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Summary

Two oak timbers from the residence of the Archbishops of York at Cawood, near York, were examined with a view to confirming the construction date indicated by the heraldic device on the gatehouse. It was not possible to date either timber.

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Tree-ring analysis of two timbers from Cawood, York, 1987

Introduction

Two oak timbers (*Quercus* spp) from the residence of the Archbishops of York at Cawood, near York, were sampled during restoration. One (CAW1) was from a major floor joist in the Castle Gatehouse, whilst the other (CAW2) was from a purlin in the attached, and presumed contemporary, brick residential range. Heraldry on the gatehouse dates its construction to the period of Archbishop Kempe (AD1426-51) and possibly as closely as AD1439-51, due to the presence of a Cardinal's hat on one of the shields. It was hoped that tree-ring analysis would corroborate the dating and confirm that both buildings are contemporary.

Method

The samples were prepared and measured following the method given by Hillam (1985). Two radii were measured on each sample and these measurements were averaged together to give a single ring sequence for both timbers. It is usual to measure only one radius on oak samples, but an exception was made in this case since only two timbers were available for tree-ring analysis. 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 widths of each timber were plotted as graphs, which were compared visually by superimposing the two curves and sliding one past the other searching for similarities in the ring pattern. This process of crossmatching is aided by the use of a computer. The computer program for this crossmatching process (Baillie & Pilcher 1973) 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).

The results only date the rings present in the timber and therefore do not necessarily represent the felling date. If the sapwood on an oak sample is complete, indicated by the presence of bark or bark edge, the exact felling year can be determined. A recent study of oak sapwood data showed that 19 out of 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. In the total absence of sapwood the addition of 10 rings to the date of the last measured heartwood ring produces a probable *terminus post quem* for felling. As the number of missing heartwood rings is unknown the actual felling date could be much later.

Results

CAW1 and *CAW2* had 79 and 45 annual growth rings respectively. The bark edge was present on *CAW1* and the appearance of the *CAW2* timber suggests that only the sapwood is missing from the sample. The cross-section of *CAW1* indicates that the timber must have come from a trunk of approximately 0.5 metres diameter and 79 years old when felled (Table 1). *CAW2* probably came from a trunk of similar or slightly younger age with a diameter of *circa* 0.3 metres.

The average ring width of both timbers is greater than 3.0mm. Generally trees with very narrow rings are from dense woodland where competition was severe (Bartholin 1978). This suggests that the Cawood timbers probably came from a more open context where competition was less severe. However a narrow band of growth rings, years 46-56, indicate that *CAW1* suffered severe stress, and hence a reduction in growth, during this period (Figure 1). This could be due to harsh local environmental growth conditions or factors such as defoliation by insects. An annual growth ring of an oak tree shows a distinct change in character between the springwood and summerwood of a total season's growth (Figure 2). Defoliation has little effect on the springwood which is formed during leaf expansion and relies on food stores laid down the previous year. However a defoliated tree produces substantially less summerwood as this is dependent on the immediate food supplies of that particular year (Varley 1978). Experimental work by

Varley (1978) has demonstrated that a tree may take several years to recover from defoliation, during which little growth occurs.

There was no similarity between the ring patterns of the two timbers but this does not necessarily indicate that they are not contempory. The ring sequences (Table 2; 3) are both short and the effect of the stress suffered by CAW1 would tend to obscure similarities in the ring sequences.

Single ring sequences of less than 50 rings are unlikely to provide reliable absolute tree-ring dates as the ring pattern may not be unique (Hillam *et al* 1987). Consequently no further work was carried out on CAW2. CAW1 was tested against reference chronologies from Britain and Europe. No consistent dating was obtained from these comparisons and therefore this sequence remains undated.

Conclusions

Sample CAW2 is probably undateable because of insufficient rings but it may be possible to obtain a tree-ring date for CAW1 as more reference material becomes available from the York area. The importance of obtaining a tree-ring date for CAW1 is enhanced by the presence of the bark edge. This would produce a precise felling date and hence an accurate indication of construction date which would refine or refute the AD1426-51 indicated by the heraldry.

