RESEARCH DEPARTMENT REPORT SERIES no. 75-2010 ISSN 1749-8775

DERLYNGHAM TOWER, THE GREAT HOSPITAL, BISHOPGATE, NORWICH, NORFOLK
TREE-RING ANALYSIS OF TIMBERS

SCIENTIFIC DATING REPORT

Martin Bridge

ARCHAEOLOGICAL SCIENCE

ENGLISH HERITAGE

Research Department Report Series 75-2010

DERLYNGHAM TOWER,
THE GREAT HOSPITAL,
BISHOPGATE,
NORWICH,
NORFOLK

TREE-RING ANALYSIS OF TIMBERS

Dr M C Bridge

NGR: TG 23701 09013

ISSN 1749-8775

The Research Department Report Series incorporates reports from all the specialist teams within the English Heritage Research Department: Archaeological Science; Archaeological Archives; Historic Interiors Research and Conservation; Archaeological Projects; Aerial Survey and Investigation; Archaeological Survey and Investigation; Architectural Investigation; Imaging, Graphics and Survey, and the Survey of London. It replaces the former Centre for Archaeology Reports Series, the Archaeological Investigation Report Series and the Architectural Investigation Report Series.
Many of these are interim reports which make available the results of specialist investigations in advance of full publication. They are not usually subject to external refereeing, and their conclusions may sometimes have to be modified in the light of information not available at the time of the investigation. Where no final project report is available, readers must consult the author before citing these reports in any publication. Opinions expressed in Research Department reports are those of the author(s) and are not necessarily those of English Heritage.

Requests for further hard copies, after the initial print run, can be made by emailing:
Res.reports@english-heritage.org.uk
or by writing to:
English Heritage, Fort Cumberland, Fort Cumberland Road, Eastney, Portsmouth PO4 9LD
Please note that a charge will be made to cover printing and postage.

SUMMARY
Samples were taken from nine timbers in two floors of the tower. One timber appeared to have been reused, but the others were considered primary and *in situ*. Two groups of timbers were formed, each containing three timbers that matched each other well, but neither these, nor any of the individual series gave consistent acceptable matches with dated reference material, and all the timbers remain undated.

CONTRIBUTOR
Dr M C Bridge

ACKNOWLEDGEMENTS
The sampling and analysis of these timbers was funded by English Heritage, and requested by Ian Harper, Historic Buildings Architect for English Heritage. I would like to thank Terry Norton (architect) for his assistance on site. Cathy Tyers (Sheffield University) and John Meadows (EH) are thanked for their comments on an earlier draft of this report.

ARCHIVE LOCATION
Norfolk Historic Environment Record
Norfolk Landscape Archaeology
Union House
Gressenhall
Dereham NR20 4DR

DATE OF INVESTIGATION
2006

CONTACT DETAILS
Dr M C Bridge
UCL Institute of Archaeology, 31–34 Gordon Square, London WC1H 0PY
E-mail: martin.bridge@ucl.ac.uk

CONTENTS

INTRODUCTION

This tower forms part of the Great Hospital complex in Norwich, founded in AD 1249, which consists of several late medieval buildings (Figs 1 and 2). Some of these buildings were the subject of an earlier dendrochronological report (Bridge 2003). The south-west tower, also known as the Derlyngham Tower, is known to have been erected after AD 1375, using money left in a will by John de Derlingham for the construction of a new bell tower. John was Master at the hospital from AD 1372–6. The tower has diagonal buttresses with ashlar facings. There is a moulded stone plinth, and a stone string course underlines the bell stage, the main tower being of flint with red brick parapets. The pointed two-light windows of the bell stage contain simple Perpendicular tracery, with cusped heads surmounted by twinned mouchettes. Tree-ring dating of timbers, mostly thought to be primary and *in situ*, within the tower was requested in order to inform grant-aided repairs being carried out.

METHODOLOGY

The timbers were originally assessed and sampling carried out in March 2006. Cores were taken from *in-situ* timbers from the tower floors using a 15mm auger attached to an electric drill. The cores were glued to wooden laths, labelled, and stored for subsequent analysis.

The cores were polished on a belt sander using 80 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a combination of visual matching and a process of qualified statistical comparison by computer. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, and higher, and for these to be well-replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values however do not preclude same-tree derivation.

