

Ancient Monuments Laboratory
Report 4/91

TREE-RING ANALYSIS OF TIMBERS FROM
BOWHILL HOUSE, EXETER, DEVON

Miss Jennifer Hillam

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Summary

This report describes the results of dendrochronological studies carried out on oak timbers from Bowhill House in 1979/80 and 1990. Although none of the primary structural timbers can be dated, some of the timbers removed during renovation work were dated and a tree-ring chronology has been constructed for the period AD1292-1468.

Author's address :-

Miss Jennifer Hillam

Department of Archaeology & Prehistory
Sheffield University
Clarke House Lane
Sheffield, South Yorkshire
S10 2TN

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Introduction

Recent renovation work has provided the opportunity to carry out tree-ring analysis on some of the timbers with a view to providing a date for the construction of the building. In 1979, samples were cut from beam 7 (1), window 41 (2) and truss XIII (3) (Fig 1). Photographs were also taken of the polished cross-sections of timbers which were exposed during the early stages of the renovation work. The timbers photographed were fireplace 3 (4), beam 3 (5) and screen 3 (6). The samples and the photographs were measured and the data analyzed in 1980 but no reliable dating was obtained. A second visit was made to Bowhill in 1990 to core any additional timbers which might prove suitable for dating. No such timbers were found in situ, but ring width measurements were taken of some of the timbers removed during renovation work. An additional three samples were cut from other timbers. It was hoped that the 1990 samples would help to date the primary structural timbers which had been examined in 1980. The 1979/80 samples were remeasured and the data reworked in 1990, along with the data from the 1990 samples.

Methods

In situ measurement of ring widths were made by preparing the cross-sections with a Stanley knife and measuring the rings with a hand lens containing a scale accurate to 0.1mm. Timber sections were sanded with coarse, medium and fine grit to obtain a polished surface on which the ring boundaries were clearly visible. The ring widths of those samples with more than 50 rings were measured on a travelling stage connected to an Apple II microcomputer (Hillam 1985, Fig 4). (Ring patterns with less than 50 rings are unlikely to be unique and might not produce reliable dates - see Hillam et al 1987 for further details.) The ring sequences were plotted as graphs using a graphing

program on the Prime mainframe (Okasha 1987). The graphs were then compared with each other on a light box to check for any similarities between the ring patterns which might indicate contemporaneity. For crossmatching purposes, the ring width data were also transferred to an Atari ST microcomputer with hard disk. The tree-ring software for the Atari was written and developed by Ian Tyers (pers comm 1990). The crossmatching routines are based on the Belfast CROS program (Baillie & Pilcher 1973; Munro 1984), and all the t values quoted in this report are identical to those produced by the first CROS program (Baillie & Pilcher 1973). Generally t values of 3.5 or above indicate a match provided that the visual match between the tree-ring graphs is acceptable (Baillie 1982, 82-5).

Dating is achieved by crossmatching ring sequences within a site or structure, combining the matching sequences into a site master, and then testing that master for similarity against dated reference chronologies. A site master is used for dating whenever possible because it enhances the general climatic signal at the expense of the background noise from the growth characteristics of the individual samples. Any unmatched sequences are tested individually against the reference chronologies.

If a sample has bark or bark edge, the date of the last measured ring is the year in which the tree was felled. A complete outer ring indicates that the tree was felled during its dormant period in winter or early spring. This is referred to as "winter felled". If the ring is incomplete, felling took place during the growing season in late spring or summer (referred to as "summer felled"). In the absence of bark edge, felling dates are calculated using the sapwood estimate of 10-55 rings. This is the range of the 95% confidence limits for the number of sapwood rings in British oak trees over 30 years old (Hillam et al 1987). Where sapwood is absent, felling dates are given as

termini post quem by adding 10 years, the minimum number of missing sapwood rings, to the date of the last measured heartwood ring. The actual felling date could be much later depending on how many heartwood rings have been removed.

