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DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS FROM LURK LANE, BEVERLEY, 1979-81.

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Summary

Tree-ring analysis was carried out on 34 samples from oak timbers excavated at Lurk Lane during 1979-81. Samples associated with a large earth-fast post structure indicate that it was probably constructed in the latter half of the 11th century. This building was then either repaired or a second similar structure erected during the mid/late 12th century. The timbers from the padstone-base building, which replaced the earth-fast post structure(s), were probably felled after AD 1236 and before AD 1280. Two site chronologies covering the periods AD 885-1124 and AD 1137-1236 were also produced.

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Dendrochronological analysis of oak timbers from Lurk Lane, Beverley, 1979-81

Introduction

Excavations at Lurk Lane by the Humberside Archaeological Unit during 1979-81, revealed a sequence of large medieval hall structures and associated buildings. The site is adjacent to the south side of Beverley Minster and it has been suggested that the buildings may represent the medieval Bedern associated with the Minster (Armstrong 1980). Archaeological evidence suggests that this complex of buildings occupied the site until the 16th century when a major change of land use is then indicated.

Oak timbers (Quercus spp) from some of these structures were sampled for tree-ring analysis. Twenty one samples were associated with a large 11th century earth-fast post structure. The positions of these timbers suggest that there could be more than one earth-fast post building and so cause some date variation within this group of samples (Armstrong pers comm).

The second group of samples relate to two phases of a large padstone-base building which replaced the earth-fast post structure in the late 12th century. Four of these samples (1419A, 1419B, 1735, 1738) belong to the earliest phase of the building (ie late 12th century) but 594 is associated with a major alteration which probably occured in the early/mid 13th century.

A third group of samples (589, 1322, 1345 and 1370) were from structural timbers, probably of 11th-13th century date, which had been dumped in a ditch. Of the remaining four samples, stratigraphical evidence suggested that 1720 may be associated with a structure that preceded the earth-fast post structure; 1077, a plank from a post hole, was thought to be 13/14th century, and 1334 and 1544 pre-13th century.

It was hoped that tree-ring analysis would provide a more precise indication of the dates of construction and alterations to the buildings and thereby help to clarify the dating framework of the site. The samples had previously been examined during 1980/81 and 1985 but no dating had been obtained even though two later medieval chronologies for

Beverley existed. Timbers from Hall Garth bridge (Hillam 1981) and Dyer Lane (Groves & Hillam 1985) produced tree-ring chronologies spanning the periods AD 1002-1324 and AD 903-1183 respectively. Following the successful dating of a large number of timbers from the excavations at Eastgate, Beverley (Groves 1987), and the availability of a new reference chronology for the East Midlands area (Laxton, Litton & Simpson pers comm), the timbers from Lurk Lane were re-examined.

Method

The samples were prepared following the method given by Hillam (1985). Any unsuitable samples were rejected before measurement. These are usually samples with unclear ring sequences or samples with sequences of less than 30 rings (short sequences are generally not unique and so cannot be dated reliably). The number of rings and their orientation and also the size of the cross-section of every sample was noted (Appendix A, B).

The annual rings of the timbers examined in 1980/81 (see Appendix A) were measured by placing the sample on a travelling stage connected to a display panel. As each ring was traversed, its width, in units of 0.1mm, was displayed on the panel. These were recorded manually and then punched into the mainframe computer. The display panel was replaced in 1983 by an Apple II microcomputer which automatically records the ring widths, in units of 0.02mm, and all remaining samples were measured on this system (Hillam 1985: fig 4).

The ring sequences were plotted as graphs and these tree-ring 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). The program was also used to compare the tree-ring sequences from the oak samples with dated reference chronologies from Britain and Europe. The difference in the units of the ring widths does not cause any problems during

crossmatching as it is the relative widths rather than the absolute widths of the rings that are compared.

Tree-ring dates 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 from the date of the last measured ring. 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 the probable terminus post quem for felling. As the number of missing heartwood rings is unknown the actual felling date could be much later.

Construction usually followed soon after felling since seasoning was not a common practice in medieval times (see, for example, Hollstein 1980 or Rackham 1976). At this stage of tree-ring analysis, however, factors such as stockpiling or timber re-use must also be considered, since they might affect the interpretation of the tree-ring dates. Thus, whilst the production of dates is a completely independent process, their interpretation can be refined by studying other archaeological evidence.