Figure 1. Map to show the location of Derlyngham Tower, Norwich (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

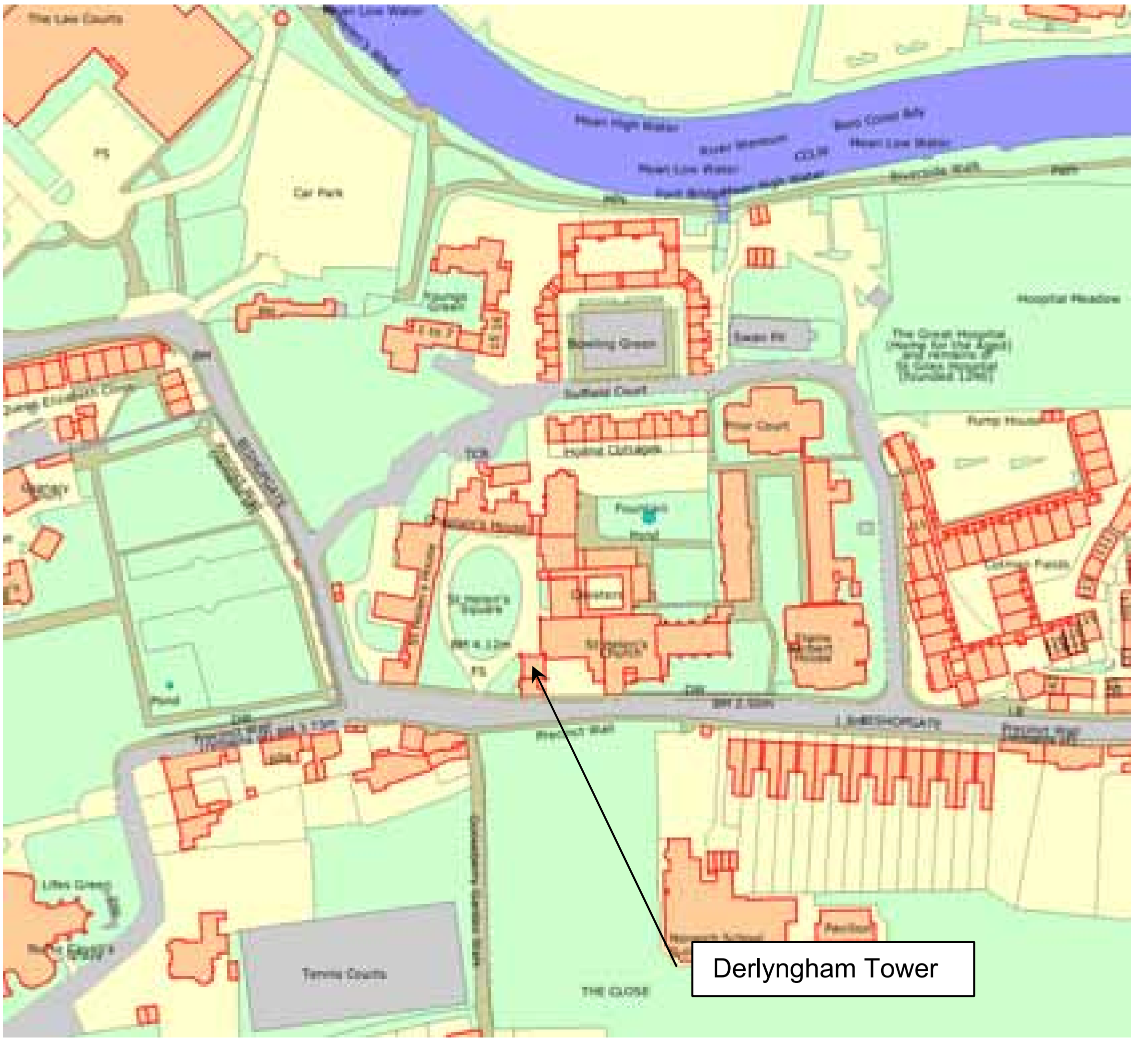


Figure 2. Map showing the location of the tower within its immediate environs (based on the Ordnance Survey map with permission of the Controller of Her Majesty's Stationery Office, ©Crown Copyright)

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or felling date range, is ascribed where possible. With samples which have sapwood complete to the underside of, or including bark, this process is relatively straightforward. Depending on the completeness of the final ring, ie if it has only the spring vessels or early wood formed, or the latewood or summer growth, a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. The number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, which in this area is 9–41 rings (Miles 1997). It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

RESULTS AND DISCUSSION

All the timbers sampled were oak (*Quercus* spp.) Basic information about the samples taken is presented in Table 1, and sketches showing their approximate positions are shown in Figs 3 and 4. Sample NGHT06 was thought to be a reused timber, since it exhibited a number of mortices and a notch which had no relationship with its current position, but it was sampled as it was thought possibly to be reused and reset from within the Tower. It also contained fewer rings than the other samples, and was not measured, as its ring sequence was considered too short for reliable analysis.

