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Ancient Monuments Laboratory Report 95/88

BILLINGSGATE LORRY PARK, CITY OF LONDON, 1982. TREE-RING ANALYSIS OF THE PERIOD VI AND VII TIMBERS.

Jennifer Hillam

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Summary

Using the results from dendrochronological analysis, this report continues to trace the chronology of the wooden features from the medieval Thames waterfront at Billingsgate Lorry Park in the City of London. The analysis and dating of the 61 timbers from Periods VI and VII are described here. Most of the 31 dated samples were either late 11th or 12th century in date, but a few were reused from the 10th century.

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Billingsgate Lorry Park, City of London, 1982. Tree-ring analysis of the Period VI and VII timbers

Introduction

This report is part of a series, the results of which outline the chronology of the timber structures at Billingsgate Lorry Park, City of London. The site was excavated in 1982 by Steve Roskams for the Museum of London's Department of Urban Archaeology, and over 600 timbers were sampled for dendrochronology. Most of the samples were collected during the excavation, but the components of the main structures were removed for conservation and sampled at a later date. The tree-ring analysis of the conservation samples is the subject of a separate report (Hillam & Groves 1985), but the results from the Period VII stave revetment will also be included here.

Tree-ring dates from the Period IV and V timbers (Hillam 1987, 1988) indicate that the medieval waterfront was developed on both sides of an inlet using timber felled in AD 1039/40 (IV.1, IV.2). An earlier structure must have existed because late 10th century timbers were also found in the 1039/40 structure. In 1055, a stave front was added to the west bank (IV.4) and both banks were consolidated with additional timbers (IV.2, V.3, V.4). Further development occurred in the second half of the 11th century, but precise tree-ring dates are not yet available. Finally a new revetment was added to the west bank (V.1), and possibly timbers added on the other side (V.8), some time after 1080. The V.1 revetment was originally thought to pre-date the V.3 bank but the tree-ring results indicated that the latter was in fact part of the IV.4 revetment.

In Period VI, the surface of the west bank was consolidated with timbers (VI.1) and the western inlet was lined with piles (VI.2). From archaeological evidence, the two events were probably contemporary. A new lining was also added to the eastern bank (VI.4).

The first phase of Period VII is represented by the stave revetment which was built on the east side (VII.1). The timbers from this structure have an estimated felling date range of 1144-1183 (Hillam & Groves 1985). VII.4 is represented by the construction of a drain in the

inlet. A new extension to the east bank revetment post-dates the VII.1 revetment (VII.5), but both structures were in use simultaneously. In VII.8, the VII.1 structure was modified, whilst the VII.5 structure was reconstructed in phase VII.9. Phase VII.13 seals the VII.9 activity, and thus post-dates it.

The tree-ring analysis of the 61 samples from periods VI and VII was undertaken to provide dates for the development of the Billingsgate waterfront in the late 11th and early 12th centuries. It was also hoped that the new dates would refine the estimated felling dates obtained for the phase V.6, V.8 and V.1 timbers.

The samples

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Twenty four timbers were sampled from the VI.1 surface consolidation. Most of them came from the timber dump but <u>5855B</u> was a stray timber, and <u>5416</u> was a grooved baseplate from the stave revetment in front of the west bank. Three timbers were sampled from the VI.2 west inlet lining, whilst fourteen samples were taken from the VI.4 east bank lining. The VI.2 timbers were piles, but those from VI.4 were either piles (eg <u>2713</u>) or cladding (eg <u>2666A</u>). The VI.4 timbers were also differentiated into those from an interim line of piles (eg <u>2713</u>) and those from a new east inlet lining (eg <u>6866</u>).

Samples from the VII.1 small stave revetment had already been analysed (Hillam & Groves 1085), but another two samples were examined for this study. <u>5082</u> was a pile from the west bank, whilst <u>5448</u> was thought to be a reused stave from the revetment.

