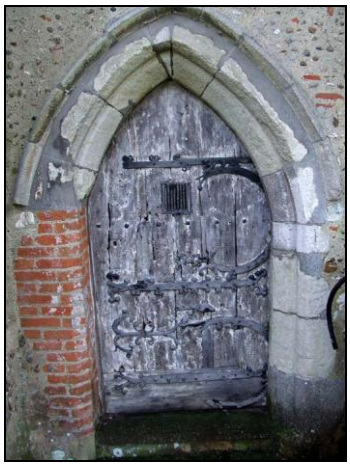
Oxford Dendrochronology Laboratory
Report 2010/04

THE TREE-RING DATING OF THE NORTH NAVE DOOR, ST MARY'S CHURCH, BUTTSBURY, ESSEX (NGR TQ 663 986)



Summary

All five boards from this door were sampled. Although splits in the boards and breaks in some cores meant that not all series were complete, cross-matching between the boards suggested that all five boards probably originated from a single tree, and allowed all sections of the boards to be dated, allowing for any missing rings. A 156-year chronology was created, covering the period AD 956–1112. Allowing for unmeasured rings from the rebates and adding on rings for the difference in the grain along the length of the boards, along with the minimum likely number of sapwood rings, the earliest possible likely felling date for these boards is 1156. Previous experience suggests that the boards are likely to have been trimmed without losing many heartwood rings, and therefore the actual felling date is likely to have been not long after this date. The similarity in ironwork and the unusual hinge form seen also on the Rainham church door dated to the 1170s, suggests that the door is likely to have been constructed in the period from 1156 to, perhaps the 1180s.

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BACKGROUND TO DENDROCHRONOLOGY

The basis of dendrochronological dating is that trees of the same species, growing at the same time, in similar habitats, produce similar ring-width patterns. These patterns of varying ring-widths are unique to the period of growth. Each tree naturally has its own pattern superimposed on the basic 'signal', resulting from genetic variations in the response to external stimuli, the changing competitive regime between trees, damage, disease, management etc.

In much of Britain the major influence on the growth of a species like oak is, however, the weather conditions experienced from season to season. By taking several contemporaneous samples from a building or other timber structure, it is often possible to cross-match the ring-width patterns, and by averaging the values for the sequences, maximise the common signal between trees. The resulting 'site chronology' may then be compared with existing 'master' or 'reference' chronologies.

This process can be done by a trained dendrochronologist using plots of the ring-widths and comparing them visually, which also serves as a check on measuring procedures. It is essentially a statistical process, and therefore requires sufficiently long sequences for one to be confident in the results. There is no defined minimum length of a tree-ring series that can be confidently cross-matched, but as a working hypothesis most dendrochronologists use series longer than at least fifty years.

The dendrochronologist also uses objective statistical comparison techniques, these having the same constraints. The statistical comparison is based on programs by Baillie & Pilcher (1973, 1984) and uses the Student's *t*-test. The *t*-test compares the actual difference between two means in relation to the variation in the data, and is an established statistical technique for looking at the significance of matching between two datasets that has been adopted by dendrochronologists. The values of '*t*' which give an acceptable match have been the subject of some debate; originally values above 3.5 being regarded as acceptable (given at least 100 years of overlapping rings) but now 4.0 is often taken as the base value. It is possible for a random set of numbers to give an apparently acceptable statistical match against a single reference curve – although the visual analysis of plots of the two series usually shows the trained eye the reality of this match. When a series of ring-widths gives strong statistical matches in the same position against a number of independent chronologies the series becomes dated with an extremely high level of confidence.

One can develop long reference chronologies by cross-matching the innermost rings of modern timbers with the outermost rings of older timbers successively back in time, adding data from numerous sites. Data now exist covering many thousands of years and it is, in theory, possible to match a sequence of unknown date to this reference material.

It follows from what has been stated above that the chances of matching a single sequence are not as great as for matching a tree-ring series derived from many individuals, since the process of aggregating individual series will remove variation unique to an individual tree, and reinforce the common signal

resulting from widespread influences such as the weather. However, a single sequence can be successfully dated, particularly if it has a long ring sequence.

Growth characteristics vary over space and time, trees in south-eastern England generally growing comparatively quickly and with less year-to-year variation than in many other regions (Bridge, 1988). This means that even comparatively large timbers in this region often exhibit few annual rings and are less useful for dating by this technique.

