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DENDROCHRONOLOGICAL ANALYSIS OF WOOD FROM ALCESTER, 1985-86.

Cathy Groves

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(April 1987)

Summary

Tree-ring analysis was carried out on 31 samples from timbers excavated at Alcester during 1985-86. Twenty oak samples were from a foundation trench of the mid 4th century town wall and eleven alder samples were from a foundation trench for a bastion added to the wall in the late 4th century. No reliable absolute dating was obtained but some relative dating was produced for both the oak and the alder samples.

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Dendrochronological analysis of wood from Alcester, 1985-86

Introduction

During the 1985-86 excavations at Alcester, under the direction of Stephen Cracknell from the Field Archaeology Unit at Warwickshire Museum, 31 wood samples were taken for tree-ring analysis. The samples, all unworked roundwood posts, came from two contexts, 628 and 861, which were Roman in date. Dating the contexts was made difficult as there was very little pottery associated with either of them. The 20 samples from the foundation trench of the town wall (context 628) were thought to be approximately mid 4th century. The second group of timbers (context 861) were from the foundation trench to a bastion, which appears to have been added to the wall late in the 4th century. It was hoped that tree-ring analysis would be able to provide more precise dates for the construction of the town wall and the subsequent addition of the bastion.

Method

The samples were prepared and measured following the method given by Hillam (1985). The alder (Alnus glutinosa Gaertn) samples were identified by examining thin sections of wood from the transverse, radial and tangential planes (see, for example, Schweingruber 1978). A note was made of the size of the cross-section, plus the number of rings and their orientation, of all the samples (Appendix A).

Three radii of each alder sample were measured and then averaged together to form a single sequence so as to minimise the problems associated with the measurement of alder ring patterns, such as feint ring boundaries and missing rings (see, for example, Elling 1966). It is usual to measure only one radius on oak samples, but an exception was made in this case since the ring sequences were all relatively short. Two radii on each oak sample were measured and combined to give a single tree-ring sequence for each timber. By taking an average of the two radii it was hoped that the common climatic signal would be accentuated and the "background noise" resulting from the local growth conditions would be reduced, thereby increasing the chances of obtaining a reliable date.

The ring sequences were represented as graphs, known as tree-ring curves. The curves were compared visually by superimposing two curves and sliding one past the other searching for similarities in the ring patterns. A computer program (Baillie & Pilcher 1973) is also used as an aid to crossmatching. This measures the amount of correlation between two ring sequences at each position of overlap. The Student's t-test is then used as a significance test on the correlation coefficient and generally a t-value of 3.5 or over represents a match provided that the visual match is acceptable (Baillie 1982: 82-5).

A site master curve is produced from any matching curves by taking an average of their ring widths and any unmatched sequences are tested against it. The master curve is also used for comparisons with dated reference chronologies as masters are usually easier to date than the ring sequence of a single sample. This is because the master curve enhances the common climatic signal but reduces the "background noise" resulting from the local growth conditions of individual trees.

Following the completion of crossmatching and dating it is necessary to calculate the felling date. If the bark or bark edge is present on a sample of any species, the exact felling year can be given. In its absence, the amount of missing wood must be estimated. The presence of sapwood on oak (Quercus spp) samples makes this process more precise since the number of sapwood rings in oak is relatively constant. A recent study on oak sapwood data showed that 19 out of every 20 samples from British trees over 30 years old had 10-55 sapwood rings (Hillam et al 1987). These 95% confidence limits are used to estimate felling dates in the absence of complete sapwood.

Results

Context 628

All the samples were oak and all were measured. They contained 36 to 60 rings but the outer rings of 628T and 628Q were very narrow. These were therefore counted rather than measured as it was not possible to determine the boundaries of the rings accurately.

The ring sequences of 18 of the samples crossmatched (Figure 1a) to give a total sequence of 60 years and their ring widths were combined to

produce a master curve, ALOAK (Table 1). The unmatched sequences were tested against the master curve but neither were found to match. ALOAK was compared with all the available reference chronologies from the Roman period, but no conclusive results were obtained so this master remains undated.

Sixteen of the samples had retained their full complement of sapwood and the results indicate that the timbers were all felled in the same year. The outermost complete sapwood ring of these 16 samples is year 60 on the arbitrary scale (Figure 1a). However, the spring vessels of the following years growth are present, indicating that the timbers were felled in the late spring/early summer of year 61.

Context 861

The samples from this context were all alder (Alnus glutinosa Gaertn) and had 29-46 rings. Several of the samples appeared to have bark edge. Despite the shortness of their ring sequences all of them were included for measurement.

Three of the ring sequences (861G, 861H, 861J) crossmatched (Figure 1b) and their ring width data was averaged to produce a master ALALDER (Table 2). Several tentative matches were obtained with other sequences but further proof is required before these could be accepted without reservation.

