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Summary

Excavations along the street frontage of Forehill, Ely, Cambridgeshire carried out in 1995 in advance of development, encountered waterlogged deposits containing medieval structural and artefactual wood. Post-excavation assessment identified the need to assess this assemblage for dendrochronological potential and also that of the one medieval building (47 Forehill) located adjacent to the excavated area. Although the building proved unsuitable for tree-ring analysis, eight timbers held in store were sampled for dating purposes. Of these, three have cross-matched giving dates of after AD 1224, after AD 1119, and one felling date of AD 1181.

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TREE-RING ANALYSIS OF TIMBERS FROM ELY FOREHILL, ELY, CAMBRIDGESHIRE

Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers recovered during excavations along some 50m of the street frontage of Forehill, Ely, Cambridgeshire (NGR TL545802). This forms part of the program of post-excavation analysis identified in the post-excavation assessment of the excavations produced by the Cambridge Archaeological Unit (Alexander 1998). In due course, as part of a multidisciplinary study, elements of this report will be combined with detailed descriptions, drawings, and other technical reports to form a comprehensive publication on the site.

The archaeological potential of the then derelict site was suggested both by its location on the route between two important foci of early medieval Ely (the wharves and the cathedral), and the survival of timber structural elements within an adjacent standing building (47, Forehill) provisionally dated on typological grounds to the fourteenth century. During the excavations, waterlogged structural and artefactual timbers encountered in earlier, medieval phases were recovered and placed in store. Post-excavation assessment (Alexander 1998) identified the need for assessment of the suitability of this assemblage for dendrochronological dating along with that of the adjacent standing building. Structural analysis of the building at 47 Forehill had identified the survival of elements of a coupled-rafter roof variously dated on typological grounds to the fourteenth or sixteenth century (Baggs 1995). The owner kindly allowed access to the house, and the visible timbers were assessed for their dating potential. The small scantling of the roof timbers and their relatively fast growth rate indicated a lack of timbers with sufficient rings for dating purposes and no samples were taken. Assessment of timbers from the excavations held in store by the Cambridge Archaeological Unit did however identify eight timbers with sufficient rings for analysis, and these were duly sub-sampled. The analysis of these timbers forms the subject of this report.

Methodology

Professional practise at the Lampeter Dendrochronology Laboratory generally follows the methods outlined in English Heritage (1998).

The detailed methodology used to analyse this assemblage was as follows. The eight waterlogged samples were placed in a freezer for 48 hours and then cleaned with a 'Surform' blade to reveal the ring sequences. The complete sequences of growth rings in the samples were measured to an accuracy of 0.01mm using a microcomputer-based travelling stage (Tyers 1997a). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised sequences. The *t*-values reported below are derived from the original CROS algorithm (Baillie and Pilcher 1973). A *t*-value of 3.5 or over is

usually indicative of a good match, although this is with the proviso that high *t*-values at the same relative or absolute position must be obtained from a range of independent sequences, and that satisfactory visual matching supports these positions.

All the measured sequences from this assemblage were compared with each other and any found to cross-match were combined to form a site master curve. These and any remaining unmatched ring sequences were tested against a range of reference chronologies, using the same matching criteria: high *t*-values replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This *tpq* may be many decades prior to the real felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 55 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Hillam *et al* 1987). Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the structure, or stratigraphic phase from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers before the dendrochronological dates given here can be reliably interpreted.

Results

A total of eight timbers were selected as suitable for sampling (Table 1). The samples were numbered **1-8** inclusive. The tree-ring sequences from these samples were then measured. The resultant series were initially compared with each other. Two sequences (from samples **7** and **8**) matched together to form an internally consistent group (Table 2). A mean chronology was calculated for this group giving a 166-year two-timber mean named EFH95T2. This mean excluded the last 53 sapwood rings from sample **8** which were poorly preserved and compressed and hence unlikely to reflect original ring-width patterns. This mean and the individual sequences were then compared with dated reference chronologies from throughout the British Isles and northern Europe. Table 3 shows the correlation between this mean sequence and a single sequence from sample **1** with regional reference chronologies and site masters at the dating position identified for each sequence, AD 963-1128 and AD 1107-1224 respectively. Table 4 lists the mean chronologies and the dated timbers are indicated graphically in Figure 2.

