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TREE-RING ANALYSIS IN THE CITY OF LONDON. THE DATING OF ROMAN TIMBERS FROM BILLINGSGATE AND NEW FRESH WHARF.

Jennifer Hillam

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Summary

Tree-ring analysis of Roman timbers from Billingsgate Lorry Park produced a master chronology dating to AD 51-239, and ten timbers were dated. Felling dates are estimated for the construction of the 3rd century quay, and these are related to the tree-ring results from nearby New Fresh Wharf.

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Tree-Ring Analysis in the City of London: the dating of Roman timbers from Billingsgate and New Fresh Wharf.

INTRODUCTION

Excavations in 1982 at Billingsgate Lorry Park (site code BIG'82) revealed over 500 oak timbers which were sampled for dendrochronology. Most of the timbers were of medieval origin, but some Roman timbers were also uncovered. These were from, or associated with, the 3rd century quay, and were of particular interest since timbers from the same structure at nearby New Fresh Wharf (Fig 1) had already been examined, the results proving controversial because they indicated an earlier construction date than that predicted by the pottery (Hillam & Morgan 1986; Miller et al 1986). The Billingsgate timbers were sampled for dendrochronology in the hope that they would provide a firm date for the construction of the quay, and perhaps resolve the problem of the discrepancy between the pottery and the tree-ring dates.

THE BILLINGSGATE QUAY AND ITS TIMBERS

Some of the timbers from the quay were removed for conservation during the excavation. They were later sampled for dendrochronology along with the components of the principal medieval revetments. The results for all these timbers are given in detail elsewhere (Hillam & Groves 1985), but the results from

the Roman timbers are included in this report since they are relevant to the dating of the 3rd century quay.

Those timbers not destined for conservation were sampled for dendrochronology on site and later sent to the Sheffield Dendrochronology Laboratory for analysis (Table 1). They were examined in 1986.

Nine timbers in all were sampled from the initial construction phase of the Roman quay (phase II.1). Of the conservation samples, 7675 was a back brace; 7679, a pile behind the quay for a tieback; and 7691, a cradling timber. The remainder were made up of: 7674, a primary facing timber; 7668 and 7697, piles for the centre tieback and a cradling timber to the east of the site respectively; and 7663 and 7681, piles from a crane base behind the quay, also at the east of the site. The latter part of the quay (7663, 7681) was structurally distinct from the timbers to the centre or west. 7697 was from a robbed section, and might belong to either group. (An additional sample, 7550, may also be from phase II.1 but, as it had only 26 rings, it was not included in the analysis.)

Following the initial stage of construction, the quay was re-faced (phase II.5). Three of the 1986 samples were from timbers associated with the re-faced quay: 6533 was from secondary foreshore accumulation (phase II.7), 7279 was from the

post-Roman quay silting (phase III.1) and 6638 was a timber displaced from the re-faced quay (phase III.2).

DATING THE BILLINGSGATE QUAY

The phase II.7 timber (6533) had only 42 annual rings, and was therefore not suitable for tree-ring dating. The remaining seven samples examined in 1986 had 54-82 rings (Table 1), and all the ring sequences were dated (Fig 2). Dating was achieved by comparing the sequences with each other and with the City/Southwark chronology (Table 2). Three of the four conservation samples had also been dated, and therefore the ten dated tree-ring sequences from Billingsgate were combined to produce a 189-year master chronology which dates to AD 51-239 (Table 3).

Interpretation of the tree-ring dates was made difficult by the lack of complete sapwood. Of the conservation samples, only the undated timber had sapwood. The dated sequences ended in years AD 167, 167 and 178, giving a terminus post quem for felling of AD 188. 7674, 7668 and 7697 have similar end dates (Fig 2), and were felled after AD 180, 192 and 201 respectively. (A sapwood estimate with 95% confidence limits of 10-55 rings is used throughout this report - see Hillam et al 1986.)

The two crane base timbers had some sapwood rings and were felled between AD 239 and 276. 6638, the timber from the

re-faced quay, also had sapwood and was felled in AD 229-274. The phase III.1 timber (7270) was felled some time after AD 147.

