Ancient Monuments Laboratory
Report 42/91

TREE-RING DATING OF OAK TIMBERS FROM AYDON CASTLE, CORBRIDGE, NORTHUMBERLAND

Miss Jennifer Hillam
& Miss Cathy Groves

AML reports are interim reports which make available the results of specialist investigations in advance of full publication They are not subject to external refereeing and their conclusions may sometimes have to be modified in the light of archaeological information that was not available at the time of the investigation. Readers are therefore asked to consult the author before citing the report in any publication and to consult the final excavation report when available.

Opinions expressed in AML reports are those of the author and are not necessarily those of the Historic Buildings and Monuments Commission for England.

Ancient Monuments Laboratory Report 42/91

TREE-RING DATING OF OAK TIMBERS FROM AYDON CASTLE, CORBRIDGE, NORTHUMBERLAND

Miss Jennifer Hillam & Miss Cathy Groves

Summary

Tree-ring analysis of ten timbers from the roof of the kitchen range at Aydon Castle produced a chronology spanning the period AD1424-1543. The timbers were felled in the winter/early spring of 1543/1544 during major alterations to the castle.

Authors' address :-

Miss Jennifer Hillam & Miss Cathy Groves

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

c Historic Buildings and Monuments Commission for England

TREE-RING DATING OF OAK TIMBERS FROM AYDON CASTLE, CORBRIDGE, NORTHUMBERLAND

Introduction

Aydon Castle, formerly Aydon Hall, is a late 13th century manor house which was originally built by Robert de Reymes as an undefended house (Dixon 1988). It was fortified shortly afterwards during a period of unrest on the Borders. Aydon Hall stayed in the de Reymes family until 1541 when it passed to Sir Reynold Carnaby of Hexham. On his death in 1543, Aydon was inherited by his younger brother Cuthbert who carried out a much needed major programme of repairs and alterations. In the 17th century the building was converted into a farmhouse and it remained as such until 1966 when it was entrusted to the Ministry of Works. Since then the building has been conserved and restored to a condition similar to that of the late Middle Ages.

In 1991 the re-roofing of the kitchen block allowed access to its roof timbers. These were sampled for dendrochronology to determine a precise date for the oak timbers. The roof is made up of five trusses running in a north-south direction. These were labelled truss 1 to truss 5, where truss 1 is the most northerly. Ten cores were removed from seven rafters, two purlins and one tiebeam (Table 1). They were examined in the Sheffield Dendrochronology Laboratory in May 1991.

Methods

The cores were taken with a corer attached to an electric drill. The half-inch diameter holes left by the cores were plugged with cotton wool for easy identification. The surfaces of the cores were first polished using a sander with paper of medium grit and then finished by hand with fine silicon carbide paper.

The ring widths were measured to an accuracy of 0.01mm on a travelling stage built in the Department of Geography, City of London Polytechnic. The stage

is connected to an Atari microcomputer which uses a suite of dendrochronology programs written by Ian Tyers (pers comm 1990). The measured 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. The Atari is also used to aid the crossmatching process. 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 phase or building, 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 date 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.

Results

The timbers were tangentially split beams, most of which retained their sapwood rings and sometimes bark at two corners (Fig 1). The rafters were approximately 300mm by 90mm in cross-section whilst the purlins were about 200mm by 110mm. The cores had 56-115 rings. Bark edge was identified on four and possibly five of the samples whilst two others were known to be close to bark edge. Although bark edge was present on all these timbers, the outer one or two rings can be damaged and lost during coring. The remaining three timbers had bark edge but not where the cores were removed. Where bark edge was present, the outer ring was complete indicating that the timbers had been felled in winter or early spring.

The ring patterns of samples 5 and 6 were so similar that they could be crossmatched by looking at the cores prior to measurement which is often an indication that the timbers were cut from the same tree. After measurement, comparison of the ring sequences gave a *t* value of 14.6 which confirmed that the two timbers were from the same tree. Generally a *t* value greater than 10 is indicative of an origin in the same tree although the reverse is not necessarily true. Examination of samples from living trees indicates that samples split from one tree can match with *t* values less than 10.

The remaining eight ring patterns also crossmatched. Sample 4 from the west purlin between trusses 3 and 4 matched least well but visual comparison of its tree-ring graph with those of the other samples confirmed that the relative dating was correct.

The correlation between the ring sequences was generally high (Table 2). Although only 5 and 6, the east rafter from truss 3 and west rafter from truss 2, could be identified as the same tree, all the timbers probably came from a single woodland. The average ring width of the cores varies from 0.98mm to 1.82mm which is relatively narrow and suggests that the trees were growing under a closed woodland canopy where competition from other trees was limiting to growth.

A site master chronology of 120 years was constructed from the ten sets of tree-ring data (Table 3). The ring widths of 5 and 6 were averaged before inclusion so as not to bias the master curve. When the master was tested against dated reference chronologies, a strong match was found over the period AD1424-1543. Consistently high t values were obtained with chronologies from the East Midlands, Lancashire, Northern Ireland, the southern Welsh Marches and Yorkshire (Table 4).

