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BEDERN HALL, YORK - TREE-RING DATING

by Jennifer Hillam, June 1982.

Summary

Tree-ring analysis of twelve oak timbers from Bedern Hall produced a 142-year chronology which was dated to AD 1228-1369 by comparison with a tree-ring sequence from the Central Tower at York Minster. The chronology was made up from ring sequences from four rafters and one rafter support. The timber for these was felled in AD 1369/70 or just after. Although the two wallplates and one wallplate-tie could not be dated, a construction date of AD 1369/70 or just after is postulated for the roof.

Twelve oak timbers (Table 1) were examined in 1981. 102, 106, 108, 112, 113 and 114 were samples from rafters, 109 and 116 were from rafter supports, 110 and 111 from gable wallplates, 107 from a scissor timber and 115 from a wallplate-tie. The samples were cleaned using an electric drill with sander attachment. Various grades of sanding disc from coarse to fine were used to give a high polish. The final finish was added by hand polishing with very fine wet-and-dry paper. The annual growth rings could be seen clearly after this preparation, each ring being distinct from the next.

The ring widths were measured on the Sheffield tree-ring measuring apparatus which consists of a travelling stage connected by a linear transducer to a display panel. The wood sample is placed on the stage and observed through a 10x binocular microscope. As each ring is traversed by moving the stage, the width in 0.1mm is shown on the display unit and is recorded manually.

The Bedern Hall timbers had between 22 and 139 annual rings. Since sequences of less than 50 rings rarely give reliable dating, some samples (108, 109, 112) were rejected at this stage. In addition, sample 107 had a large knot which distorted its tree-ring record, and this too was discarded. The ring widths from the remaining samples (listed in the Appendix) were plotted against time in years on transparent semi-logarithmic recorder paper. The use of transparent paper allows the ring patterns to be compared by superimposing one graph over another and searching for similarities between them. A computer program (Baillie & Pilcher, 1973) is also available for crossdating purposes. It calculates the correlation value,

Student's t, for each position of overlap between two ring sequences. A value greater than t = 3.5 indicates a tree-ring match if it is accompanied by an acceptable visual match, i.e. the quality of the latter is the important factor in crossdating. The computer program is used to save time by indicating the possibility of a match, or to give a statistical evaluation of the degree of correlation between two tree-ring curves.

Four of the rafter sequences (102, 106, 113, 114) and one of the rafter support sequences (116) crossmatched to give a total sequence of 142 years (Fig.1). The agreement values vary between 1.20 and 7.45 (Table 2). The highest value results from a comparison between 102 and 106 which has an overlap of only 20 years. This contrasts with the comparison between 102 and 114 where an overlap of 25 years gives a value of 1.20. When the matches were examined visually, that between 102 and 114 was poor whilst the one between 102 and 106 was almost perfect, indicating that timbers 102 and 106 probably originated in the same tree (Fig.2) whereas 114 came from a different tree.

The ring patterns from the two gable wallplates (110, 111) crossmatched with each other (t = 7.87, overlap 53 years) forming a total sequence of 77 years. Niether this nor the remaining timber (115) crossmatched with the sequences described above.

A Bedern master chronology (Table 3) was constructed by averaging the ring widths of the matching samples. This was also tested against 110/111 and 115 but still no crossmatching was found. The master curve was then compared by computer with dated medieval tree-ring

tree-ring chronologies from the British Isles. (These are too numerous to list but see, for example, Baillie, 1982; Fletcher, 1977; Hillam, 1981.) An acceptable match was found between Bedern and an unpublished sequence, AD 1214-1462, constructed from timbers in the Central Tower at York Minster. (The original work on these timbers was carried out by V. Siebenlist-Kerner; the data was processed and the chronology produced by R. Morgan.) The match, part of which is illustrated in Fig.3, gave a t-value of 4.79 and dated the Bedern sequence to AD 1228-1369. A second match (t = 3.65) with a chronology from south-central Scotland (Baillie, 1977) confirmed the dating. 110/111 and 115 were also compared with the reference chronologies but no reliable crossdating could be found.