Interpretation

The last surviving ring of sample **1**, derived from an off-cut from a radially split oak plank associated with

a group of driven stakes (context 292), dated to AD 1224. Given the absence of the heartwood/sapwood boundary, this indicates a *terminus post quem* for the felling of the timber's parent tree of AD 1234. As its archaeological context has been dated to the fourteenth century on other, archaeological grounds, it seems likely that the off-cut represents reuse of old timber.

It has been suggested that timbers derived from context 1829, a non-structural ash layer, including a radially split oak fragment from which sample **7** was taken, could be furniture fragments. The dating of this sample's last surviving ring to AD 1119, gives a *terminus post quem* for the felling of the timber's parent tree of AD 1129. This could again indicate the presence of discarded, old timber as its archaeological context is assigned to phase 6 and dated to the thirteenth or fourteenth century.

Sample **8** is derived from an *in situ* post located just to the north of a roadside ditch and provisionally assigned to phase 5/6 dating to the thirteenth or fourteenth century. The timber retained 63 sapwood rings - an unusually large number given usual sapwood estimates of 10-55 rings - and probable bark edge indicating a probable felling date of AD 1181.

Acknowledgements

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References

Alexander, M, 1998 *Excavations at Forehill, Ely, Cambridgeshire. Post-excavation Assessment and Updated Project Design*, Cambridge Archaeol Unit

Baggs, A, 1995 *47 Forehill, Ely, Cambridgeshire. A Historical Analysis,* Cambridge Historic Buildings Group

Baillie, M G L, and Pilcher, J R, 1973 A simple crossdating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7-14

Brown, D, 1993 Dendrochronological analysis, in *A Medieval Industrial Complex and its Landscape: the Metalworking Watermills and Workshops of Bordesley Abbey* (G G Astill), CBA Res Rep, **92**, 242-5

English Heritage, 1998 *Dendrochronology: guidelines on producing and interpreting dendrochronological dates*, London

Groves, C, 1992 Tree-ring analysis of timbers, in *Excavations at 33-35 Eastgate, Beverley, 1983-86* (D H Evans and D G Tomlinson), *Sheffield Excavation Rep*, **3**, 256-65

Groves, C, 1993 *Dendrochronological analysis of timbers from The Lanes, Carlisle, Cumbria, 1978-82: Volume 1*, Anc Mon Lab Rep, **21/93**

Groves, C, and Hillam, J, 1985 *Beverley: Dyer Lane 1982, Dendrochronology,* Anc Mon Lab Rep, **4691**

Groves, C, and Hillam, J, 1987 *Tree-ring analysis of timbers from Swan Lane, City of London, 1981*, Anc Mon Lab Rep, **30/87**

Groves, C, and Tyers, I, 1992 *Wasdale Beck Logboat: Tree-ring analysis*, unpubl rep

Hibberd, H, 1992 *Dendrochronology Spot-dates; Vintry and Vintners, City of London*, MoL Dendro Rep, **DEN09/92**

Hillam, J, 1992a Tree-ring analysis of oak timbers, in *Aspects of Saxo-Norman London: III. The Bridgehead and Billingsgate to 1200* (eds K Steedman, T Dyson, and J Schofield), LAMAS special paper **14**, 143-73

Hillam, J, 1992b *Tree-ring analysis of timbers from The Brooks, Winchester, Hampshire*, Anc Mon Lab Rep, **69/92**

Hillam, J, and Groves, C, 1993 *Tree-ring analysis of oak timbers from the South Range roof of the Blackfriars Priory, Gloucester, Gloucestershire*, Anc Mon Lab Rep, **26/93**

Hillam, J, Morgan, R A, and Tyers, I, 1987 Sapwood estimates and the dating of short ring sequences, in *Applications of tree-ring studies: current research in dendrochronology and related areas* (ed R G W Ward), BAR Int Ser, **333**, 165-85

Howard, R E, Laxton, R R, and Litton, C D, 1997 *Tree-ring analysis of timbers from Westwick Cottage, Westwick Row, Leverstock Green, Hemel Hempstead, Hertfordshire,* Anc Mon Lab Rep, **77/97**

Laxton, R R, and Litton, C D, 1988 *An East Midlands master tree-ring chronology and its use for dating vernacular buildings*, University of Nottingham, Dept of Classical and Archaeological Studies, Monograph Series, **III**

Laxton, R R, and Litton, C D, 1989 Construction of a Kent master chronological sequence for oak, 1158-1540 AD, *Med Archaeol*, **33**, 90-8

Munro, M A R, 1984 An improved algorithm for crossdating tree-ring series, *Tree Ring Bulletin*, **44**, 17-27