Dating the timbers

A total of nine samples were rejected as they had either insufficient rings (eg 1322) or unclear ring sequences (eg 1081B). The remaining samples contained from 38-180 annual rings and 5 (824, 848, 1345, 1735, 1738) had retained sapwood (Appendix A, B). Despite the length of the ring sequences only 2 of the 25 samples measured crossmatched; a good visual match and a t-value of 6.2 was obtained between 1419B and 1735. The ring width data of these two samples was combined to give a master curve, LURK1, for the padstone-base building (Table 1).

Due to the lack of reliable crossmatching between most of the samples, all the individual ring sequences and LURK1 were tested against various dated reference chronologies (for details, see Appendix C). The most commonly used chronologies were from Beverley:Eastgate and Dyer Lane, East Midlands and Bristol:Dundas Wharf. The 100 year sequence LURK1

dated to AD 1137-1236 and consistent results were obtained for 7 other samples (Table 2; Figure 1). The results were confirmed when the matches were checked visually. The ring width data of samples 750, 799, 800, 821, 956, 1077 and 1544 were averaged to produce a second site master curve, LURK2, which spanned the period AD 885-1124. (Ring width data of all dated samples was converted to units of 0.02mm prior to making the master curve.)

All undated sequences were then tested against both site masters and an additional sample, 1081A, was dated to the period AD 961-1018. This rings sequence was incorporated into LURK2 and a final master LURK3 was produced (Table 3).

Interpretation

The estimated felling dates of the timbers associated with the earth-fast post structure indicate that there were at least two felling phases (Figure 1). Samples 821, 956 and 1081A appear to be contemporary and a probable terminus post quem for felling of AD 1043 is obtained. Samples 750, 799 and 800 were all probably felled after AD 1134. The absence of sapwood on the dated timbers causes the felling dates and hence the construction dates to be less precise. However the results suggest that the earth-fast post structure was probably built in the mid/late 11th century and that a further phase of construction or alteration was likely to have been carried out during the mid/late 12th century. Although dendrochronological analysis has shown that there are at least two felling phases associated with this group of timbers, it is not possible to determine from the results whether they represent more than one earth-fast post structure.

The estimated felling date range of the two dated timbers from the foundations of the padstone-base building is AD 1236-1280. It was therefore probably constructed in the mid 13th century and not during the late 12th century as suggested by other archaeological evidence. Sample 594 was unsuitable for measurement and consequently no dendrochronological date could be obtained for the major alteration to the padstone-base building.

The estimated felling dates for 1077 and 1544 of after AD 1119 and after AD 1102 respectively suggest that these dumped structural timbers were probably originally felled and used in the 12th century. It is therefore possible that they are contemporary with the second phase of construction associated with the earth-fast post structure.

The Timbers

It is noticeable that many of the timbers appear to have been cut or split from poor quality wood. The distortion of the ring patterns by knots and the lack of sapwood on many of the samples makes it difficult to assess the size and age of the trees used to provide the timbers. However, it seems likely that the majority of the timbers were cut from parent trunks of at least 0.5 metres diameter and probably mostly over 50 years old. Some of the trees (eg 1077) may have been at least 200 years old when felled.

The variation in average ring widths from 0.74 to 3.55mm and the lack of significant similarity between the individual ring sequences may be due to the timbers having been obtained from a number of diverse sources, where the trees were subject to differing local environmental conditions. However, in this instance, it is also possible that the lack of crossmatching and dating is due to the distortion of the ring patterns by the presence of knots.

Conclusion

Analysis of the timbers associated with the earth-fast post structure indicated that it could not have been erected before AD 1033 and was unlikely to have been built before AD 1043. The second felling phase indicated by timbers from the earth-fast post structure suggest that either a second structure was built, or alterations to the original building were carried out, after AD 1134. Additional archaeological evidence and examination of the relative positions of the timbers is necessary to determine the more likely interpretation. During the 13th century the earth-fast post structure(s) was replaced by a padstone-base building which was probably constructed in the period AD 1236-1280 shortly after the timbers were felled.

