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Summary

This work represents the dating of a second area of this building, the roof structure having been worked on previously (Bridge 1997a). A number of main floor beams and joists accessible in the cellar of the building were examined and found to be contemporaneous with the roof structure (felling period for the timbers AD 1554-1576). One joist was probably felled earlier than this and may be a re-used timber. The previous study of the roof structure found two groups of contemporaneous timbers, probably from two different sources, and the floor timbers can be divided into the same groups, resulting in two strengthened site chronologies covering the periods AD 1434-1542 and AD 1421-1544.

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TREE-RING ANALYSIS OF TIMBERS FROM THE BASEMENT, BRUCE CASTLE, TOTTENHAM, LONDON

Introduction

This report details the dendrochronological work carried out on timbers from the basement of Bruce Castle, Tottenham, Greater London (TQ334907) at the request of Andy Wittrick of English Heritage. The roof structure of this building has been investigated (Bridge 1997a). Access to the basement area was not convenient at that time and the work on the floor was therefore carried out nearly a year later. Dendrochronological analysis of the floor timbers was sought in order to establish whether or not they were contemporaneous with the roof timbers, and if so, whether they could further refine the felling dates obtained from the previous study, and hence more closely pinpoint the presumed date of construction (Wittrick 1997). The two dendrochronological studies form part of, and aid, a proposed much wider study of the building and its context, and will assist in any decision-making process for the development of the site.

Bruce Castle is a complex building. Fragmentary remains suggest an early courtyard house which has undergone a number of changes to arrive at its present form. Readers who wish to know more about the building are referred to the Royal Historic Buildings Report (Bradbeer 1995). Previous histories of the house mostly suggested that the present building developed from one built shortly after 1514 by Sir William Compton, although Pevsner (1951, 156) and Bradbeer (1995) both ascribe it to the late sixteenth century. A letter written in November 1568 by the Marquis of Winchester makes reference to the felling of trees on the estate and comments on "...how yt shall be employed.... myndinge a better house to be built on the ground" (in Bradbeer 1995).

The house was much altered and extended in the eighteenth century and the exterior of the building more closely resembles a building of this age. Parts of the building are open to the public as a museum run by the London Borough of Haringey.

Methodology

The building was visited in November 1997 and the floor timbers were assessed for their suitability for dendrochronological analysis. Primarily, one is looking for long sequences of rings, including sapwood which allows for a better estimate of the felling date of the trees used. Samples were removed using purpose-made 15mm diameter corers attached to an electric drill (a system developed from commercially available materials by Don Shewan at London Guildhall University). The resulting holes were plugged using softwood dowel glued into place with Evostick wood adhesive. Where possible, cores were taken along a radius through sapwood. Sample locations are indicated in Figure 1.

The cores were glued to wooden laths, labelled, and stored for subsequent analysis. They were prepared for measuring by sanding using an electric belt-sander with progressively finer grit papers down to 400 grit. Any further preparation necessary was done manually. Those samples with more than 50 annual rings had their sequences measured to an accuracy of 0.01 mm using a specially constructed system utilizing a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to an Atari desktop computer. The software used in measuring and subsequent analysis was written by Ian Tyers (pers comm 1992).

Suitably long ring sequences were plotted on translucent semi-log graph paper to allow visual comparisons to be made between sequences on a light table. This activity also acts as a measure of quality control in identifying any errors in the measurements. Statistical comparisons were

also made using standard dendrochronological software (Baillie and Pilcher 1973; Munro 1984). Usually, any internal site mean sequences produced are then compared with a number of reference chronologies, both multi-site chronologies from a region and dated individual site chronologies, in an attempt to date them. In this case however, the samples were first compared with the existing site masters (BRUCE1 and BRUCE2) constructed from the roof timbers (Bridge 1997a). The newly dated samples were then combined into the existing site means, where appropriate, to produce new better-replicated site means (BRUCE3 and BRUCE4). Now that the original two groups had been better replicated with the addition of the floor timbers, and as more site chronologies had become available since the last report was written, the question of the geographical origins of the timbers was reconsidered.