A single stray reused timber ($\underline{6690}$) was sampled from the VII.4 drain, and four from the new east bank extension. $\underline{6042}$ was a plank fragment and $\underline{6378}$ was a pile from the north/south revetment, but the function of $\underline{6559}$ and $\underline{6594}$ is unknown. One timber ($\underline{6245}$) was sampled from VII.6, and three ($\underline{6327}$, $\underline{6552}$, $\underline{6659}$) from VII.7. Four samples were taken from the VII.8 modifications, although one of them ($\underline{6325}$) was a stray timber. Three planks ($\underline{4524}$, $\underline{6380}$, $\underline{6482}$) were sampled from VII.9, and two timbers ($\underline{5985}$, $\underline{6064}$) from VII.13. $\underline{5985}$ was a replacement timber for a VII.8 tieback, whilst 6064 was a pile from either a drain or a fence.

Methods

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The samples were prepared, measured and crossdated following the method given in Hillam (1985). They were examined phase by phase in groups of about ten. Any samples with less than 40 rings were rejected, along with any that had knots obscuring the ring pattern or had very narrow, unreadable rings (Appendices A, C). Usually the rings along only one radius per sample were measured, but occasionally two or even three radii were measured. This might be done if 1) the ring sequence was particularly knotty or difficult to measure; 2) the ring sequence was relatively short but had sapwood or bark edge; or 3) if the sequence was undated but was considered particularly important.

The measured ring sequences were plotted as graphs to facilitate visual comparison, and each sequence was compared by computer with other medieval reference chronologies from London. At the start of the study, the three chronologies used for comparison were CITY MED - made up of tree-ring data from the City of London (Hillam unpubl), SOUTHWARK tree-ring data from Southwark (Tyers unpubl), and BIG - the chronology produced during the study of the Billingsgate conservation samples (Hillam & Groves 1985). As work on the medieval samples progressed, various working masters were constructed from the Period IV and V samples. These were also used for dating purposes. Although the computer program CROS (Baillie & Pilcher 1973) was used to save time, the results were checked visually. Each ring sequence was checked against the other ring sequences as well as against the reference chronologies. A match was only accepted if the ring sequence crossmatched at least two others. Such careful checking prevents the inclusion of spurious matches which may occur, especially if the initial matching is done by computer.

A new computer program SORT-STRING (Crone 1987; Okasha 1987) has also been used in the Billingsgate study. Based on the original CROS program, it compares each sequence from a group against each other and calculates the highest <u>t</u>-value per pair. (A simple explanation of the <u>t</u>-test as applied to dendrochronology is given by Baillie, 1982 82.) The results are then sorted so as to find internally consistent groups of sequences based on the highest <u>t</u>-value. Thus, if a group A-E was selected, B would

crossmatch A, C would match A and B, and so on, with "match" in this case being equivalent to the highest t-value.

The program was designed chiefly for short oak and non-oak ring sequences, and has been used successfully on prehistoric tree-ring data (Crone pers comm). Billingsgate is the first complex urban site on which it has been used. It was used initially on the 115 sequences from phase V.3, after they had been analysed using traditional methods (Hillam 1988). The results of the test were mixed in that it confirmed a few tentative matches but missed some firm matches. In the present study, the data from Periods VI and VII were examined by the author using traditional methods. The data were then analysed independently by Cathy Groves using the SORT_STRING program.

The results from the visual and computer crossmatching were set out as a bar diagram (Figs 1,2) to make it easier to estimate felling dates (see Appendix C). It was not always necessary to estimate felling dates because a few of the samples had bark or bark edge. Where the sapwood was incomplete, a sapwood estimate of 10-55 rings was used to calculate the 95% confidence limits for the period of felling (Hillam <u>et al</u> 1987). In the total absence of sapwood, the probable <u>terminus post quem</u> for felling is given by adding ten years to the date of the last measured heartwood ring.

Results

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> Details of the samples are provided in Appendix A, whilst sketches of the cross-sections showing how the timbers were dressed are illustrated in Appendix B. Full details of the results are given in Appendix C, but they are summarised in Figs 1 and 2, and will be described below phase by phase. Because of the complexity of the site and the large number of samples, it is not possible to give full details of how each sample was dated. However the ring width data from all the measured samples are stored in the Sheffield Dendrochronology Laboratory, and can be consulted on request. A site master curve (or curves) will be produced when all the Billingsgate timbers have been examined.