The Bedern Hall tree-ring sequence dates to AD 1228-1369 but in order to relate this to the felling date of the timbers, and hence to the date of construction, it is necessary to examine the amount of sapwood, if any, remaining on the timbers. Sapwood is the outer part of the tree which in oak is distinguishable by colour and structure from the inner heartwood (Fig.2). The number of sapwood rings in oak is relatively constant at 20-40 rings so if the heartwood-sapwood transition is present on a timber a fairly accurate felling date can be estimated (for further discussion, see Hughes et al, 1981). Of course, if the sapwood is preserved up to the bark or waney edge, a felling date exact to the year can be quoted.

Of the matching samples, 106, 113, 114 and 116 had 19, 1, 22 and 28 sapwood rings respectively (Fig.1). Samples 106, 114 and 116 ended within five years of each other, and 116 appeared to have its full complement of

sapwood rings. (The waney edge, the line separating the outermost sapwood ring from the bark, seemed to be present along one edge of the timber, but the outer ring was too worn to be absolutely certain.) The outer ring on 116 was fully formed indicating that, if the presence of the waney edge is accepted, the tree was felled in the winter or early spring of AD 1369/70. It can be postulated therefore that the timber for the rafters and rafter supports was felled in AD 1369/70 or, allowing for the slight uncertainty about the waney edge, just after. The seasoning of timber for building purposes is a recent introduction. Unless it was to be used for furniture or panelling, timber was usually felled as required and used almost immediately (e.g. Harvey, 1975, p.115; Rackham, 1976, p.76), so that felling dates and construction dates or often one and the same. Bedern Hall roof therefore was constructed in AD 1369/70 or just after.

Acknowledgements

I am grateful to Mrs R.Morgan for making available her data from the Central Tower, York Minster, and for her help in preparing this report. The work was financed by the Department of the Environment.

References

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Fletcher J.M. 1977, Tree-ring chronologies for the 6th to 16th centuries for oaks of southern and eastern England. J. Archaeol. Science 4, 335-52.

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Legends to Figures and Appendix

Fig.1 Bar diagram illustrating the relative positions of the ring sequences. Sapwood rings are represented by hatching, and the heartwood/ sapwood transitions by arrows.

Fig.2 Sketch of a tree trunk showing the possible positions of 102 and 106. One or both of the timbers could of course have been taken from the opposite half of the trunk.

Fig.3 Matching tree-ring curves: a section of the match between the Bedern and York Minster chronologies.

Appendix Listing of the ring width data: the first two lines identify the sample, the third gives the number of rings measured, and the fourth and subsequent lines list the ring widths in 0.1mm.