Acknowledgements

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Table 1: Details of the samples; sketches are not to scale; hs - indicates heartwood-sapwood transition.

sample number	number of rings	sapwood	average ring width (mm)	sketch	maximum dimensions (mm)
CAW1	79	18	3.24		360x245
CAW2	45	?hs	3.18		185x140

Table 2: Ring width data, in units of 0.02mm, of <u>CAW1</u>.

year	ring widths									
1	84	90	101	114	172	198	183	185	255	234
11	145	234	185	213	186	147	160	128	143	112
21	220	151	147	178	153	171	169	210	181	194
31	236	226	209	204	121	198	265	239	155	118
41	181	341	324	155	251	75	33	22	26	28
51	33	40	49	60	68	90	131	118	157	160
61	194	133	202	164	234	149	150	181	272	147
71	118	114	145	184	140	211	153	244	290	

Table 3: Ring width data, in units of 0.02mm, of <u>CAW2</u>.

year	ring widths									
1	31	77	136	86	135	183	194	203	181	220
11	203	241	179	185	220	209	184	150	217	158
21	153	186	206	152	180	169	198	177	200	130
31	123	122	107	136	105	122	163	132	198	157
41	142	161	91	130	119					

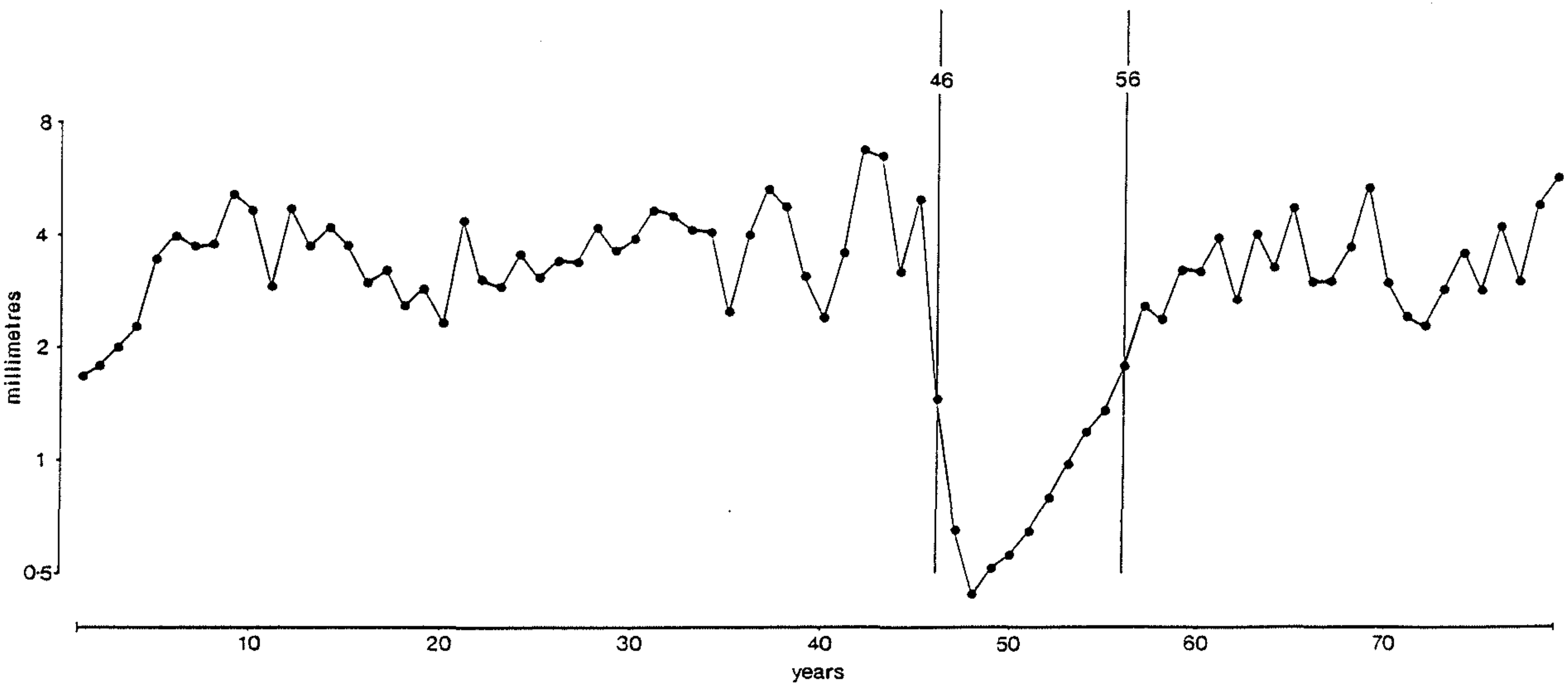

Figure 1: The tree-ring sequence of CAW1 with the narrow band of growth rings between years 46–56.