The relative and absolute dating of the ten timbers indicates that those timbers with bark edge were felled in the winter of 1543/1544 (Fig 2; Table 1). The remainder are also contemporary. Since timbers were generally felled as occasion demanded (Rackham 1990, 69), it is likely that the roof of the kitchen block was constructed in 1544 or very soon afterwards. The work was therefore carried out by Cuthbert Carnaby during the major repairs which he undertook shortly after he inherited Aydon Hall from his brother in 1543.

Acknowledgements

The work was funded by English Heritage. We are also grateful to Ian Tyers for unpublished computer software.

References

Baillie MGL 1977a The Belfast oak chronology to AD1001, *Tree Ring Bulletin* 37, 1-12.

Baillie MGL 1977b An oak chronology for south central Scotland, *Tree Ring Bulletin* 37, 33-44.

Baillie MGL 1982 *Tree-Ring Dating and Archaeology*, London: Croom Helm.

Baillie MGL & Pilcher JR 1973 A simple crossdating program for tree-ring research, *Tree Ring Bulletin* 33, 7-14.

Dixon P 1988 *Aydon Castle*, English Heritage.

Hillam J 1982 Tree-ring analysis of oak timbers from Calverley Hall, West Yorkshire. *Ancient Monuments Laboratory report series* 3751.

Hillam J 1984 Tree-ring analysis of timbers from Elland Old Hall, West Yorkshire. *Ancient Monuments Laboratory report series* 4165.

Hillam J, Morgan RA & Tyers I 1987 Sapwood estimates and the dating of short ring sequences. In RGW Ward (ed), *Applications of tree-ring studies: current research in dendrochronology and related areas*, BAR S333, 165-85.

Laxton RR & Litton CD 1988 *An East Midlands master tree-ring chronology and its use for dating vernacular buildings.* University of Nottingham, Dept of Classical & Archaeological Studies, Monograph Series III.

Leggett PA 1980 *The use of tree-ring analyses in the absolute dating of historical sites and their use in the interpretation of past climatic trends*, PhD Thesis, CNAA (Liverpool Polytechnic).

Morgan RA 1977 Dendrochronological dating of a Yorkshire timber building. *Vernacular Architecture* 8, 809-14.

Munro MAR 1984 An improved algorithm for crossdating tree-ring series, *Tree Ring Bulletin* 44, 17-27.

Okasha MKM 1987 *Statistical methods in dendrochronology.* PhD thesis, Sheffield University.

Rackham O 1990 *Trees and woodland in the British Landscape* (2nd edition). Dent: London.

Siebenlist-Kerner V 1978 The chronology, 1341-1636, for certain hillside oaks from Western England and Wales. In JM Fletcher (ed), *Dendrochronology in Europe*, BAR S51, 157-61.

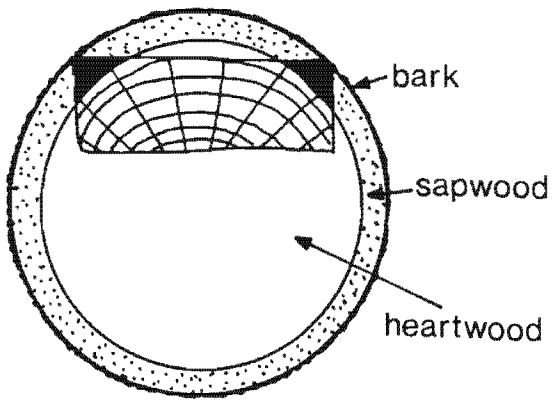

Fig 1: Drawing showing the section of tree trunk used for the Aydon Castle timbers.

