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ST MARY'S CHURCH, BEESTON-NEXT-MILEHAM, NORFOLK
TREE-RING ANALYSIS OF TIMBERS FROM THE NAVE ROOF

SCIENTIFIC DATING REPORT

Dr Martin Bridge

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Tree-Ring Analysis of Timbers from the nave roof at St Mary's Church, Beeston-next-Mileham, Norfolk

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Summary

Twenty samples were taken from various timbers of the nave roof, predominantly principal rafters and hammerbeams. Measurements from one group of seven timbers matched each other and were combined into a single site master chronology, **BEESTON1**. Two further timbers matched each other and were combined into a second site master. Neither of these sequences, nor any of the other measured but ungrouped samples, could be dated, even though one series contained 222 rings.

Keywords
Dendrochronology
Standing Building

Author's Address
Institute of Archaeology, University College London, 31–34 Gordon Square, London, WC1H 0PY.
Tel: 020 7679 1540. Email: martin.bridge@ucl.ac.uk

Introduction

The grade-I listed medieval Beeston-next-Mileham parish church (NGR TF 894 153; Fig 1) was receiving grant aid towards repairs of the nave roof at the time of this investigation. Pevsner (1961) describes the roof as "a special pleasure". The hammerbeams are supported on very tall wall-posts with fine carved figures (Figure 2), and the hammerbeams are connected by shallow longitudinal arched braces. These alternate with short horizontal pieces with figures against them, supporting principals. There are four bays and the roof is thought to be of fifteenth-century date. Tree-ring analysis of this roof was requested to inform these ongoing repairs.

Figure 1: Map showing the location of St Mary's Church, Beeston-next-Mileham (circled).

Methodology

The site was visited in July 2006 and again in March 2007. In the initial assessment, accessible oak timbers with more than 50 rings and traces of sapwood were sought, although slightly shorter sequences are sometimes sampled if little other material is available. Those building timbers judged to be potentially useful were cored 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 prepared for measuring by sanding, using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary, eg where bands of narrow rings occurred, was done manually. Suitable samples had their tree-ring sequences measured to an accuracy of 0.01 mm, 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 and dating was accomplished 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 on a light table. This method provides a measure of quality control in identifying any errors in the measurements when the samples cross-match.

In comparing one sequence or site sequence against another, *t*-values over 3.5 are considered significant, although in reality it is common to find *t*-values of 4 and 5 which are demonstrably spurious because more than one matching position is indicated. For this reason, it is necessary to obtain some *t*-values of 5, 6, and higher, and for these to be well replicated with different, independent chronologies and with local and regional chronologies well represented, unless the timber is imported. Where two individual sequences match with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have been derived from the same parent tree.

When cross-matching between samples is found, their ring-width sequences are averaged to form an internal 'working' site mean sequence. Other samples may then be incorporated after comparison with this 'working' master until a final site sequence is established. This is then compared with a number of reference chronologies (multi-site chronologies from a region) and dated individual site masters in an attempt to date it. Individual long series which are not included in the site mean(s) are also compared with the database to see if they can be dated.

The dates thus obtained represent the time of formation of the measured rings in each sample. These dates require interpretation for the construction date of the phase under investigation to be determined. An important aspect of this interpretation is the estimate of the number of sapwood rings missing. The sapwood estimates used here are based on those proposed for this area by Miles (1997), in which 95% of oaks contain 9–41 rings. Where complete sapwood or bark is present, the exact date of tree felling may be determined

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the building. However, evidence suggests that, except in the reuse of timbers, construction in most historical periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