When interpreting the information derived from the dating exercise it is important to take into account such factors as the presence or absence of sapwood on the sample(s), which indicates the outer margins of the tree. Where no sapwood is present it may not be possible to determine how much wood has been removed, and one can therefore only give a date after which the original tree must have been felled. Where the bark is still present on the timber, the year, and even the time of year of felling can be determined. In the case of incomplete sapwood, one can estimate the number of rings likely to have been on the timber by relating it to populations of living and historical timbers to give a statistically valid range of years within which the tree was felled. For this region the estimate used is that 95% of oaks will have a sapwood ring number in the range 9 – 41 (Miles 1997).

BUTTSBURY DOOR

The north nave door has long been an object of interest, particularly in relation to its date. Hewett wrote in 1982 in his book Church Carpentry that it must be from the beginning of the eleventh century. The rounded ledges to which the outside boards are attached using nails and roves is similar in construction to the north door at Hadstock, which has been dated dendrochronologically (Bridge and Miles 2003). The Hadstock boards did not have sapwood, and therefore the tree-ring date could only be put as after 1034, but the stonework of the doorway strongly suggests a date in the 1060s. Geddes (1999) suggests the ironwork on the Buttsbury door is mid-twelfth century. There are similarities with the hinges at Rainham (Essex) where the south chancel door has the same unusual arrangement of the ends of the hinges, where they fit around the pintles are horizontally aligned, rather than forged around the pintle (Figure 1). Rainham church dates from the 1170s and the ironwork is thought to date to that time, though the woodwork was found to be late-fourteenth or early fifteenth century (Bridge and Miles 2009). Buttsbury church itself has records going back to the 1190s.

SAMPLING

Sampling took place in February 2010. The outer boards of the door, five oak (*Quercus* spp.) planks, were cored using a specialist micro-borer (Figures 2 and 3).

The samples were removed for further preparation and analysis. Cores were mounted on wooden laths and then these were polished using progressively finer grits down to 400 to allow the measurement of ring-widths to the nearest 0.01 mm. The samples were measured under a binocular microscope on a purpose-built moving stage with a linear transducer, attached to a desktop computer. Measurements and subsequent analysis were carried out using DENDRO for WINDOWS, written by Ian Tyers (Tyers 2004).

Figure 1: The Rainham hinge (left) and the Buttsbury hinge (right), showing similarities in their unusual formation.