The *t*-values quoted below were derived from the original CROS program (Baillie and Pilcher 1973) in which *t*-values in excess of 3.5 are taken to be indicative of acceptable matching positions provided that they are supported by satisfactory visual matches (Baillie 1982, 82-5).

The dates thus obtained represent the time of formation of the rings on each sample; interpretation of these dates then has to be undertaken to relate these findings to the likely felling dates of the trees used and then relate these in turn to the construction date of the basement. Where only heartwood is found on the sample, one can make allowances for the expected number of sapwood rings on the tree and add this to the date of the last available ring to give a date after which felling took place; one does not know how many heartwood rings may be missing in these cases. Where the heartwood/sapwood boundary is found, or some sapwood rings survive, a felling date range can be calculated using the best available estimate of the number of sapwood rings likely to have been on the original tree (Baillie 1982). In this report, the sapwood estimate employed is a minimum of 10 rings and a maximum of 55 rings, representing the 95% confidence limits derived by Hillam *et al* (1987). Where bark is present, the year of felling will be the date of the last surviving ring.

The dates derived for the felling of the trees used in construction do not necessarily relate directly to the date of construction of the floor. Evidence suggests that, except in the re-use of timbers, construction in most historic periods took place within a very few years after felling (Salzman 1952; Hollstein 1965).

Results

Eleven oak (*Quercus* spp.) timbers were sampled from the basement, (Fig 1, Table 1). The heartwood/sapwood boundary was noted on a number of timbers at the time of sampling. The samples were cross-matched with each other and with BRUCE 1 and BRUCE 2, the two chronologies produced from the roof timbers, and this succeeded in dating nine of them (Table 1).

The two groups found in the roof timbers have been maintained, and the floor timbers assigned to the most appropriate group indicated by the level of crossmatching (Table 2). As a result, two timbers, BCB04 and BCB05 were added to BRUCE 1 to form a new chronology - BRUCE 3, and six timbers (BCB01, BCB02, BCB06, BCB09, BCB10, and BCB11) were added to BRUCE 2 to form a new chronology - BRUCE 4 (Table 4). Whilst these two chronologies did not match well with each other ($t = 2.7$ with 109 years of overlap) each new chronology gave generally stronger matches than the original BRUCE 1 and BRUCE 2 chronologies with a range of reference and site chronologies (Table 3). In several cases, each Bruce Castle chronology crossdated well with a third reference or site chronology, despite their poor crossmatching with each other.

Figure 1: Drawing to show the timbers sampled from the floor of the principal southern range of Bruce Castle, Tottenham, London