PERIOD VI

Phase VI.1

Several of the samples contained knots, some of which completely obscured the ring patterns. For this reason, four samples (5244, 5410, 5653, 5717) were rejected. Two other samples were also rejected: 5413because it had only 25 rings, and 5475 because the rings were too narrow to measure accurately. The remaining eighteen samples had measurable ring sequences of 45-164 rings.

Eight sequences were dated (Fig 1). <u>5262</u> from the timber dump was dated by comparison with the BIG53 chronology, which is made up of sequences from phase V.3. The match between BIG53 and <u>5262</u> gives a <u>t</u>-value of 10.2 when the latter sequence covers the period AD 611-725. This surprisingly early date is explained by examining the match between <u>5262</u> and the V.3 sequence <u>5927</u>B. The ring patterns are almost identical (<u>t</u>=10.1), and may indicate that the two timbers came from the same tree or group of trees. Certainly <u>5262</u> must be residual from phase V.3.

Five other timbers from the dump were dated. They have end dates between 1002 and 1050 but, with the exception of 5767 which may have two sapwood rings, none of the timbers had sapwood. If the outer two rings of 5767 are sapwood, the timber has a probable felling date range of 1039-1084. The <u>terminus post quem</u> of the most recent dated timber in the dump, 4456, is 1060, but the actual felling date could be much later.

The only dated timber which definitely had sapwood was the stray timber <u>5855</u>B. Its outer ring dates to 1056 and its heartwood-sapwood transition to 1024, which gives a probable felling range of 1056-1078. The grooved baseplate <u>5416</u> has a <u>terminus post quem</u> for felling of 971, and is probably reused.

Phase VI.2

The three phase VI.2 timbers had 102-197 rings, and all the sequences were dated. Since the outer ring of <u>6610</u>, which dates to 1108, appeared to be bark edge, the date of felling is either 1108 or one or two years later.

Phase VI.4

<u>2738</u> was rejected because it was very knotty. The remaining samples had 42-192+ rings. <u>6869</u>A and <u>6988</u> with 42 and 45 rings respectively, were measured because they had sapwood and, in the case of <u>6869</u>A, bark edge, but neither sample was dated. <u>2666</u>A had more than 192 rings but the inner rings could not be measured because of a knot.

Ten sequences were dated: five from the interim line of piles, and five from the east line of piles which was parallel to VI.2 western line. Both groups seem to be made up of timbers with two phases of felling. The earliest group (2727A & B, 2713, 6868, 6867, 6866) were probably felled within the period 1021-1063, and are therefore residual from Period V. The later group (2694, 2716, 2666A & B) are primary timbers with end dates of 1065, 1070, 1090 and 1098 respectively. This gives a <u>terminus post quem</u> for felling of 1108. However the heartwood-sapwood transition of 2716 dates to 1071, which indicates that the timber was probably felled in the period 1080-1125. The combined felling date for phase VI.4 is therefore 1108-1125, which is consistent with the date of 1108 or shortly afterwards for VI.2.

PERIOD VII

Phase VII.1

The results of the tree-ring analysis on the conservation samples from the small stave revetment are summarised in Table 1. The two new samples (5082, 5448) were both dated but, as neither had sapwood, their dating did not help to refine the felling date range of 1144-1183 which was obtained in the previous study (Hillam & Groves 1985).

The reused stave <u>5448</u> had a <u>terminus post quem</u> for felling of 1129. It had previously been used in a grooved baseplate similar to the VI.1 example (<u>5416</u>), which was probably reused. The VII.1 baseplate remains undated, possibly indicating that it too was reused since its ring pattern is different to those of the dated staves.

Phase VII.4

The single tree-ring sample from this phase, <u>6690</u>, was from a reused grooved timber. It had 94 rings which dated to 1012-1105, giving a terminus post quem for felling of 1125.

Phase VII.5

The four phase VII.5 ring sequences were of widely differing lengths. <u>6024</u> and <u>6378</u> with 71 and 265 rings respectively were dated, but <u>6559</u> and <u>6594</u> with 44 and 147 rings were not. <u>6042</u> dates to 818-888, and was clearly reused, whilst <u>6378</u> ends in 1129 and was therefore felled after 1139. Since the VII.5 extension post-dates the VII.1 revetment, <u>6378</u> is likely to have been felled after 1144.