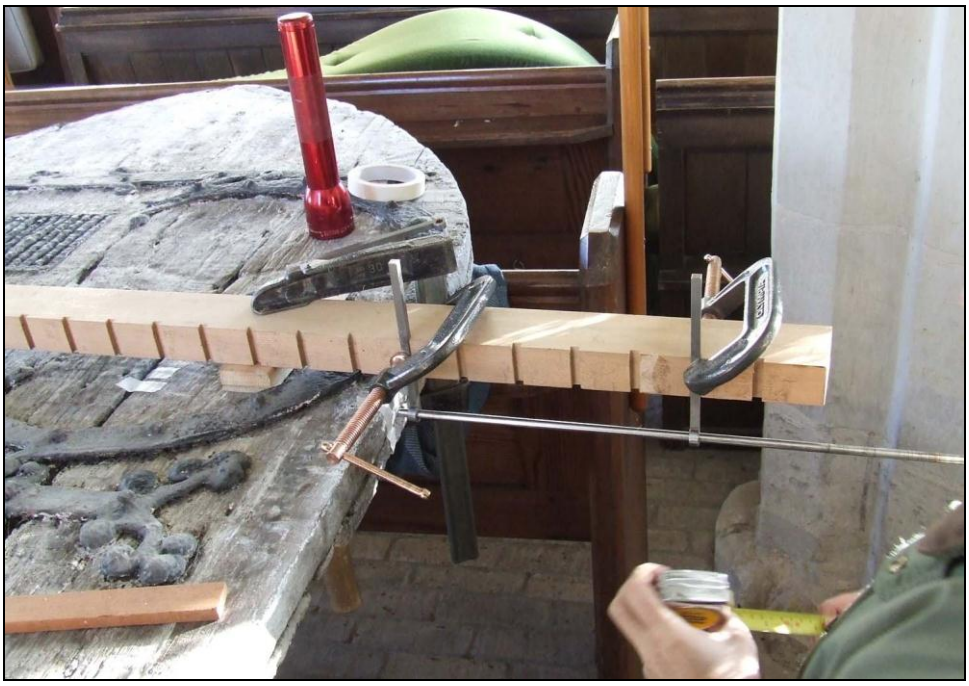

Figure 2: Coring of the boards using the micro-borer

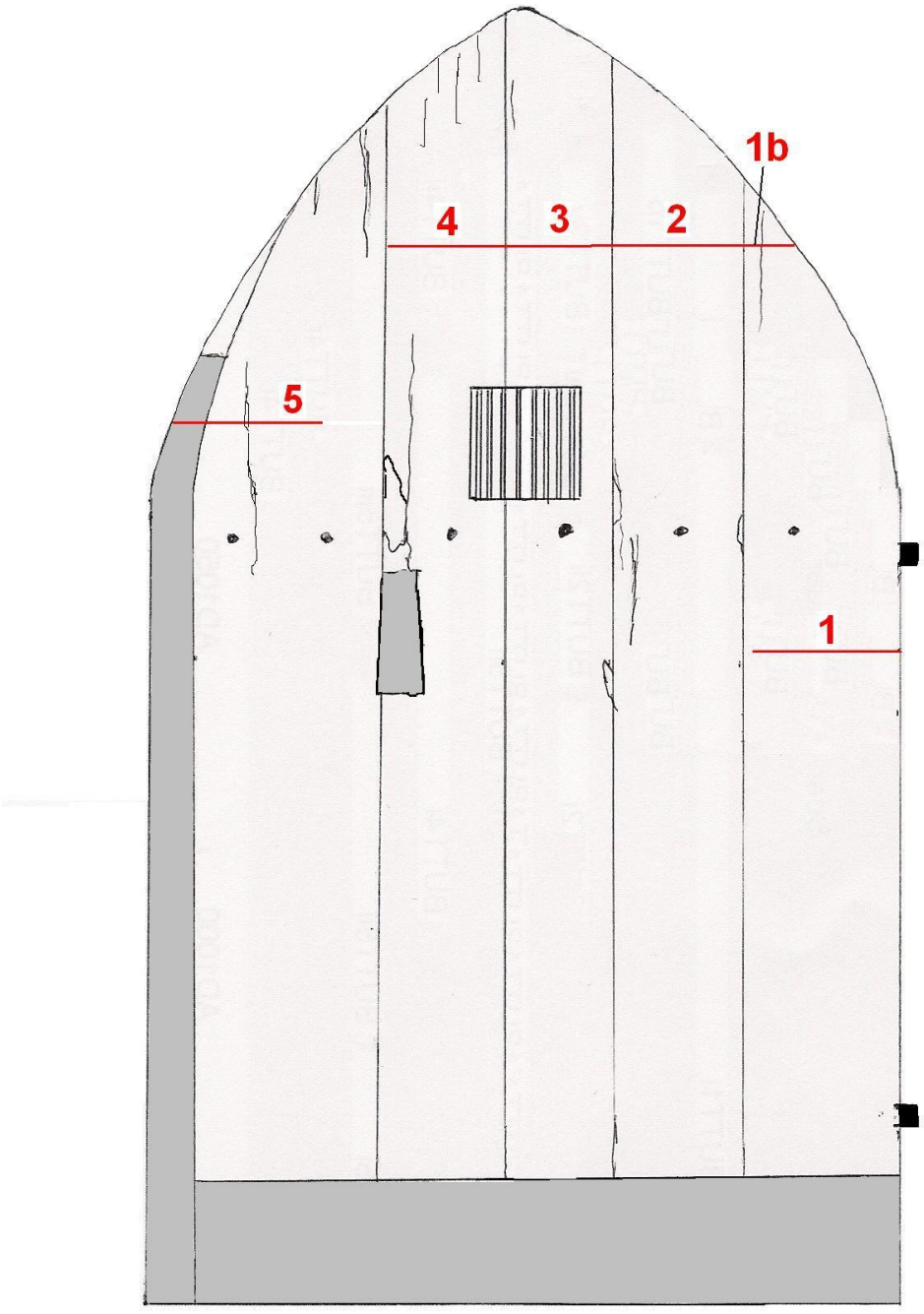

Figure 3: Sketch of the front of the door showing the approximate positions of cores removed. Dark grey areas represent newer wood additions.