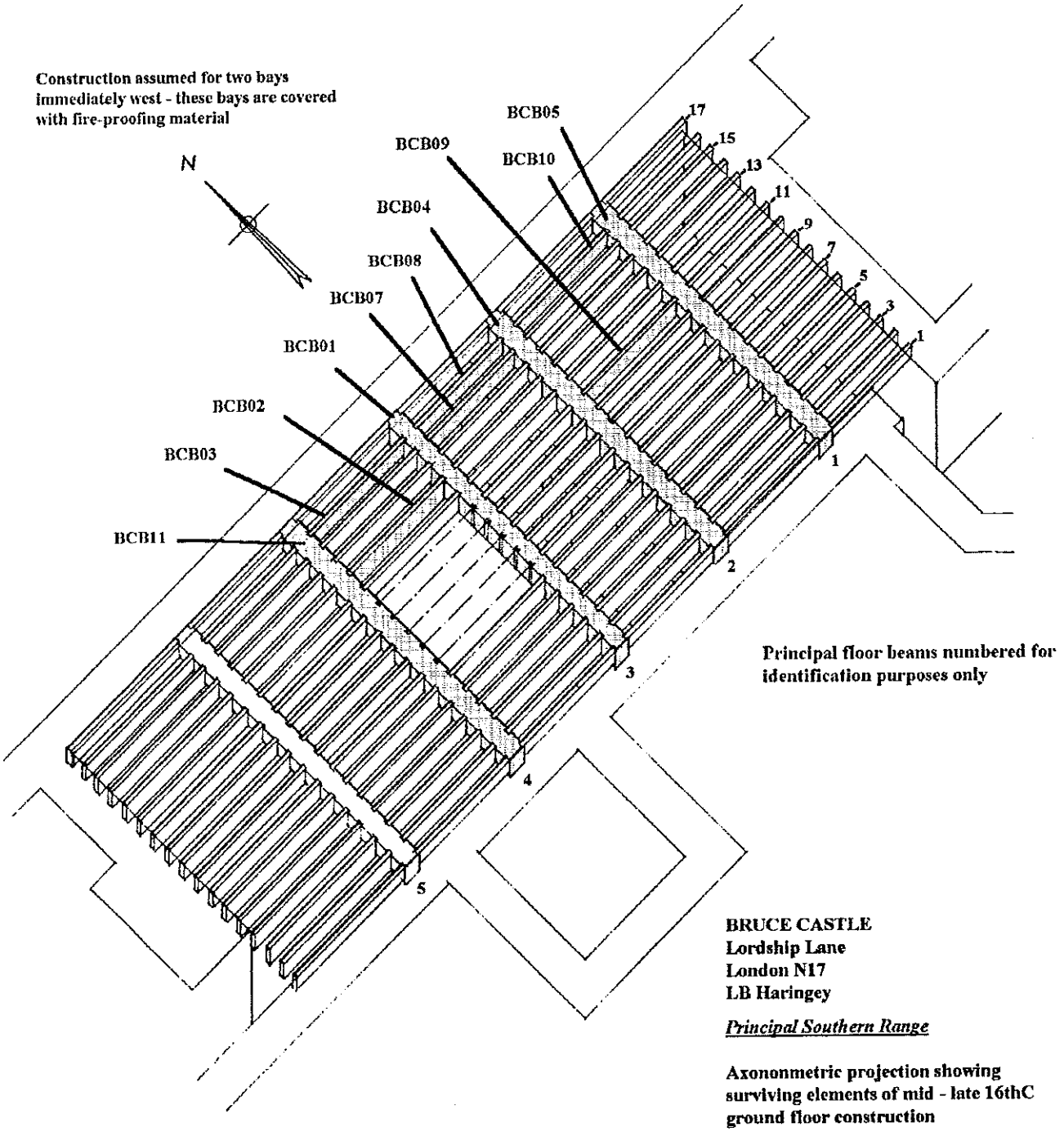


Table 1: List of samples. Numbering of the timbers follows that of Wittrick (1997) and Fig 1

Sample No.	Origin of sample	Total number of years	Sapwood details	Average growth rate (mm yr^{-1})	Date of sequence	Felling date of sequence
BCB01	Floor beam 3	107	h/s	2.10	1429 - 1535	1545 - 1590
BCB02	Joist, bay 4 No.13	65	1	2.06	1445 - 1509	1518 - 1563
BCB03	Joist, bay 4 No.16	21	-		not measured	
BCB04	Floor beam 2	57	h/s	3.10	1486 - 1542	1552 - 1597
BCB05	Floor beam 1	88	h/s	2.18	1453 - 1540	1550 - 1595
BCB06	Lintel, bay 3	54	-	2.48	1472 - 1525	after 1535
BCB07	Joist, bay 3 No.15	69	-	1.53	undated	-
BCB08	Joist, bay 3 No.16	47	-	3.37	undated	-
BCB09	Joist, bay 2 No.11	59	-	1.68	1448 - 1506	after 1516
BCB10	Joist, bay 2 No.15	61	-	1.74	1477 - 1537	after 1547
BCB11	Floor beam 4	113	6	1.58	1424 - 1536	1540 - 1585

Table 2: Inter-correlation between the dated cores from the floor of Bruce Castle, Tottenham, London, and correlation with the roof chronologies BRUCE 1 and BRUCE 2 (Bridge 1997a). The values are *t*-values derived from CROS 73 (Baillie and Pilcher 1973). Only values above $t = 3.0$ are shown, values below $t = 3.0$ or with less than 15 years of overlap are shown by a dash.