fig. 1

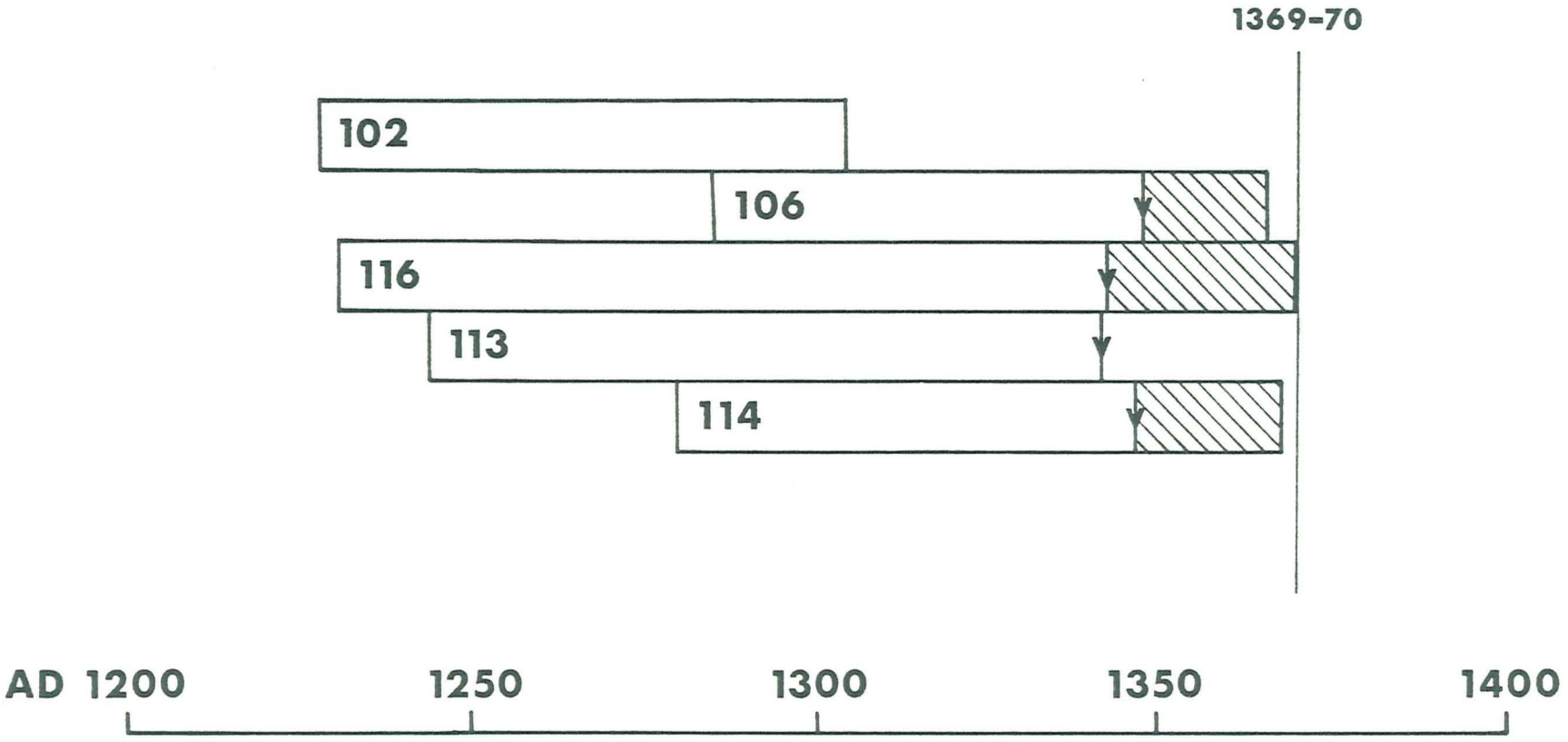
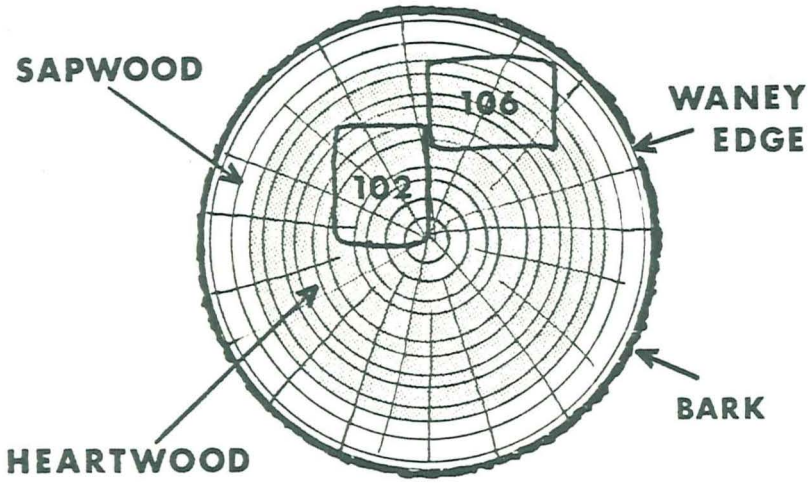


Fig. 2



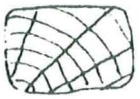
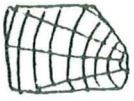
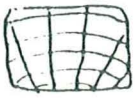
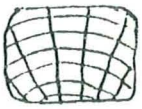
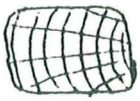
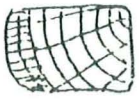
no.	function	no. of rings	sapwood rings		average width(mm)	dimensions (cm)	sketch
102	roof rafter	77	-		2.05	10 x 14	
106	rafter	81	19		1.75	10-11 x 16	
*107	scissor	?	-		?	11 x 16	knot
*108	rafter	31	-		-	12 x 14-16	
*109	rafter support	22	-		-	13 x 13	
110	gable wallplate	72	21		2.13	18-19 x 24	
111	gable wallplate	58	-		1.96	20 x 19-22	
*112	rafter	29	-		-	12 x 12-13	
113	rafter	98	1		1.52	12 x 15	
114	rafter	88	22		1.77	11 x 15	
115	wallplate tie	100	-		1.40	14 x 15	
116	rafter support	139	28	bark edge?	1.23	13 x 15	

Table 1: Details of Bedern Hall tree-ring samples. Sketches are not to scale; asterisks indicate unmeasured samples.