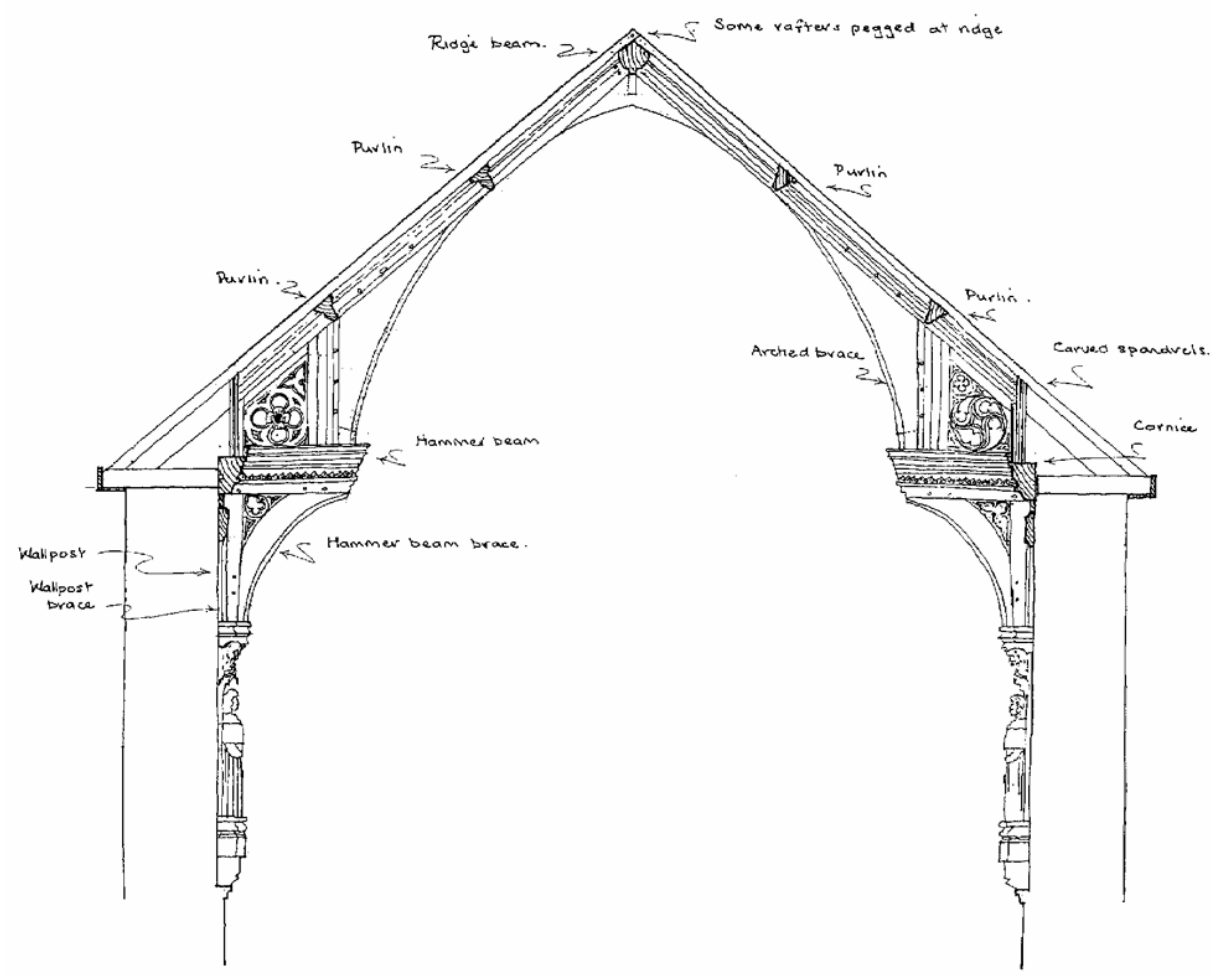

Figure 2: Section through a typical nave truss (truss 7), looking west. Adapted from an original drawing by Ruth Blackman

Results

Trusses were numbered from the east end, with the nine trusses forming four bays with intermediate divisions. A total of twelve cores was taken from various elements within the roof on the first visit. The subsequent failure of a site chronology to date led to a second cohort of eight samples being taken. Details of the locations and ring series are given in Table 1. Some cross-matching was found between the individual samples.

A group of seven timbers matched each other (Table 2) and were combined into a site master chronology, **BEESTON1**. This chronology failed to date. The relative positions of overlap of the series in the site master are shown in Figure 4. Samples **bee03** and **bee02** matched each other (t = 5.7 with 66 years overlap) and these two series were combined into a single sequence, **BEESTON2**, which did not match the first site series, and failed to date. The remaining individual series did not match either of the above two site series, or the independent reference material. The ring-width data for the two site series are presented in Table 3.

