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June 1987

Summary

The analysis and dating of two groups of oak timbers is described. Both groups date to the late 3rd century, and were felled at the same time. The quality of the crossmatching between the two groups, as well as the visual appearance of the timbers themselves, suggest that the timbers came from the same structure which was constructed in AD 294 or shortly afterwards.

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Tree-ring dating of Roman timbers from St Peter's Hill (PET'81) and Sunlight Wharf (SUN'86), City of London

In 1983, samples from 17 oak foundation piles at St Peter's Hill in the City of London were examined. The excavation was at the west end of Thames Street, near Baynards Castle, a site which had already produced timbers for dating from the Roman riverside wall (Morgan 1980; Sheldon & Tyers 1983). The tree-ring analysis of the St Peter's samples was undertaken to determine the dates of the piles and hence the relationship of the structure to other Roman remains in the vicinity, such as the riverside wall.

The oak timbers from Sunlight Wharf were excavated in 1986 from a structure close to, and on a similar alignment to, the structure at St Peter's Hill represented by the foundation piles. It was hoped that tree-ring analysis, carried out in 1987, would determine whether or not the two groups of samples were from the same structure.

Methods

The samples were examined following the method given by Hillam (1985). Initially the ring widths along one radius only were measured, but because the ring patterns were often short and because crossmatching between the sequences sometimes proved difficult, two radii per sample were occasionally measured, and the two sets of measurements averaged. Since the analysis of the St Peter's samples, it has become general policy in the Sheffield Dendrochronology Laboratory to measure two radii on all roundwood samples with less than about 80 rings in order to improve the quality of crossmatching. When the Sunlight Wharf samples were measured in 1987 therefore, two radii were measured on all the roundwood samples.

The St Peter's ring sequences were compared together by superimposing one graph over another to look for similarities in ring patterns. This process was aided by a computer program (Baillie & Pilcher 1973) which calculates the degree of correlation between two ring patterns for each position of overlap. The significance of the potential match is then tested by the Student t statistic. Values of t of 3.5 and above indicate

a match providing that the visual match is acceptable (Baillie 1982 82-5).

When a group of samples had been crossmatched, their ring widths were averaged to produce a site master curve. Any unmatched curves were tested against the master, and the process repeated until no more curves could be matched with confidence. The site master, plus the individual curves, were then compared against reference chronologies for the Roman period (Table 1) to try to achieve absolute dating.

The analysis of the Sunlight Wharf samples followed a similar pattern, except that their master curve and the individual ring patterns were tested firstly against the St Peter's Hill tree-ring data.

Interpretation of the tree-ring dates to find the felling date of the timbers was simplified by the presence of bark or bark edge on the majority of the samples. Hence the date of the outer ring was usually the date of felling, and examination of the completeness of the outer ring gave the season of felling. For those timbers that had been dressed and did not have complete sapwood, the sapwood allowance of 10-55 rings was used. Addition of this allowance to the date of the heartwood-sapwood transition gives the 95% confidence limits for the probable period of felling (Hillam et al 1987). In the complete absence of sapwood, the addition of 10 rings to the date of the outer ring gives the probable terminus post quem for felling.

Results

St Peter's Hill

The samples contained 50 to 107 annual growth rings, although the majority had between 50 and 70 rings (Appendix A). All but four of the samples (1361, 1365, 1535, 1536) had complete sapwood (Appendix B), and often bark was present. Most of the outer rings were not complete indicating that the timbers had been felled in late spring or early summer. (The widths of the incomplete rings were not measured, so that in Appendix A the number of rings for summer-felled timbers is an underestimate by one year.) One of the timbers, 1307 was definitely felled in winter or early spring, whilst the season of felling of 1297

was indeterminable. 1361 and 1365 were trimmed roundwood samples which had 4 and 5 sapwood rings respectively, whilst 1535 and 1536 were split from larger timbers and had only heartwood rings.

The inner rings of samples 1551, 1558 and 1569 were not measured because of a band of very narrow rings. In addition 1551 had an injury mark on the ring prior to the start of measurement.

Visual comparisons showed that many of the sequences crossmatched, and that the narrow bands of rings mentioned above were contemporary. A site master curve was made from ten sequences, but was abandoned because it was too complacent (that is, showed little variation in width from year to year). At this stage, second radii were measured for three of the samples (1297, 1307, 1369). A master of 104 years in length was then made from four samples (PETMEAN2: 1297M, 1307M, 1365, 1369M). When unmatched samples were tested against this curve, an additional three samples were found to match (1304, 1477, 1551). These were added to the master curve to produce a new master of 104 years containing seven sequences (PETMEAN3). A further five samples crossmatched this new master (1350, 1367, 1467, 1558, 1569), and these were added to produce PETMEAN4.