Whilst there is no difficulty in estimating the felling dates for the single timbers from phases III.1 and III.2, there are two possible interpretations of the phase II.1 results. If the timbers were all felled at the same time, the most likely felling date is AD 239-276. However, examination of the bar diagram (Fig 2) shows that there could be two phases of felling. The two crane base timbers (7663, 7681) were felled in 239-276 but the main group of timbers (7679, 7691, 7674, 7668) could represent a separate felling event. In the absence of sapwood, Baillie (1982 56) suggests that a group of at least five timbers which end within twenty years of each other represent a felling phase where only the sapwood rings have been removed from the timbers. The Billingsgate results meet these criteria, so that the estimated felling range for the main group is AD 192-222. 7697 was felled after 201, and might belong to either phase.

Since the two groups come from sections of the quay which are structurally distinct, the second possibility seems more likely dendrochronologically. However further evidence is needed, and towards this end it is necessary to re-assess the tree-ring results from the adjacent site of New Fresh Wharf (Fig 1).

THE QUAY AT NEW FRESH WHARF

The three phases which are particularly important at New Fresh Wharf (also known as St Magnus House) are:

1. phase 3, the second revetment (phase 2, the first revetment, contained no datable timbers)

2. phase 4, the 3rd century quay - an extension to the west of the Billingsgate phase II.1 quay

3. phase 8, the riverside wall - originally thought to be 4th century, but now dated dendrochronologically to the mid-late 3rd century (Sheldon & Tyers 1983)

The results of the New Fresh Wharf tree-ring work (Hillam & Morgan 1986) suggested that phases 3 and 4 were similar in date, the timbers being felled during the period AD 209-224. This contrasts with the results from the pottery which indicated a date of circa AD 235-40 for phase 4 (Miller et al 1986). The phase 8 timbers were somewhat later in date, the terminus post quem for their felling being AD 241 (Table 4).

When the New Fresh Wharf sequences were re-examined, a further three samples were dated. The results from the two sites were combined in an attempt to give a more precise construction date for the quay, and the ring sequences and timbers were compared so as to extract more information about the use of timber in Roman London.

CONSTRUCTION OF THE QUAY

The three sequences dated in 1986 were 681 from the phase 3 revetment, and 5002 and 5013 from the quay (Table 4). 681 ends in AD 178, which makes the felling date for the revetment AD 188-223. The others end in AD 160 and 172, and their dates do not affect the estimated felling date of AD 209-224 for the New Fresh Wharf quay timbers.

When the results are combined, the bar diagram (Fig 3) shows that most of the timbers have end dates or heartwood-sapwood dates between AD 165 and 191, and that there is an even distribution between these dates (Fig 4). There is then an interval of 31 years before the heartwood-sapwood transition of 7663. Several interpretations are possible:

1. The most likely explanation on dendrochronological grounds is that 7663 and 7681 were felled in the period 239-276, and the remainder in 209-224. This would make the crane base timbers more similar in date to the New Fresh Wharf phase 8 timbers from the riverside wall (Fig 2).

2. Within the main group, 386, 321, 279 and 7697 could form a separate group of timbers which were felled in AD 209-244, whilst the remainder were felled 207-224.

3. The final interpretation is the one that most closely

agrees with the results predicted by the pottery. This involves all the timbers being felled at the same time, in which case there is a felling date of AD 239-244. This would indicate that 378 from New Fresh Wharf had 70-75 sapwood rings which is outside the 95% confidence limits but is not impossible.

THE RING SEQUENCES

Comparisons were made between the individual ring sequences from the quays at both sites (eg Table 5). Some of the Billingsgate sequences were more similar to those at New Fresh Wharf than to others from Billingsgate, and vice versa. For example, the new dates for New Fresh Wharf (Table 4: 681, 5002, 5013) were obtained because, although they did not appear to match other New Fresh Wharf sequences, their growth patterns synchronised with those from Billingsgate. It would therefore appear that the same source of timber was being exploited for the building of structures at both sites and, since some of the agreement values within each site are poor, it could be postulated that a large area, or several areas, of woodland were being exploited.