Phases VII.6 and VII.7

<u>6245</u> from VII.6 had 72 rings, including 18 sapwood rings, but no dating was obtained. The three VII.7 samples (<u>6327, 6552, 6659</u>) had 80-84 rings, but again none of the sequences could be dated.

Phase VII.8

The four samples had 73-205 rings. <u>4193</u> had 16 sapwood rings and probably bark edge, but it remains undated, as does <u>6544</u>. Samples <u>4746</u> and <u>6325</u> date to 997-1091 and 865-992 respectively, and were probably reused.

Phase VII.9

<u>6380</u> and <u>6482</u> had 167 and 62 rings respectively, but neither were dated. The remaining sample from this phase (<u>4524</u>) had 403 rings, of which the last 11 were sapwood. Whilst samples with 400+ rings have been found amongst the bog oaks of Northern Ireland (Baillie 1982), it is unusual to find such samples amongst archaeological timbers, and it is the first time a sample with more than 400 rings has been examined at Sheffield. 4524 dated to 770-1172, and its likely felling date range is 1172-1216.

Phase VII.13

Both samples from this phase were dated: <u>5985</u> to 1073-1149 (heartwood-sapwood transition - 1133), and <u>6064</u> to 1007-1070. The latter may have been reused since its <u>terminus post quem</u> for felling is 1080. The likely felling range for the tieback <u>5985</u> is 1149-1187, but since phase VII.13 post-dates VII.9, the date must be later than 1172.

All the above samples were dated by the traditional methods outlined above. When the data was analysed by Cathy Groves using the SORT_STRING program, no further samples were dated, nor were any tentative matches confirmed. In addition, only about half the above results were obtained,

indicating that the program is of no use for small groups of material from urban sites, although it may have limited use for larger assemblages such as the timbers from phase V.3 (Hillam 1988).

The timbers

The Period VI and VII timbers, like those from Period V (Hillam 1988), were very variable (Appendix A, B). Some of the Period VI samples were knotty and of poor quality, but there was good quality timber available, particularly in Period VII.

The Period VI timbers tended to have fewer rings than those from Period VII. Most of the parent trees were probably felled between 100 and 200 years of age, but a few (eg 5049, 5413, 5855A) were younger than this, and others (2666A, 2964, 6610) were older. The average ring widths were variable but the samples tended to be wider-ringed than those from Period V. This suggests that faster-grown but younger trees were being selected in Period VI.

The Period VII timbers also came from parent trees of variable age. $\underline{6245}$ and $\underline{6482}$ were probably felled when less than 100 years old, but at least four timbers ($\underline{4524}$, $\underline{6378}$, $\underline{6380}$, $\underline{6544}$) came from trees older than 200 years. The plank $\underline{4524}$ must have been well over 400 years because the sample had incomplete sapwood and no pith. The quality of its timber is comparable to that used for panelling or furniture.

The growth rates of the Period VII trees tended to be slower than those from Period VI, but faster than those of Period V. The fact that none of the Period VII samples were rejected because of knots or very narrow rings also points to the timber being of good quality. All the samples tended to have straight grain with a regular growth rate. Thus, although the size of the sample is small, it seems that the Period VII timber is generally superior to other Billingsgate timber so far examined, and particularly to the Period VI timbers.

The chronology of Periods VI and VII

The chronology of the Billingsgate timbers for Periods IV-VII is set out in Table 2. The results are based on the tree-ring evidence carried out so far, so that the later dates may modified once new tree-ring dates from Periods VIII onwards are obtained. They may also be modified by dating evidence from other archaeological sources which is not yet available.

As in the earlier Periods (Hillam 1987, 1988), several reused timbers were identified from Period VI and VII. Some were identified by their unexpectedly early dates, such as 5262 from VI.1 which dated to 611-725, or 6042 from VII.5, dating to 818-88. Others, such as some of the piles from phase VI.4, were not exceptionally early but were still too early with respect to the stratigraphy, and some were identified during excavation, such as stave 5448 from VII.1. The reused timbers were identified because as many timbers as possible were examined from each phase. The following deductions therefore are based on the assumption that the timbers producing the dates are primary.