The St Peter's ring sequences and their masters were compared with dated reference chronologies (Table 1). Although matching with the individual sequences was poor, the masters gave consistently good results, particularly with other London chronologies, when they spanned the period AD 191-294 (Table 2). The two worked timbers however were earlier in date: the last measured ring of 1535 was 18 BC, whilst 1536 ended in AD 25. No dating was obtained for the roundwood sample 1361, although it was probably contemporary with the other roundwood piles.

Examination of the tree-ring dates (Fig 1; Appendix 3) indicates that most of the sequences ended in AD 293, but that the spring vessels of AD 294 were also present. The winter-felled timber, 1307, was felled AD 293/4, whilst 1297 ended in 294, and was felled in 294 or possibly 295. The timbers were not felled at exactly the same time therefore, but they could have been felled within a few weeks of each other. Oak trees produce spring wood in about April, and this production of large vessels is completed by the end of May (Baillie 1982, Fig 2.1). In addition,

formation of spring wood does not commence simultaneously around the circumference of the tree, so that a sample could appear "winter-felled" in one section and "summer-felled" in another. It is not necessary therefore to postulate a long period of storage or stockpiling for the St Peter's timbers, nor is it likely that they would have been seasoned (eg Hollstein 1980).

As neither of the worked timbers had sapwood, estimation of exact felling dates is impossible. 1535 must have been felled after about 8 BC, and 1526 after about AD 35.

Sunlight Wharf

Of the 13 samples from this site, 641 was rejected because its rings were too narrow to count accurately, and 556 was a worked timber with 106 heartwood rings. The remainder were roundwood samples with 40 to 69 rings (Appendix 1). These samples either had bark or appeared to have bark edge, although the outer one or two rings had been damaged occasionally during excavation or sampling. The timbers had been felled in winter or early spring. With the exception of 644, none of these timbers had been trimmed. 644 had been dressed, but bark edge was present at some points on the circumference.

Several of the samples crossmatched (Fig 1). A site master, SUN1, 69 years long, was constructed using data from 551, 551B, 552, 554, 555, 557, and 558. (The ring width data of all the master curves are set out in Appendix D. The ring width data from the individual samples are stored at the Sheffield Dendrochronology Laboratory.) Although all the other unmatched roundwood sequences appeared to match SUN1, only the matches with 543 and 642 were good enough to be accepted. The latter curves were not incorporated into SUN1.

Comparison of the Sunlight Wharf master with those from St Peter's Hill showed that the ring patterns from the two sites were very similar. The comparison between SUN1 and PETMEAN4, for example, gave a t-value of 8.2 (Fig 2). This agreement dates SUN1 to AD 225-293. SUN1 also gives a weak agreement with the two German chronologies at this date, but the curve is too late in date to match the other London chronologies by which St

Peter's was dated (Table 2). No reliable dating was found for the worked timber, 556.

The two site masters, SUN1 and PETMEAN4, were combined to give a chronology which contains 19 samples and dates to AD 191-294 (Appendix D).

The date of the outer rings of all the matched Sunlight samples except 558 is AD 293, so that the timbers were felled in AD 293/4. 558 ends in AD 292, but the bark edge was only queried for this sample so it too is probably contemporary.

Discussion

Relationship between the two sites

The roundwood timbers from St Peter's Hill and Sunlight Wharf were felled at roughly the same time, probably in the spring of AD 294. The only possible exception is PET 1297 which could have been felled a few months later.

In physical appearance the samples from the two sites are similar. They mostly belong to the same age range of 50-70 years, and many have similar dimensions. When the cross-sections are compared with the naked eye, diagnostic ring patterns can be detected.

A matrix of *t*-values was obtained between all the roundwood ring sequences (Table 4). Some of the highest *t*-values were in fact obtained for comparisons between the two sites rather than within a single site, for example, PET 1477 against SUN 551B gives 7.6. (A matrix was also obtained for single radius comparisons. This made little difference to the results, except that the values were generally lower.) It seems likely therefore that the roundwood timbers are foundation piles from the same structure, and that the timbers came from the same woodland.

The growth of PET 1551, 1558 and 1569 was adversely affected at the same time, as shown by the contemporary band of narrow rings. The date of the damaged or injured ring on 1551 is AD 238, so it would seem that these timbers suffered local damage at this time.