It was not possible to identify timbers from the same tree being used on the two stretches of quay. But this is not always easy using tree-rings because the within-tree variation in ring width can be greater than the between-tree variation (Milsom 1979).

The ring sequences from the Billingsgate quay were also compared with those from the New Fresh Wharf riverside wall. The agreements between the growth patterns suggested that the same source of timber was being exploited, but any attempt to identify timbers from the same tree was made more difficult by the shortness of the New Fresh Wharf ring sequences. It was not possible therefore to link the phase 8 New Fresh Wharf timbers with those from the Billingsgate crane base by examining the ring patterns.

THE TIMBERS

It is apparent from the examination the type of timber used is that by the mid-3rd century AD, much smaller and shorter-lived trees were being used by the Romans in their waterfront structures. The 1st century quay at Pudding Lane, for example, was made up from massive timbers (Milne 1985), and even the timbers from the New Fresh Wharf quay which seem to date to the early 3rd century (eg 378 from phase 4) came from large oak trees which were well over 200 years of age. However the timbers which appear to be later in date, such as 7663 and 7681 from Billingsgate and the riverside wall sequences from New Fresh Wharf, came from smaller trees which were probably little over 100 years old when felled. This may indicate that by the mid-late 3rd century, the Romans had cleared most of the larger trees from the surrounding woodland.

Examination of the axiometric plan of the New Fresh Wharf (Hillam & Morgan 1986) shows that those timbers from the larger, older trees functioned as either sill-beams (eg 378) or beams from the two tiers of beam above the sills (eg 5013), whilst the cradling timbers (eg 321) and braces (eg 386) tend to be from smaller, younger trees. The same tends to be true at Billingsgate, although the difference is not as marked. This difference in size and age of tree may be dependent on the timber's function in the quay, although the larger, older timbers do tend to be slightly earlier in date.

CONCLUSION

Tree-ring analysis of the Billingsgate Roman timbers has produced dates for most of the timbers, and a tree-ring chronology for the period AD 51-239. It has also made it possible to date three more timbers from New Fresh Wharf. Felling dates are given first for the individual quays and then for the combined structure at Billingsgate and New Fresh Wharf. Various interpretations of the tree-ring results are possible: the most likely is that most of the timbers were felled in the period AD 209-224, and that the two crane base timbers were felled in AD 239-276. Whether the quay was built in 239-276 using timbers felled in 209-224, or whether it was built in AD 209-224 and altered in 239-276 cannot be determined from the tree-rings. Less likely dendrochronologically, but still possible, is that all the timbers were felled in AD 239-244. Such a date

is more in accordance with the pottery dates since the Roman practice of using green timber (eg Hollstein 1980) means that the quay would be constructed at about the same time or just after.

ACKNOWLEDGEMENTS

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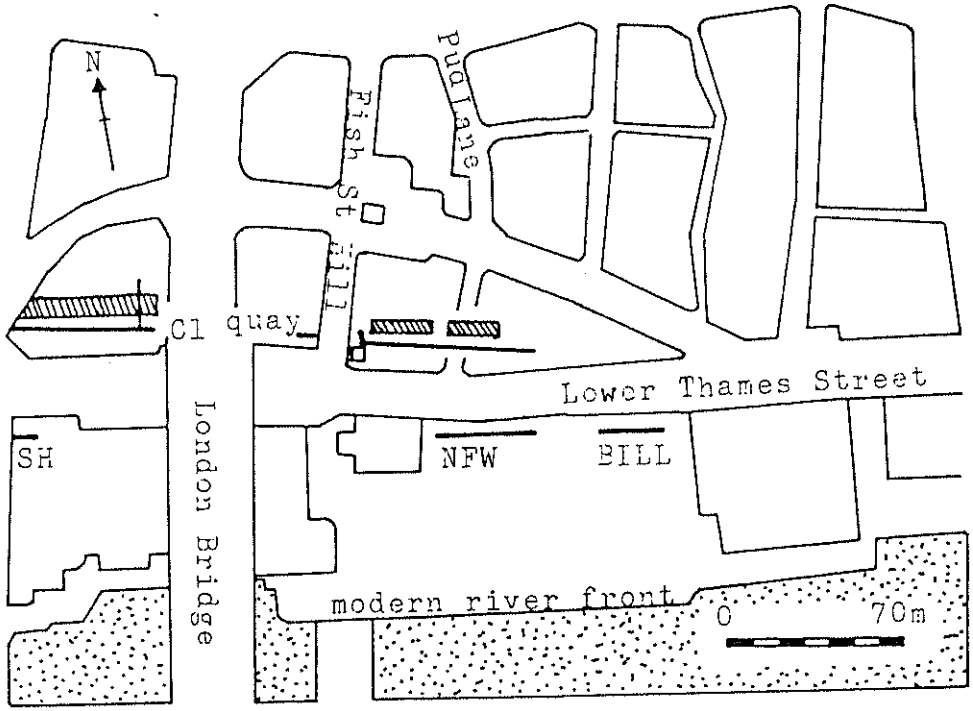
LEGEND TO FIGURES