The latest phase of Period V was the construction of the V.1 revetment. Its construction could not have started before 1080, the <u>terminus post</u> <u>quem</u> for felling of timber <u>6788</u> from the revetment (Hillam 1988). This result can now be modified to 1080-1108/10 since Period VI activity started in 1108 or just after when timbers were felled for the lining of the western bank (VI.2). Phase VI.1 is thought to be contemporary with VI.2 which suggests that the surface of the bank was also consolidated in 1108 or one or two years later. On the east side of the inlet, timbers for the lining of the bank (VI.4) were felled in 1108-1125, so that both sides of the inlet could have been lined at the same time. The eastern lining also included piles from earlier phases.

The staves for the new VII.1 revetment were felled in 1144-1183. The VII.5 extension to this eastern revetment was constructed some time after this, ie later than 1144, but the revetment and extension continued in use together. In phase VII.8, more modifications were made to the VII.1 revetment, but the tree-ring evidence is vague as to their date. Again it must be later than 1144.

Plank <u>4524</u> which was used in the phase VII.9 reconstruction of the VII.5 extension, was probably felled during 1172-1216. However the VII.13 tieback <u>5985</u> has an estimated felling date range of 1149-1187. Since VII.13 seals the VII.9 activity, the latter date must be after 1172,

whilst the VII.9 timber was probably felled before 1187. This gives the same likely felling date range for VII.9 and VII.13 but, within this period of 1172-1187, phase VII.13 must be later than VII.9.

Conclusion

Examination of the 41 tree-ring samples from Period VI and 20 from Period VII resulted in the dating of 31 timbers, 21 from VI and 10 from VII. The results produced an outline chronology for the two Periods, and a modification to the date for the construction of the earlier phase V.1 revetment.

Although the sample size for the two Periods is relatively small compared to Periods IV and V, it is possible to suggest that generally the timber used for the Period VII structures was of better quality than at other times, whilst the Period VI timbers tended to be poor quality. The finest timber from Period VII was a plank with 403 rings. This is probably the first time an archaeological timber with more than 400 rings has been examined in England.

Crossmatching was carried out using traditional dendrochronolgical methods. Use of a new computer program (SORT_STRING - Crone unpubl), failed to identify about 50% of the matches presented above.

Acknowledgements

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Fig 1: Bar diagram showing the relative positions of the Period VI ring sequences. Sample 5262, AD611-725, is not included. White bar heartwood rings; hatching - sapwood rings; HS - heartwood-sapwood transition; + - unmeasured rings present.

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Fig 2: Bar diagram for the Period VII ring sequences. White bar heartwood rings; hatching - sapwood rings. Accession numbers are used for the VII.1 conservation samples (see Hillam & Groves 1985); other samples are labelled by context number.

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. * 1 a **Table 1:** Summary of results already obtained for the small stave revetment, phase VII.1. The date of heartwood-sapwood transition, if present, is given in brackets. Felling dates are calculated using the sapwood estimate of 10-55 rings; the combined felling date for the revetment is AD1144-1183.

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<u>context</u>	<u>accession</u>	<u>function</u>	<u>date span (AD)</u>	felled
6822	-	stave	1048-1139(1135)	1144-1189
6568	3512	stave	907-1046	1056+
6569	3513	stave	1045-1118	1128+
6570	3514	stave	1020-1123	1133+
6571	3515	stave	1043-1124	1134+
7573	3517	stave	1024-1114	1124+
6331	3518	stave	1026-1137(1133)	1142-1187
6574	3519	stave	1039-1132(1129)	1138-1183
6579	3525	stave	958-1 0 64	1074+
6580	3526		972-1080	1090+
6585	3532	crosspiece	1040-1115	1125+
6825	3533	baseplate	undated, 50 rings	
6577	3535	stave	1042-1129	1139+
6823	3536	stave	1034-1127	1137+

Table 2: The chronology of medieval Billingsgate, Period IV-VII, as indicated by the tree-ring results. * - this date could be 1 or 2 years later.

