TREE-RING ANALYSIS OF TIMBERS FROM NORWICH: COURTS SITE, 1981

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Abstract

Fifty-one tree-ring samples were examined from this waterfront site. The 24 post-medieval boards from a barrel well (1079) were of sweet chestnut, a species so far not used for tree-ring dating, but no attempt could be made on these samples as they all had less than 25 rings. The medieval timbers consisted of one alder sample and 26 oak samples. Sixteen oak timbers were rejected either because they had less than 50 rings, or because they were poor quality wood with knots. The ten usable timbers had 65-143 annual rings, but only one ring sequence could be reliably dated. This timber, 1203, was felled some time after AD 1193, but uncertainty about the presence of sapwood precluded the determination of a more precise felling date. Possible reasons for the lack of dating at this site, and others in East Anglia, are discussed, and recommendations made about future tree-ring work in this area.

Tree-Ring Analysis of Timbers from Norwich: Courts Site, 1981

Excavation by Brian Ayers at this waterfront site (no 450N) produced 51 timbers which were sampled for tree-ring analysis. They were examined at the Sheffield Dendrochronology Laboratory in 1984/85 with the aim of dating the different phases of waterfront activity, as well as extracting information about the timbers themselves.

The timbers

Most of the timbers were from waterfront deposits (Table 1). The exceptions are the three timbers from context 1069, and the one from 2250, which came from contexts outside the waterfront area. The five timbers from 1164, a wicker-lined cess pit, may also come from behind the working waterfront area. The barrel well, 1079, with its 24 boards, may have been associated with post-medieval housing on the waterfront itself. The remaining timbers were either individual posts, or timbers from fences, along the waterfront.

Most of the timbers were medieval in date, the archaeological evidence indicating that they belonged to several phases within the 11th-13th centuries. The only post-medieval timbers were those from 1079 (Table 1).

Examination of the samples showed that most were oak (Quercus spp). Sample 1164B proved to be alder (Alnus glutinosa (L) Gaertn), whilst the post-medieval boards were of sweet chestnut (Castanea sativa Mill). Oak was the chief timber species in the past, and is by far the most common on

archaeological sites. Alder is not a valuable building timber because of its poor durability, but it survives well in water or wet ground. It is therefore sometimes found as posts or as pit linings during excavations. Sweet chestnut is rarely found. It was supposed to have been used frequently as a building timber in the Middle Ages, but this in fact has proved to be false (Rackham 1980 330; Salzman 1967 252). The sweet chestnut building tradition theory may have arisen because chestnut and oak are very similar in structure (Fig 1). Reports of sweet chestnut building timbers have usually turned out to be oak (although there is no reason why chestnut would not make a suitable building timber).

It would have been interesting to use the chestnut for tree-ring dating. Like oak, it has very distinct rings which are suitable for measurement, but I know of no instance where this species has been used for dating. Unfortunately the Norwich samples are tangentially split boards with only 6-21 growth rings (Table 2). This is insufficient for reliable crossmatching.

The chestnut boards were split from young trees - probably less than 30-40 years old, and under 200-300mm in diameter. The timber was worked whilst still green, because the boards have warped as they dried (see, for example, 1079E or 1079G.

The alder sample (1164B) had 28 rings, and was worked from a halved trunk. The sample was rejected for dating purposes because alder is unsuitable, although it also had insufficient rings.

The oak timbers varied a great deal (Table 2). Some were radially split planks (eg 1069A), others were whole stems (eg 1195) which were sometimes roughly squared (eg 1164). Often the trunk was split into halves or quarters, and the timber shaped from these (eg 1069D and 1166). The size of the timbers varied in cross-section. Many had less than 50 rings, and were rejected for dating purposes. Ring sequences with less than 50 rings tend not to be unique, and usually cannot be dated reliably, unless there are many samples from a single context (Hillam 1985a). Other samples contained knots which obscured the ring pattern (eg 1181, 1194), and these too had to be rejected. Out of the original 51 samples, the only ones that proved suitable for tree-ring dating were 1069A, 1069C, 1069D, 1121, 1136, 1140, 1147, 1166, 1189 and 1203. The number of rings varied from 65 to 143 (Table 2).