Fig 1: Roman waterfront sites in the City of London. Approximate lines of the 1st and 3rd century quays are also marked. BILL - Billingsgate; NFW - New Fresh Wharf/St Magnus; SH - Seal House.

Fig 2: Bar diagram showing the relative position of the ring sequences from Billingsgate and New Fresh Wharf. For simplicity, only those sequences with sapwood are illustrated for New Fresh Wharf phase 4. White bar - heartwood rings; hatching - sapwood; + - presence of uncountable rings; e - unmeasured rings are included.

Fig 3: Bar diagram showing the combined results for the two sites. Ring sequences are arranged in chronological order of the heartwood-sapwood transition or the last measured heartwood ring. Sequences marked with asterisks are from Billingsgate; the remainder are from New Fresh Wharf.

Fig 4: Diagram of the Billingsgate and New Fresh Wharf end dates (closed circles) or heartwood-sapwood transitions (open circles). The Billingsgate samples are marked by asterisks.


N
Fish St Hill
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NFW
BILL
modern river front
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Fig 1

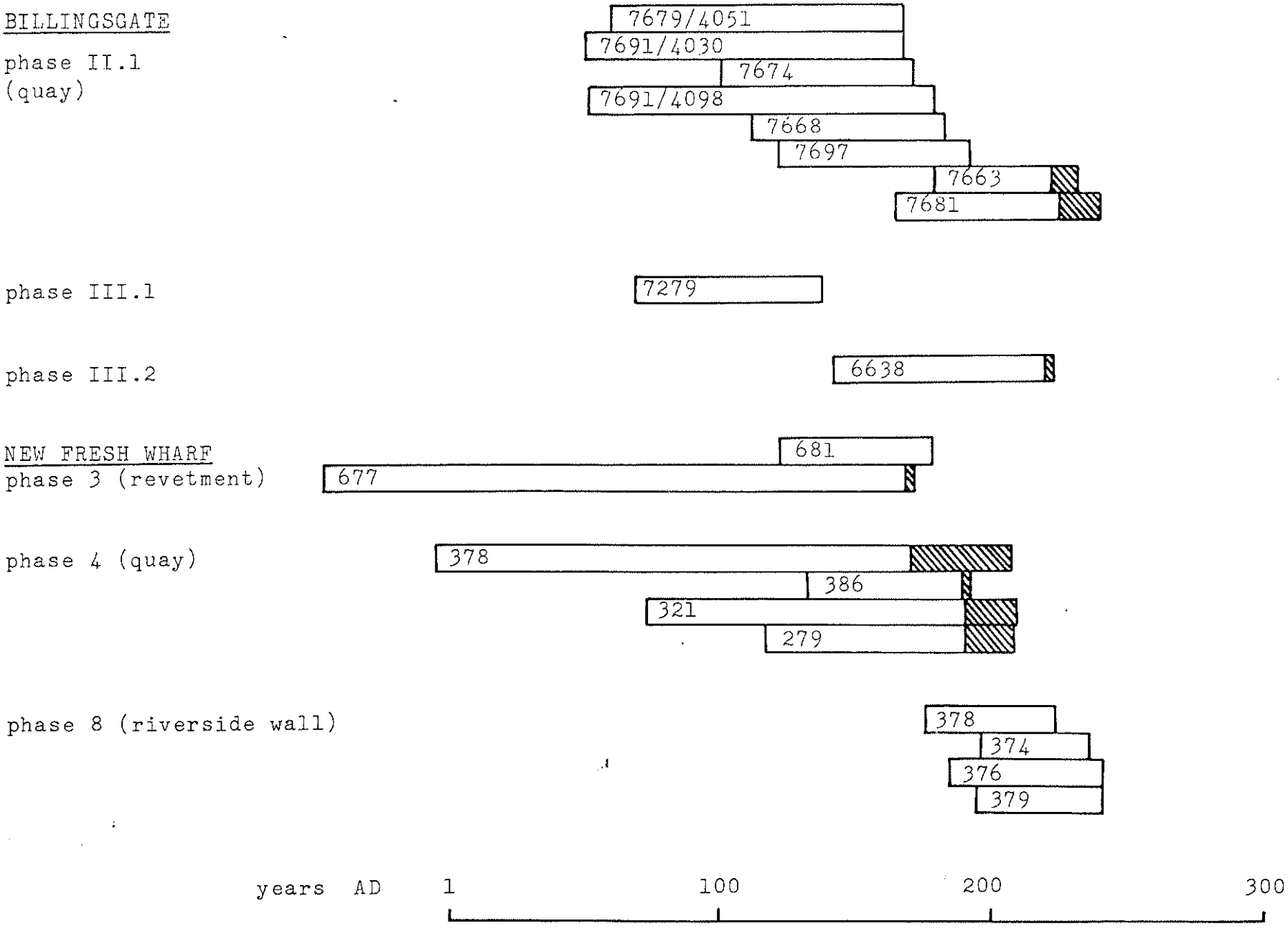
BILLINGSGATE
phase II.1
(quay)
7679/4051
7691/4030
7674
7691/4098
7668
7697
7663
7681
phase III.1
7279
phase III.2
6638
NEW FRESH WHARF
phase 3 (revetment)
681
677
phase 4 (quay)
378
386
321
279
phase 8 (riverside wall)
378
374
376
379
years AD
1
100
200
300

