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Summary

The analysis of fifty timbers from six sites included in the Oxford Shire Lake Project is described. The timbers best suited to dendrochronology were those from the Trill Mill stream at 89 St Aldgates. These produced felling date ranges in the 10th and 11th century AD, and a tree-ring chronology covering the period AD 632-1001. The remaining timbers had fewer rings but, despite this, tree-ring dates for three other sites were obtained. A felling date range of AD 577-619 was obtained for a pile underneath the Norman causeway at the British Telecom tunnel site. Timbers from the Police Station site produced a felling date range of AD 973-1018, whilst a single timber from 56-60 St Aldates was felled after AD1099. The final site master curves span the periods AD 435-577 and AD 632-1089.

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TREE-RING ANALYSIS OF TIMBERS FROM THE OXFORD SHIRE LAKE PROJECT

Introduction

Shire Lake is the name given to the river channel which formed the medieval ridden boundary between the City of Oxford and the county of Berkshire. Excavations along this channel, including its Saxon and Norman river crossings, have been carried out periodically since 1970. This report summarises the tree-ring results from those sites which revealed waterlogged timbers (Fig 1).

In 1979, the excavation at 33 St Aldates (33STA) produced a single oak timber from beneath the Norman bridge causeway at the mid-Shire Lake. The most northern site on the crossing line was excavated in 1985 at the Trill Mill Stream, 89 St Aldates (OX TMS 85). It produced 22 oak samples, many of which came from relatively long-lived oak trees, and contained more than 100 growth rings. During redevelopment in 1987 and 1988, excavations in the St Aldates area produced further timbers. The "Land Adjoining Police Station" site (OX LAPS 88) near 33 St Aldates produced another pile from under the Norman bridge causeway. The north bank of Shire Lake at the St Aldates Police Station site (OX PS 88) provided six oak samples, whilst the south bank at 56-60 St Aldates (OX SASL 88) produced fourteen samples, 11 oak and 3 non-oak. In 1991, a watching brief during tunnelling by British Telecom under the Norman bridge causeway at the southern edge of the research area, produced samples from a further six oak piles (OX SAM 91).

The samples from the Trill Mill Stream and the LAPS site were analysed informally by one of us (DM) in 1988. This resulted in the production of absolute dates for TMS, and a tentative date for LAPS. Second samples were cut from the timbers from both these sites and these, plus the samples from the remaining sites, were examined at Sheffield in 1992.

Method

For simplicity, the method used at Sheffield is described. The samples were prepared by freezing them for at least 48 hours and

then cleaning their cross-sections with a surform plane (Hillam 1985). When the samples had thawed, a note was made of their cross-sectional dimensions and the orientation of the annual rings (Table 1). Any non-oak species were identified by taking thin sections from the transverse, radial and tangential planes and examining them microscopically. Diagnostic features were noted and compared to keys, such as Schweingruber (1990) and Wheeler *et al* (1986). Samples which were unsuitable for dating purposes were rejected at this stage. These include some non-oak species (Groves & Hillam 1988), and oak samples with unclear annual rings and/or insufficient rings. Normally samples are not measured unless they contain more than 50 rings, but, where bark edge is present, samples with 30-50 rings might be considered (Hillam *et al* 1987).

The ring widths were measured to an accuracy of 0.01mm on a travelling stage built in the Department of Geography, City of London Polytechnic. The stage is connected to an Atari microcomputer which uses a suite of dendrochronology programs written by Ian Tyers (pers comm 1992). The measured ring sequences were plotted as graphs either by hand or using an Epson HI-80 plotter. The graphs were then compared with each other on a light box to check for any similarities between the ring patterns which might indicate contemporaneity. The Atari is also used to aid the crossmatching process, although it is the quality of the visual matching which dictates whether or not a match is accepted. The crossmatching routines are based on the Belfast CROS program (Baillie & Pilcher 1973; Munro 1984), and all the *t* values quoted in this report are identical to those produced by the first CROS program (Baillie & Pilcher 1973). Generally *t* values of 3.5 or above indicate a match provided that the visual match between the tree-ring graphs is acceptable (Baillie 1982, 82-5).

Dating is achieved by crossmatching ring sequences within a site or structure, combining the matching sequences into a site master, and then testing that master for similarity against dated reference chronologies. A site master is used for dating whenever possible because it enhances the general climatic signal at the

expense of the background noise from the growth characteristics of single trees. Any unmatched sequences are tested individually against the reference chronologies.

If a sample has bark or bark edge, the date of the last measured ring is the date in which the tree was felled. A complete outer ring indicates that the tree was felled during its dormant period in winter or early spring. This is referred to as "winter felled". If the ring is incomplete, felling took place during the growing season in late spring or summer (referred to as "summer felled"). In the absence of bark edge, felling dates of oak timbers are calculated using the sapwood estimate of 10-55 rings. This is the range of the 95% confidence limits for the number of sapwood rings in British oak trees over 30 years old (Hillam *et al* 1987). Where sapwood is absent, felling dates are given as *termini post quem* by adding 10 years, the minimum number of missing sapwood rings, to the date of the last measured heartwood ring. The actual felling date could be much later depending on how many heartwood rings have been removed.