Tree-ring dating

The samples were deep-frozen for 48 hours before being cleaned, still frozen, with a Stanley surform. This leaves a smooth cross-section on which the individual rings can be measured with some precision. The ring widths were measured on a travelling stage which is connected to an Apple micro-computer (Hillam 1985a, fig 4). Each ring width is stored in the Apple's memory. When the complete ring sequence has been measured, it can be printed out or stored more permanently on floppy disc. The microcomputer is also used in the cross-matching process (see below). The software was produced by JR Pilcher at the Belfast Tree-Ring Laboratory.

The ring widths (listed in the Appendix) were plotted

as graphs, known as tree-ring curves, and were compared with each other to test for contemporaneity. None of the ten sequences seemed to crossmatch, ie there were no similarities between the various ring patterns. The Belfast crossdating program (Baillie & Pilcher 1973) confirmed this result. The computer program compares two sets of data, and measures the correlation between them for each position of overlap. A t-value greater than 3.5 indicates a tree-ring match if it is accompanied by an acceptable visual match (for further details, see Baillie 1982 82-85).

The sequences were next tested against the dated oak reference chronologies from Britain and Europe which cover the 11th to 13th centuries (Table 3). They were also compared with a 244-year undated Norwich sequence from the 1979 Whitefriars Street Car Park excavation (Hillam 1983). The ring sequences from the two Norwich sites however did not appear to match.

The only ring sequence which showed consistent agreement, both visually and statistically, with the reference chronologies, was 1203, a horizontal timber from phase I1. It produced t-values greater than 3.0 with nine chronologies from the British Isles when its ring sequence covered the period AD 1115-1193 (Table 4a). Timber 1203 therefore cannot have been felled before AD 1193, although this is a more recent date than that indicated by the archaeological evidence. It was not possible to determine whether or not the timber had sapwood. Sapwood is usually easily distinguishable from the heartwood, but occasionally the distinction between sapwood, included sapwood and lightly-coloured heartwood is

difficult to make (Hillam 1986). This was the case with 1203, and so it is not known how much wood was removed from the timber when it was converted into a plank: it could have been just a few sapwood rings, or it may have been some heartwood as well as sapwood. All that is definitely known is that the tree was not felled before AD 1193.

The remaining nine ring sequences gave hundreds of t-values over 3.5 with the reference chronologies but only 1069C, 1069D, 1121 and 1140 gave such t-values at the same date with more than one chronology. These are listed in Table 4b, but they are not as consistent as those for 1203: the t-values are not particularly high, nor are the visual matches very good. They are listed therefore, not as definite tree-ring dates, but as reference for future work - to be confirmed or rejected as appropriate.

Discussion

Since only one out of 51 samples could be dated, it is necessary to consider the reasons for the lack of dating. A glance at Tables 1 and 2 shows that some of the material comes from brushwood and wattle layers - layers, that might be expected to produce small timbers with few rings. The larger timbers are often of poor quality with knots, or they come from fast-grown oaks with wide rings, so that they do not have long ring sequences. In addition, about half of the samples were not oak.

Of the ten usable ring sequences, five have over 100 rings, and five have 65-82 rings: all of which are sufficient

for reliable dating. However there is no internal cross-matching, which means that a site master cannot be constructed. Site masters are usually much easier to date than individual sequences since the common climatic signal is enhanced at the expense of the 'background noise' from the individual trees.