	106	113	114	116
102	7.45(20)	3.37(61)	1.20(25)	3.06(74)
106		3.13(57)	3.74(88)	5.54(81)
113			5.28(62)	4.36(98)
114				4.42(88)

Table 2: Summary of t-values. Figures in brackets indicate the length of overlap between each pair of ring sequences.

year	ring width (0.1mm)										
	0	1	2	3	4	5	6	7	8	9	n
1228									34.0	27.0	1
1230	24.0	16.5	16.0	14.5	21.0	26.5	21.0	30.5	32.0	29.0	2
1240	23.5	28.0	33.5	28.0	24.3	23.3	15.0	22.7	19.7	20.7	3
1250	22.0	24.0	27.0	32.0	34.7	33.3	23.0	22.0	17.7	17.7	3
1260	22.0	18.3	13.3	11.3	15.7	15.3	14.7	12.0	13.3	17.3	3
1270	15.0	14.0	9.3	9.3	11.0	13.3	20.0	21.3	16.3	13.3	3
1280	21.8	21.3	18.5	16.5	18.5	17.8	12.3	10.0	12.5	21.5	4
1290	26.3	29.5	22.3	21.3	16.0	13.8	11.8	15.0	12.5	11.8	4
1300	15.0	16.0	11.5	8.3	8.0	16.5	16.7	13.7	12.2	20.2	4
1310	11.2	14.2	11.2	11.0	12.7	17.2	13.0	16.0	15.0	13.5	4
1320	10.5	9.2	7.0	8.5	7.0	10.2	9.2	15.5	14.7	10.7	4
1330	8.0	7.5	12.5	12.0	13.7	20.2	12.0	10.5	11.0	16.2	4
1340	16.5	20.0	27.7	27.0	24.3	20.0	13.3	12.0	17.7	14.0	3
1350	10.7	10.0	9.0	11.0	14.3	17.3	20.0	13.3	10.3	8.7	3
1360	7.3	14.3	9.3	15.3	16.3	13.0	6.5	5.0	6.0	7.0	3

Table 3:

Bedern Hall master curve, AD 1228-1369. 'n' denotes the number of trees per decade.

APPENDIX

BEDERN HALL, YORK
BED 102
33
34 33 24 [illegible] 32 15 [illegible] 38 51 [illegible] [illegible] 35 [illegible] 25 23 20 37 30 18 26 29 32 25 [illegible]
32 30 32 17 30 16 11 16 14 17 [illegible] 11 12 14 10 13 15 16 22 10 12 15 17 23 [illegible]
19 13 20 26 24 21 [illegible] 23 [illegible] [illegible] 15 12 [illegible] 25 25 17 14 15 16 14 [illegible] 9 12 [illegible]
[illegible] [illegible]

BEDERN HALL, YORK
BED 106
31
30 16 12 15 22 32 36 31 24 14 10 12 18 14 [illegible] 17 19 13 [illegible] 9 14 28 29 23 16 [illegible]
19 18 14 11 [illegible] 5 [illegible] [illegible] 11 [illegible] [illegible] 10 [illegible] [illegible] 11 17 10 11 13 [illegible] [illegible] [illegible] 22 [illegible] [illegible]
28 16 13 17 24 15 21 29 33 29 21 15 16 27 25 17 19 14 15 23 29 33 18 15 [illegible]
11 24 12 23 [illegible] 17

BEDERN HALL, YORK
BED 110
32
15 10 14 18 21 16 25 25 34 31 25 40 31 33 49 48 37 34 26 29 29 26 32 40 [illegible]
33 30 36 47 44 26 30 23 17 17 31 29 20 10 22 32 19 21 14 21 14 15 16 16 [illegible]
13 10 10 10 [illegible] 9 16 [illegible] [illegible] 12 14 12 13 10 [illegible] 5 5 6 6 9 5 5 6