RESULTS AND DISCUSSION

The boards were cored along three lines, as shown in Fig 3, and the complete core obtained from board 3, along with the additional rings from the rebate of board 2 are shown in Fig 4. Information about the samples obtained is given in Table 1. The cores from each board were incomplete, and were measured in sections, numbered i, ii, iii etc. Cross-matching the longest sections enabled a working master to be made from samples **but1i**, **but3ii** and **but4i**, as illustrated in Fig 6 and detailed in Table 2. Statistical comparisons with this working master and the plots of the individual sections of the five cores, allowed all the sections to be dated. The ring patterns for all sections are illustrated in Fig 7.

All dated sections were meaned together to form the 156-year long site chronology **BUTTSBRY.** The relative overlaps of the individual series are illustrated in Fig 8, along with their interpreted felling date. This was subsequently dated to the period AD 957–1112 by comparison with a number of independent dated reference chronologies, Table 3a showing the strongest matches against multi-site regional chronologies, and Table 3b showing the strongest matches with individual site chronologies. These strongly suggest that the wood used was grown locally.

It is interesting that all five boards have their last measured rings within a few years of each other. Fig 4 shows a piece of tape marking the end of the core taken from board 2 (**but2iv**) – this is where the rebate starts on the underside of the board. From this point another 24 rings were noted on the board at this point. Following the grain along the length of the board down the door (Fig 5) an additional 16 rings could be seen to the edge of this board. Therefore when interpreting the end date of this board, the outermost measured ring formed in 1107 needs 24 + 16 rings added, taking it to 1147. No sapwood was present on any of the boards, so more rings have to be added to derive the earliest likely felling date, this number being 9 in this part of the country (Miles 1997b). This makes the *terminus post quem*, or earliest time after which the tree was felled, 1156.

Although one cannot know for certain how many years have been lost after this date, experience with similar artefacts suggests that little trimming had taken place in the conversion of the boards, with minimal amounts of heartwood having been trimmed when the sapwood was removed. It seems likely therefore that the actual felling date, and by extrapolation the construction date for the door, was in the few decades after 1156. The dating of the ironwork on stylistic grounds, and the similarity in the form of the hinge between this and the Rainham door (dating to the 1170s) is strong corroborating evidence that the door dates to the second half of the twelfth century.

Figure 4: Photograph showing the core for board 3 (right) along with the additional section of core from board 2 from the overlapping part of the board. The masking tape right-hand edge marks the end of the core for board 2 taken from left to right.

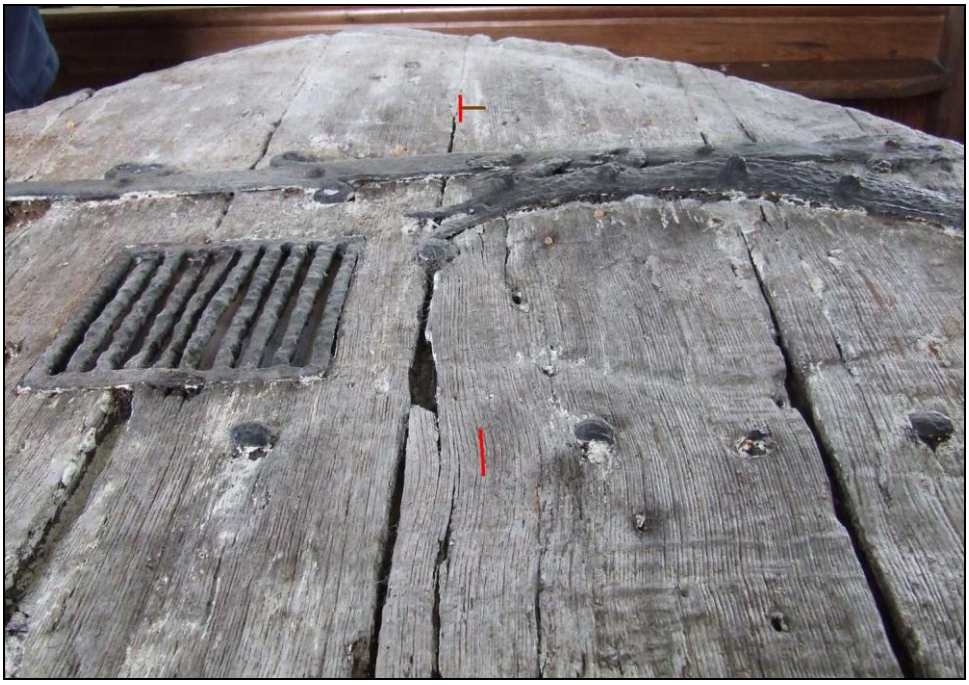

Figure 5: Photograph showing the approximate position of the additional part of board 2 from the overlap (brown line), with the red lines indicating how the grain drifts down the length of the board, necessitating the addition of rings to the last measured ring from the coring position to judge the last ring of the board itself.