Timbers from East Anglia have often been difficult to date (Hillam 1985b). The 244-year sequence from Whitefriars in Norwich seems highly suitable for tree-ring dating, but numerous attempts to date it have failed (Hillam 1983). None of the timbers from Cecelia Street, Ipswich (Hillam 1980b), were dated, whilst the Bridge Street timbers from Ipswich are proving equally difficult (Hillam unpubl). At the latter site, at least three of the timbers were imported, probably from the Baltic (Baillie et al 1985; Hillam 1985b), and this may also apply to other East Anglian timbers, for example the well timbers from Lower Brook Street, Ipswich (Hillam 1984b). With this in mind, the Courts sequences were tested against several Continental chronologies (Table 3), but there is no evidence of similarity between them. The dated timber, 1203, in fact matched only with British chronologies. However, even if the Courts timbers were not imported, they may have come from different areas of England.

Another reason why East Anglia is difficult dendrochronologically may be because environmental conditions there

are more favourable for tree growth than in other parts of Britain. The climatic signal in the rings would not then be as strong, making crossmatching more difficult. This explanation is not totally acceptable since East Anglian timbers have been dated, such as the modern oaks from near Norwich (Baillie 1983) or the Saxon timbers from Mersea Stroud (Hillam 1981). It does seem, however, that unless a site master can be constructed, East Anglian timbers are almost impossible to date. The exceptions are those where it is suspected that they are imported from the Continent.

Conclusion

The Courts site produced 51 tree-ring samples from various wood-bearing contexts. The post-medieval boards from 1079 were sweet chestnut, a species not yet used for tree-ring dating. Insufficient rings made experimentation impossible in this case, but in theory the species should be suitable for dating.

Apart from one alder sample, the remaining 27 timbers were oak samples of various shapes and sizes. Ten were suitable for ring measurement, but only one timber, 1203, could be reliably dated. The prime cause of this lack of success is seen as the inability to produce a site master curve because, without a site master, East Anglian timbers are very difficult to date.

The reasons why none of the Courts sequences crossmatched are numerous. Many timbers were rejected because they were not oak, had insufficient rings, or were of poor quality. Of the

ten suitable samples, it is suggested that environmental factors and/or different sources of timber may be responsible for the lack of dating (although there is no evidence that any of the timbers were imported from the Continent). The study highlights the need for sampling as many timbers as possible from a site (Hillam 1985a). This is important for all sites but particularly those in East Anglia where so many timbers are likely to be undatable. Previous work has shown that some timbers from this region can be dated, so it is recommended that more tree-ring work is carried out in East Anglia in order to solve the problems raised by its archaeological timbers.

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References

Baillie MGL 1977a The Belfast oak chronology to AD 1001. Tree Ring Bulletin 37, 1-12.

---------- 1977b Dublin Medieval Dendrochronology. Tree Ring Bulletin 37, 13-20.

---------- 1982 Tree-Ring Dating and Archaeology. Croom Helm, London.

---------- 1983 Is there a single British Isles oak tree-ring signal? in A Aspinall & SE Warren (eds) Proc 22nd Symposium on Archaeometry, University of Bradford, 73-82.

Baillie MGL & Pilcher JR 1973 A simple crossdating program for tree-ring research. Tree Ring Bulletin 33, 7-14.

Baillie MGL, Hillam J, Briffa KR & Brown DM 1985 Re-Dating the English Type-A Tree-Ring Chronologies (forthcoming).

Bridge M 1983 The use of tree-ring widths as a means of dating timbers from historical sites. PhD thesis, Portsmouth Polytechnic.

Delorme A 1972 Dendrochronologische Untersuchungen an Eichen des Südlichen Weser- und Leineberglandes. Dissertation, Göttingen.

Fletcher JM 1977 Tree-ring chronologies for the 6th to 16th centuries for oaks of southern and eastern England. Journal Archaeological Science 4, 335-52.

Fletcher JM & Morgan RA 1981 The dating of doors and cupboards in the Zouche Chapel, York Minster. Yorkshire Archaeological Journal 53, 45-49.

Hillam J 1980a A medieval oak tree-ring chronology from south-west England. Tree Ring Bulletin 40, 13-22.

Hillam J 1980b Cecelia Street, Ipswich (IAS 5001) - Tree-ring analysis. Ancient Monuments Laboratory report 3006.