Fig 2

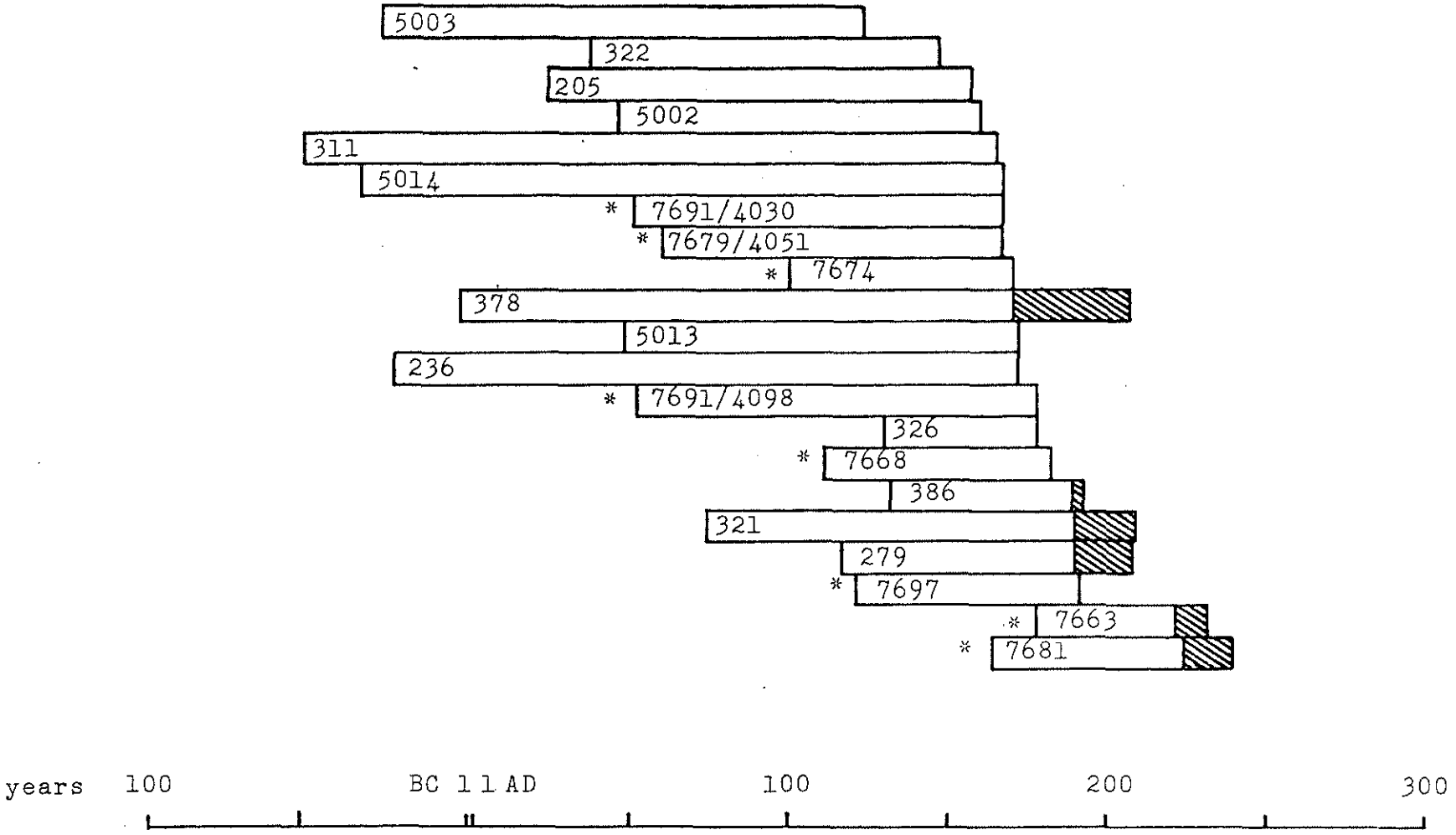
5003
322
205
5002
311
5014
* 7691/4030
* 7679/4051
* 7674
378
5013
236
* 7691/4098
326
* 7668
386
321