ALALDER and all the individual alder sequences were tested against ALOAK, as there are indications that the ring patterns of some species, eg ash (Fraxinus excelsior L.), can be crossmatched with oak. However, no reliable crossmatches were obtained.

Discussion

Within a group of matching samples not all comparisons will produce high t-values, but each sequence should match well with at least two others. The quality of the crossmatching between the Alcester oak tree-ring sequences (Table 3) suggests that the timbers were obtained from a single woodland source and probably from the same area within that woodland. It is also possible that some of the timbers eg 861A and 861M

were cut from the same parent tree (indicated by a very good visual match and a t-value of 13.3).

Lack of absolute dating is probably due to the shortness of the sequences and the fact that the few reference chronologies available that span the 4th century are either Irish or German. This lack of reference chronologies may be caused by the occurence of a possible depletion/regeneration phase as discussed by Baillie (1982: 217) in association with the decline of the Roman influence in Britain.

Although three alder ring sequences were successfully crossmatched, the difficulties of obtaining reliable relative dating from alder are demonstrated. Some consistent results were obtained for several of the other alder sequences but the t-values for the possible matches were generally low (usually less than 3.5) and could not be confirmed. The need for further detailed research into the use of non-oak species for dating purposes is evident.

Conclusion

The successful crossmatching of some alder sequences demonstrates the possibility of obtaining relative dating from non-oak species when found in sufficient quantities. The lack of dating for the Alcester oak timbers emphasises the difficulties associated with the use of short oak tree-ring sequences for absolute dating and also the need for more dendrochronological work on 4th century Roman timbers from England.

Acknowledgements

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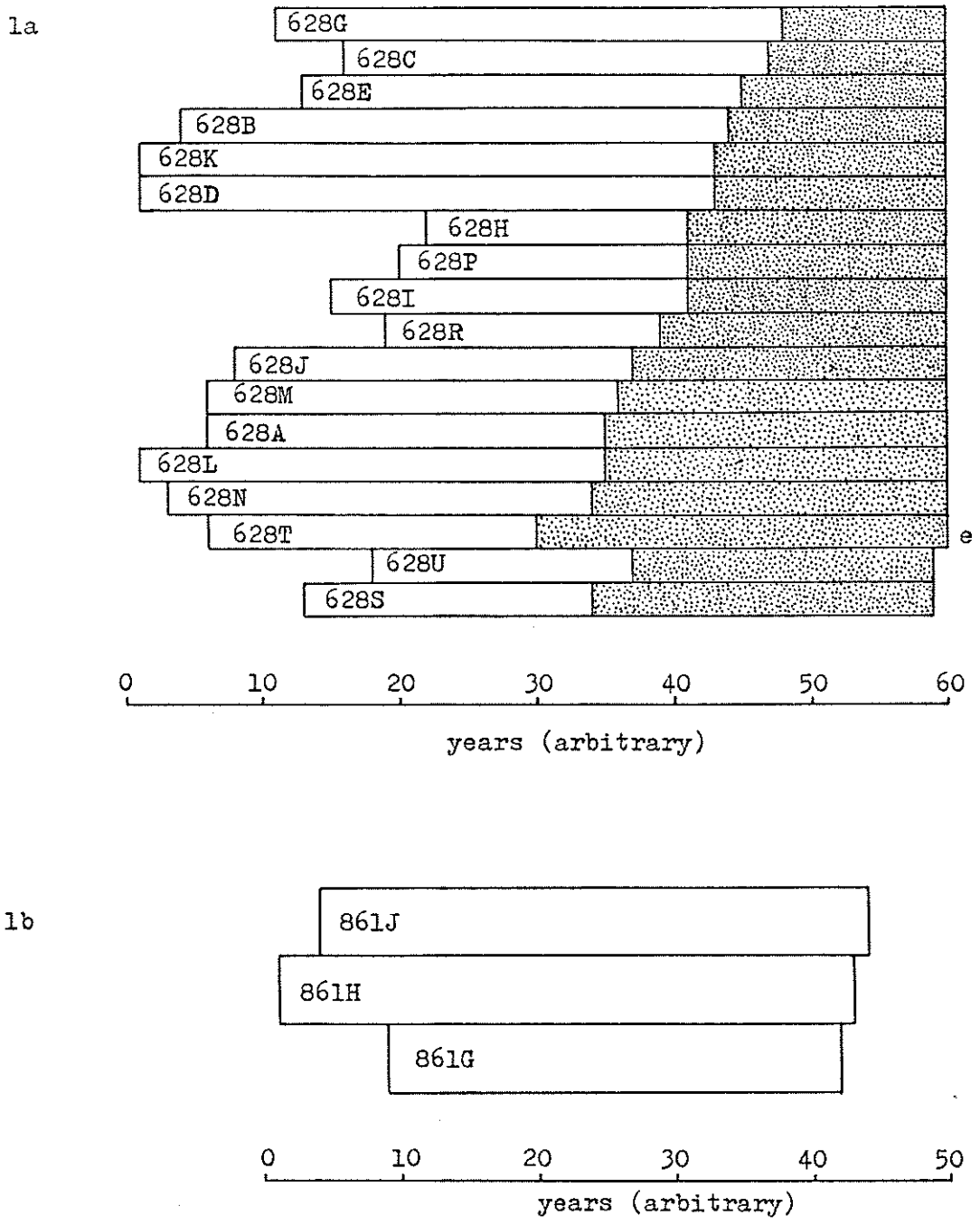