Once the felling date range or *terminus post quem* has been calculated, factors such as seasoning of timber, reuse, stock-piling, or repairs have also to be taken into account. Thus whilst the tree-ring dates for the measured rings are precise and independent, the interpretation of these dates often requires other archaeological evidence.

Results

The results are described below site by site following the numerical order of the sample numbers (see Table 1). Where the measurements from the 1988 samples extended the ring sequences produced in 1992, both sets of data were combined to give a single sequence. Ring width data are given for the master curves and single dated sequences. The data from the individual samples can be consulted on request to the authors.

1. The mid-Shire Lake, LAPS 87

Sample 104 was from a roundwood oak pile about 190mm in diameter. It contained 55 rings, 24 of which were sapwood. The last measured ring was not bark edge but must have been within one or two rings of it. The tree would have been less than 60 years old when felled.

Tree-ring measurements were made along two radii, and averaged to give a single ring sequence. The agreement between the two radii was low (t = 5.7) considering they were from the same tree. Generally t values from same tree comparisons are expected to give t values greater than 10.

A tentative felling date range of 810-820 had been produced during the informal analysis, but this was not confirmed by the 1992 analysis. Although the data were tested against all the available reference data, no reliable date was obtained. The low correlation between the two radii probably indicates that the sample is undatable.

2. North bank of Shire Lake, PS 88

Of the six oak timbers from this waterfront, four were suitable for dating purposes. 212, a roundwood pile, was rejected as it had only 27 rings; 219 had insufficient rings and was also knotty. The measured samples came from radially split planks and contained 57-117 rings. Except for 217, all had additional rings which could not be measured because of breaks in the samples (Table 1).

The ring sequences from 213 and 214 crossmatched with a t value of 5.6 to give a single sequence of 117 years (Table 2). Comparison with reference chronologies produced consistently high t values over the period AD850-966 (Table 3). Neither 217 nor 218 matched this dated sequence, but 218 gave consistent results with reference data and other Shire Lake masters over the period AD847-909 (Table 3).

3. South bank of Shire Lake, SASL 88

The three non-oak samples (304-6) were identified as *Salix/ Pop ulus*. As they were knotty and had indistinct ring boundaries, the samples were not used for dating purposes.

Of the oak samples, four were rejected. 327 and 328 had bands of very narrow rings which could not be measured accurately; 320A had only 36 rings, and 333 was not measured since it was a duplicate of 323.

307, 320, 321, and 326 all had less than 50 rings, but these were measured since they appeared to have bark edge. A match with a *t* value of 12.6 was found between 320B and 326, probably indicating that they originated in the same tree. No match was found with any of the other samples or with reference chronologies, and these samples remain undated.

No match was found between those samples with more than 50 rings. When they were tested individually against reference chronologies, 318 produced consistent results over the period AD968-1089 (Tables 4, 5). Dates have not yet been found for the other measured samples.

4. The mid-shire Lake, 33STA

The 1979 sample 409 was a rectangular-shaped timber without sapwood. It contained 61 rings but the sequence could not be dated.

5. The Trill Mill Stream, TMS 85

Eleven of the 22 oak timbers were rejected because they had less than 40 rings (Table 1). 711 with 47 complete rings, plus 1 incomplete ring, was measured but no dating was obtained. The timber had been felled in summer.

The measured samples were from large timbers cut from relatively long-lived oak trees. 703 and 704, for example, both had 247 rings and, as neither had sapwood or pith, the parent trees are likely to have been well over 300 years old when felled. The

timber was also of good quality, being straight-grained and free from knots. The samples contained 76-247 rings. 721 was in two pieces: the inner section (721B) contained 85 measurable rings and the outer part (721A) had 130 rings.

Eight ring sequences crossmatched to give a TMS site master of 294 years (Table 6,7). The level of agreement between the individual curves was very variable. 702, for example, matched well with 710 but less well with the others, whilst 721 matched best with 704. The correlation between the two long sequences, 703 and 704, was also relatively low (t = 4.4), although both matched other sequences. This variablility in levels of correlation probably indicates that they were not cut from the same woodland, since a single source would produce uniformly high t values.

The 294-year master matched the Police Station sequence PS213/214 with a t value of 6.1 over the period AD632-925. It also gave high t values with reference chronologies at this date, particularly those from London and Winchester (Table 3). Analysis of the Winchester timbers had suggested that they might have come from woodlands that also supplied London (Hillam 1992). The high t values between the TMS sequences and the London/Winchester chronologies might indicate that the same woodland areas were exploited to produce timbers for all three cities. In addition, the lack of uniformity between the TMS individuals mentioned above, might signify that the Oxford samples had been brought from a timber yard.