Relationship with other Roman structures

Figure 3 shows the temporal relationship between St Peter's/Sunlight and other ring sequences from 2nd and 3rd century London sites. The two worked timbers from St Peter's were felled after about 8 BC and AD 35, but, because the number of missing heartwood rings is unknown, felling could have been much later. The piles, felled in AD 294, represent the latest structure from London dated by dendrochronology. The timbers from the Roman riverside wall, sampled at Baynards Castle, New Fresh Wharf and the Tower of London, were probably felled in the period AD 255-70 (Hillam & Morgan 1986; Sheldon & Tyers 1983), so that this structure is earlier in date to the foundation piles at St Peters and Sunlight Wharf. The third century quay at New Fresh Wharf and Billingsgate Lorry Park (Hillam 1987) and the structure at Chamberlains Wharf in Southwark (Tyers pers comm) are also earlier in date.

Dendrochronological Implications

The study involved samples with relatively short ring sequences. It became apparent during the analysis of the St Peter's samples that the quality of the crossmatching could be improved if two sets of measurements were made along different radii. This has now become general policy at Sheffield when shorter ring sequences are examined, and certainly was successful with the Sunlight Wharf samples.

Examination of the quality of agreement between the master curves from St Peter's Hill and the dated reference chronologies shows that it is PETMEAN3, the master containing seven sequences, which is most suitable for absolute dating (Table 2). However PETMEAN4, with 12 sequences, is better when compared with Sunlight Wharf. PETMEAN4 gives a $\underline{t}$-value of 8.2 with SUN1, whilst PETMEAN2 gives only 5.0. For dating samples from the same site therefore it is better to have a master curve containing as many ring sequences as possible. But for absolute dating with reference chronologies, which are often from different areas or even different countries, such a master may not be ideal since it incorporates a growth signal with too much local information.

Conclusion

Tree-ring analysis of samples from St Peter's Hill and Sunlight Wharf shows that both groups of roundwood piles were felled between AD 293 and 295, and probably in the spring of 294. All aspects of the two groups of timbers are similar, and it is therefore suggested that the foundation piles belong to the same structure. This structure is later in date than the 3rd century quay or the Roman riverside wall.

Acknowledgements

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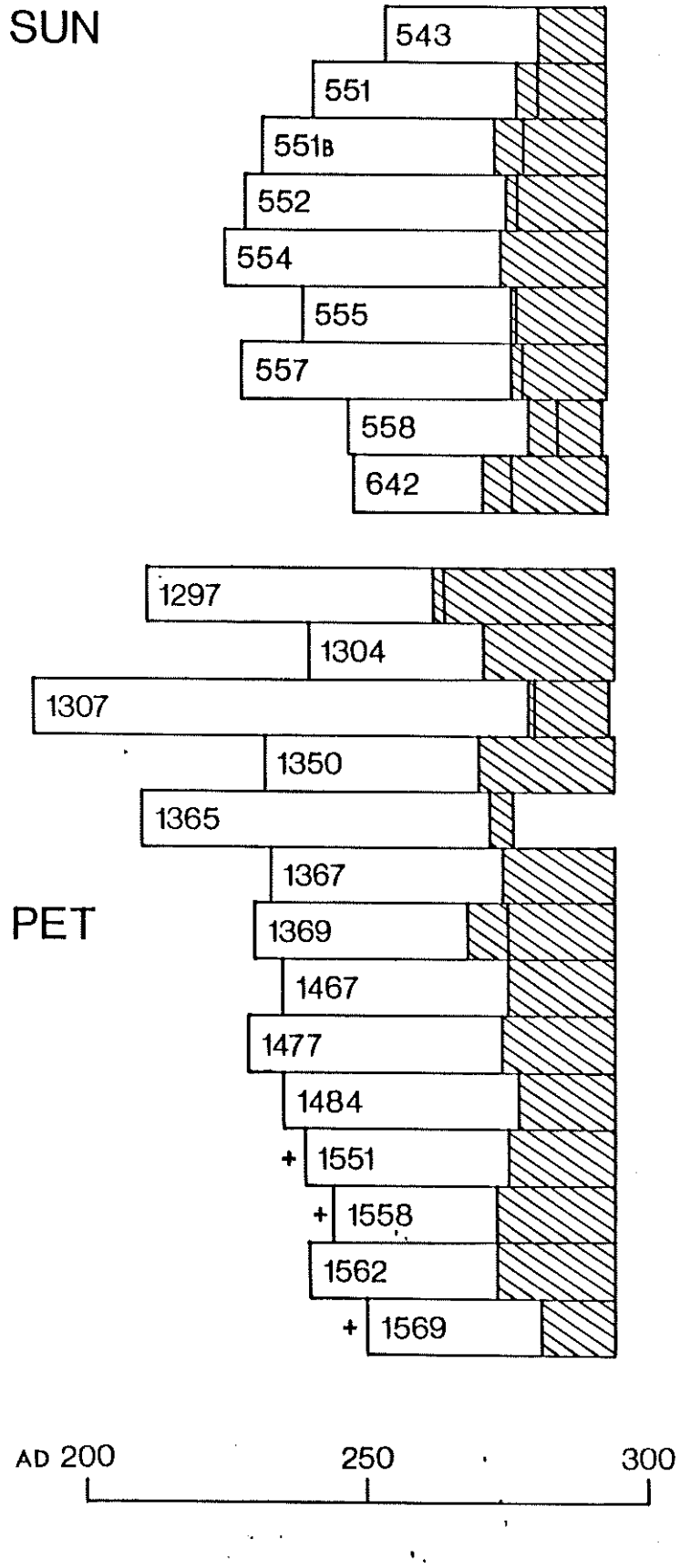
Legends to Figures