At this stage of the study, factors such as reuse, stockpiling, or repairs have also to be taken into account. Thus whilst the tree-ring dates for the measured rings are precise and independent, the interpretation of these dates often requires other archaeological evidence.

Results

Details of the samples are given in Table 1. Two of the photographs (5, 6) were rejected because the timbers had less than 50 rings. The first 59 rings were measured on the photograph of fireplace 3 (sample 4) but the sapwood rings were not clear enough for accurate measurement. The timber was remeasured in situ during the 1990 visit. The sapwood was still difficult to measure but the remeasure (D3) confirmed that the original ring sequence was correct and that there were 24-26 rings to the bark edge.

The timber sections collected in 1979 had 53-73 rings; those collected or measured at Bowhill in 1990 had 73-136 rings.

When the ring sequences were compared one against the other, a group of four were found to match. These were all from timbers of unknown function (D4-D7). The t values between the ring sequences are not very high (Table 2) but visual comparison of the graphs showed that the matches were acceptable. Their ring widths were averaged to produce a 177-year master curve (Table 3). When this was tested against dated reference chronologies, a very good match with chronologies from many parts of the British Isles was found for the period AD1292-1468 (Table 4).

No match was found between this master and the remaining Bowhill sequences, nor did the latter give any consistent results when they were tested against the reference chronologies.

Details of the dates are given in Table 5, and the relative position of the dated ring sequences are illustrated in Fig 2. The results are disappointing because the original function of timbers D4-D7 is unknown. Assuming that the timbers are primary, a *terminus post quem* of AD1478 for the construction of Bowhill is obtained.

The lack of dating of some of the timbers plus the relatively poor correlation between the ring sequences of those that do date, suggests that the timber came from more than one source.

Conclusion

The study produced a tree-ring chronology for the period AD1292-1468 but none of the structural timbers of known function could be dated. If the dated samples are from primary structural timbers, the analysis provides a *terminus post quem* of AD1478 for the construction of Bowhill.

Acknowledgements

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Table 1: Details of the tree-ring samples. Sketches are not to scale. Samples 1-6 were from the 1979 study; D1-D7 from the 1990 study.

no	timber	total no of rings	sapwood rings	average ring width (mm)	comments
1	beam 7	73	HS?	2.15	complete section
2	window 41	78	-	3.36	part of cross-section
3	truss XIII	53	-	4.45	part of cross-section
4	fireplace 3	59+	yes	-	photo; + about 24 rings to bark edge
5	beam 3	33	-	-	photo; rejected
6	screen 3	34	-	-	photo; rejected
D1	screen?	73	13	2.62	measd at Bowhill 1990
D2	major rafter?	97	HS	2.88	measd at Bowhill 1990
D3	fireplace 3	+55	22	1.76	remeasure of sample 4
D4	function unknown	81	HS	2.37	measd at Bowhill 1990
D5	function unknown	124	-	1.93	sample cut 1990
D6	function unknown	136	-	1.81	sample cut 1990
D7	function unknown	109	-	1.81	sample cut 1990

Table 2: Relative dating. t values between the matching ring sequences.

	D4	D5	D6	D7
D4	*	2.8	3.9	3.6
	D5	*	4.1	3.4
		D6	*	3.4
			D7	*

Table 3: Exeter Bowhill tree-ring chronology, AD1292-1468.