The samples in the TMS master had already been dated during the informal analysis. A new result, however, was the dating of 701. This 131-year sequence (Table 8) matched with dated chronologies over the period AD871-1001 (Table 3), although it gave a t value of only 3.1 with the TMS master. Like most of the other dated Shire Lake samples, it matched best with London and Winchester, although not as well as had the other TMS individuals.

6. The British Telecom tunnel, SAM 91

Only two of the oak piles (823, 824) proved suitable for dating purposes. The remainder had less than 40 rings, and 821 and 825 were also knotty. 824 was a squared timber shaped from less than a quarter of the trunk. It contained 55 rings but remains undated. 823 was a radially split segment, similar in width to 824, but it contained 143 very narrow rings (Table 9). When the ring sequence was tested against dated Saxon chronologies, consistent results were found for the period AD435-577 (Table 10).

The Shire Lake tree-ring chronologies

The data from PS213/214, PS218, SA318, TMS701 and the TMS master were combined to give a 458-year chronology for the period AD632-1089 which includes data from thirteen timbers. This extends the existing Oxford chronology for the period AD1043-1987 (Haddon-Reece, Miles & Munby - in prep) back in time by several centuries, and should prove useful for dating timbers from other sites in the Oxford area.

The potential for extending the Oxford curve still further back in time is demonstrated by the British Telecom sample whose rings span the period AD435-557.

Interpretation of the tree-ring dates

No dating was obtained for the samples from the LAPS site or 33 St Aldates. Dendrochronology is therefore unable to help with the chronology of the mid-Shire Lake sites. The tree-ring dates for the remaining sites are set out, with their estimated felling date ranges, in Table 12.

PS 88. Of the three dated timbers from the north bank of the channel, only 214 had any sapwood. Its last heartwood ring dates to AD963, giving a probable felling date range of AD973-1018. 213 and 218 have *termini post quem* for felling of AD945 and AD919 respectively and are probably contemporary with 214.

SASL 88. The only dated timber from this south bank site had no sapwood. The last measured ring of 318 dates to AD1089, giving a *terminus post quem* for felling of AD1099.

TMS 85. The group of eight timbers which produced the TMS master seem to be contemporary (Fig 2). 702 and 710 have 14 and 2 sapwood rings respectively. 702 has a last heartwood ring dating to AD911 and a last measured sapwood ring of AD925. This gives a felling date range of AD925-965. The last heartwood ring of 710 dates to AD908, producing a similar felling date range of AD918-963. If these two ranges are combined, the felling date for the group becomes AD925-963. This probably dates the primary construction of the feature, although if the timbers were stockpiled, a date in the middle or end of this range is perhaps more likely.

The newly dated timber 701 ends in AD1001 with what is possibly its last heartwood ring. It was therefore felled after AD1011 and, if the last ring is the sapwood boundary, it was probably felled before AD1056. This makes it distinctly more recent than the other dated timbers from the Trill Mill Stream, and may indicate that 701 is intrusive from a later phase.

BT tunnel. The dated BT timber has 13 sapwood rings. The outer heartwood ring dates to AD564, and the last measured sapwood ring to 577. It therefore has a probable felling date range of AD577-619.

Conclusion

Although approximately half the samples were unsuitable for dating purposes, estimated felling date ranges were obtained for timbers from four of the six sites. A date for the Mid-Saxon crossing of the river is provided by the BT timber which was felled during AD577-619. Later activity is dated by timbers from the Trill Mill stream, felled in AD925-963, and Police Station site, felled AD973-1018. A single timber from 56-60 St Aldates was felled some time after AD1099. The study also produced tree-ring sequences for the periods AD435-577 and AD632-1089, the data from which

might throw new light on the exploitation of woodlands in southern England during the Saxon and Norman periods.