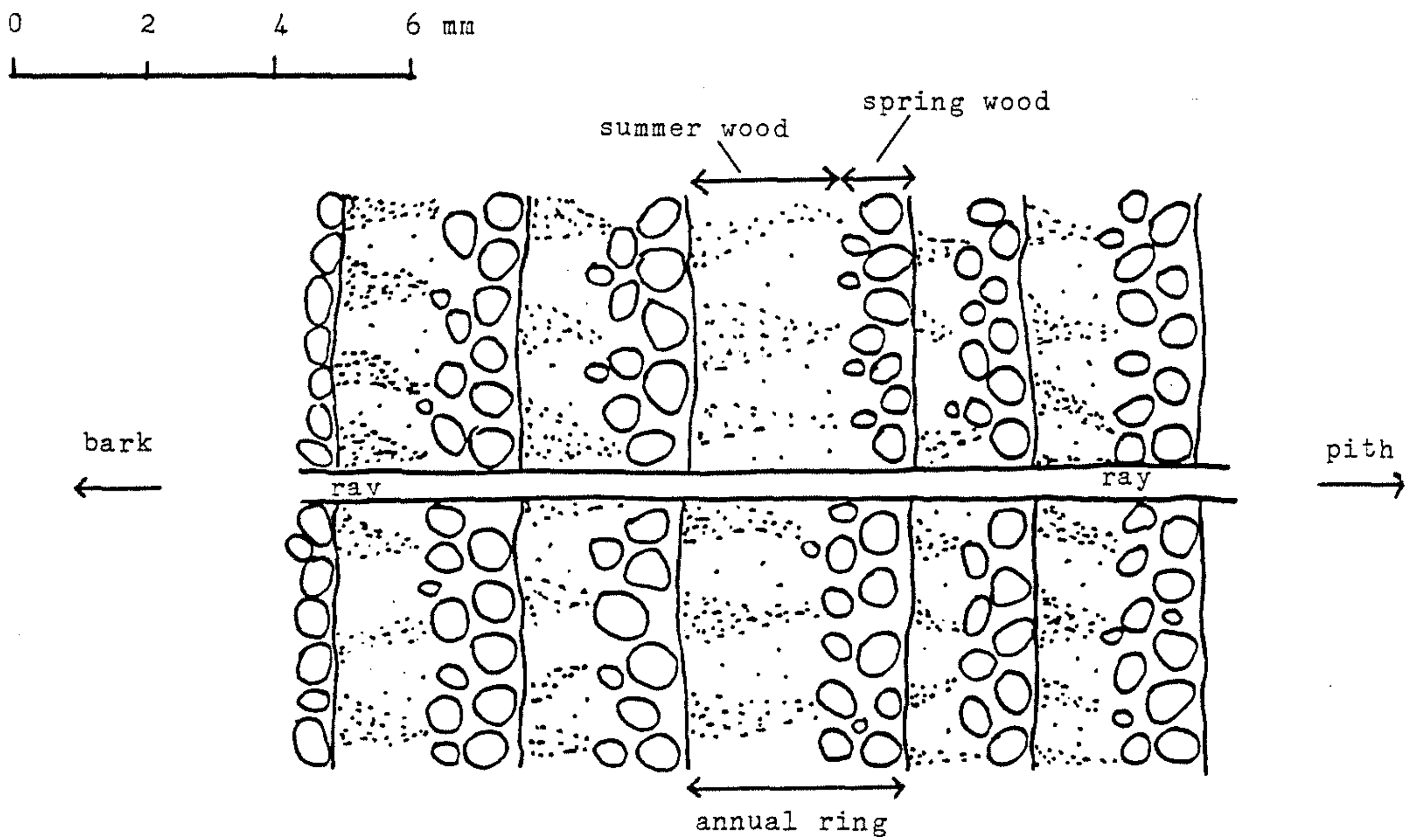

Figure 2: Diagram of the structure of oak growth rings. The springwood consists of large vessels formed between March and May. The summerwood becomes increasingly fibrous and contains much smaller vessels.