-------- 1981 An English tree-ring chronology, A.D. 404-1216. Medieval Archaeology 25, 31-44.

-------- 1983 Wood, in B Ayers & P Murphy, A waterfront excavation at Whitefriars Street Car Park, Norwich, 1979. East Anglian Archaeology report no 17, 44-45.

-------- 1984a Bristol Bridge dendrochronology. Analysis of the re-used boat timbers. Ancient Monuments Laboratory report 4168.

-------- 1984b Lower Brook Street, Ipswich: tree-ring analysis of well timbers. Ancient Monuments Laboratory report.

-------- 1985a Theoretical and applied dendrochronology: how to make a date with a tree. In P Phillips (ed) The Archaeologist and the Laboratory, CBA research report (forthcoming).

-------- 1985b Recent tree-ring work in Sheffield. Current Archaeology (forthcoming).

-------- 1986 Problems of dating archaeological timbers. In RGW Ward (ed) Tree-ring studies in Britain, BAR (forthcoming).

Hollstein E 1980 Mitteleuropaische Eichenchronologie. Zabern, Mainz am Rhein.

Laxton RR, Litton CD, Simpson WG & Whitley PJ 1982 Tree-ring dates for some East Midland buildings. Transactions Thoroton Society 86, 73-78.

Leggett PA 1980 The use of tree-ring analyses in the absolute dating of historical sites and their use in the interpretation of past climatic trends. PhD thesis, Liverpool Polytechnic.

Rackham O 1980 Ancient Woodland. Its history, vegetation and use in England. Edward Arnold, London.

Salzman LF 1967 Buildings in England down to 1540. Kraus reprint of original 1952 edition (Clarendon Press, Oxford).

Table 1: Details of contexts which produced timbers for tree-ring analysis.

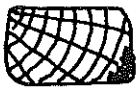
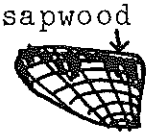
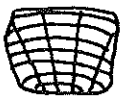
Context	Period	Date	Comments
1069	II2	c1170-c1300	3 timbers located immediately outside cesspit arch of Norman building set into pit 1061.
1079	IV	late 16th - early 17th century	24 timbers from a barrel well.
1121	I1	11th century - ?1st ½	Post set into pit at waterfront.
1125	I2	11th century - ?2nd ½	2 timbers in haphazard arrangement within area of Saxo-Norman waterfront.
1136	I1		Wattle fence at waterfront.
1140	I1		Layer of brushwood at waterfront.
1147	I1		Post within waterfront area.
1150	I1		Brushwood deposits.
1164	I2		5 timbers from wickerlined cess pit.
1166	I2		Post within waterfront area.
1172	I1		2 'planks' associated with waterfront features.
1181	I2		Post in pit.
1187	I2		Timber fence at waterfront.

cont/

Table 1/cont

1189	I1	11th century - ?1st ½	Wattle fence at waterfront.
1192	I1		Brushwood layer.
1194	I1		Large unworked timber - possibly forming crude platform with 1121.
1195	I1		Post within waterfront area.
1196	I1		Post within waterfront area.
1203	I1		Horizontal timber held to gravel by peg.
2250	II1	c1100-c1170	Partfill of pit 2249 (not in waterfront area).

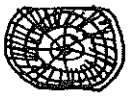
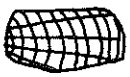
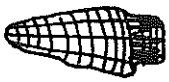
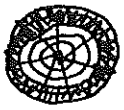
Table 2: Details of the tree-ring samples. The sketches of the cross-sections are not to scale; measurements to the nearest 5mm are given for the maximum dimensions of the cross-section.

sample	total no of rings	sapwood rings	sketch	dimensions(mm)
Alder				
1164B	28			105 x 60
Oak				
1069A	143 measd	-		145 x 25
1069C	125 measd	-		130 x 25
1069D	65 measd	-		100 x 75
1121	82 measd	-		240 x 240
1125	17	5		110 x 80
1125.2	13	-		160 x 60
1136	73 measd	19		110 x 50
1140	142 measd (+8)	28 (+8)		110 x 70
1147	66 measd (+c25)	-		90 x 85
1150	13	-		160 x 60
1164	20	16		60 x 50

cont/

Table 2/cont

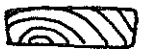
Oak (cont)