Fig 1: Bar diagram showing the relative positions of the matching ring sequences from Sunlight Wharf (SUN) and St Peter's Hill (PET). Sapwood is represented by hatching; any variation in the number of sapwood rings is shown by vertical lines in the hatching. + - unmeasured rings present on the sample.

Fig 2: Comparison of the Sunlight Wharf (SUN1) and St Peter's Hill (PETMEAN4) master curves in their synchronous positions ($\underline{t}$ = 8.2). The vertical scale is logarithmic.

Fig 3: Temporal relationship of the Sunlight Wharf (SUN) and St Peter's Hill (PET) ring sequences to those from other sites in London. BC - Baynards Castle; Tower - Tower of London; NFW - New Fresh Wharf. Site references are given in Table 1. The Chamberlains Wharf data were supplied by I Tyers.



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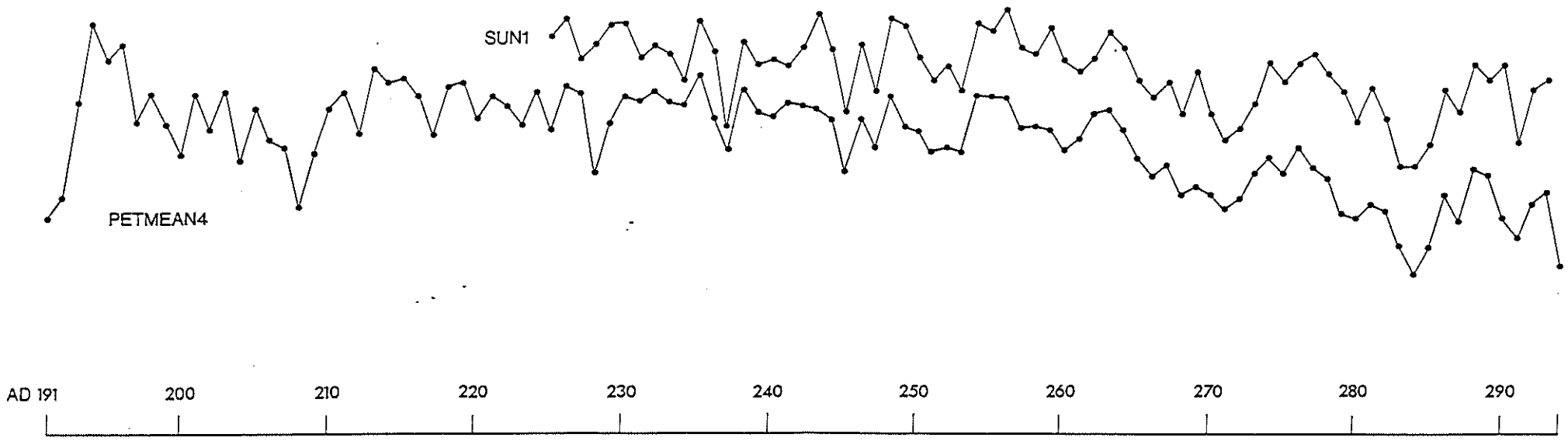