The dendrochronological results for the earth-fast post structure(s) are consistent with dating indicated by other archaeological evidence, but the mid 13th century date obtained for the padstone-base building is later than expected. The re-examination and subsequent dating of timbers from Lurk Lane demonstrates the increased likelihood of obtaining results for previously undated sites as more local and regional reference chronologies become available.

Acknowledgements

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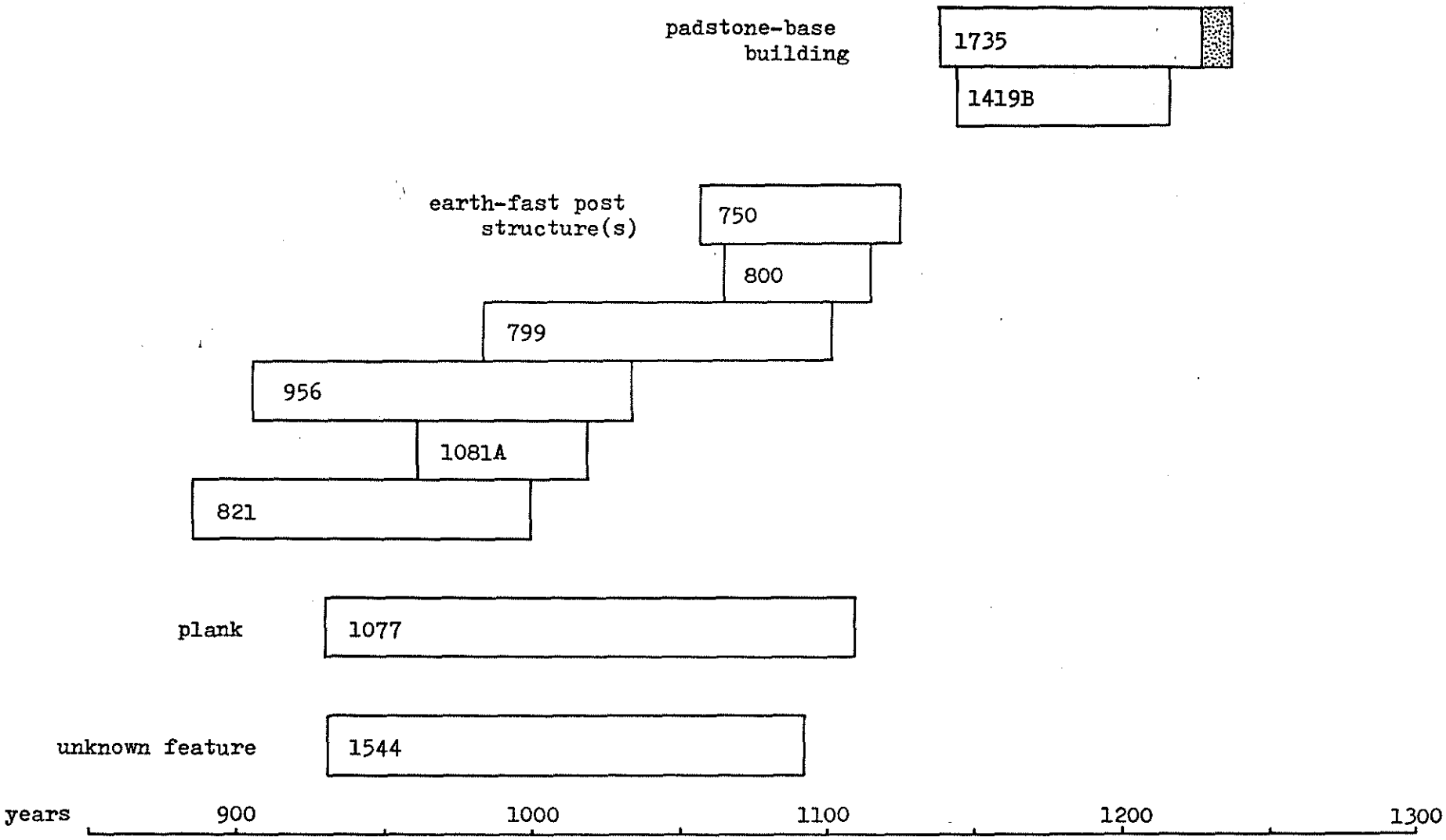


Figure 1: Bar diagram showing the relative positions of the dated Lurk Lane ring sequences. Shading indicates sapwood.