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<u>date</u>	west bank	east bank
1039/40	IV.1 bank	IV.2 bank
1055	IV.4 frontage V.3 bank V.4 timbers	IV.2 more timbers
1059-64	V.6 timbers V.3 1 or 2 timbers	-
1056-1101	-	V.8 bank
1080-1108*	V.1 new revetment	(V.8 bank could be contemporary with the V.1 revetment)
1108*	VI.1 consolidation of bank	-
1108*	VI.2 lining of western inlet	VI.4 new eastern inlet lining (1108-1125)
1144-1183	-	VII.1 stave revetment
1144+	-	VII.5 new east bank extension (post-dates VII.1, but in use with it)
1144+	-	VII.8 modifications to VII.1
1172-1187	-	VII.9 reconstruction of VII.5 using planking
1172-1187 (but later than abo	- ve)	VII.13 replacement of VII.8, seals & post-dates VII.9

Appendix A

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> Details of the tree-ring samples Context - context number Accn - accession number Rings - total number of rings Sapwood - number of sapwood rings Av. width - Average ring width in mm f - felled w - winter hs - heartwood/sapwood transition + - rings present but not measured 6.1 - phase VI.1 SSSR - small stave Saxon revetment (see Hillam & Groves 1985)

APPENDIX A - DETAILS OF SAMPLES

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CONTEXT	ACCN	PHASE	RINGS	SAPWOOD	AV.WIDTH	COMMENTS
4456	4539	6.1	82	_	1.89	-
5047	4542	6.1	71	-	1.43	-
5049	4969	6.1	49	10	2.88	nr pith; f ?ω
5244	4541	6.1	-	-	-	knotty
5245	4678	6.1	79		1.71	-
5253	4546	6.1	109	-	1.20	ş,
5260	4390	6.1	100	-	0.91	knotty; ?errors; damaged yr 67
5262	4504	6.1	115	-	1.12	-
5406	4562	6.1	45	8	1.90	pith
5410	4370	6.1	-			knotty; few rings
5413	4537	6.1	25	2		-
5416	4741	6.1	61	-	1.41	•••
5475	4884	6.1			-	rings unreadable
5478	4507	6.1	76	26	1.67	fw; knotty; nr pith
5485	4390	6.1	134	-	0.52	pith
5653	4494	6.1	-		-	knotty
5662	4493	6.1	122		0.98	-
5715	4505	6.1	106		1.20	-
5717	4355	6.1	-	-		knotty
5767	4491	6.1	132	2?	0.97	-
5855A	4503	6.1	43	14	2.14	fw
5855B	4667	6.1	164+	28+	0.83	+ at least 5 rings
60 67	4607	6.1	107	-	0.95	
6071	-	6.1	-	-	-	-
6072	4301	6.1	53	-	1.54	-
6610	4441	6.2	197	35-41	0.76	?felled 1108
6956	4956	6.2	111		1.30	-
6961	4877	6.2	102		1.59	-
2666B	4544	6.4	67	-	2.53	-
2666A	4586	6.4	+192	-	0.90	inner rings knotty
2694	4623	6.4	178	-	1.01	-
2713	4625	6.4	79		1.17	pith
2716	4385	6.4	104	yes	1.30	hs at 105
2727A	3382	6.4	74	-	2.22	-
2727B	4229	6.4	125	-	1.83	-
2738	4306	6.4	-	_	-	knotty; few rings
6866	4912	6.4	100	12	2.08	
6867	4412	6.4	91	-	1.34	-
6868	4941	6.4	+71		Ø.71	many inner rings too narrow
6869A	4459	6.4	42	14	3.30	fម
6869B	4921	6.4	101	31	0.46	?fw
6988	4956	6.4	45	14	2.28	-
5082	4638	7.1	107	-	1.13	SSSR
5448	4923	7.1	129	-	1.37	SSSR
6690	4091	7.4	94		1.53	-
6042	4892	7.5	71	-	1.53	
6378	4411	7.5	265		0,99	-
6559	4907	7.5	44	18	1.62	-
6594	4946	7.5	147	37	0.74	?felled
6245	4922	7.6	72	18	1.50	nr pith; sap rings contorted

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APPENDIX A - DETAILS OF SAMPLES