Acknowledgements

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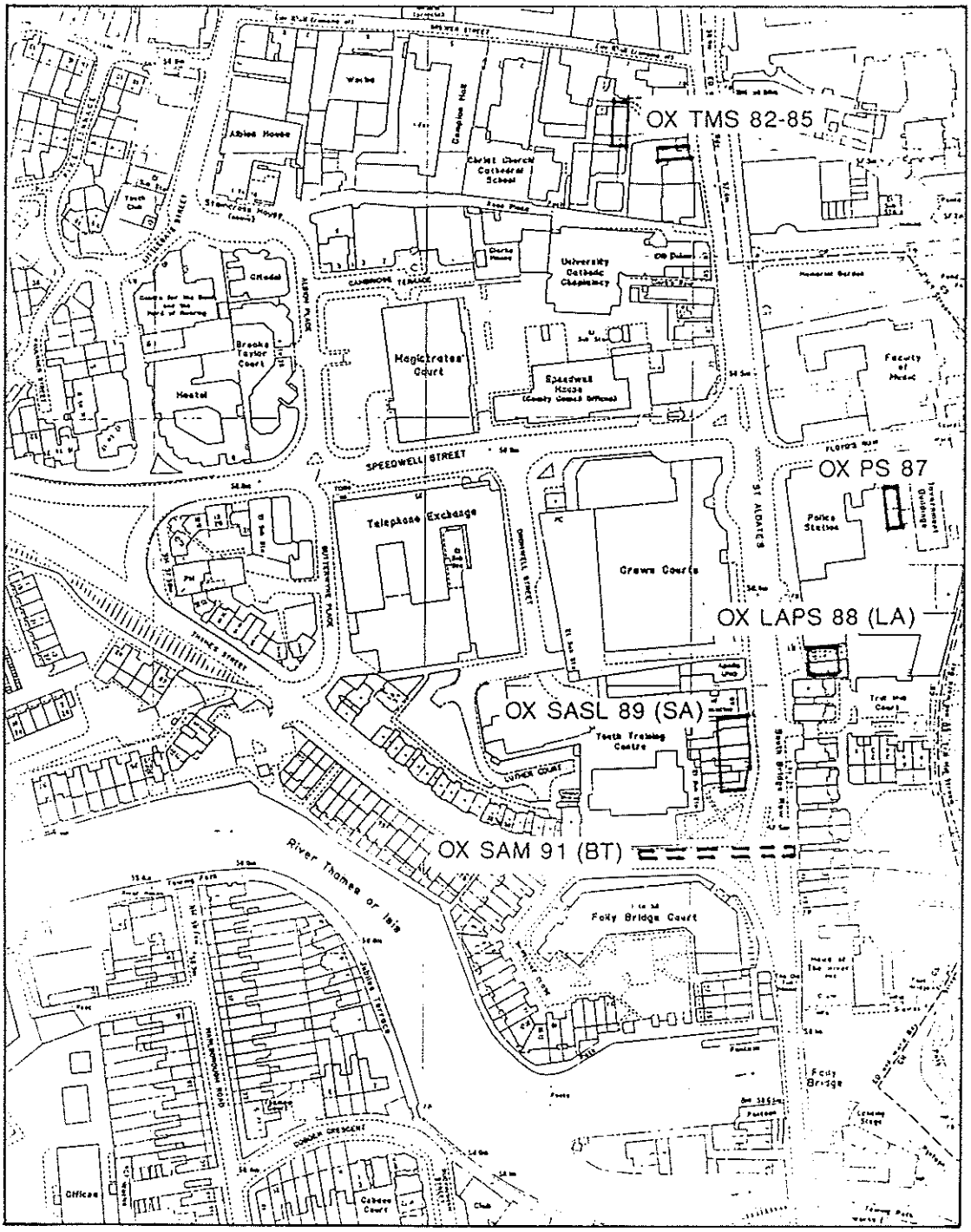


Fig 1: The south suburb of medieval Oxford, showing the location of sites contributing tree-ring samples.

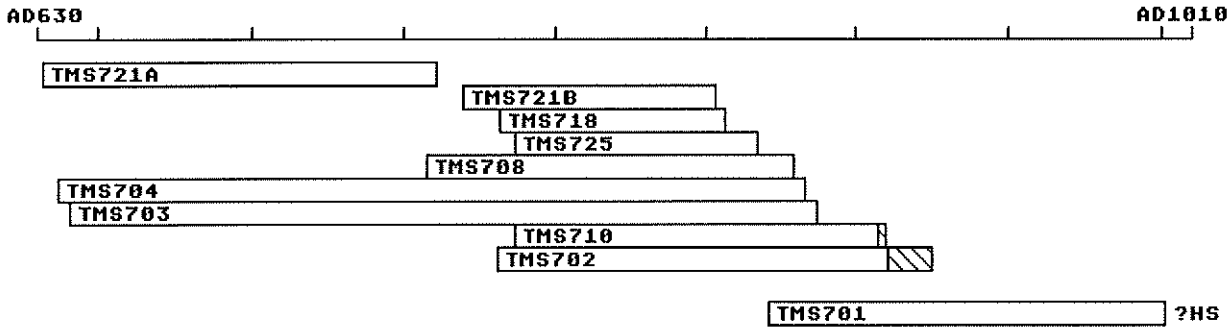
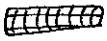
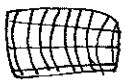
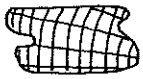
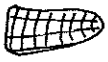
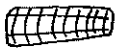
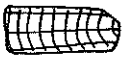
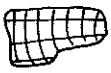
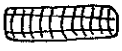


Fig 2: Bar diagram showing the relative positions of the dated ring sequences from the Trill Mill Stream. 721A and 721B are from the same timber. White bars - heartwood rings; hatching - sapwood; HS - heartwood-sapwood boundary.