	BCB05	BCB01	BCB02	BCB06	BCB09	BCB10	BCB11	**BRUCE 1**	**BRUCE 2**
BCB04	4.4	-	-	3.8	-	3.7	-	4.9	3.7
BCB05		-	-	-	-	-	-	5.3	-
BCB01			5.8	3.1	5.6	4.5	7.5	-	8.2
BCB02				-	3.0	-	3.7	-	3.8
BCB06					5.5	-	3.4	-	5.1
BCB09						-	4.8	-	7.0
BCB10							3.7	-	5.7
BCB11								-	7.8

Figure 2: Bar diagram showing the relative positions of the dated ring sequences from Bruce Castle, Tottenham, London.
H/S = heartwood/sapwood boundary, hatched bar = sapwood rings. *BCA* = roof timbers (Bridge 1997a), BCB = basement timbers.

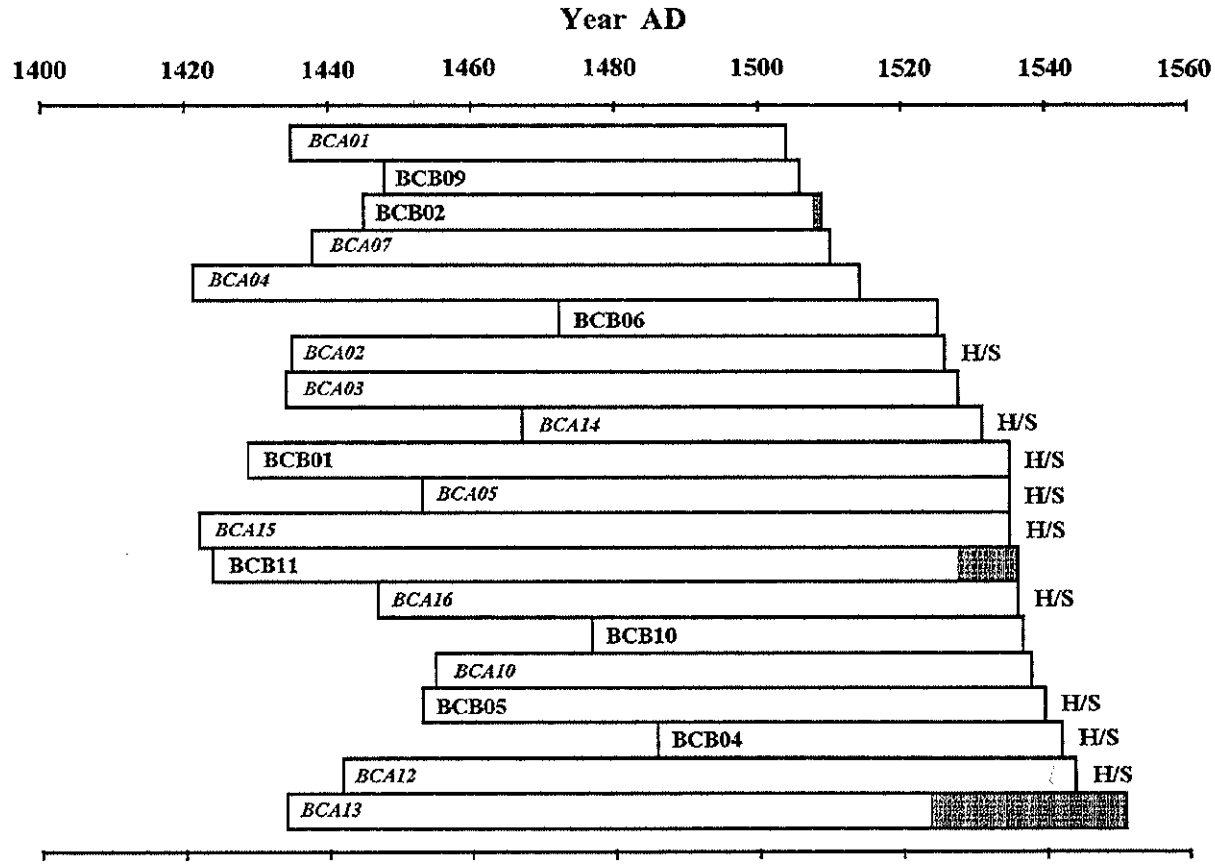