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CONTEXT	ACCN	PHASE	RINGS	SAPWOOD	AV.WIDTH	COMMENTS
6327	4415	7.7	+84		1.63	broken, inner part not measd
6552	4909	7.7	+80	16	1.05	narrow band in middle
6659	4939	7.7	80+	-	1.82	c19 outer rings not measd
4193	3309	7.8	73	16	2.47	?fw
4746	4523	7.8	95	-	i.36	-
6325	4880	7.8	128	-	1.11	pith
6544	4895	7.8	205		0.91	nr hs
4524	4528	7.9	403	11	0.76	-
6380	4883	7.9	167	-	1.67	broken at ring 94/5
6482	4951	7.9	62	12	1.99	nr pith
5985	4563	7.13	77	17	1.86	-
6064	4363	7,13	64		2.05	pith

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<u>Appendix B</u>

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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 represented by shading.

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PHASE	CONTEXT	ACCN	DIMENSIONS
6.1	4456	4539	150 × 105
6.1	5047	4542	115 x 75
6.1	5049	4969	145 x 125
6.1	5244	4541	180 x 135
6.1	5245	4678	185 x 90
6.1	5253	4546	150 × 65
6.1	5260	4390	135 x 75
6.1	5262	4504	150 × 60
6.i	5406	4562	140 x 120
6.1	5410	4370	160 × 65
6.1	5413	4537	155 x 95
6.1	5416	4741	105 x 90
6.1	5475	4884	125 x 105
6.1	5478	4507	245 × 185
6.1	5485	4390	140 × 120
6.1	5653	4494	140 × 125
6,1	5662	4493	130 × 75
6.1	5715	45Ø5	140 x 75
6.1	5717	4355	260 x 195
6.1	5767	4491	150 × 85
6.1	5855A	4503	100 × 90
6.1	5855B	4667	150 x 135
6.1	6067	4607	115 x 65
6.1	6071	-	
6.1	6072	4301	100 × 65

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PHASE	CONTEXT	ACCN	DIMENSIONS
6.2	6610	4441	165 x 155
6.2	6956	4956	165 × 140
6.2	6961	4877	180 x 155
6.4	2666B	4544	270 x 140
6.4	2666A	4586	325 x 35
6.4	2694	4623	210 × 185
6.4	2713	4625	175 x 155
6.4	2716	4385	140 x 120
6.4	2727A	3382	175 x 30
6.4	2727B	4229	260 × 110
6.4	2738	4306	235 × 190
6.4	6866	4912	215 x 120
6.4	6867	4412	205 x 125
6.4	6868	4941	140 × 120
6.4	6869A	4459	210 x 125
6.4	6869B	4921	100 × 95
6.4	6988	4956	110 × 100
7.1	5082	4638	120 × 110
7.1	5448	4923	225 x 60
7.4	6690	4091	145 x 65
7.5	6042	4892	125 x 30
7.5	6378	4411	270 x 25
7.5	6559	4907	135 x 70
7.5	6594	4946	120 x 50
7.6	6245	4922	230 × 100

APPENDIX B - CROSS-SECTIONAL SKETCHES AND DIMENSIONS (MM)

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PHASE	CONTEXT	ACCN	DIMENSIONS	
7.7	6327	4415	245 × 145	
7.7	6552	4909	240 × 110	
7.7	6659	4939	185 x 35	
7.8	4193	3309	255 X 115	
7.8	4746	4523	150 x 70	
7.8	6325	4880	245 x 120	
7.8	6544	4895	120 × 50	
7.9	4524	4528	335 x 25	
7.9	6380	4883	300 x 25	
7.9	6482	4951	240 x 2 3 0	
7.13	5985	4563	145 x 140	
7.13	6064	4363	195 × 190	

Appendix C

Results

Context - context number Accn - accession number f - felled w - winter hs - heartwood/sapwood transition + - rings present but not measured 7.4 - phase VII.4 SSSR - small stave Saxon revetment (see Hillam & Groves 1985)

Dates of heartwood-sapwood transitions, where present, are given in brackets. 95% confidence limits for the felling date range can be obtained by adding 10-55 rings to this date. In the absence of sapwood, add 10 to the date of the last measured heartwood ring to obtain the probable <u>terminus post quem</u> for felling. (Note that one in twenty samples are likely to have either more than 55 or less than 10 sapwood rings - see Hillam <u>et al</u> 1987 for further details on sapwood estimates).