Table 1: Details of the tree-ring samples. Cross-sectional sketches are not drawn to scale; shading on the sketches indicates the presence of sapwood. "+" - unmeasured rings present; HS - heartwood-sapwood transition. Asterisks indicate samples unsuitable for dating purposes.

sample no	context no	no of of rings	sapwood rings	average ring width (mm)	sketch	dimensions (mm)	comments
Site LAPS87							
104	301	55+	24+	1.56		190x170	+ 1 ring; 2 measures
Site PS88							
212*	41/15	27	13	1.59		90x85	
213	41/3	57+	-	0.70	-	-	broken
214	41/2	117	3	0.91		135x45	broken; + 26 inner rings
217	41/5	65	HS	1.31		105x40	knotty
218	41/8	63	-	1.35		135x30	broken; + 44 inner rings
219*	41/12	28	4	1.79		115x85	
Site SASL88							
304*	510	-	-	-		265x135	knotty; Salix/Populus
305*	510	-	-	-		170x140	knotty; Salix/Populus
306*	510	-	-	-		160x140	knotty; Salix/Populus
307	508/11	43	12	1.80		155x155	bark edge
317	55/3	123	-	1.44		190x110	knotty; 2 measures
318	55/4	122	-	2.10		255x145	2 measures
319	55/10	51	14	1.65		210x100	bark edge?
320A*	55/11	36	2	2.78		180x80	
320B	55/11	45	5	2.60		165x105	

sample no	context no	no of of rings	sapwood rings	average ring width (mm)	sketch	dimensions (mm)	comments
321	55/12	46+	21+	1.66		170x95	+ spring wood; felled summer
323	55/2	136	–	1.81		240x110	2 measures
326	54/13	48	10	1.65		170x85	2 pieces
327*	54/12	–	yes	–		105x90	narrow rings in sapwood
328*	55/6?	–	–	–		125x60	very narrow rings
333*	55/2	–	–	–	–	–	duplicate of 323
Site 33STA							
409	411	61	–	1.83		240x180	
Site TMS							
701	776	131	HS?	1.12		155x40	
702	780	145	14	1.35		200x60	2 measures
703	782/1	247	1	0.92		255x85	knot at inside
704	782/2	247	–	1.11		275x60	
705*	814	23	7	2.39		105x40	felled winter
707*	793/11	21	HS	2.07		110x55	
708	794	123	–	0.96		120x85	
710	785	124	2	1.51		190x60	
711	793/12	47+	25+	1.14		55x30	+ spring wood; felled summer
712*	795	20	–	3.75		120x70	
713*	793/2	25	10–20	0.88		55x40	bark

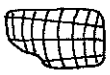
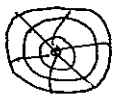
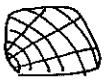
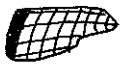
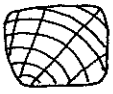
sample no	context no	no of of rings	sapwood rings	average ring width (mm)	sketch	dimensions (mm)	comments
714*	792/2	33	-	1.97		125x50	
715*	793/10	29	15	3.45		185x85	felled winter
716*	793/9	32	16	2.34		160x75	felled winter
717*	793/5	28	9	5.71		250x80	
718	781	76	-	0.80		60x50	
719*	793/3	39	-	1.97		80x25	
721A	790	130+	-	0.99		130x55	2 measures; outer section
721B	790	85	-	0.62		75x90	inner section
722*	791/1	31	15	1.61		105x60	
724*	-	13	-	3.85		115x50	
725	783	82	-	0.77		90x65	+ inner rings
726	793/6	39	19	2.69		195x105	bark; felled winter?
Site BT 821*	0/2	-	-	-		220x195	insufficient rings; knotty
822*	0/2	24	-	-		125x125	
823	0/2	143	13	0.62		105x50	2 measures
824	0/2	55	-	1.82		105x100	
825*	0/2	-	-	-		210x210	insufficient rings; knotty
838*	0/9	19	4	4.21		135x110	

Table 2: Ring width data for PS 213/214.

year	ring widths (0.01mm)										no of samples									
AD850										116										1
AD851	72	211	267	253	257	232	178	129	109	86	1	1	1	1	1	1	1	1	1	1
	90	152	126	101	114	111	121	88	120	129	1	1	1	1	1	1	1	1	1	1
	77	65	51	59	70	114	83	81	72	97	1	1	1	1	1	1	1	1	2	2
	58	80	85	56	66	80	91	54	72	57	2	2	2	2	2	2	2	2	2	2
	84	83	77	78	62	55	46	53	46	58	2	2	2	2	2	2	2	2	2	2
AD901	64	61	61	69	62	61	70	49	61	45	2	2	2	2	2	2	2	2	2	2
	53	58	63	69	50	46	74	46	58	52	2	2	2	2	2	2	2	2	2	2
	55	53	54	39	58	62	75	73	99	85	2	2	2	2	2	2	2	2	2	2
	67	69	52	52	63	67	68	68	69	77	2	2	2	2	2	1	1	1	1	1
	68	48	71	86	81	91	101	101	73	117	1	1	1	1	1	1	1	1	1	1
AD951	102	167	147	147	137	106	83	141	197	187	1	1	1	1	1	1	1	1	1	1
	174	233	212	171	185	244					1	1	1	1	1	1				