BEDERN HALL, YORK
BED 111
58
15 17 26 21 23 27 29 30 34 31 42 51 26 25 29 23 35 27 28 39 33 30 24 18 [illegible]
15 12 16 26 25 20 16 [illegible] 29 30 17 10 10 10 [illegible] 7 13 16 14 [illegible] 8 12 [illegible] 14 17 10 [illegible]
13 11 10 12 12 11 [illegible] [illegible]

BEDERN HALL, YORK
BED 113
56
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BEDERN HALL, YORK
BED 114
[illegible]
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16 10 15 13 [illegible] 11 [illegible] 15 15 [illegible] [illegible] [illegible] 41 24 22 16 12 [illegible] 11 [illegible] [illegible] 16 32 25 [illegible]
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BEDERN HALL, YORK
BED 115
107
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BEDERN HALL, YORK
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132
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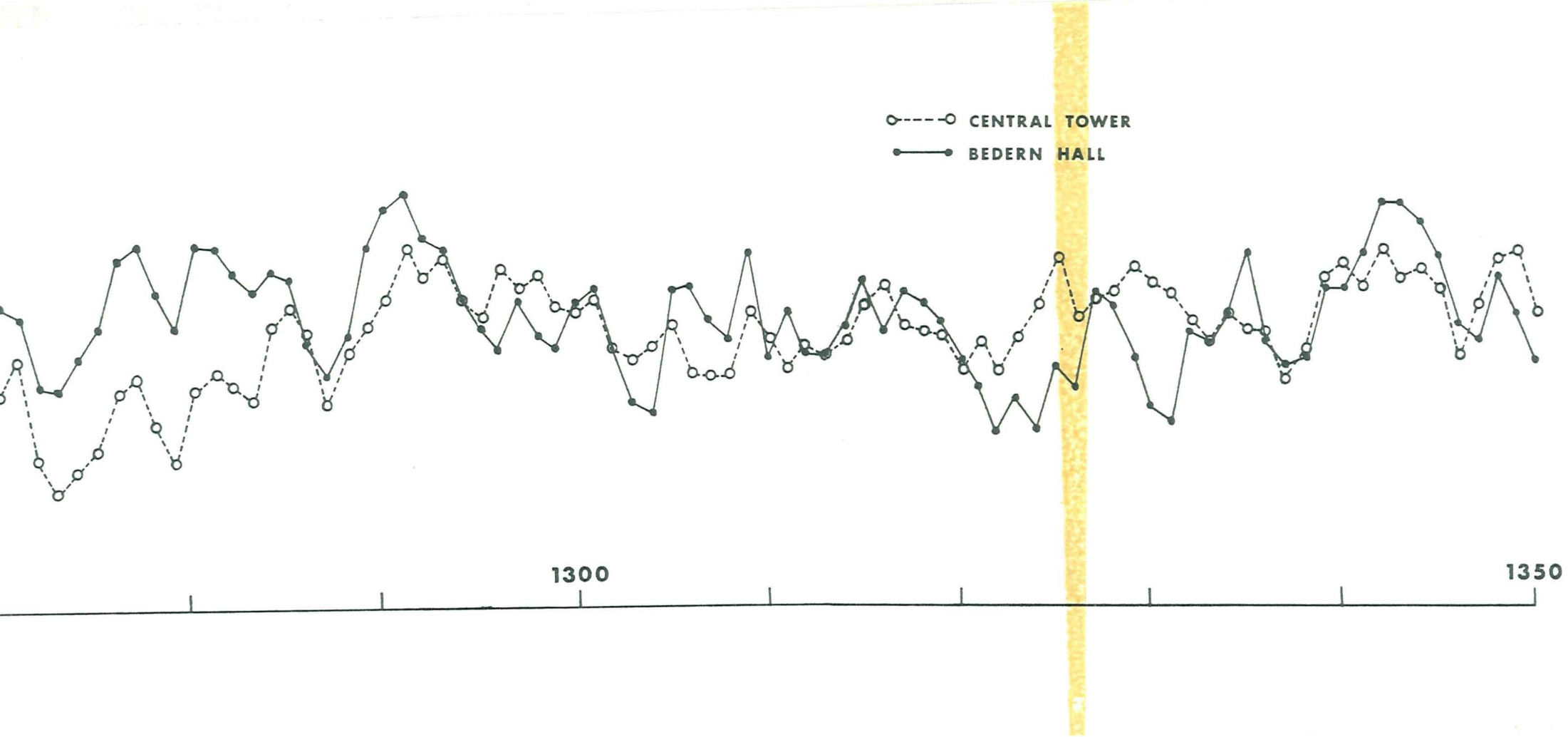
CENTRAL TOWER
BEDERN HALL
1300
1350