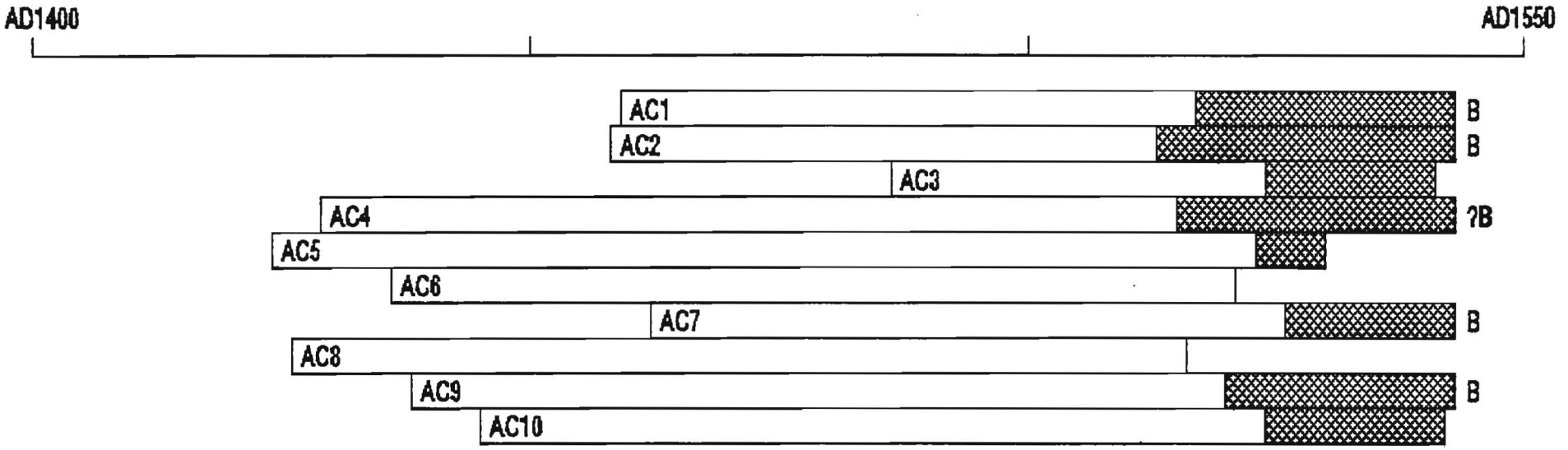

Fig 2: Bar diagram showing the relative positions of the dated ring sequences. White bars - heartwood rings; hatching - sapwood; B - bark edge. The timbers were felled in winter 1543/1544.

Table 1: Details of the tree-ring samples.

no	timber	total no of rings	sapwood rings	bark	average ring width (mm)	date span	comments
1	truss 5, west rafter	85	26	yes	1.68	1459-1543	felled winter
2	truss 5, east rafter	86	30	yes	1.47	1458-1543	
3	truss 4, east rafter	56	17	close	1.82	1486-1541	
4	truss 3/4, west purlin	115	28	yes?	0.98	1429-1543	
5	truss 3, east rafter	107	7	no	1.57	1424-1530	same tree as 6
6	truss 2, west rafter	86	-	no	1.77	1436-1521	same tree as 5
7	truss 1, east rafter	82	17	yes	1.62	1462-1543	felled winter
8	truss 1, tiebeam	91	-	no	1.03	1426-1516	bark present elsewhere
9	truss 1/2, west purlin	106	23	yes	1.01	1438-1543	felled winter
10	truss 1, west rafter	98	18	close	1.46	1445-1542	

Table 2: t value matrix showing the correlation between the matching ring sequences. Values less than 3.0 are not printed.

	1	2	3	4	5	6	7	8	9	10
1	*	9.8	5.7		6.7	7.5	5.2	3.5	7.6	7.7
2		*	3.1		5.6	5.3	4.5		5.7	4.6
3			*		7.4	6.5	3.1		5.0	8.1
4				*				4.0	3.7	5.5
5					*	14.6	5.4	5.7	8.4	6.8
6						*	6.5	4.6	9.1	6.6
7							*	3.1	5.9	4.6
8								*	4.3	4.8
9									*	6.4
10										*

Table 3: The Aydon Castle chronology, AD1424-1543.

date	ring widths (0.01mm)										no. of samples									
AD1424				187	182	90	97	136	257	208				1	1	2	2	2	3	3
	197	221	151	176	156	169	138	136	102	114	3	3	3	3	3	3	3	4	4	4
	130	114	145	168	168	122	133	113	141	114	4	4	4	4	5	5	5	5	5	5
AD1451	143	169	154	166	117	154	135	119	131	123	5	5	5	5	5	5	5	6	7	7
	128	128	115	122	125	149	169	173	124	128	7	8	8	8	8	8	8	8	8	8
	120	85	91	70	135	153	165	144	156	134	8	8	8	8	8	8	8	8	8	8
	154	138	134	142	138	149	195	154	150	153	8	8	8	8	8	9	9	9	9	9
	133	157	130	141	165	237	192	163	183	159	9	9	9	9	9	9	9	9	9	9
AD1501	92	76	93	151	199	173	134	139	160	135	9	9	9	9	9	9	9	9	9	9
	130	122	147	137	145	151	117	148	143	122	9	9	9	9	9	9	8	8	8	8
	113	132	120	146	142	150	126	113	101	105	8	8	8	8	8	8	8	8	8	8
	114	105	105	121	137	132	123	95	122	147	7	7	7	7	7	7	7	7	7	7
	143	102	113								7	6	5							

Table 4: Dating the Aydon Castle chronology. t values with dated reference chronologies. All the chronologies are independent of each other.

chronology	t value
Belfast (Baillie 1977a)	6.3
Bishops' House, Sheffield (Morgan 1977)	5.8
Calverley Hall, W Yorks (Hillam 1982)	6.3
East Midlands (Laxton & Litton 1988)	6.5
Elland Old Hall, W Yorks (Hillam 1984)	4.5
Golden Cock, W Yorks (Hillam & Groves unpubl)	6.4
Houndhill Barn, S Yorks (Groves unpubl)	4.8
Ridgeway, S Yorks (Groves unpubl)	5.3
South Central Scotland (Baillie 1977b)	5.5
Stayley Hall, Greater Manchester (Leggett 1980)	6.0
Welsh Border (Siebenlist-Kerner 1978)	5.9