Table 3: Dating timbers fron sites PS and TMS. *t* values with dated reference chronologies. Values less than 3.0 are not listed; \ - short overlap.

chronology	213/214	218	TMSmaster	TMS701	OSLP
Exeter (Hillam 1980)	3.8	-	6.0	-	5.3
Germany (Hollstein 1980)	-	-	4.4	3.0	6.0
London, Billingsgate 4-7 (Hillam unpubl)	3.7	4.4	8.4	5.9	9.7
London, Milk Street (Hillam & Groves 1985)	-	3.4	5.8	-	5.6
London, Southwark (Tyers pers comm)	-	5.4	4.4	3.9	5.9
London, various sites (Nayling pers comm)	5.4	-	6.7	4.7	7.9
Oxford PS213/214	#	-	6.1	3.3	#
Oxford TMS master	6.1	4.2	#	3.1	#
Ref6 (Fletcher 1977)	3.2	3.1	3.6	6.1	5.9
Tamworth (Hillam 1981)	\	\	5.8	\	5.8
Winchester (Hillam 1992)	5.6	5.0	8.8	5.3	9.0

Table 4: Ring width data for SA318.

Year	Ring widths (0.01mm)									
AD968								306	202	217
	200	269	269	336	340	400	292	253	234	242
	243	203	305	195	237	263	290	372	308	295
	287	361	311	257	293	300	197	274	339	271
AD1001	240	285	231	306	206	277	281	399	353	214
	238	201	199	151	223	181	231	198	208	191
	209	209	235	251	228	273	325	258	209	309
	291	241	158	121	202	157	266	197	160	157
	198	220	185	117	110	172	194	136	139	138
AD1051	144	136	146	94	171	154	129	151	163	293
	155	138	119	103	103	122	122	120	108	130
	114	109	115	135	244	169	141	120	85	135
	109	162	153	221	159	174	141	125	171	

Table 5: Dating SA318 to AD968-1089.

chronology	*t* value
Beverley, Eastgate (Groves 1992)	4.0
Bristol, Dundas Wharf (Nicholson & Hillam 1987)	4.6
East Midlands (Laxton & Litton 1988)	4.4
London, Billingsgate 4-7 (Hillam unpubl)	4.0
London, Custom House XIII (Fletcher pers comm)	5.4
London, Swan Lane (Groves & Hillam 1987)	4.8
Nantwich (Leggett 1980)	4.7
Stafford (Groves unpubl)	4.3

Table 6: *t* value matrix for site TMS. Values less than 3.5 are not listed; \ - overlap less than 15 years.

	702	703	704	708	710	718	721A	721B	725
702	*				7.9		\		3.5
703		*	4.4	3.8			4.6		
704			*	5.2		4.7	9.9	4.8	4.5
708				*	4.2	10.3	\		5.8
710					*		\		5.1
718						*	\		5.4
721A							*	\	\
721B								*	
725									*

Table 7: TMS master chronology, excluding TMS701.