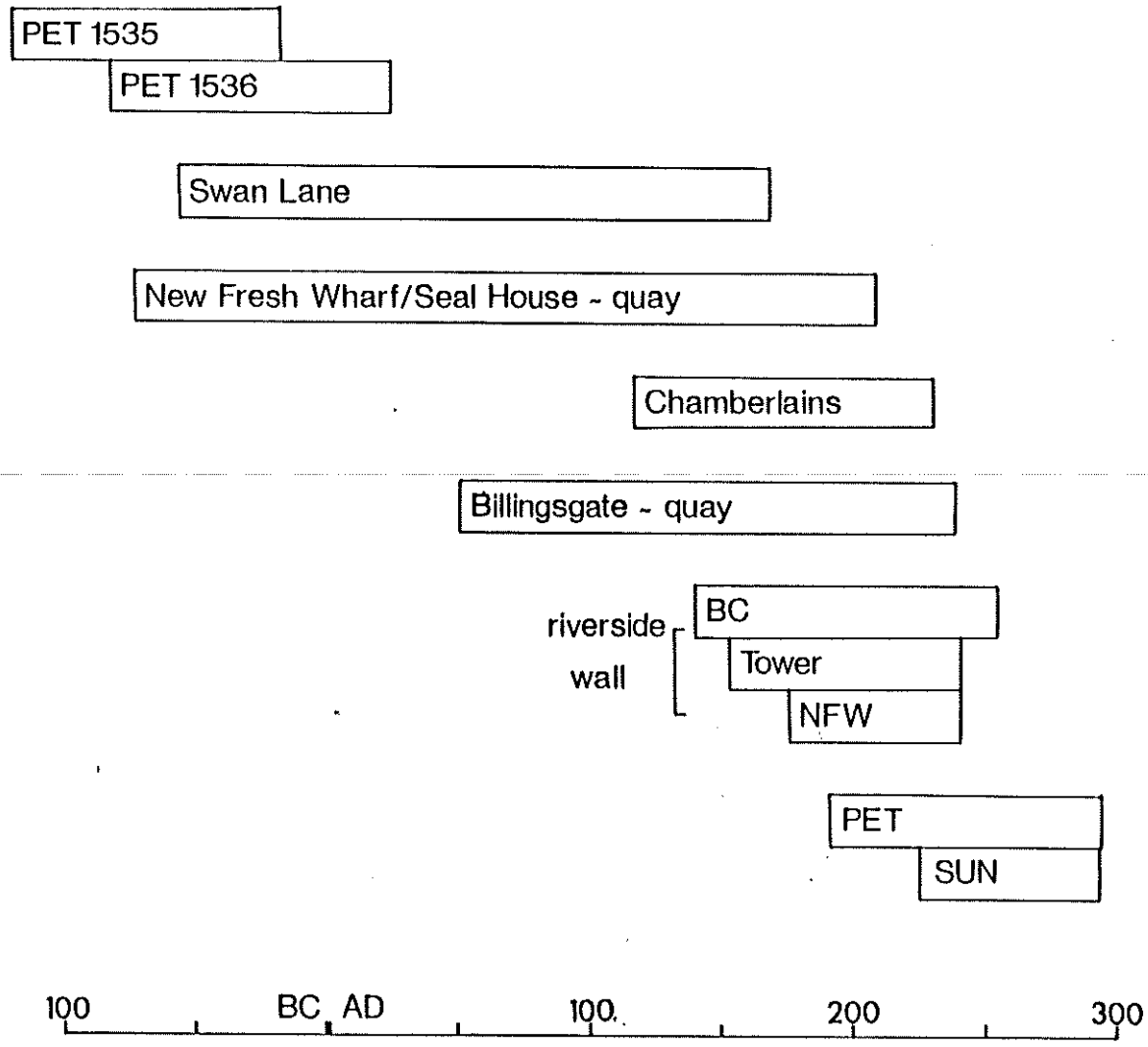

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Table 1

Details of dated reference chronologies used in this study. SDL - Sheffield Dendrochronology Laboratory unpublished data.

chronology	date
London:	
Baynards Castle (Morgan 1980)	AD 140-255
Billingsgate (Hillam 1987)	AD 51-239
Chamberlains Wharf (Tyers pers comm)	AD 117-231
City/Southwark (SDL/Tyers)	252BC-AD255
New Fresh Wharf (SDL)	AD 176-241
New Fresh Wharf/Seal House (SDL)	73BC-AD209
Peninsular House (Hillam 1986)	252BC-AD70
Pudding Lane (Hillam 1980)	176BC-AD86
Roman London (SDL)	159BC-AD171
Tower of London (SDL)	AD 153-241
Germany:	
south (Becker 1981)	370BC-present
west (Hollstein 1980)	700BC-present
Ireland:	
Teeorry (Baillie & Pilcher pers comm)	AD 1-894

Table 2

Dating St Peter's Hill and Sunlight Wharf. t-values for comparisons these sites and dated reference chronologies, details of which are given in Table 1. * - overlap of 30 years or less.

chronology	PET2	PET3	PET4	SUN1	SUN/PET
London:					
Baynards Castle	3.9	4.2	4.1	*	4.3
Billingsgate	5.4	5.3	5.1	*	4.5
Chamberlains Wharf	3.8	3.8	3.8	*	3.3
City/Southwark	4.8	5.2	5.0	3.1	5.1
New Fresh Wharf	5.3	5.4	5.3	*	5.1
Tower of London	4.3	4.3	3.8	*	3.4
Germany south	2.9	3.2	3.4	3.4	3.7
Germany west	3.7	4.2	3.9	3.2	4.2
Ireland Teeorry	4.3	4.1	3.8	1.9	3.2
SUN1	5.0	6.9	8.2	-	-

Table 3

Dating PET1535 (end 18 BC) and 1536 (end AD 25). t-values with dated reference chronologies.