<u>date</u>	<u>ring width (filtered data)</u>										<u>no of samples</u>								
AD1292	89	63	108	76	136	89	62	59	47		1	1	1	1	1	1	1	1	1
AD1301	55	60	34	57	47	56	88	82	78	94	1	1	1	1	1	1	1	1	1
	95	132	111	148	150	97	120	108	107	99	1	1	1	1	1	1	1	1	1
	100	92	190	174	108	93	131	144	157	174	1	1	2	2	2	2	2	2	2
	115	134	104	133	160	113	108	114	122	113	2	2	2	2	2	2	2	2	2
	113	135	116	106	127	105	104	133	135	89	3	3	3	3	4	4	4	4	4
AD1351	87	85	107	98	104	102	109	111	113	73	4	4	4	4	4	4	4	4	4
	96	126	121	133	106	110	98	88	118	112	4	4	4	4	4	4	4	4	4
	96	104	118	114	110	139	99	106	136	115	4	4	4	4	4	4	4	4	4
	90	106	106	98	98	125	117	121	143	89	4	4	4	4	4	4	4	4	4
	104	94	103	82	112	128	96	124	126	108	4	4	4	4	4	4	4	4	4
AD1401	127	86	102	97	79	97	77	117	124	88	3	3	3	3	3	3	3	3	3
	71	79	73	69	67	58	78	55	43	64	3	3	3	3	3	3	3	3	3
	70	64	88	66	79	46	65	101	92	73	3	2	2	2	2	2	2	2	2
	69	77	63	67	73	50	61	67	43	63	2	2	2	2	2	2	2	2	2
	57	47	58	74	69	58	67	77	61	48	2	2	2	2	2	2	2	2	2
AD1451	73	66	64	73	60	73	65	82	52	89	2	2	2	2	2	2	2	2	1
	57	76	62	38	53	62	67	54			1	1	1	1	1	1	1	1	

Table 4: Absolute dating. t values with dated reference chronologies. (All the chronologies are independent of each other.)

<u>chronology</u>	<u>t value</u>
Belfast (Baillie 1977a)	5.3
Dublin (Baillie 1977b)	4.8
Calverley Hall, West Yorks (Hillam 1982)	5.9
Droitwich, Upwich (Groves & Hillam 1990)	5.6
East Midlands (Laxton & Litton 1988)	7.3
Scotland (Baillie 1977c)	3.5
Welsh Border (Siebenlist-Kerner 1978)	6.9
Worcester, Commandery (Pilcher pers comm)	6.8
St Cuthberts, Wick (Bridge 1983)	7.4
Yorkshire buildings, Yorks2 (Hillam unpubl)	6.3

Table 5: Details of the tree-ring dates. Date of heartwood-sapwood transition (HS), if present, is given in brackets.

<u>sample</u>	<u>date of ring sequence</u>	<u>sapwood</u>	<u>felling date</u>
D4	1345-1421(1421?)	HS?	1431-1476 or 1431+
D5	1345-1468	no	1478+
D6	1323-1458	no	1468+
D7	1292-1400	no	1410+