year	ring widths (0.01mm)										no of samples									
AD632		77	105	69	82	97	177	169	142	117		1	1	1	1	1	2	2	2	2
	69	62	79	67	72	64	100	95	101	102	3	3	3	3	3	3	3	3	3	3
AD651	67	106	65	70	64	75	90	118	81	79	3	3	3	3	3	3	3	3	3	3
	97	104	123	109	104	136	129	98	102	100	3	3	3	3	3	3	3	3	3	3
	86	80	92	130	100	98	67	83	76	72	3	3	3	3	3	3	3	3	3	3
	74	90	86	89	98	86	101	84	94	88	3	3	3	3	3	3	3	3	3	3
	125	100	126	93	119	91	76	60	61	81	3	3	3	3	3	3	3	3	3	3
AD701	100	70	126	131	127	97	73	75	95	66	3	3	3	3	3	3	3	3	3	3
	70	79	85	96	100	86	99	125	114	119	3	3	3	3	3	3	3	3	3	3
	110	122	184	99	96	83	99	128	122	142	3	3	3	3	3	3	3	3	3	3
	113	124	101	96	77	100	127	100	118	100	3	3	3	3	3	3	3	3	3	3
	70	97	115	112	111	126	135	125	154	163	3	3	3	3	3	3	3	3	3	3
AD751	143	108	111	123	128	112	91	128	123	120	3	3	3	3	3	3	3	4	4	4
	109	85	64	81	83	102	105	133	119	105	4	3	3	3	3	3	3	3	3	4
	100	93	110	116	105	67	68	98	98	122	4	4	4	4	4	4	4	4	4	4
	169	157	139	153	184	143	128	126	87	118	5	6	6	6	6	6	8	8	8	8
	92	88	72	88	119	106	119	118	106	99	8	8	8	8	8	8	8	8	8	8
AD801	127	139	105	97	70	83	90	69	116	108	8	8	8	8	8	8	8	8	8	8
	141	129	142	133	101	105	111	141	126	113	8	8	8	8	8	8	8	8	8	8
	111	105	78	78	97	142	112	129	117	90	8	8	8	8	8	8	8	8	8	8
	111	116	125	129	102	106	159	102	92	96	8	8	8	8	8	8	8	8	8	8
	93	110	100	94	135	106	109	81	85	85	8	8	8	8	8	8	8	8	8	8
AD851	69	104	105	106	128	115	97	99	98	79	8	8	8	8	7	7	7	6	6	6
	86	113	81	84	108	113	102	113	135	132	6	6	6	6	6	6	6	6	5	5
	109	91	137	94	133	166	111	101	118	138	5	5	5	5	5	5	5	5	5	5
	116	99	87	77	105	117	120	101	98	86	4	4	4	3	3	3	3	2	2	2
	103	76	52	46	48	41	29	38	37	52	2	2	2	2	2	2	2	2	2	2
AD901	58	57	72	83	77	69	82	66	65	52	2	2	2	2	2	2	2	2	2	2
	66	76	78	75	54	50	68	53	50	54	1	1	1	1	1	1	1	1	1	1
	44	58	62	53	75						1	1	1	1	1					

Table 8: Ring width data for TMS701.

Year	Ring widths (0.01mm)									
AD871	81	55	46	74	103	125	76	101	120	135
	132	122	103	57	120	130	140	155	126	115
	174	108	80	76	95	109	120	136	115	149
AD901	84	95	100	129	116	89	114	121	194	117
	130	136	117	99	137	81	117	72	91	113
	133	123	113	95	134	91	74	63	87	104
	100	130	99	127	130	145	132	129	106	148
	133	135	65	90	100	114	148	103	81	155
AD951	108	110	129	97	80	58	78	80	108	123
	137	141	130	105	83	120	104	125	92	118
	127	151	134	84	103	99	129	89	111	125
	91	116	110	93	94	87	124	102	109	92
	133	144	136	127	134	161	96	80	146	175
AD1001	178									

Table 9: Ring width data for BT823.

Year	Ring widths (0.01mm)									
AD435					229	220	222	190	136	124
	151	150	147	118	108	73	57	64	41	56
AD451	59	27	41	43	51	54	53	90	78	54
	66	77	64	52	31	32	61	78	90	71
	38	60	73	82	72	46	41	42	36	31
	40	52	62	70	53	44	42	29	34	30
	37	25	36	33	38	24	30	30	48	48
AD501	43	41	29	37	42	36	46	53	67	63
	67	63	36	32	64	47	74	56	71	47
	47	46	50	59	39	32	34	25	25	27
	43	50	56	59	48	44	44	36	32	31
	33	38	48	60	60	72	51	34	66	99
AD551	70	96	84	64	74	53	40	72	98	61
	77	59	59	43	54	70	75	59	88	66
	57	88	59	56	81	98	102			

Table 10: Dating BT823 to AD435-577.

chronology	*t* value
Barking (Tyers 1988)	3.9
Hamwic (Hillam 1984)	4.7
Ipswich, Smart Street (Groves 1987)	4.2
London, York Buildings (Tyers 1989)	5.6
Mersea Strood, Essex (Hillam 1981)	3.6
Odell, Beds (Hillam 1981)	4.9
Old Windsor (Fletcher pers comm)	4.6
Slough House Farm, Essex (Hillam 1990a)	5.0
West Heslerton, N Yorks (Hillam 1990b)	4.4

Table 11: The Oxford Shire Lake chronology, AD632-1089.