Table 1: Ring width data, in units of 0.02mm, of the master curve LURK1 (AD1137-1236).

year AD	ring widths 0	1	2	3	4	5	6	7	8	9
1137								308	404	334
1140	373	413	335	350	208	263	306	274	283	266
1150	290	239	282	302	252	242	240	222	138	173
1160	101	108	139	224	189	168	121	188	200	231
1170	246	225	174	170	132	107	86	116	100	86
1180	51	47	78	95	45	41	46	74	63	56
1190	65	95	107	127	98	125	105	54	36	29
1200	35	37	44	55	42	36	42	51	53	71
1210	77	55	38	35	48	50	46	124	71	63
1220	64	61	50	67	73	95	88	73	84	74
1230	79	65	47	38	70	75	65			

Table 2: Dating the Lurk Lane ring sequences. Results of comparisons with various reference chronologies for 750, 799, 800, 821, 956, 1077, 1544, LURK1 and LURK3. Details of the reference chronologies are given in Appendix C.

	t-values								
reference chronology	750	799	800	821	956	1077	1544	LURK1	LURK3
Belfast	-	-	-	-	-	-	-	3.9	-
Coppergate medieval, York	4.4	3.9	-	-	-	-	-	3.6	5.2
Coppergate Viking, York	-	-	-	3.6	3.9	-	3.9	-	4.6
Dublin	-	-	-	4.8	-	-	-	-	3.2
Dundas Wharf, Bristol	3.9	-	4.2	3.9	3.0	3.3	-	-	4.3
Dyer Lane, Beverley	3.6	3.9	4.2	-	-	-	-	-	3.9
East Midlands	4.4	6.6	5.1	3.2	8.1	4.4	5.2	3.7	10.5
Eastgate, Beverley	5.3	4.2	4.0	3.1	4.7	5.6	3.2	4.4	8.2
England	-	-	-	4.0	3.2	4.8	-	-	4.6
Hall Garth, Beverley	-	-	-	-	-	-	-	3.1	-
Hartlepool	-	4.3	-	-	-	3.0	-	-	4.1
Hull	-	-	-	-	-	-	-	3.8	-
Scotland	-	-	-	-	-	-	-	3.4	-

Table 3: Ring width data, in units of 0.02mm, of the master curve LURK3 (AD885-1124).

year	ring widths									
AD	0	1	2	3	4	5	6	7	8	9
885						125	110	105	115	90
890	130	70	55	50	50	40	30	35	55	60
900	60	55	60	45	55	80	105	70	122	90
910	67	95	90	65	75	67	75	57	57	67
920	65	60	70	65	72	45	60	52	47	80
930	88	84	62	51	83	67	80	90	79	98
940	93	92	52	35	53	60	77	79	81	80
950	64	46	39	41	56	85	53	43	71	54
960	61	56	38	54	55	47	75	62	56	55
970	65	78	70	50	49	54	49	71	74	80
980	79	59	68	91	66	88	67	63	66	58
990	49	63	52	83	86	81	63	51	58	66
1000	72	74	97	90	78	74	65	62	65	60
1010	63	74	98	62	72	96	89	55	67	72
1020	70	93	77	78	63	56	57	90	105	90
1030	95	89	78	96	51	57	83	93	96	93
1040	93	80	72	39	66	57	50	63	53	37
1050	37	58	45	36	46	56	50	53	45	50
1060	48	52	43	35	39	32	64	47	59	53
1070	58	46	48	48	58	61	78	76	73	68
1080	78	51	61	65	61	85	75	58	64	78
1090	60	74	72	75	63	91	66	69	72	50
1100	49	46	48	64	39	55	68	55	79	50
1110	47	38	61	86	90	71	75	80	51	32
1120	47	61	89	65	84					