Table 1. Details of the samples taken for dendrochronology

Sample	Description	Rings	Sapwood	Mean ring-width (mm)	Date of measured sequence (AD)
NGHT01	West beam supporting first floor	86	h/s	1.10	undated
NGHT02	East beam supporting first floor	115	21½C	1.19	undated
Second floor					
NGHT03	East inner beam	69	h/s	2.41	undated
NGHT04	East outer beam	88	h/s	1.66	undated
NGHT05	West inner beam	95	22¼C	1.97	undated
NGHT06	West outer beam (reused?)	<45	h/s	NM	undated
NGHT07	South interrupted beam	74	-	1.77	undated
NGHT08	North bell opening trimmer	46	h/s	1.58	undated
NGHT09	South bell opening trimmer	79	h/s	1.86	undated

h/s = heartwood-sapwood boundary; C = complete sapwood, winter felled; ¼C = complete sapwood, felled the following spring; ½C = complete sapwood, felled the following summer; NM = not measured

Some cross-matching was found between the individual sequences:

- NGHT01 *v* NGHT02, $t = 5.2$ with 86 rings overlap
- NGHT03 *v* NGHT05, $t = 10.7$ with 69 years overlap (indicating potentially the same tree)
- NGHT09 *v* NGHT07, $t = 6.1$ with 73 years overlap
- NGHT04 *v* NGHT05, $t = 4.7$ with 75 years overlap

There was also internally consistent matches between two groups, each of three timbers, as shown in tables 2a and 2b below.

Table 2a and 2b. Cross-matching between samples, the values given are t-values with the number of years of overlap in brackets below

Sample	NGHT04	NGHT05
NGHT03	3.8 (69)	10.7 (69)
NGHT04		4.7 (75)

Sample	NGHT08	NGHT09
NGHT07	10.0 (46)	6.1 (73)
NGHT08		5.4 (46)

New sequences were made combining these tree-ring series at the overlap indicated statistically, but none of these new sequences, nor any of the individual sequences, gave acceptable consistent matches with the database of reference material. This is unusual for sequences of this length with no obvious signs of management or other stresses. Whilst the dendrochronology suggests that some of the timbers came from the same source, it was not possible to give evidence of dating of the timbers. This contrasts with the success in dating other buildings within the complex shown previously (Bridge 2003). This poor intra-site cross-matching and lack of dating is somewhat more common in Norfolk than elsewhere.

The data for the measured sequences can be found in the Appendix.