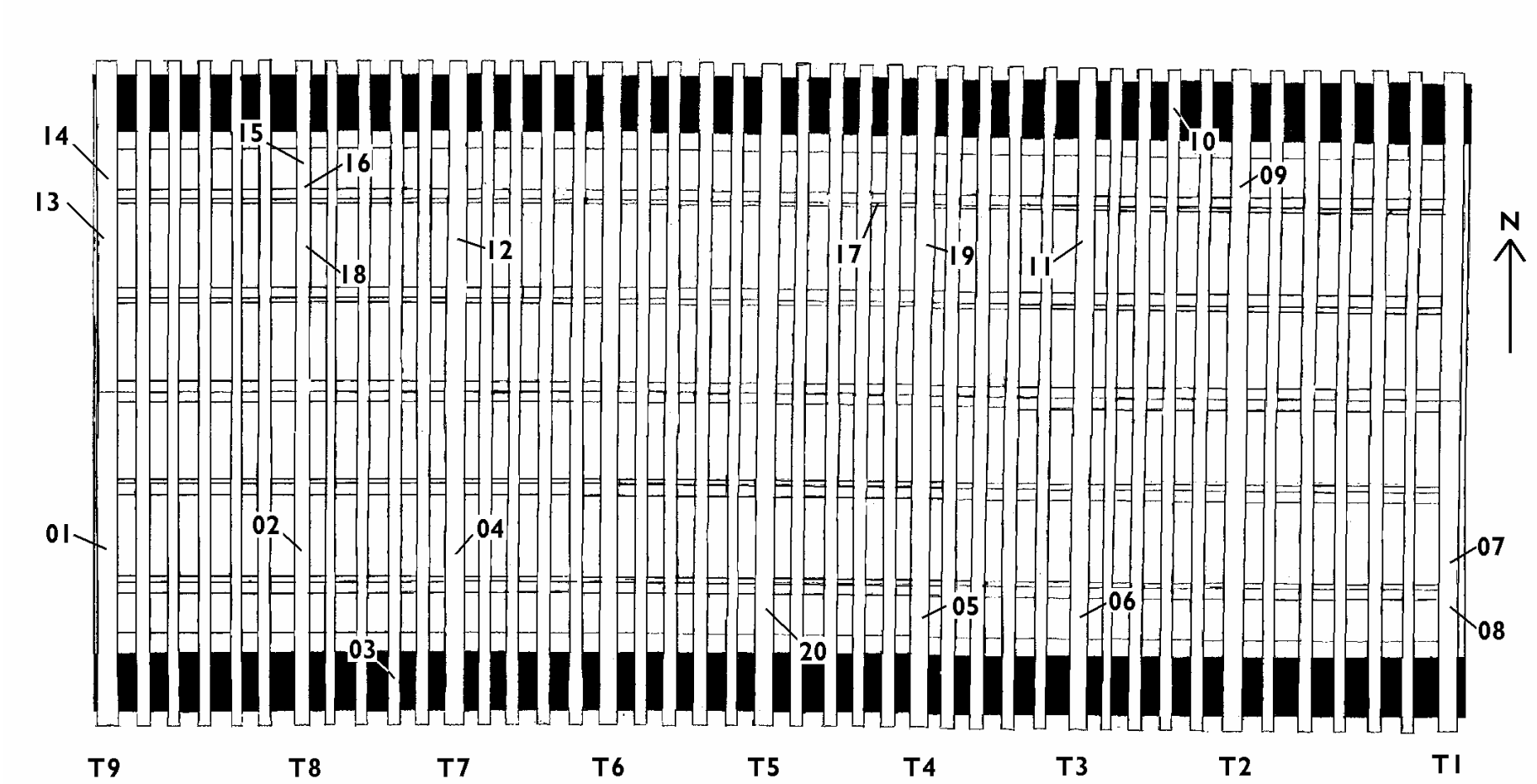

Figure 3: Plan of the nave roof showing the approximate locations of the samples taken for dendrochronology. Adapted from a drawing by Ruth Blackman

Table 1: Details of oak (*Quercus* spp.) timbers sampled from the nave roof of St Mary's Church, Beeston-next-Mileham, Norfolk

Sample Number	Timber and position	No of rings	Mean width (mm)	Mean sens (mm)	Sapwood complement
bee01	South principal rafter 9	<45	NM	-	H/S
bee02	South principal rafter 8	91	1.57	0.21	H/S
bee03	Sole plate 2 in bay T7–T8 south	66	2.12	0.19	H/S
bee04	South principal rafter 7	71	1.88	0.22	?H/S
bee05	Hammerbeam 4 south	64	2.54	0.17	?H/S
bee06	Hammerbeam 3 south	222	0.91	0.20	5
bee07	South principal rafter 1	77	2.08	0.15	21?C
bee08	Hammerbeam 1 south	66	2.75	0.22	4
bee09	Hammerbeam 2 north	46	2.20	0.24	-
bee10	Sole plate 2 in bay T2–T3 north	<45	NM	-	3
bee11	North principal rafter 3	62	2.20	0.21	1
bee12	North principal rafter 7	48	2.23	0.21	-
bee13	North principal rafter 9	49	3.26	0.16	-
bee14	Hammerbeam 9 north	<45	NM	-	-
bee15	North arch-brace truss 8	<45	NM	-	-
bee16	Hammer-post truss 8 north	<45	NM	-	-
bee17	North lower purlin, bay 4	43	2.97	0.17	H/S
bee18	North principal rafter 8	72	1.97	0.24	H/S
bee19	North principal rafter 4	61	2.01	0.17	H/S
bee20	Wall post 5 south	93	1.59	0.18	H/S

NM = not measured; H/S = heartwood/sapwood boundary; C = complete sapwood

Table 2: Cross-matching between series forming the site master **BEESTON1**

Sample	bee08	bee09	bee11	bee12	bee18	bee20
bee04	5.0	2.2	4.3	4.3	3.8	2.7
bee08		5.8	4.9	4.5	5.5	4.2
bee09			3.7	5.8	3.0	3.3
bee11				3.6	4.2	2.5
bee12					1.3	1.3
bee18						4.5