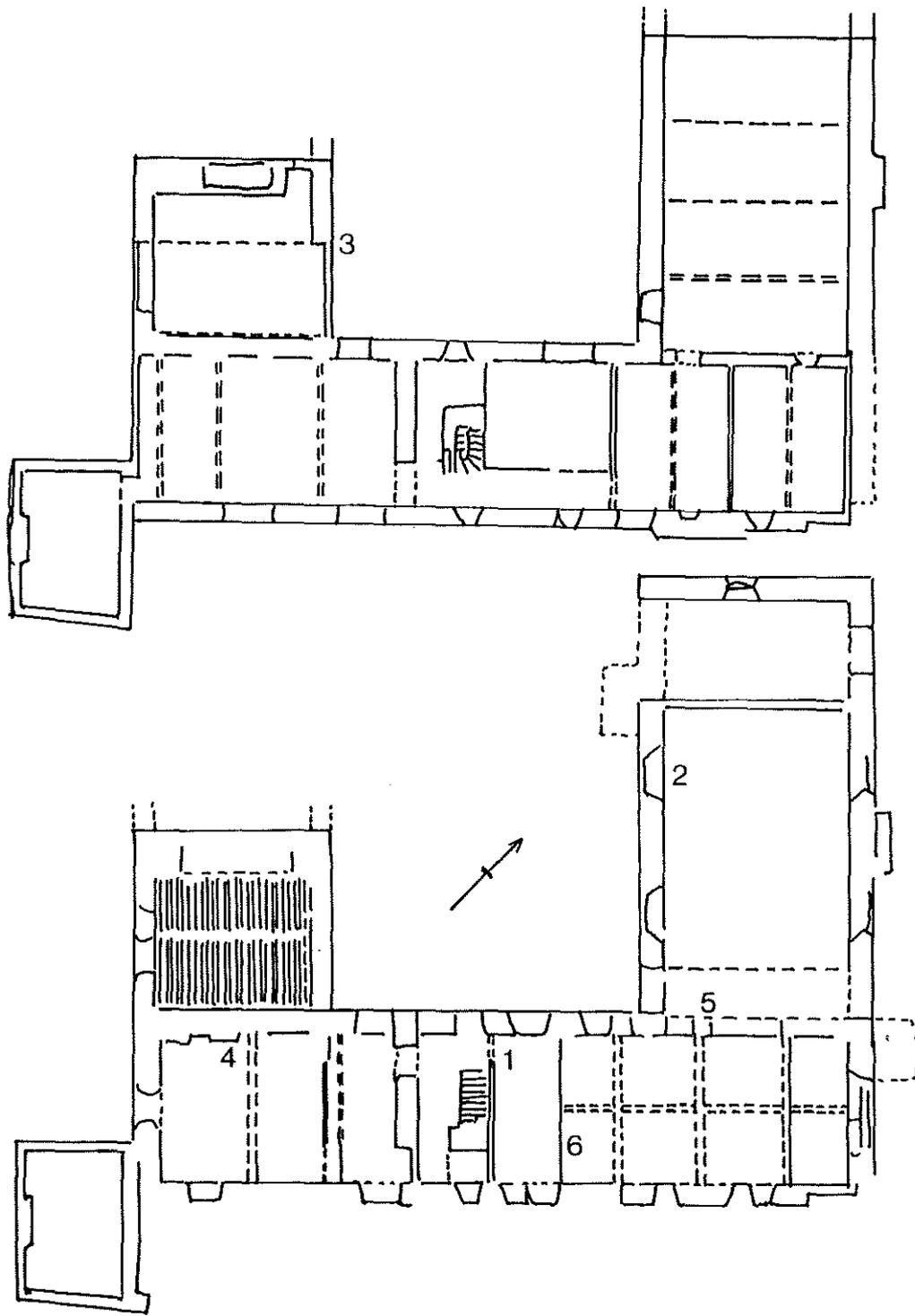


Fig 1: Plan of Bowhill House (after Everett 1958). Top - upper floor; bottom - ground floor.

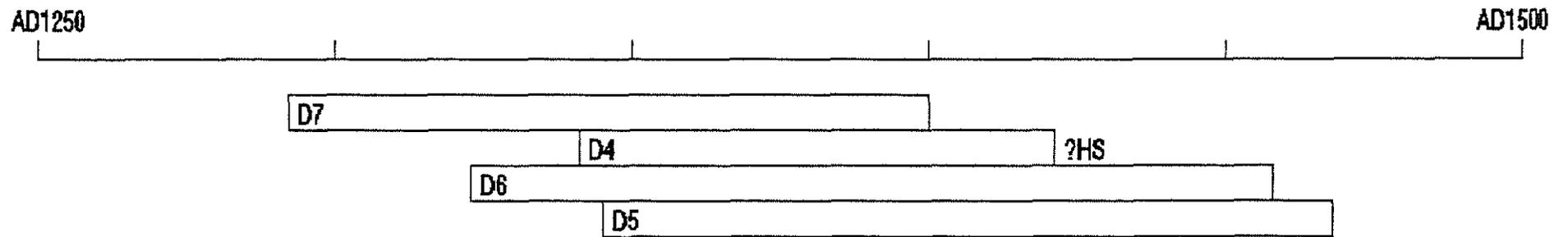


Fig 2: Bar diagram showing the relative positions of the matching ring sequences. HS? - possible heartwood-sapwood transition.