1164C	20	12	?felled summer		60 x 50 (radius 30)
1164D	25	18	felled winter		95 x 70 (radius 55)
1164E	18	11	felled winter		85 x 75 (rad 40-45)
1166	138 measd	-			95 x 60
1172	? sample badly broken				
1172.2	35	-			240 x 130
1181	? knots	-			175 x 140
1187	35	5			180 x 95
1189	137 measd	47	?felled winter		110 x 40
1192	? narrow rings	?			85 x 80
1194	c40 knots	-			510 x 420
1195	29	6			190 x 180 (rad 90-100)
1196	less than 30	13			240 x 200
1203	79 measd	?22			150 x 55
2250	35	-			80 x 20

(timber broken - largest piece measured)

cont/

Sweet chestnut

1079A	6		-		100 x 30
1079B	7		-		90 x 15
1079C	21		-		125 x 25
1079D	15		-		120 x 35
1079E	12		-		135 x 20
1079F	11		-		130 x 40
1079G	13		-		145 x 25
1079H	13		-		115 x 25
1079I	15		-		115 x 20
1079J	14		-		110 x 25
1079K	14		-		140 x 30
1079L	16		-		120 x 20
1079M	11		-		110 x 30
1079N	15		-		115 x 30
1079O	15		-		110 x 20
1079P	9		-		110 x 20
1079Q	16	?bark	no obvious sapwood		115 x 35
1079R	7		-		115 x 30

cont/

Table 2/cont

Sweet chestnut (cont)

1079S	13	-		155 x 20
1079T	13	-		130 x 15
1079U	12	-		125 x 20
1079V	14	-		115 x 25
1079W	10	-		165 x 20
1079X	15	-		115 x 30

Table 3: Reference chronologies against which the Norwich sequences were dated.

chronology	dates	reference
Belfast	1001-1970	Baillie 1977a
Bradwell Abbey	1083-1279	Bridge 1983
Bristol	1032-1239	Hillam 1984a
Britain	401-1981	Baillie & Pilcher, pers comm
Dublin	855-1306	Baillie 1977b
England	404-1981	Baillie & Pilcher, pers comm
Exeter	799-1216	Hillam 1980a
Germany, north	1004-1970	Delorme 1972
Germany, Schleswig	741-1460	Eckstein, pers comm
Germany, west	700BC-1975	Hollstein 1980
Glastonbury	1095-1334	Bridge 1983
Lincoln	882-1184	Laxton et al 1982
Nantwich	930-1330	Leggett 1980
Ref 6	780-1193	Fletcher 1977
Ref 7	993-1267	Fletcher, pers comm
York, Coppergate	1. 715-1011	Hillam, unpubl
	2.1031-1248	Hillam, unpubl
York, Zouche	1118-1386	Fletcher & Morgan 1981, but for dates see Baillie et al 1985
Norwich, Whitefriars	244 years, undated	Hillam 1983

Table 4: Tree-ring results. a) The dating of 1203. b) Results for 1069C, 1069D, 1121 and 1140. These have not yet been confirmed, and therefore are not true tree-ring dates. Each sequence gives a t-value of 3.0 or higher with at least three reference chronologies at the same date. (Details of chronologies are given in Table 3.)

a) 1203 - ring sequence dates to 1115-1193

chronology	t-value
Bradwell Abbey	3.2
Bristol	3.7
Britain	4.6
England	5.0
Exeter	3.7
Glastonbury	3.2
Lincoln	3.6
Nantwich	4.1
Ref 7	5.3

b) 1069C - end year 1207?

Bristol	4.0
Britain	3.5
Dublin	4.6

1069D - end year 1061?

Germany, west	4.0
Lincoln	3.6
Ref 6	3.7

1121 - end year 938?