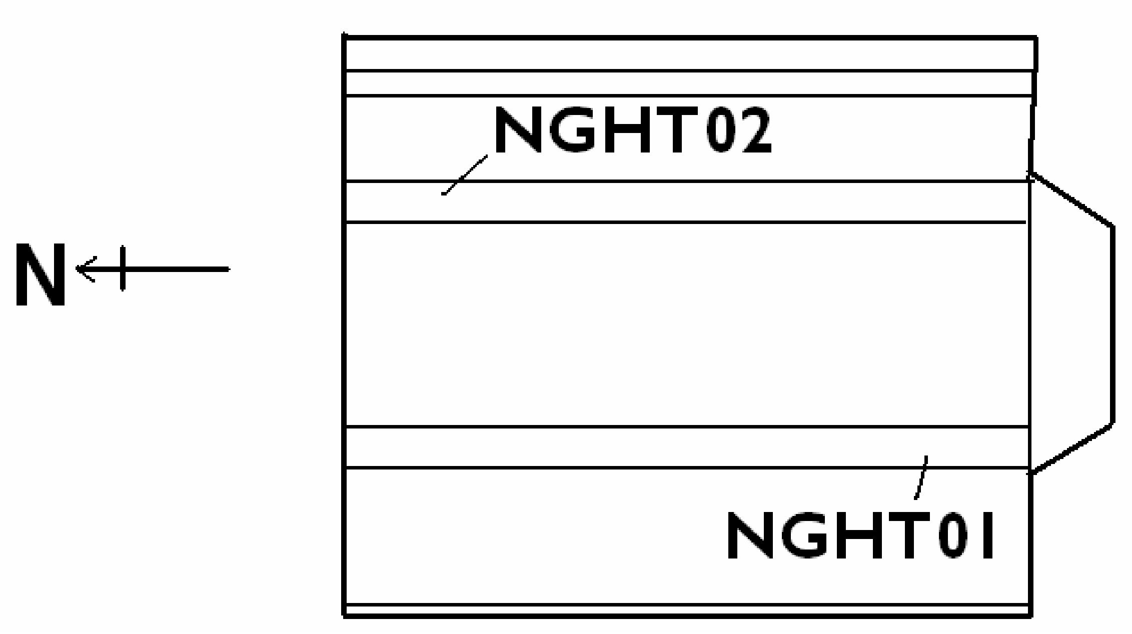


Figure 3. Field sketch of the first floor showing the timbers sampled

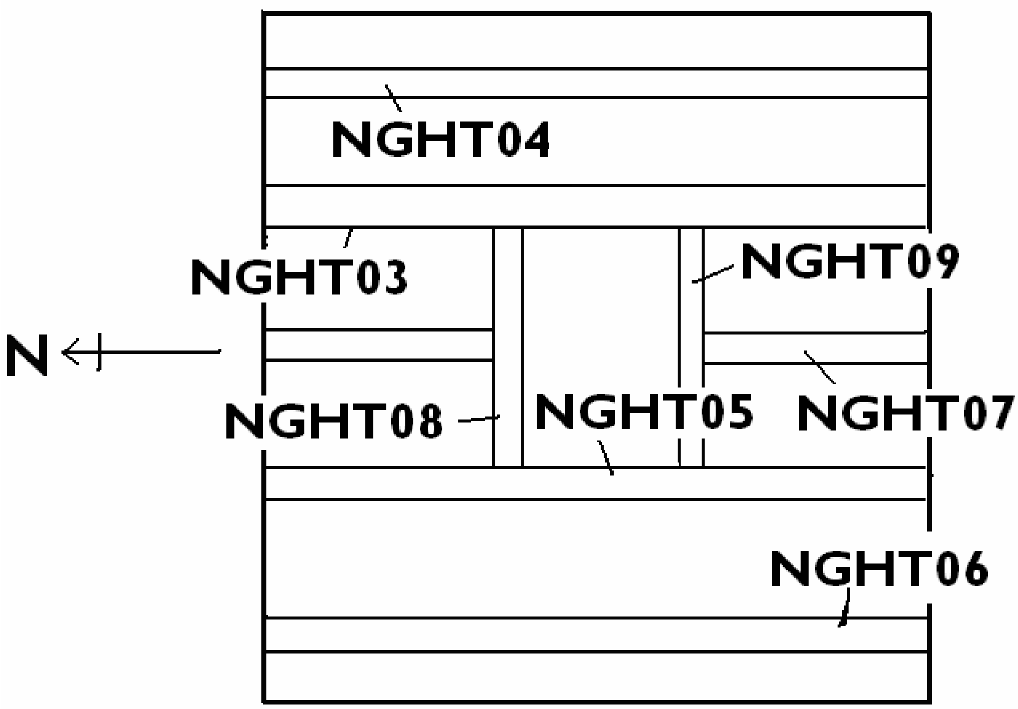


Figure 4. Field sketch of the second floor showing the timbers sampled

BIBLIOGRAPHY

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

Bridge, M C, 2003 *Tree-ring analysis of timbers from the Great Hospital, Bishopgate, Norwich, Norfolk*, Centre for Archaeol Rep, 10/2003

Miles, D H, 1997 The interpretation, presentation, and use of tree-ring dates, *Vernacular Architect*, 28, 40–56

RCHM(E) report (undated) *The Hospital of St Giles (Great Hospital), Bishopgate*

Tyers, I, 2004 *Dendro for Windows Program Guide 3rd edn*, ARCUS Report, 500b

APPENDIX

Ring width values (0.01mm) for the sequences measured

NGHT01

159	218	290	200	167	146	199	189	185	167
211	157	186	160	130	75	52	44	45	49
83	82	97	100	134	118	85	80	104	76
119	146	159	133	140	70	105	109	109	126
91	85	69	113	151	95	84	93	113	83
123	177	149	127	136	169	140	88	100	72
56	55	63	65	94	78	79	88	94	63
84	67	88	102	87	94	72	58	58	91
95	81	67	61	72	98				

NGHT02

222	243	206	470	491	285	226	184	263	218
197	155	136	115	119	93	136	128	134	184
172	98	60	62	54	50	48	46	86	71
75	74	81	83	67	130	159	129	151	147
235	152	139	118	128	159	137	142	99	78
64	62	89	76	65	60	62	61	94	99
93	86	96	116	103	71	76	67	45	50
52	61	91	94	102	76	75	76	87	92
96	103	83	78	65	61	53	99	115	98
89	87	87	115	127	123	146	94	109	134
171	132	117	122	148	128	166	166	107	105
107	109	121	107	96					