279
* 7697
* 7663
* 7681
years
100
BC 1 1 AD
100
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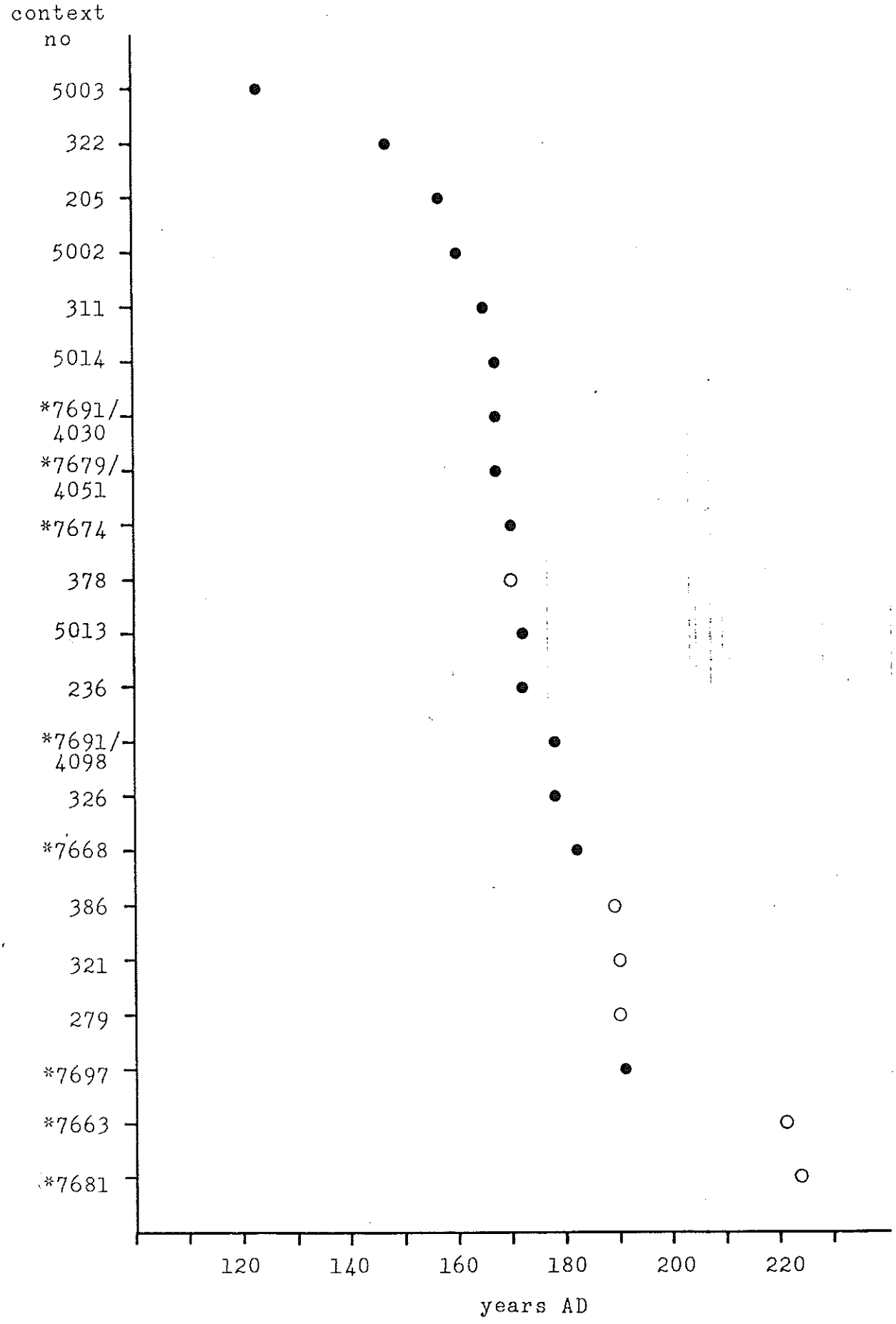
Fig 3