Nayling, N, 1991 *Dendrochronology report on timbers from Thames Exchange, City of London*, MoL Dendro Rep, **DEN07/91**

Nicholson, R, and Hillam, J, 1987 Tree-ring analysis of medieval oak timbers from Dundas Wharf, Redcliffe Street, Bristol, *Trans Bristol Gloucs Archaeol Soc*, **105**, 133-45

Tyers, I, 1991 *Interim Dendrochronology Report on timbers from the Horsefair site, Kingston*, MoL Dendro Rep, **DEN06/91**

Tyers, I, 1996 *Tree-ring analysis of the tower of St John The Baptist Church, Mamble, Hereford and Worcester*, Anc Mon Lab Rep, **22/96**

Tyers, I, 1997a *Dendro for Windows program guide*, ARCUS Rep, **340**

Tyers, I, 1997b *Updated dendrochronology archive for MoLAS Project 53a Medieval London Bridge*, ARCUS Rep, **257**

Tyers, I, 1999a *Tree-ring analysis of oak timbers from Peterborough Cathedral, Peterborough, Cambridgeshire: Structural timbers from the Nave Roof and North-West Portico*, Anc Mon Lab Rep, **9/99**

Tyers, I, 1999b *Tree-ring analysis of the bell tower of the Church of St Mary, Pembridge, Herefordshire*, Anc Mon Lab Rep, **1/99**

Tyers, I, and Hibberd, H, 1993 *Dendrochronology, wood identification, and wattle analysis for the Fleet Valley developers report*, MoLAS Dendro Rep, **DEN03/93**

Figure 1 Bar diagram showing the chronological positions of the three dated timbers. The felling period for each sequence is also shown and sapwood is shaded.

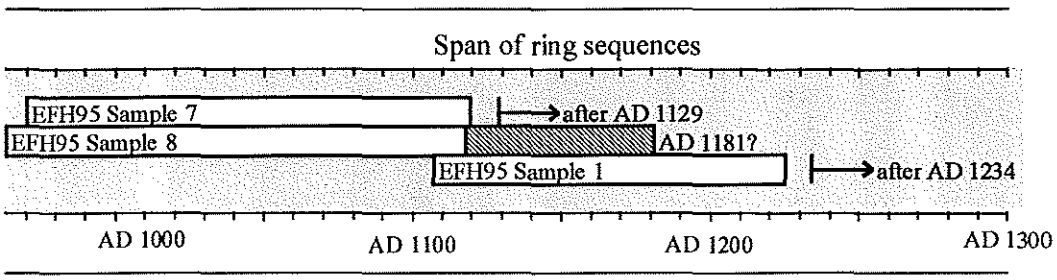

Table 1

List of samples

Sample No	Origin of sample	Cross-section size (mm)	Cross-section of tree	Total rings	Sapwood rings	ARW mm/year	Date of sequence	Felling period
1	Context 0292	134 x 32	Radial	118	-	1.10	AD 1107-1224	after AD 1234
2	Context 1069	91 x 40	Radial	62	?h/s	1.37	undated	
3	Context 1097	135 x 40	Radial	58	-	2.22	undated	
4	Context 1098	140 x 70	Radial	67	-	2.02	undated	
5	Context 1239	65 x 62	Radial	65	-	1.14	undated	
6	Context 1240	115 x 65	Radial	67	-	1.83	undated	
7	Context 1829	200 x 20	Quarter	150	-	1.28	AD 970-1119	after AD 1129
8	Context 1851	295 x 160	Quarter	219	63+?b	0.68	AD 963-1181	AD 1181?

All samples are oak (*Quercus* spp.)
Total rings = all measured rings
Sapwood rings: ?h/s possible heartwood/sapwood boundary, ?b = possible bark-edge
ARW = average ring width of the measured rings

Table 2

t-value matrix for the timbers forming the chronology EFH95T2.
KEY: - = *t*-values under 3.0, \ = no overlap

	7
8	4.65

Table 3

a) Dating the mean sequence EFH95T2, AD 963-AD 1128 inclusive. *t*-values with independent reference chronologies