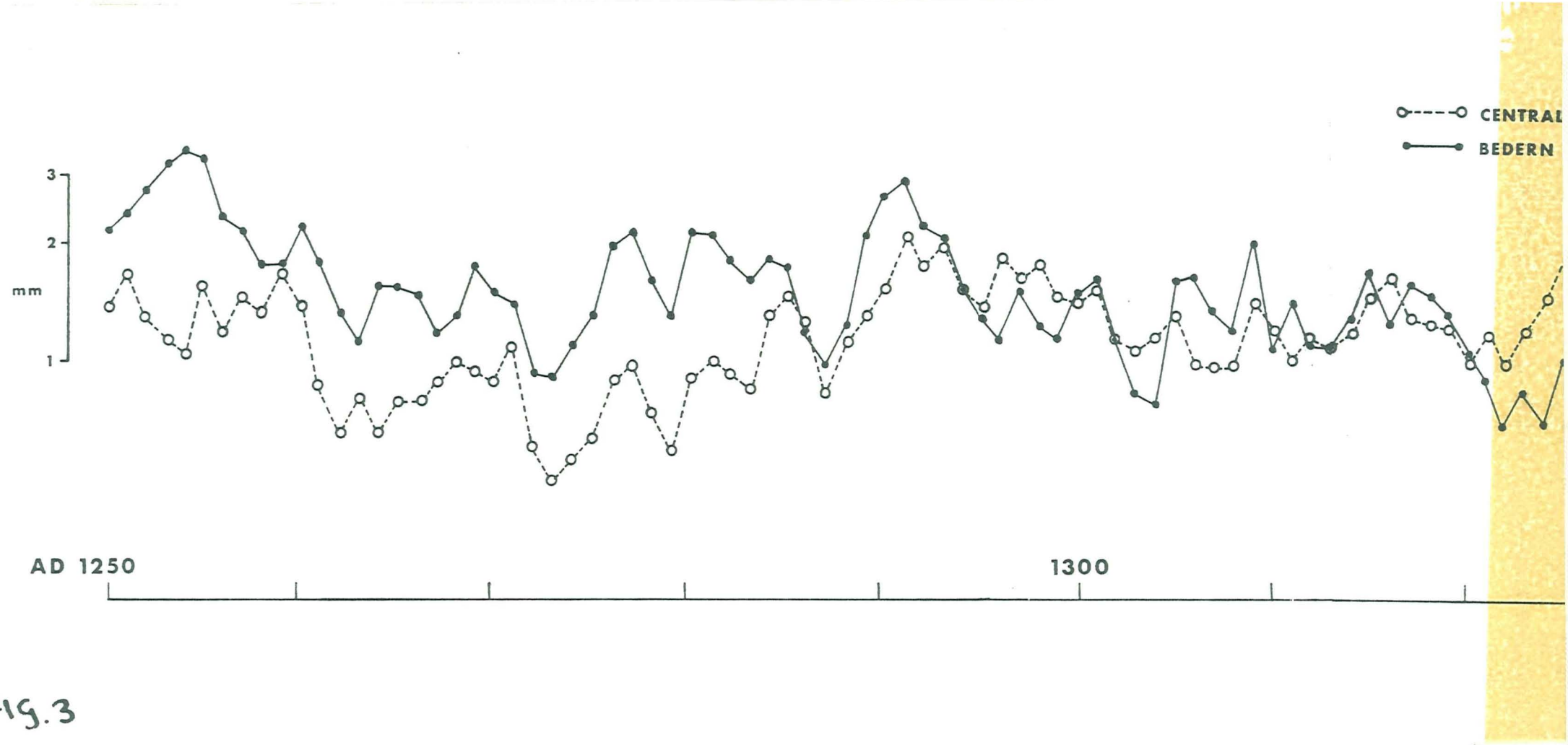

Fig.3