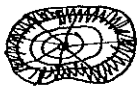
chronology	1535	1536
City/Southwark	5.0	5.0
New Fresh Wharf/Seal House	2.6	3.5
Peninsular House	5.3	4.5
Pudding Lane	4.1	3.2
Roman London	4.3	5.1

	PET												SUN						
	1297	1304	1307	1350	1365	1367	1369	1467	1477	1551	1558	1569	551	551B	552	554	555	557	558
1297M	-	2.1	5.4	2.1	2.9	1.9	3.9	2.0	1.2	1.7	1.4	2.7	1.6	3.9	0.7	0.4	2.0	3.8	1.6
	1304	-	1.4	3.0	1.6	4.6	3.6	2.2	3.4	3.8	3.6	2.3	2.2	6.1	6.7	3.3	4.3	3.9	0.6
		1307M	-	2.8	4.8	1.4	4.2	1.2	2.1	1.2	0.0	2.4	1.3	3.2	1.2	0.9	0.9	2.6	0.0
			1350	-	0.0	4.9	3.7	4.6	5.3	1.5	3.0	1.6	3.9	4.8	4.9	4.1	4.1	3.4	3.0
				1365	-	0.4	4.3	0.0	0.9	1.6	2.1	0.0	1.5	3.2	1.2	1.6	0.6	4.3	0.7
					1367	-	5.0	4.3	3.9	3.3	4.3	2.1	4.1	4.1	4.0	3.7	6.1	3.0	3.1
						1369M	-	4.3	6.0	5.0	3.7	2.9	4.8	6.6	3.6	3.8	4.2	4.5	3.2
							1467	-	5.0	3.4	3.5	3.1	2.3	5.0	4.1	3.1	3.4	2.8	1.2
								1477	-	3.0	5.5	3.0	3.9	7.6	5.4	4.7	3.5	3.8	3.8
									1551	-	2.9	3.8	2.6	4.8	4.1	2.5	4.3	3.9	1.6
										1558	-	1.8	3.1	6.6	5.2	6.2	4.7	3.5	3.5
											1569	-	0.6	4.0	2.3	0.8	2.5	1.0	0.3
												551	-	3.4	2.4	4.4	5.0	2.7	2.9
													551B	-	7.3	5.4	6.3	7.1	3.1
														552	-	4.6	4.3	4.7	1.7
															554	-	4.0	4.1	3.7
																555	-	5.0	3.2
																	557	-	2.0
																		558	-

Table 4: Matrix of t-values for samples included in PETMEAN4 and SUN1. All the Sunlight Wharf, plus PET1297, 1307 and 1369, are the mean of two radii. 0.0 - indicates negative correlation.

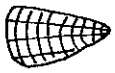
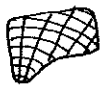
Appendix A

Sample cross-sections: dimensions(mm) and orientation of rings

CONTEXT		SIZE
SUN543		230x185
SUN551		225x220
SUN551B		220x215
SUN552		170x160
SUN554		200x180
SUN555		230x220
SUN556		270x215
SUN557		215x200
SUN558		195x190
SUN640		180x170
SUN641		160x140
SUN642		170x160
SUN644		190x170
PET1297		220x190
PET1304		220x210
PET1307		230x210
PET1350		240x230
PET1361		150x120
PET1365		190x120
PET1367		200x200
PET1369		260x230
PET1467		220x110
PET1477		250x210
PET1484		220x140

/cont

Sample cross-sections: dimensions(mm) and orientation of rings

CONTEXT		SIZE
PET1535		140x110
PET1536		140x120
PET1551		150x130
PET1558		240x200
PET1562		200x170
PET1569		180x100

Appendix B

Details of the tree-ring samples from Sunlight Wharf (SUN) and St Peter's Hill (PET).

CONTEXT - context number

ACCN - Museum of London accession number, not available for St Peter's Hill

RINGS - total number of complete rings (incomplete outer rings are not included. + - indicates the presence of unmeasured rings.

SAP - number of complete sapwood rings. Where this varies around the circumference, the maximum and minimum number is given.