Fig 4


context no
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*7691/ 4030
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*7674
378
5013
236
*7691/ 4098
326
*7668
386
321
279
*7697
*7663
*7681
120
140
160
180
200
220
years AD

Table 1: Details of the tree-ring samples. Sketches not to scale; + - rings present but not measured; shading on sketches - sapwood. (For details of conservation samples - see Hillam & Groves 1985.)

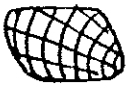
context no	phase	total no of rings	sapwood rings	average ring width(mm)	sketch	maximum dimensions (mm)
7550	?II.1	26	2	-		120 x 110
7663	II.1	54	11	3.16		280 x 220
7668	II.1	72+	-	2.43		330 x 280
7674	II.1	56+(15)	-	1.94		165 x 135
7681	II.1	76	16	2.33		280 x 225
7697	II.1	71	-	2.07		220 x 215
6533	II.7	42	-	1.78		120 x 80
7279	III.1	69	-	2.53		160 x 120
6638	III.2	82	4	2.99		280 x 230

Table 2: The tree-ring dates for Billingsgate. t-values are given for comparisons with the City/Southwark chronology (Sheldon & Tyers 1983). Dates of heartwood-sapwood boundary, if present, is given in brackets; felling dates are based on sapwood estimates of 10-55 rings. Asterisks indicate conservation samples.

context	phase	AD date	felling date	t-value
7663	II.1	178-231 (221)	239-276	4.8
7668		111-182+		5.0
7674		100-155+15		5.8
7679*		60-167		-
7681		164-239 (224)		5.8
7691/4030*		51-167		-
7691/4098*		52-178		-
7697		121-191		4.8
7279	III.1	69-137	after 147	6.0
6638	III.2	141-222 (219)	229-274	7.0

Table 3: Billingsgate Roman chronology, AD 51-239. n - number of samples per decade; number of rings - 189.