Area	Reference chronology	*t*-values
East Midlands	East Midlands (Laxton and Litton 1988)	9.31
Cambridgeshire	Peterborough Cathedral (Tyers 1999a)	7.40
London	Billingsgate (Hillam 1992a)	5.00
London	Bull Wharf (Tyers pers comm)	5.69
London	Fennings Wharf (Tyers 1997b)	5.16
London	Thames Exchange (Nayling 1991)	5.11
London	Fleet Valley (Tyers and Hibberd 1993)	4.94
London	Vintry (Hibberd 1992)	5.21
Hereford and Worcester	Bordesley Abbey (Brown 1993)	4.17
Hereford and Worcester	Pembridge belltower (Tyers 1999b)	5.15
Cumbria	Carlisle, The Lanes (Groves 1993)	4.41
Hampshire	Winchester, The Brooks (Hillam 1992b)	4.65
Bristol	Bristol, Dundas Wharf (Nicholson and Hillam 1987)	5.90
Humberside	Beverley; Dyer Lane (Groves and Hillam 1985)	8.10
Humberside	Beverley; Eastgate (Groves 1992)	7.28

b) Dating the sequence EFH95_1 (sample **1**), AD 1107-1224 inclusive. *t*-values with independent reference chronologies

Area	Reference chronology	*t*-values
Hertfordshire	Leverstock Green cottage (Howard *et al* 1997)	4.86
Cambridgeshire	Peterborough Cathedral (Tyers 1999a)	3.90
London	Billingsgate BIG82 (Hillam 1992a)	4.20
London	Kingston Horsefair (Tyers 1991)	4.26
London	Swan Lane (Groves and Hillam 1987)	4.34
London	Fleet Valley (Tyers and Hibberd 1993)	4.93
Northamptonshire	Guesten Hall (Pilcher and Brown pers comm)	6.77
Hereford and Worcester	Mamble Church (Tyers 1996)	4.37
Cumbria	Wasdale Beck log boat (Groves and Tyers 1992)	4.75
Kent	Kent 88 master sequence (Laxton and Litton 1989)	4.52
Gloucester	Gloucester Blackfriars (Hillam and Groves 1993)	4.75

Table 4

Ring-width data from site master s a) EFH95T2, b) EFH95_1 dated to AD 963-AD 1128 and AD 1107-1224 inclusive respectively.

a) EFH95T2

Date	Ring widths (0.01mm)										No of samples									
AD 963			59	61	62	74	96	113	86	105			1	1	1	1	1	1	1	2
	113	93	127	135	142	160	164	97	142	124	2	2	2	2	2	2	2	2	2	2
	106	124	127	85	142	130	135	145	127	73	2	2	2	2	2	2	2	2	2	2
	135	126	142	151	141	130	146	161	135	134	2	2	2	2	2	2	2	2	2	2
AD 1001	96	119	147	151	130	118	138	145	137	128	2	2	2	2	2	2	2	2	2	2
	116	113	146	96	156	142	132	62	116	118	2	2	2	2	2	2	2	2	2	2
	113	156	161	127	116	91	107	140	125	140	2	2	2	2	2	2	2	2	2	2
	165	135	121	123	97	87	121	101	94	86	2	2	2	2	2	2	2	2	2	2
	111	135	85	70	120	113	125	102	128	119	2	2	2	2	2	2	2	2	2	2
AD 1051	98	78	66	71	117	120	109	139	101	86	2	2	2	2	2	2	2	2	2	2
	74	67	61	55	50	79	96	76	86	92	2	2	2	2	2	2	2	2	2	2
	82	82	79	66	116	80	84	93	55	75	2	2	2	2	2	2	2	2	2	2
	52	64	76	64	75	65	56	56	70	54	2	2	2	2	2	2	2	2	2	2
	62	62	48	62	67	69	72	82	74	63	2	2	2	2	2	2	2	2	2	2
AD 1101	51	49	70	63	75	78	74	90	78	56	2	2	2	2	2	2	2	2	2	2
	47	70	96	106	99	78	99	94	67	79	2	2	2	2	2	2	2	2	2	1
	104	117	171	139	186	54	35	60			1	1	1	1	1	1	1	1		

b) EFH95_1

Date	Ring widths (0.01mm)									
AD 1107							123	122	120	100
	128	120	108	99	110	114	98	159	116	148
	106	143	124	146	125	123	174	163	141	103
	110	151	152	157	143	92	82	118	124	136
	125	110	130	136	156	136	106	143	148	91
AD 1151	107	101	131	112	122	128	105	97	104	123
	96	93	94	97	108	110	89	107	105	91
	123	108	110	120	110	107	95	108	113	102
	109	100	121	103	123	114	81	81	101	135
	121	77	84	118	93	121	89	91	77	85
AD 1201	100	88	107	103	103	108	95	92	89	96
	100	91	85	74	82	82	81	93	83	91
	86	99	83	94						