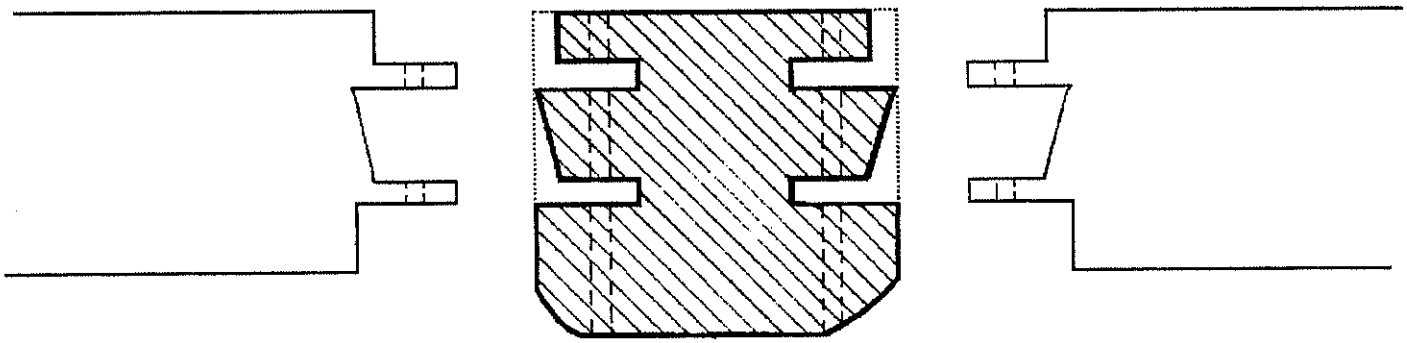


Figure 3: Drawing to show the main floor beam and common joist assembly from the ground floor construction of Bruce Castle, Tottenham, London

Double tenon, upper tenon housed, lower tenon with diminished haunch and peg



Principal Southern Range

Main floor beam and common floor joist assembly

BRUCE CASTLE
Lordship Lane
London N17
LB Haringey

A. R. Wittrick, English Heritage, Nov. 1997

Table 3: Dating of the two new master curves from Bruce Castle, giving the *t*-values with dated chronologies. Values of *t* below 3.5 are indicated by a dash.