APPENDIX A

Details of the samples

SAMPLE - sample number

RINGS - total number of rings

SAP - number of sapwood rings

AV WIDTH - average ring width in mm

DIMENSIONS - maximum dimensions of the cross-section in mm

* - indicates samples measured in 1980/81

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

APPENDIX A - DETAILS OF THE SAMPLES AND RESULTS

File: LURKDATA

Report: SAMPLES

SAMPLE	RINGS	SAP	AV WIDTH	DIMENSIONS	RESULT1	RESULT2	COMMENT
589*	+116	-	0.91	70x40	undated	-	-
594	20	-	-	145x130	rejected	-	knotty
709*	113	-	1.83	420x310	undated	-	knotty
734*	86	-	1.54	240x220	undated	-	knotty
750	+69	-	1.26	200x175	dated	1056-1124	knotty
799*	119	-	1.52	220x150	dated	983-1101	-
800*	+51+	-	1.17	200x180	dated	1064-1114	-
816*	53	-	3.30	370x240	undated	-	-
821*	115	-	1.12	140x80	dated	885-999	-
824*	70+	28+	2.83	250x250	undated	-	+7 rings
848*	53	19	3.55	280x200	undated	-	-
923*	84	-	1.96	260x140	undated	-	-
938	c.30	-	-	230x70	rejected	-	-
953	c.30	-	-	160x100	rejected	-	-
956*	129	-	1.17	240x190	dated	905-1033	-
965*	74	-	2.37	320x310	undated	-	re-used?
1054	-	-	-	-	rejected	-	fragmented
1057	-	-	-	280x180	rejected	-	knotty
1077*	180	-	1.52	290x20	dated	930-1109	-
1081A*	58	-	1.96	180x160	dated	961-1018	-
1081B	c.43	-	-	230x190	rejected	-	knotty
1322	29	2	-	200x170	rejected	-	-
1334	152	-	1.58	430x280	undated	-	-
1345	58	14	2.23	370x250	undated	-	-
1370	c.35	-	-	340x280	rejected	-	knotty
1419A	66	-	2.20	140x130	undated	-	-
1419B	73	-	2.59	225x180	dated	1143-1215	-
1480	-	-	-	-	rejected	-	fragmented
1490	+88	-	0.74	170x135	undated	-	knotty
1534	53	-	2.63	190x155	undated	-	knotty
1544	162	-	1.11	210x185	dated	931-1092	-
1720	38	-	2.53	155x90	undated	-	-
1735	100	11	2.70	245x175	dated	1137-1236	-
1738	+116	36	0.61	275x235	undated	-	knotty

APPENDIX B

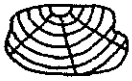
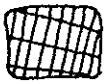
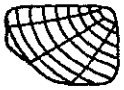
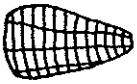
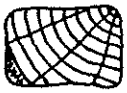
Cross-sectional sketches

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
589		70x40
594		145x130
709		420x310
734		240x220
750		200x175
799		220x150
800		200x180
816		370x240
821		140x80
824		250x250
848		280x200
923		260x140
938		230x70
953		160x100
956		240x190
965		320x310
1054	fragmented	-

Sample	Sketch	Dimensions
1057		280x180
1077		290x20
1081A		180x160
1081B		230x190
1322		200x170
1334		430x280
1345		370x250
1370		340x280
1419A		140x130
1419B		225x180
1480	fragmented	-
1490		170x135
1534		190x155
1544		210x185
1720		155x90
1735		245x175
1738		275x235

APPENDIX C

Details of reference chronologies used in the dating of Lurk Lane tree-ring sequences

chronology	date span
Belfast (Baillie 1977a)	893-1600
Coppergate medieval, York (SDL unpublished)	1031-1248
Coppergate Viking, York (SDL unpublished)	715-1011
Dublin (Baillie 1977b)	855-1306
Dundas Wharf, Bristol (Nicholson & Hillam 1987)	770-1202
Dyer Lane, Beverley (Groves & Hillam 1985)	903-1183
East Midlands (Laxton, Litton & Simpson pers comm)	882-1976
Eastgate Beverley (Groves 1987)	858-1310
England (Baillie & Pilcher pers comm)	404-1981
Hall Garth, Beverley (Hillam 1981)	1002-1324
Hartlepool (Hillam 1983)	951-1212
Hull (Hillam 1979)	1126-1297
Scotland (Baillie 1977c)	950-1924

(SDL - Sheffield Dendrochronology Laboratory)