Where bark or bark edge is present, the felling date is known exact to the year, and does not have to be estimated.

APPENDIX C - RESULTS

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CONTEXT	ACCN	PHASE	RESULT 1	RESULT 2	COMMENTS
4456	4539	6.1	dated	969-1050	_
5047	4542	6.1	undated	-	-
5049	4969	6.1	undated		nr pith; f ?w
5244	4541	6.1	rejected		knotty
5245	4678	6.1	dated	935-1013	-
5253	4546	6.1	dated	894-1002	-
5260	4390	6. 1	undated		knotty; ?errors; damaged yr 67
5262	4504	6.1	dated	611-725	~ ~ ~ ~ ~
5406	4562	6.1	undated	-	pith
5410	4370	6.1	rejected	_	knotty; few rings
5413	4537	6.1	rejected	-	_
5416	4741	6.1	dated	911-971	-
5475	4884	6.1	rejected	_	rings unreadable
5478	4507	6.1	undated	-	fw; knotty; nr pith
5485	4390	6.1	undated	-	pith
5653	4494	6.1	rejected	_	knottu
5662	4493	6.1	undated	_	_
5715	4505	6.1	undated	_	**
5717	4355	6.1	rejected	-	knottu
5767	4491	6.1	dated	900-1031(1030?)	_
5855A	4503	6.1	undated	_	fn
5855B	4667	6.1	dated	888-1051(1024)+	+ at least 5 rings
6067	4607	6.1	dated	922-1028	-
6071		6.1	undated	_	-
6072	4301	6.1	undated	_	-
6610	4441	6.2	dated	912-1108(1068-74)	2felled 1108
6956	4956	6.2	dated	965-1075	_
6961	4877	6.2	dated	982-1083	-
2666B	4544	6.4	dated	1024-1090	_
2666A	4586	6.4	dated	+907-1098	inner rinos knottu
2694	4623	6.4	dated	888-1065	
2713	4625	6.4	dated	920-998	nith
2716	4385	6.4	dated	967-1070(1071)	hs at 105
2727A	3382	6.4	dated	919-992	-
27278	4229	6.4	dated	860-984	447
2738	4306	6.4	rejected	_	knottu: few rinos
6866	4912	6.4	dated	922-1021(1010)	
6867	4412	6.4	dated	915-1005	-
6868	4941	6.4	dated	933-1003	many inner rings too narrow
6869A	4459	6.4	undated	-	fu
4849B	4921	6.4	undated	_	
4988	4954	6 4	undated	_	
5082	4478	7.1	dated	974-1080	5558
5448	4923	7 1	dated	991-1119	SSSR
	4720	7 4	dated	1012-1105	-
5070 4042	4897	7.5	dated dated	818-888	-
4770	4672	75	dated	845-1129	_
6370 4550	4907	7.5	undatod		_
0337 2507	7747 1012	(•) 7 5	undated	_	2follod
0174 29/5	4740 7000	(,,) 7 4	unuateo undated	_	litittu nu nith, con uinan contoutad
0243	4722	(.0	uncated	—	nr pith; sap rings concorted

APPENDIX C - RESULTS

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CONTEXT	ACCN	PHASE	RESULT 1	RESULT 2	COMMENTS
6327	4415	7.7	undated	_	broken, inner part not measd
6552	4909	7.7	undated	-	narrow band in middle
6 659	4939	7.7	undated	-	c19 outer rings not measd
4193	3309	7.8	undated		?fw
4746	4523	7.8	dated	997-1091	9 40
6 325	4880	7.8	dated	865-992	pith
6544	4895	7.8	undated	-	nr hs
4524	4528	7.9	dated	770-1172(1162)	-
6380	4883	7.9	undated	-	broken at ring 94/5
6482	4951	7.9	undated	-	nr pith
5985	4563	7,13	dated	1073-1149(1133)	-
6064	4363	7,13	dated	1007-1070	pith