year	ring widths (0.01mm)										no of samples									
AD632		80	108	72	85	100	180	172	145	120		1	1	1	1	2	2	2	2	
	72	65	82	70	75	67	103	98	104	105	3	3	3	3	3	3	3	3	3	
AD651	70	109	68	73	67	78	93	121	84	82	3	3	3	3	3	3	3	3	3	
	100	107	126	112	107	139	132	101	105	103	3	3	3	3	3	3	3	3	3	
	89	83	95	133	103	101	70	86	79	75	3	3	3	3	3	3	3	3	3	
	77	93	89	92	101	89	104	87	97	91	3	3	3	3	3	3	3	3	3	
	128	103	129	96	122	94	79	63	64	84	3	3	3	3	3	3	3	3	3	
AD701	103	73	129	134	130	100	76	78	98	69	3	3	3	3	3	3	3	3	3	
	73	82	88	99	103	89	102	128	117	122	3	3	3	3	3	3	3	3	3	
	113	125	187	102	99	86	102	131	125	145	3	3	3	3	3	3	3	3	3	
	116	127	104	99	80	103	130	103	121	103	3	3	3	3	3	3	3	3	3	
	73	100	118	115	114	129	138	128	157	166	3	3	3	3	3	3	3	3	3	
AD751	146	111	114	126	131	115	94	131	126	123	3	3	3	3	3	3	3	4	4	4
	112	88	67	84	86	105	108	136	122	108	4	3	3	3	3	3	3	3	3	4
	103	96	113	119	108	70	71	101	101	125	4	4	4	4	4	4	4	4	4	4
	172	160	142	156	187	146	131	129	90	121	5	6	6	6	6	6	8	8	8	8
	95	91	75	91	122	109	122	121	109	102	8	8	8	8	8	8	8	8	8	8
AD801	130	142	108	100	73	86	93	72	119	111	8	8	8	8	8	8	8	8	8	8
	144	132	145	136	104	108	114	144	129	116	8	8	8	8	8	8	8	8	8	8
	114	108	81	81	100	145	115	132	120	93	8	8	8	8	8	8	8	8	8	8
	114	119	128	132	105	109	162	105	95	99	8	8	8	8	8	8	8	8	8	8
	96	113	103	97	138	109	120	90	96	97	8	8	8	8	8	8	9	9	9	10
AD851	74	119	129	132	154	137	113	118	115	95	10	10	10	10	9	9	9	8	8	8
	99	125	96	93	118	119	111	119	141	132	8	8	8	8	8	8	8	8	7	7
	108	91	121	91	128	158	106	105	115	135	8	8	8	8	8	8	8	8	9	9
	111	102	92	68	93	113	118	102	98	90	8	8	8	7	7	7	7	6	6	6
	112	94	79	79	75	70	65	70	60	72	6	6	6	6	6	6	6	6	6	6
AD901	67	72	83	96	85	79	93	76	102	65	6	6	6	6	6	6	6	6	6	5
	78	85	83	81	75	58	86	57	67	70	4	4	4	4	4	4	4	4	4	4
	74	74	73	59	84	74	77	72	98	94	4	4	4	4	4	3	3	3	3	3
	81	92	70	80	88	109	103	101	90	115	3	3	3	3	3	2	2	2	2	2
	103	94	71	91	93	105	127	105	80	139	2	2	2	2	2	2	2	2	2	2
AD951	108	141	141	125	111	85	83	113	155	158	2	2	2	2	2	2	2	2	2	2
	158	190	174	141	137	185	107	217	149	169	2	2	2	2	2	2	1	2	2	2
	165	212	203	212	223	251	212	173	174	185	2	2	2	2	2	2	2	2	2	2
	169	161	209	146	167	177	209	239	210	195	2	2	2	2	2	2	2	2	2	2
	212	254	225	194	215	232	148	179	244	225	2	2	2	2	2	2	2	2	2	2
AD1001	211	286	232	307	207	278	282	400	354	215	2	1	1	1	1	1	1	1	1	1
	239	202	200	152	224	182	232	199	209	192	1	1	1	1	1	1	1	1	1	1
	210	210	236	252	229	274	326	259	210	310	1	1	1	1	1	1	1	1	1	1
	292	242	159	122	203	158	267	198	161	158	1	1	1	1	1	1	1	1	1	1
	199	221	186	118	111	173	195	137	140	139	1	1	1	1	1	1	1	1	1	1
AD1051	145	137	147	95	172	155	130	152	164	294	1	1	1	1	1	1	1	1	1	1
	156	139	120	104	104	123	123	121	109	131	1	1	1	1	1	1	1	1	1	1
	115	110	116	136	245	170	142	121	86	136	1	1	1	1	1	1	1	1	1	1
	110	163	154	222	160	175	142	126	172		1	1	1	1	1	1	1	1	1	

Table 12: Details of tree-ring dates. Estimated felling date ranges are calculated using a sapwood estimate of 10-55 rings.

sample	no	date of measd ring sequence	felled	comments
PS	213	879-935+	945+	outer rings broken off
	214	850-966	973-1018	
	218	847-909	919+	inner rings broken off
SASL	318	968-1089	1099+	
TMS	701	871-1001	1011-?1056	
	702	781-925	925-965	
	703	641-887	897+	
	704	637-883	893+	
	708	758-880	890+	
	710	787-910	918-963	
	718	782-857	867+	
	721A	632-761	see 721B	
	721B	770-854	864+	
	725	787-868	878+	
BT	823	435-577	577-619	