WIDTH - average ring width (mm)

Appendix B

Details of tree-ring samples

CONTEXT	ACCN	RINGS	SAP	WIDTH	COMMENT
SUN543	450	40	13	2.31	pith; mean 2 radii
SUN551	444	53	13-17	1.80	pith; mean 2 radii
SUN551B	452	62	16-21	1.52	pith; mean 2 radii
SUN552	447	65	17-19	1.19	pith; mean 2 radii
SUN554	445	69	20	1.27	pith; mean 2 radii
SUN555	446	55	17-18	1.90	pith; mean 2 radii
SUN556	451	106	-	1.79	worked timber
SUN557	449	66	16-18	1.48	pith; mean 2 radii
SUN558	453	46	9-14	2.23	pith; mean 2 radii
SUN640	442	55	16	1.41	pith; mean 2 radii
SUN641	443	-	yes	-	rejected: narrow rings
SUN642	448	46	18-23	1.55	pith; mean 2 radii
SUN644	441	59	18	1.49	pith; mean 2 radii
PET1297	-	74	31-33	1.14	nr pith; mean 2 radii
PET1304	-	54	23	1.66	nr pith
PET1307	-	103	14-15	1.16	pith; mean 2 radii
PET1350	-	62	24	1.88	nr pith
PET1361	-	55	4	1.54	pith
PET1365	-	67	5	1.90	nr pith
PET1367	-	61	20	1.62	nr pith
PET1369	-	64	19-26	1.69	pith; mean 2 radii
PET1467	-	59	19	1.71	pith
PET1477	-	65	20	1.70	nr pith
PET1484	-	59	17	1.68	nr pith
PET1535	-	102	-	1.41	worked timber
PET1536	-	+107	-	1.13	worked timber
PET1551	-	+55	19	1.07	tree injured AD 238
PET1558	-	+50	21	1.64	-
PET1562	-	64	21	1.47	pith
PET1569	-	+54	13	1.08	-

Appendix C

Tree-ring results for Sunlight Wharf (SUN) and St Peter's Hill (PET).

CONTEXT - context number

ACCN - accession number, not available for St Peter's Hill

RESULT - date span of the ring sequences with the date of the heartwood -sapwood transition given in brackets if present. All dates are AD unless stated otherwise. + - indicates the presence of unmeasured rings.

FELLED - date of felling. w - felled winter or early spring; s - felled spring or early summer. ? - bark edge was not identified with certainty when sample was measured. The terminus post quem for felling for PET1535 and PET1536 is estimated using the sapwood allowance of 10-55 rings (Hillam et al 1987).

Appendix C

Tree-ring dates

CONTEXT	ACCN	RESULT	FELLED
SUN543	450	254-293(281)?	w 293/4?
SUN551	444	241-293(277-81)	w 293/4
SUN551B	452	232-293(273-8)	w 293/4
SUN552	447	229-293(275-7)	w 293/4?
SUN554	445	225-293(274)	w 293/4?
SUN555	446	239-293(276-7)	w 293/4?
SUN556	451	-	-
SUN557	449	228-293(276-8)	w 293/4
SUN558	453	247-292(279-84)	-
SUN640	442	-	-
SUN641	443	-	-
SUN642	448	248-293(271-6)?	w 293/4?
SUN644	441	-	-
PET1297	-	221-294(262-4)	294/5
PET1304	-	240-293(271)	s 294
PET1307	-	191-293(279-80)	w 293/4
PET1350	-	232-293(270)	s 294
PET1361	-	-	-
PET1365	-	210-276(272)	-
PET1367	-	233-293(274)	s 294
PET1369	-	230-293(268-75)	s 294
PET1467	-	235-293(275)	s 294
PET1477	-	229-293(274)	s 294
PET1484	-	235-293(277)	s 294
PET1535	-	119-18BC	8BC+
PET1536	-	82BC-AD25	35+
PET1551	-	+239-293(275)	s 294
PET1558	-	+244-293(273)	s 294
PET1562	-	230-293(273)	s 294
PET1569	-	+240-293(281)	s 294

Appendix D

Ring width data in units of 0.02mm for the master curves mentioned in the text. The number of samples per year is given to the right of the ring widths. (Data from the individual samples are stored in the Sheffield Dendrochronology Laboratory.)

Masters included are:

PETMEAN2, AD 191-294 - includes samples 1297M, 1307M, 1365, 1369M
PETMEAN3, AD 191-294 - PETMEAN2, 1304, 1477, 1551
PETMEAN4, AD 191-294 - PETMEAN3, 1350, 1367, 1467, 1558, 1569
SUN1, AD 225-293 - 551, 551B, 552, 554, 555, 557, 558
SUN/PET, AD 191-294 - PETMEAN4, SUN1 (19 samples)