	BRUCE 3		BRUCE 4	
	AD 1434 - 1542		AD 1421 - 1544	
Dated reference or site master chronology.	t-value	Overlap (yrs)	t-value	Overlap (yrs)
London1175 (Tyers unpubl)	6.2	109	8.4	124
Oxon93 (Miles unpubl)	3.8	109	6.4	124
S. England (Bridge 1988)	4.9	109	7.0	124
Brittany 3 (Pilcher unpubl)	-	109	5.8	124
Southwark (Tyers unpubl)	5.8	109	6.1	124
Kent (Laxton and Litton 1989)	6.0	107	5.3	120
E. Midlands (Laxton and Litton 1988)	4.7	109	4.9	124
Mary Rose Refit (Bridge unpubl)	6.2	102	5.6	115
Little Totham, Essex (Tyers 1996a)	6.0	84	-	97
Martin Tower, Tower of London (Bridge 1983)	5.9	101	6.2	114
Mottisfont, Hampshire (Miles 1996)	5.2	105	5.0	118
Upwich 3 (Groves and Hillam forthcoming)	4.9	89	6.0	91
Eastbury Manor, Greater London (Tyers 1997a)	4.8	109	4.0	124
Hereford-FC (Tyers 1996b)	4.8	109	4.5	124
Elland Hall (Hillam 1984)	4.5	109	3.7	124
Gosfield Hall, Essex (Bridge forthcoming (b))	4.3	88	4.8	88
Trees2, Wiltshire (Miles pers comm)	4.1	107	5.0	109
Thames, London (Hillam 1997)	4.1	109	3.7	124
Old Basing, Hampshire (Bridge unpubl)	4.1	102	-	115
Windsor Castle kitchen (Hillam unpubl)	4.1	109	6.3	124
Nuffield (Miles unpubl)	4.1	109	5.0	124
Broomfield House, Enfield (Bridge 1997b)	-	97	10.6	99
Sinai Park, Staffordshire (Tyers 1997b)	-	109	5.8	124
Wimborne, Dorset (Miles 1994)	-	109	5.7	124
Mary Rose Original (Bridge unpubl)	-	70	5.4	83
Bayton, Worcestershire (Bridge unpubl)	-	92	4.8	105
Exeter Guildhall, Devon (Bridge 1983)	-	109	4.8	121
Thaxted2, Essex (Tyers pers comm)	-	93	4.8	106
Hereford-CC (Tyers 1996b)	-	109	4.6	124

The BRUCE 1 chronology was shown to give generally lower crossmatching with material from London and the South-east, and slightly higher values with material from further north. This situation is far less clear when the new information is assessed however. The BRUCE 3 chronology exhibits its strongest crossmatching with site chronologies from a wide range of geographical areas which now include Essex and London, although interestingly it still gives very poor matching against the closest site, Broomfield (Bridge 1997b).

The BRUCE 4 chronology gives a very high $t = 10.6$ against the Broomfield site and can now be demonstrated to give strong crossmatching against a far more widely scattered group of site chronologies than its predecessor BRUCE 2, including sites from Staffordshire, Dorset, and Herefordshire as well as London and Essex.

With these new data therefore the question of geographical sources for the timber used becomes even more confusing, and it is suggested that it is the genetic and/or ecological make up of the sites which has as great an influence on crossmatching as geographical proximity, as discussed elsewhere (Bridge forthcoming (a)). This could mean that the timbers come from two distinct populations within a single woodland, or more likely, from two woodlands with different genetic and/or distinct micro-environments.

One timber BCB07 (69 years) could not be satisfactorily crossmatched with the individual or site chronologies from Bruce Castle and it remains undated (data given in Table 4). When compared with a range of site chronologies from elsewhere, a number of statistical matches were found equivalent to a date for the outer ring of AD 1564, but these were judged to be unsatisfactory to accept as a date for this timber. BCB07 did not crossmatch with BCA08, the undated timber from the roof.

Interpretation

The roof timbers gave a felling date range of AD1554-1576 (Bridge 1997a). The grouping of the timbers illustrated in Figure 2 strongly suggests a single phase of building for both the roof and the floor. One timber, BCB02, a common floor joist with a felling date range of AD 1518-1563, may represent a re-used timber, or a single piece of wood which had been stored for many years prior to use. Alternatively, it could represent a timber with an exceptional number of sapwood rings and actually be contemporaneous with the others used. This would narrow the felling range for the timbers to AD 1554-1563, but this interpretation is considered unwise on the basis of this single timber. All the other felling dates lie within the range derived from the roof timbers and the proposed date of construction therefore remains the same. The dendrochronological date for the construction of the floor (Figs 1 and 3) agrees well with its dating on stylistic grounds (Wittrick 1997).

