Hillam and Groves 1991)	HAFOTY1	1372-1499	103	7.5
Somerset	Somerset Master Chronology	(Miles 2004)	**SOMRST04**	770-1979	103	6.9
Northern England	Northern England Master	(Hillam and Groves 1994)	**NORTH**	440-1742	103	6.8
Wales	Welsh Master Chronology	(Miles 1997b)	**WALES97**	404-1981	103	6.7
Herefordshire	Booth Hall, Hereford	(Boswijk and Tyers 1997)	HIGHTOWN	1302-1487	103	6.6
Wales	Plas Mawr House	(Miles and Haddon-Reece 1996)	PLASMWR2	1360-1578	103	6.6
Shropshire	Roseleigh, All Stretton	(Miles *et al* 2007)	ALLSTRET	1386-1509	100	6.4
Somerset	George Inn, Norton St Philip	(Miles and Worthington 1998)	GEORGIN2	1290-1509	103	6.3
Shropshire	Shropshire Master Chronology	(Miles 1995)	**SALOP95**	881-1745	103	6.3

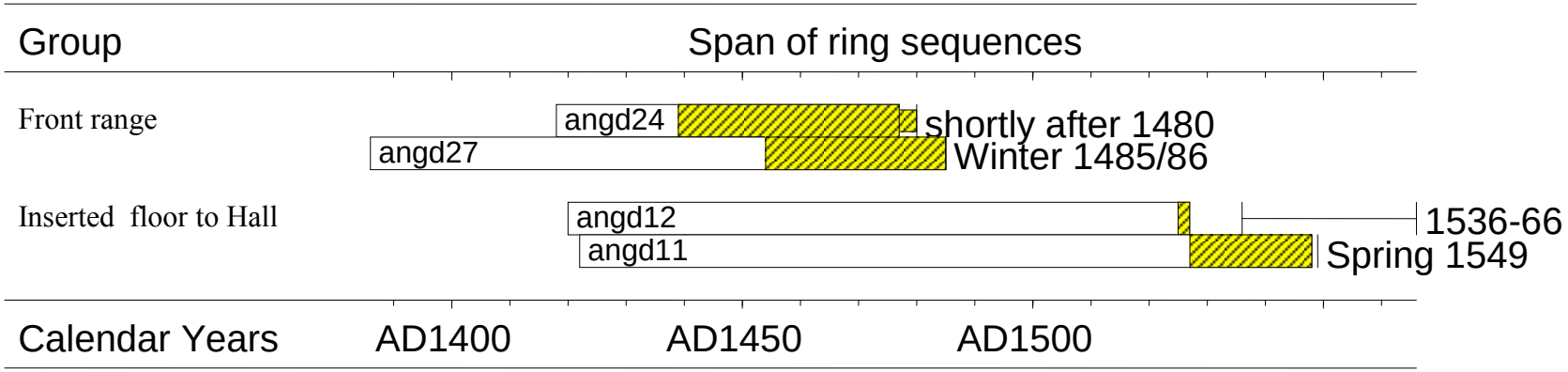

Figure 7: Bar diagram showing the relative positions of overlap of the dated timbers from 32 Castle Street, Beaumaris, along with their interpreted felling dates/date ranges. Yellow hatched sections represent sapwood rings.

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