NGHT03

363	254	313	397	389	403	352	288	167	248
306	344	443	449	461	253	268	168	310	317
295	308	288	326	278	324	270	197	211	265
345	277	166	151	155	171	211	210	122	115
121	203	186	218	203	275	178	117	85	176
283	273	149	151	141	162	122	266	183	147
226	206	295	207	224	159	184	110	188	

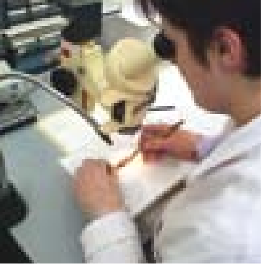
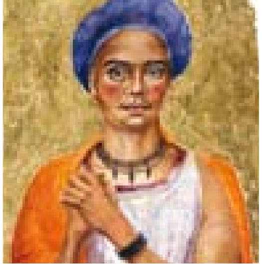
NGHT04

338	328	347	231	338	391	271	298	297	373
296	304	278	325	269	247	214	232	251	255
272	321	330	214	205	222	175	177	170	236
144	146	142	135	187	119	152	146	140	104
128	98	84	86	73	152	158	128	68	74
104	107	117	82	79	90	94	54	68	69
93	92	74	77	76	129	138	143	103	82
96	98	98	128	58	74	99	77	84	115
101	145	118	167	122	143	155	148		

NGHT05

414	351	263	234	274	377	474	474	499	418
277	258	243	253	350	304	396	235	261	186
266	284	295	281	258	234	251	278	243	197
199	162	211	197	156	128	124	149	193	174
113	129	123	181	191	211	141	211	175	116
103	139	218	198	108	117	137	162	153	178
140	102	146	180	215	148	153	117	132	128
206	148	116	130	122	180	226	173	127	113
146	176	166	139	134	113	124	111	96	93

106	99	91	112	93					
NGHT07									
227	261	235	236	265	275	314	256	361	258
309	268	272	259	275	260	209	227	194	206
154	190	169	213	163	208	136	103	127	122
145	180	143	238	170	157	120	147	223	193
215	154	133	184	214	211	164	132	93	124
89	123	149	107	92	89	89	152	188	155
106	113	128	158	141	113	138	104	122	158
128	127	142	67						
NGHT08									
161	166	150	168	161	153	213	164	209	185
180	125	176	204	213	205	180	163	204	213
232	182	137	92	123	105	152	182	122	117
135	98	151	214	166	126	115	136	192	153
116	150	95	107	128	135				
NGHT09									
331	284	354	272	313	387	273	286	212	228
247	285	283	226	307	261	306	268	295	303
248	258	186	158	187	275	139	132	127	200
171	228	214	174	163	143	147	245	180	225
205	148	105	161	197	219	235	153	135	133
196	215	179	148	113	122	86	147	131	119
85	71	71	66	123	67	106	68	106	112
110	107	106	111	131	150	130	142	149	



ENGLISH HERITAGE RESEARCH DEPARTMENT

English Heritage undertakes and commissions research into the historic environment, and the issues that affect its condition and survival, in order to provide the understanding necessary for informed policy and decision making, for sustainable management, and to promote the widest access, appreciation and enjoyment of our heritage.

The Research Department provides English Heritage with this capacity in the fields of buildings history, archaeology, and landscape history. It brings together seven teams with complementary investigative and analytical skills to provide integrated research expertise across the range of the historic environment. These are:

- *Aerial Survey and Investigation*
- *Archaeological Projects (excavation)*
- *Archaeological Science*
- *Archaeological Survey and Investigation (landscape analysis)*
- *Architectural Investigation*
- *Imaging, Graphics and Survey (including measured and metric survey, and photography)*
- *Survey of London*

The Research Department undertakes a wide range of investigative and analytical projects, and provides quality assurance and management support for externally-commissioned research. We aim for innovative work of the highest quality which will set agendas and standards for the historic environment sector. In support of this, and to build capacity and promote best practice in the sector, we also publish guidance and provide advice and training. We support outreach and education activities and build these in to our projects and programmes wherever possible.

We make the results of our work available through the Research Department Report Series, and through journal publications and monographs. Our publication Research News, which appears three times a year, aims to keep our partners within and outside English Heritage up-to-date with our projects and activities. A full list of Research Department Reports, with abstracts and information on how to obtain copies, may be found on www.english-heritage.org.uk/researchreports

For further information visit www.english-heritage.org.uk

ENGLISH HERITAGE