Conclusion

The dendrochronological evidence from both the roof and floor structures allow the *c* AD1514 date for the construction of the main southern range of the current building to be discarded. It strongly indicates that floor and roof were built in the same phase from the same source or sources of timbers, although the geographical origin of these timbers is less certain.

The new data from the floor do not allow any narrowing of the felling dates for the timbers used than was achieved from the roof timbers. It remains most likely that construction took place in the **third quarter of the sixteenth century**, the felling range derived being from AD 1554 - 1576. This is consistent with documentary evidence for the felling and use of timbers in AD1568 but unfortunately the lack of bark on the samples does not allow for confirmation of this date by dendrochronological means.

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Table 4: Ring-width data of the two site master curves and sample BCB07 for oaks from the roof and floor of Bruce Castle, Tottenham, London

Year	ring widths (0.01mm)	number of trees per year
BRUCE3		
AD1434	101 83 100 97 104 69 102	2 2 2 2 2 2 2
	104 117 121 127 136 126 125 100 106 134	2 2 2 2 2 2 2 2 2 2
AD1451	123 122 130 172 172 206 185 168 114 122	2 2 3 3 4 4 4 4 4 4
	189 196 211 195 217 169 165 212 203 245	4 4 4 4 4 4 5 5 5 5
	150 136 146 158 210 164 120 153 169 165	5 5 5 5 5 5 5 5 5 5
	181 133 176 191 165 219 203 134 150 163	5 5 5 5 5 6 6 6 6 6
	107 130 125 169 176 208 127 118 110 99	6 6 6 6 6 6 6 6 6 6
AD1501	113 113 137 140 123 119 111 102 104 96	6 6 6 6 6 6 6 6 6 6
	114 109 134 164 150 138 102 133 108 94	6 6 6 6 6 6 6 6 6 6
	97 133 110 150 117 116 101 108 117 125	6 5 5 5 5 5 5 5 4 4
	198 148 160 157 160 164 199 222 195 227	4 3 3 3 3 3 3 3 2 2
	240 187	1 1
BRUCE 4		
AD1421	198 88 110 140 135 106 172 201 149 166	1 2 2 3 3 3 3 3 4 4
	136 192 138 179 128 113 92 108 108 90	4 4 4 4 6 6 6 7 7 7
	85 93 103 174 225 211 175 155 154 109	7 8 9 9 10 10 11 12 12 12
AD1451	143 103 119 134 104 145 140 133 140 169	12 12 12 12 12 12 12 12 12 12
	126 124 129 89 131 121 116 146 159 186	12 12 12 12 12 12 12 12 12 12
	124 159 168 159 220 172 144 106 154 127	12 13 13 13 13 13 14 14 14 14
	187 136 118 125 144 145 158 163 188 184	14 14 14 14 14 14 14 14 14 14
	166 139 159 165 149 165 148 110 138 120	14 14 14 14 14 14 14 14 14 14
AD1501	106 110 109 119 131 124 107 115 151 113	14 14 14 14 13 13 12 12 12 11
	141 161 140 151 159 124 100 137 142 87	10 10 10 10 9 9 9 9 9 9
	99 147 133 123 122 112 102 121 117 107	9 9 9 9 9 8 7 7 7 7
	136 104 115 139 161 181 153 105 136 125	7 7 7 7 7 7 4 2 1 1
	108 76 119 51	1 1 1 1
BCB07 (undated)		
Relative year		
1	444 197 228 357 281 217 202 166 186 159	
	148 137 114 120 120 120 99 108 99 94	
	102 89 84 114 84 127 228 135 182 110	
	109 126 110 137 115 159 137 155 130 162	
	181 161 171 132 170 194 139 176 193 213	
51	158 141 147 124 147 183 104 107 116 145	
	131 134 122 123 146 197 140 116 123	