year AD	ring widths (0.02mm) 0	1	2	3	4	5	6	7	8	9	n
51		139	145	107	106	117	116	109	108	117	2
60	149	135	121	123	151	172	165	135	123	111	3
70	99	102	106	99	74	56	71	60	107	104	4
80	105	121	89	74	45	56	70	90	85	73	4
90	73	84	82	59	56	92	103	130	73	89	4
100	98	117	78	49	51	72	63	71	76	93	5
110	79	84	87	71	58	57	72	94	96	86	6
120	108	70	100	93	110	91	118	125	108	123	7
130	97	88	134	112	129	112	128	107	88	99	7
140	81	113	114	124	105	123	72	132	126	109	7
150	119	102	90	77	68	124	87	65	76	68	7
160	65	81	88	86	99	84	72	91	95	85	6
170	65	85	83	78	97	83	123	104	136	126	5
180	79	75	103	140	93	119	111	113	166	156	4
190	185	137	153	135	220	138	184	166	174	129	3
200	117	140	107	147	117	113	114	144	108	141	3
210	151	112	107	123	127	143	162	98	110	123	3
220	125	135	127	107	117	91	86	113	58	49	2
230	91	78	94	106	101	114	76	50	81	82	1

Table 4: Summary of the New Fresh Wharf tree-ring results. IV - New Fresh Wharf (FRE'78); III - St Magnus (SM'75). t-values with City/Southwark chronology are given for new dates only. Dates of heartwood-sapwood transitions, where present are in brackets.

sample	date span	felled	t-value
phase 3 (revetment)			
IV 677	46BC-AD171 (168)	AD 188-223	-
IV 681	AD 122-178		4.7
phase 4 (quay)			
III 205	AD 24-157	AD 209-224	-
III 236	25BC-AD172		-
III 279	AD 117-208 (190)		-
III 311	53BC-AD165		-
III 321	AD 74-209 (190)		-
III 322	AD 37-147		-
III 326	AD 130-178		-
III 378	5BC-AD207 (170)		-
III 386	AD 132-192 (189)		-
IV 5002	AD 46-160		5.5
IV 5003	29BC-AD123		-
IV 5013	AD 48-172		4.5
IV 5014	35BC-AD167		-
phase 8 (riverside wall)			
IV 374	AD 196-236	after AD 251	-
IV 376	AD 184-241		-
IV 378	AD 176-223		-
IV 379	AD 195-241		-

Table 5: Matrix of *t*-values for comparisons between ring sequences from the Billingsgate and New Fresh Wharf quays. Asterisks - overlap less than 30 years.

	BILLINGSGATE										NEW FRESH WHARF		
	7691/ 4030	7679/ 4051	7691/ 4098	6638	7279	7663	7668	7674	7681	7697	681	5002	5013
7691/4030	-	6.2	11.6	*	1.7	*	2.0	3.0	*	1.7	5.3	5.0	5.0
7679/4051		-	6.9	*	2.6	*	3.3	3.6	*	2.5	3.1	5.2	4.4
7691/4098			-	2.6	3.3	*	1.7	3.3	*	2.2	5.4	4.7	5.1
6638				-	*	2.8	4.2	*	2.9	4.0	2.8	*	2.1
7279					-	*	*	3.9	*	*	*	3.5	3.8
7663						-	*	*	5.0	*	*	*	*
7668							-	1.0	*	5.6	3.6	1.7	1.8
7674								-	*	1.9	3.5	2.0	1.4
7681									-	*	*	*	*
7697										-	4.8	3.3	4.2
681											-	3.1	3.8
5002												-	11.3
5013													-
Mean *t*	4.6	4.2	4.7	3.1	3.1	3.9	2.8	2.6	4.0	3.4	3.9	4.4	4.3

Table 6: Matrix of *t*-values for comparisons between ring sequences from the Billingsgate quay and New Fresh Wharf riverside wall. Asterisks indicate overlaps of less than 30 years.

	BILLINGSGATE			NEW FRESH WHARF				
	6638	7663	7681	374	376	378	379	Mean *t*
6638	-	2.8	2.9	*	1.5	5.7	*	3.2
7663		-	5.0	1.9	3.7	3.6	3.2	3.4
7681			-	1.0	3.7	1.6	2.7	2.8
374				-	3.1	*	9.9	4.0
376					-	2.7	5.0	3.3
378						-	*	3.4
379							-	5.2