Britain	3.5
England	3.7
Germany, west	3.6

cont/

Table 4/cont

1140 - end year 1173?	
Bristol	4.0
Britain	3.3
Dublin	4.2
Exeter	3.9

Fig 1: Sweet chestnut (top) and oak (bottom). The two timbers are very similar in structure. The most obvious difference is that oak has broad medullary rays running from pith to bark whereas chestnut has not. (Photo: PW Kingsland)

Appendix

Ring width data of the ten Norwich timbers used for dating. First two lines identify the site and sample, third line - total number of measured ring widths, fourth and subsequent lines - ring widths in units of 0.02mm. Notes are given at the end of the data if the ring pattern is in any way unusual eg sapwood, abnormal ring, rings which cannot be measured accurately. HS - heartwood-sapwood transition.

NORWICH
NOR 1.06.96
143

1 -	41	58	66	63	70	64	46	38	54	75
11 -	79	50	34	58	62	58	49	78	42	52
21 -	47	40	44	58	46	38	40	37	40	49
31 -	48	49	53	60	48	88	67	78	47	40
41 -	60	40	49	42	66	68	50	75	67	65
51 -	73	34	43	58	46	34	48	59	51	61
61 -	51	48	50	41	59	40	38	32	52	51
71 -	43	32	38	36	36	48	36	42	43	62
81 -	55	44	55	39	33	49	62	57	73	41
91 -	57	39	35	28	31	29	31	31	38	43
101 -	43	36	61	55	60	33	57	33	35	28
111 -	32	38	31	43	35	40	30	25	34	24
121 -	57	40	40	51	44	37	37	41	50	46
131 -	72	56	54	75	52	61	33	54	61	75
141 -	73	62	62							

COMMENT - RING 104 - SMALL VESSELS

NORWICH
NOR1069C
(25)

1 - 50 34 62 32 62 103 46 30 49 27

11 - 38 47 41 37 38 43 36 65 30 46

21 - 42 48 33 46 38 37 30 66 61 48

31 - 73 38 61 52 42 51 38 48 67 58

41 - 62 53 64 41 55 43 43 65 77 66

51 - 47 51 55 58 62 55 64 60 55 67

61 - 47 48 48 69 49 64 51 57 73 49

71 - 54 49 33 49 39 53 49 37 40 45

81 - 60 53 58 39 56 44 52 36 65 67

91 - 50 48 34 41 31 42 61 46 26 50

101 - 32 39 49 68 46 38 32 66 52 39

111 - 41 57 45 45 39 35 52 67 36 50

121 - 49 44 58 44 41

COMMENT -

NORWICH
NOR1069D
65

1	140	116	108	65	36	56	69	78	42	22
11 -	22	22	41	27	50	67	58	34	59	32
21 -	39	25	34	46	66	75	78	56	66	50
31 -	64	35	28	41	49	67	64	51	48	33
41 -	46	59	36	54	41	52	38	26	43	37
51 -	42	27	33	45	37	31	20	25	36	30
61 -	19	31	41	26	44					

COMMENT - NEAR PITH - RING 56 COULD BE TWO

[illegible]