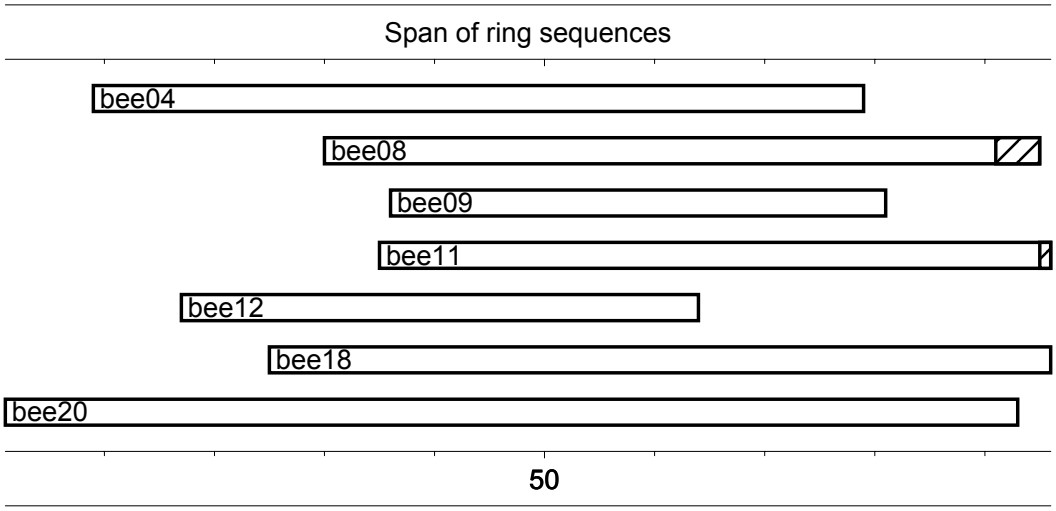

Figure 4: Bar chart showing the relative positions of overlap of the samples included in the undated site master, **BEESTON1**; the hatched parts of the bars represent sapwood rings

Interpretation and Discussion

Despite cross-matching between several of the samples, and an individual series in excess of 200 rings with no apparent unusual growth patterns, none of the series produced from the nave roof could be dated. The timbers may have come from an area with a unique microclimate, or could have been imported from outside Britain, although the latter idea seems somewhat unlikely. The reference material included material from the near Continent.

The one notable timber is **bee06**, which contained over two hundred rings. This is quite unlike any other timber in the roof and may represent a reused timber, or wood imported to the area.

Acknowledgements

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Table 3: Ring width data for the undated site chronologies **BEESTON1** and **BEESTON2**

Ring widths (0.01mm)	no of trees
BEESTON1	
150 240 253 253 239 210 212 260 284 251	1 1 1 1 1 1 1 1 2 2
254 120 134 136 279 269 268 190 254 295	2 2 2 2 2 2 3 3 3 3
275 279 249 242 252 295 287 186 190 208	3 3 3 3 4 4 4 4 4 5
170 164 246 223 275 261 176 125 201 241	5 5 5 5 6 7 7 7 7 7
226 209 215 190 119 123 136 193 235 192	7 7 7 7 7 7 7 7 7 7
144 163 165 143 160 218 228 210 197 194	7 7 7 7 7 7 7 7 7 7
157 190 221 191 223 225 256 293 218 237	7 7 7 7 6 6 6 6 6 6
231 178 190 240 180 185 203 255 278 283	6 6 6 6 6 6 6 6 6 5
206 192 143 197 201 159 122 200 218 210	5 4 4 4 4 4 4 4 4 4
222 201 213 229 249 201	4 4 4 3 3 2
BEESTON2	
482 450 435 465 426 562 449 333 187 199	1 1 1 1 1 1 1 1 1 1
123 87 72 82 75 100 53 79 84 93	1 1 1 1 1 1 1 1 1 1
77 75 77 93 255 233 261 172 133 225	1 1 1 1 2 2 2 2 2 2
198 163 174 155 184 148 138 202 177 228	2 2 2 2 2 2 2 2 2 2
211 188 198 161 187 155 162 171 149 128	2 2 2 2 2 2 2 2 2 2
145 165 159 174 188 250 194 118 103 158	2 2 2 2 2 2 2 2 2 2
169 203 212 244 167 174 199 210 173 144	2 2 2 2 2 2 2 2 2 2
139 169 244 149 143 180 126 149 166 206	2 2 2 2 2 2 2 2 2 2
158 118 137 145 136 131 179 145 190 156	2 2 2 2 2 2 2 2 2 2
159	1