Figure 1: Bar diagram showing the relative positions of the matching ring sequences from Alcester: a) the oak sequences from context 628, 'e' indicates the presence of unmeasured rings, ▒ indicates sapwood; b) the alder sequences from context 861.

Table 1: Ring width data, in units of 0.02mm, of the Alcester master curve, ALOAK.

year	ring widths									
	0	1	2	3	4	5	6	7	8	9
1		89	79	109	129	126	98	75	131	162
10	121	109	127	140	114	77	98	92	126	110
20	92	75	78	99	125	138	114	96	87	89
30	80	77	82	95	80	62	61	61	61	60
40	51	58	60	57	49	46	48	59	56	47
50	50	55	48	42	48	43	42	28	22	29
60	38									

Table 2: Ring width data, in units of 0.02mm, of the Alcester master curve, ALALDER.

year	ring widths									
	0	1	2	3	4	5	6	7	8	9
1		190	161	117	123	93	102	80	74	132
10	132	129	137	124	125	101	114	79	70	83
20	88	74	42	49	59	61	45	28	43	34
30	53	42	47	45	41	22	33	53	22	26
40	19	18	18	29	19					

Table 3: Matrix of t-values obtained for comparisons between the 18 ring sequences from context 628 included in the master curve ALOAK. '-' indicates a t-value of less than 3.0.

	A	B	C	D	E	G	H	I	J	K	L	M	N	P	R	S	T	U
A	*	3.4	3.5	7.9	6.3	4.3	3.0	3.9	4.4	6.3	7.6	13.3	5.7	3.7	6.3	3.0	6.6	5.1
B	3.4	*	-	5.3	4.2	-	3.0	-	-	7.0	4.0	4.0	5.1	4.5	3.4	3.1	-	-
C	3.5	-	*	3.9	5.0	3.5	5.3	3.7	-	3.4	3.9	4.9	-	4.9	3.4	-	-	-
D	7.9	5.3	3.9	*	6.9	6.0	4.7	3.7	3.8	8.0	4.8	8.1	4.7	5.6	4.3	4.9	4.7	4.6
E	6.3	4.2	5.0	6.9	*	3.7	7.0	-	6.5	6.0	4.4	6.9	7.4	6.1	3.4	-	4.0	-
G	4.3	-	3.5	6.0	3.7	*	-	-	4.2	4.7	3.9	4.6	3.5	3.1	3.2	-	3.3	-
H	3.0	3.0	5.3	4.7	7.0	-	*	-	-	3.3	-	3.5	-	4.7	-	-	-	-
I	3.9	-	3.7	3.7	-	-	-	*	-	-	3.0	-	-	-	-	-	3.0	3.3
J	4.4	-	-	3.8	6.5	4.2	-	-	*	3.5	-	4.9	7.5	3.3	-	-	3.7	-
K	6.3	7.0	3.4	8.0	6.0	4.7	3.3	-	3.5	*	5.5	7.5	4.4	5.7	4.4	3.0	3.5	-
L	7.6	4.0	3.9	4.8	4.4	3.9	-	3.0	-	5.5	*	10.3	3.0	3.5	4.2	-	4.4	-
M	13.3	3.9	4.9	8.1	6.9	4.6	3.5	-	4.9	7.5	10.3	*	5.4	5.2	6.5	-	6.5	3.8
N	5.7	5.1	-	4.7	7.4	3.5	-	-	7.5	4.4	3.0	5.4	*	3.7	-	-	5.8	-
P	3.7	4.5	4.9	5.6	6.1	3.1	4.7	-	3.3	5.7	3.5	5.2	3.7	*	3.6	-	-	-
R	6.3	3.4	3.4	4.3	3.4	3.2	-	-	-	4.4	4.2	6.5	-	3.6	*	4.5	-	4.2
S	3.0	3.1	-	4.9	-	-	-	-	-	3.0	-	-	-	-	4.5	*	-	-
T	6.6	-	-	4.7	4.0	3.3	-	3.0	3.7	3.5	4.4	6.5	5.8	-	-	-	*	-
U	5.1	-	-	4.6	-	-	-	3.3	-	-	-	3.8	-	-	4.2	-	-	*