1 - 45 132 152 104 48 119 195 121 102 170

11 - 171 118 105 161 103 121 160 112 164 203

21 - 106 123 141 120 111 71 59 77 51 80

31 - 112 110 103 88 106 68 59 71 101 78

41 - 82 99 100 109 96 102 116 112 101 74

51 - 87 108 76 79 107 144 69 83 79 67

61 - 83 71 97 81 75 93 67 73 77 75

71 - 90 60 89 59 65 65 49 44 48 72

81 - 61 80

COMMENT - PITH - BADLY ATTACKED BY FUNGUS

NORWICH
NORTH
73

1 - 71 93 75 64 61 [illegible] 37 44 69 89

11 - 53 41 50 72 61 49 71 61 68 47

21 - 72 42 67 55 80 105 131 123 116 128

31 - 133 124 81 126 78 199 132 99 85 89

41 - 68 46 77 53 56 71 75 65 76 104

51 - 65 64 64 73 64 55 78 53 84 91

61 - 62 67 91 97 111 72 63 61 67 51

71 - 48 47 40

COMMENT - HS 55

NORWICH
NOR140
142

1 -	57	49	41	55	55	71	66	43	71	57
11 -	44	22	27	26	40	57	53	35	26	70
21 -	49	57	33	44	39	48	29	30	47	79
31 -	50	51	49	42	33	68	101	52	47	38
41 -	36	26	28	21	25	32	29	36	31	25
51 -	23	22	25	21	18	24	19	23	24	31
61 -	27	33	22	15	21	27	25	30	30	33
71 -	26	17	20	25	30	19	31	23	27	40
81 -	32	31	30	35	45	34	51	37	43	28
91 -	31	30	20	28	28	29	38	25	41	28
101 -	24	20	23	45	25	18	15	17	22	23
111 -	25	24	29	30	42	16	28	31	32	34
121 -	29	26	19	23	30	18	21	31	15	30
131 -	23	21	25	20	22	24	20	17	16	16
141 -	22	16								

COMMENT - NEAR PITH - FIRST HS AT 51 - LAST 115 BUT COULD BE INCLUDED? - PL
US AT LEAST ANOTHER 8 V NARROW RINGS

NORWICH
NOR1 1.66
138

1 - 34 39 48 36 36 62 66 32 42 57

11 - 46 36 57 54 51 35 45 54 44 41

21 - 44 68 74 71 41 40 43 44 53 39

31 - 45 30 43 31 50 61 39 46 42 39

41 - 21 36 23 40 39 32 32 24 22 16

51 - 28 39 32 34 17 34 41 32 25 18

61 - 33 40 30 21 33 36 38 24 35 39

71 - 28 39 25 24 26 25 19 13 14 12

81 - 14 11 14 16 12 14 18 16 21 16

91 - 20 22 22 25 26 20 14 26 33 30

101 - 32 23 18 20 24 25 36 34 54 32

111 - 48 59 59 46 50 34 27 45 33 25

121 - 46 47 36 31 29 21 17 17 17 16

131 - 19 17 15 16 14 16 17 24

COMMENT -

NORWICH
NOR 1 1839
137

1 - 10	85	108	96	79	61	87	127	95	86	88
11 - 20	61	30	42	36	29	51	46	39	64	37
21 - 30	47	41	42	48	42	35	38	22	42	38
31 - 40	29	26	15	22	38	23	49	54	43	33
41 - 50	43	17	26	45	31	36	59	21	12	23
51 - 60	16	16	23	34	56	52	31	42	54	35
61 - 70	27	24	19	38	26	30	45	28	26	18
71 - 80	15	16	14	23	15	29	13	23	16	24
81 - 90	28	37	29	21	39	28	21	29	23	33
91 - 100	37	41	43	33	30	24	13	49	25	32
101 - 110	43	29	40	33	48	39	39	36	29	35
111 - 120	55	39	51	60	37	24	31	33	39	38
121 - 130	47	43	31	59	23	30	25	20	36	27
131 - 137	36	25	30	26	34	25	27			

COMMENT - QUERY AT RINGS 33 49 71-73 - HS 91 - ?FELLED WINTER

NORWICH
NOR1203S
7%

AD 1115-1193

1 -	110	92	80	52	67	46	109	136	148	174
11 -	131	112	147	134	63	85	118	53	33	41
21 -	72	48	32	74	53	102	92	74	71	75
31 -	78	64	69	40	53	45	35	33	63	52
41 -	46	46	56	46	69	98	70	107	59	64
51 -	91	87	80	77	81	124	96	74	55	48
61 -	59	76	46	66	166	137	144	130	120	115
71 -	103	70	59	48	56	135	122	79	134	

COMMENT - LAST 22 RINGS (MAX) COULD BE SAPWOOD - OR MAY BE INCLUDED SAPWOOD