ST PETERS HILL
PETMEAN2
104

43	49	105	198	150	168	90	110	89	70	1	1	1	1	1	1	1	1	1	1
111	88	112	67	101	79	74	46	70	99	1	1	1	1	1	1	1	1	1	2
112	83	136	123	126	110	80	117	121	92	2	2	2	2	2	2	2	2	2	2
111	101	88	113	85	118	112	61	89	107	3	3	3	3	3	3	3	3	3	4
87	73	73	74	102	56	39	84	60	73	4	4	4	4	4	4	4	4	4	4
102	114	82	65	44	54	57	70	56	56	4	4	4	4	4	4	4	4	4	4
51	59	61	94	108	107	88	93	71	74	4	4	4	4	4	4	4	4	4	4
77	82	75	80	60	54	54	52	48	45	4	4	4	4	4	4	4	4	4	4
43	55	61	64	53	57	44	44	29	35	4	4	4	4	4	4	3	3	3	3
31	35	26	23	37	43	38	48	45	30	3	3	3	3	3	3	3	3	3	3
28	33	37	28		3	3	3	1											

ST PETERS HILL
PETMEAN3
104

43	49	105	198	150	168	90	110	89	70	1	1	1	1	1	1	1	1	1	1
111	88	112	67	101	79	74	46	70	99	1	1	1	1	1	1	1	1	1	2
112	83	136	123	126	110	80	117	121	92	2	2	2	2	2	2	2	2	2	2
111	101	88	113	85	118	112	61	88	111	3	3	3	3	3	3	3	3	4	5
107	83	71	70	100	61	43	86	68	90	5	5	5	5	5	5	5	5	6	7
106	108	99	82	56	89	71	105	80	74	7	7	7	7	7	7	7	7	7	7
63	68	67	102	112	104	88	91	79	77	7	7	7	7	7	7	7	7	7	7
78	89	84	78	63	54	52	50	47	43	7	7	7	7	7	7	7	7	7	7
41	48	54	62	55	62	54	51	37	41	7	7	7	7	7	7	6	6	6	6
41	42	31	24	34	47	39	55	53	36	6	6	6	6	6	6	6	6	6	6
31	41	45	28		6	6	6	1											

ST PETERS HILL
PETMEAN4
104

43	49	105	198	150	168	90	110	89	70	1	1	1	1	1	1	1	1	1	1
111	88	112	67	101	79	74	46	70	99	1	1	1	1	1	1	1	1	1	2
112	83	136	123	126	110	80	117	121	92	2	2	2	2	2	2	2	2	2	2
111	101	88	113	85	118	112	61	88	111	3	3	3	3	3	3	3	3	4	5
107	112	106	102	127	92	72	116	97	95	5	6	7	7	8	8	8	8	9	11
102	101	98	90	61	91	73	104	86	83	11	11	11	12	12	12	12	12	12	12
71	72	71	109	109	108	85	86	84	72	12	12	12	12	12	12	12	12	12	12
79	96	98	84	67	58	62	50	53	51	12	12	12	12	12	12	12	12	12	12
45	48	59	67	60	72	62	57	43	42	12	12	12	12	12	12	11	11	11	11
46	44	33	27	33	49	41	61	58	41	11	11	11	11	11	11	11	11	11	11
36	46	50	28		11	11	11	1											

SUNLIGHT WHARF
SUN1
69

105	116	89	96	113	113	88	94	89	74		1	1	1	2	3	3	3	4	4	4
116	91	53	97	84	85	83	96	121	93		4	4	4	4	5	5	6	6	6	6
57	96	68	117	112	87	75	80	68	113		6	6	7	7	7	7	7	7	7	7
110	126	94	92	108	85	80	86	105	94		7	7	7	7	7	7	7	7	7	7
72	65	71	57	78	57	46	49	60	83		7	7	7	7	7	7	7	7	7	7
74	82	88	76	67	52	66	53	37	37		7	7	7	7	7	7	7	7	7	7
43	66	56	80	74	80	44	66	73		7	7	7	7	7	7	7	7	6		

LONDON
SUN/PET
104

43	49	105	198	150	168	90	110	89	70		1	1	1	1	1	1	1	1	1	1
111	88	112	67	101	79	74	46	70	99		1	1	1	1	1	1	1	1	1	2
112	83	136	123	126	110	80	117	121	92		2	2	2	2	2	2	2	2	2	2
111	101	88	113	90	117	106	75	99	112		3	3	3	3	4	4	4	5	7	8
100	105	100	92	124	92	66	110	93	92		8	10	11	11	12	12	12	12	14	16
95	100	106	91	61	93	72	109	96	85		17	17	17	18	18	18	19	19	19	19
73	75	70	111	110	115	89	88	93	77		19	19	19	19	19	19	19	19	19	19
80	92	101	88	69	61	65	53	62	53		19	19	19	19	19	19	19	19	19	19
46	48	60	73	65	76	72	65	53	46		19	19	19	19	19	19	18	18	18	18
54	48	35	31	37	55	47	69	65	57		18	18	18	18	18	18	18	18	18	18
39	54	59	28		18	18	17	1												