APPENDIX A

Details of the samples and the results

SAMPLE - context and sample number
RINGS - total number of rings
SAPWOOD - number of sapwood rings
AV.WIDTH - average ring width in mm
DIMENSIONS - maximum dimensions of the cross-section in mm

+ - indicates the presence of rings which could not be measuered accurately

be - indicates the presence of the bark edge

fs - indicates that the timber was felled in the late spring/early summer

APPENDIX A - DETAILS OF THE SAMPLES AND RESULTS
File: ALDATA
Report: SAMPLES AND RESULTS

SAMPLE	SPECIES	RINGS	SAPWOOD	AV WIDTH	RESULT	DIMENSIONS	COMMENT
628A	oak	55	24-26	1.55	matched	180x180	fs
628B	oak	57	15-17	1.21	matched	150x150	fs
628C	oak	45	14	1.66	matched	165x140	fs
628D	oak	60	17-18	1.65	matched	220x220	fs
628E	oak	48	16	1.83	matched	195x170	fs
628F	oak	36	17-20	1.71	unmatched	140x130	fs
628G	oak	50	13	1.58	matched	180x150	fs
628H	oak	39	18-20	1.61	matched	165x145	fs
628I	oak	46	18-20	1.45	matched	180x160	fs
628J	oak	53	21-24	1.26	matched	150x135	fs
628K	oak	60	12-18	1.68	matched	210x190	fs
628L	oak	60	25-26	1.51	matched	200x190	fs
628M	oak	55	23-25	1.32	matched	200x180	fs
628N	oak	58	22-27	1.26	matched	155x155	fs
628P	oak	41	16-20	1.94	matched	175x140	fs
628Q	oak	43+	23-31	1.40	unmatched	140x120	+6 to be
628R	oak	42	21-22	1.64	matched	145x135	fs
628S	oak	47	17-26	1.30	matched	135x125	-
628T	oak	34+	30-31	1.84	matched	155x140	+21 to be
628U	oak	42	21-23	1.24	matched	125x110	-
861A	alder	29	-	2.67	unmatched	170x160	be?
861B	alder	46	-	1.64	unmatched	180x160	be
861C	alder	35	-	1.67	matched	145x135	be?
861D	alder	34	-	1.61	unmatched	125x125	-
861E	alder	33	-	1.82	matched	135x135	be
861F	alder	39	-	1.39	matched	140x125	be?
861G	alder	34	-	1.28	matched	115x115	-
861H	alder	43	-	1.51	matched	160x130	-
861I	alder	34	-	1.81	unmatched	140x140	be?
861J	alder	41	-	1.30	matched	125x115	be?
861K	alder	42	-	1.55	unmatched	150x145	-

APPENDIX B

Cross-sectional sketches

These are not drawn to scale, and are intended as a rough guide to the way in which the timbers were cut or split.

Sapwood is indicated by shading.

APPENDIX B

Sample	Sketch	Dimensions
628A		180x180
628B		150x150
628C		165x140
628D		220x220
628E		195x170
628F		140x130
628G		180x150
628H		165x145
628I		180x160
628J		150x135
628K		210x190
628L		200x190
628M		200x180
628N		155x155
628P		175x140
628Q		140x120
628R		145x135

Sample	Sketch	Dimensions
628S		135x125
628T		155x140
628U		125x110
861A		170x160
861B		180x160
861C		145x135
861D		125x125
861E		135x135
861F		140x125
861G		115x115
861H		160x130
861I		140x140
861J		125x115
861K		150x145

APPENDIX C

Details of reference chronologies used in this study.

chronology	date span
Alcester, Warwickshire (Baillie pers comm)	184BC-AD95
Allistragh, Ireland (Baillie & Pilcher pers comm)	AD39-337
Balloo Cottage, Ireland (Baillie & Pilcher pers comm)	AD18-312
Bridgehead, London (Hillam 1986)	252BC-AD86
Caerleon (Hillam 1987)	33BC-AD62
Carlisle (Baillie pers comm)	247BC-AD90
Droitwich Friar Street (Hillam 1982)	141BC-AD44
Droitwich Old Bowling Green (Crone pers comm)	215BC-AD25
London City-Southwark (Tyers pers comm)	252BC-AD255
London Late Roman (SDL)	AD117-294
Mancetter, Warwickshire (SDL)	139BC-AD33
Mill Lough, Ireland (Baillie & Pilcher pers comm)	13BC-AD390
Nantwich (Laxton, Litton & Simpson pers comm)	134BC-AD132
South Germany (Becker 1981)	370BC-AD1969
Southern Ireland Mills (Baillie pers comm)	AD261-881
Walton-le-Dale, Preston (Groves 1987)	235BC-AD119
West Germany (Hollstein 1980)	400BC-AD1965

(SDL - Sheffield Dendrochronology Laboratory)