ACKNOWLEDGEMENTS

This study was largely financially supported by a grant from the Essex Heritage Trust, which we gratefully acknowledge. The study depended on the goodwill of Buttsbury PCC, and we are especially grateful to the churchwarden, Bryan Shedel, who opened up the church early for us and assisted in moving things around to facilitate our work. Elphin Watkin also lent a hand moving the door, and supplied refreshments. We are grateful to Prof. Warwick Rodwell OBE FSA who suggested that we should look at this door after our successful dating of the Hadstock door.

We thank our fellow dendrochronologists for permission to use their data.

Table 1: Details of samples taken from the North Nave Door, St Mary's Church, Buttsbury, Essex

Sample number	Board	Dates AD spanning	No of rings	Additional rings	Mean width mm	Std devn mm	Mean sens	Felling seasons and dates/date ranges (AD)
butt1i	One	967–1068	102		1.59	0.43	0.176	
butt1ii	One	1070–1103	34	12 unmeasured + 8 grain drift	1.69	0.33	0.173	after 1132
butt1b	One	1084–1112	29		1.54	0.21	0.149	
butt2i	Two	1004–1034	31		1.98	0.39	0.107	
butt2ii	Two	1036–1058	23		2.28	0.40	0.188	
butt2iii	Two	1961–1080	20		1.86	0.28	0.091	
butt2iv	Two	1085–1107	23	24 unmeasured + 16 grain drift	1.45	0.22	0.149	after 1156
butt3i	Three	undated	20		1.83	0.37	0.147	
butt3ii	Three	1025–1108	84		1.79	0.27	0.156	after 1117
butt4i	Four	1004–1078	75		1.74	0.29	0.142	
butt4ii	Four	1088–1105	18		1.71	0.39	0.233	after 1114
butt5i	Five	957–987	31		2.05	0.68	0.291	
butt5ii	Five	989–1037	49		1.96	0.43	0.175	
butt5iii	Five	1045–1101	57		1.59	0.29	0.177	after 1110
BUTTSBRY		**957–1112**	**156**		**1.75**	**0.34**	**0.146**	

Key: std devn = standard deviation; mean sens = mean sensitivity

Table 2: Cross-matching between the three longest series measured

	t-values	
Sample	**butt3ii**	**butt4i**
butt1i	4.1	4.6
butt3ii		4.7

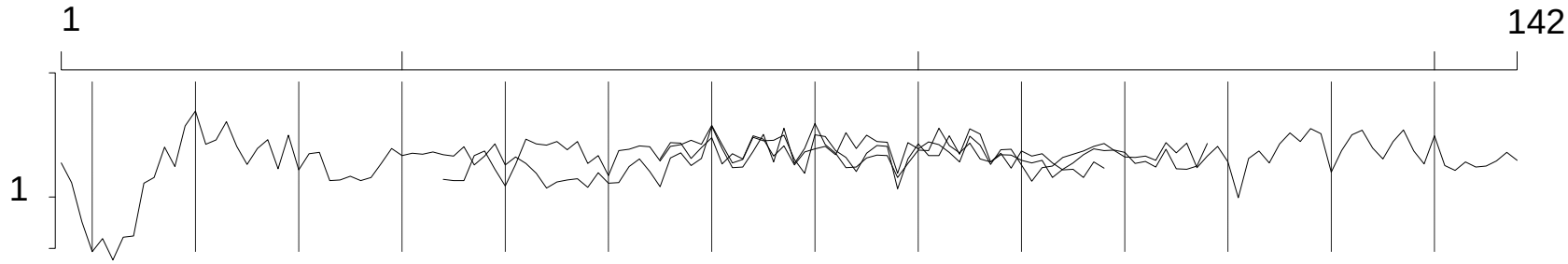

Figure 6: Overlapping curves of samples **butt1i**, **butt3ii** and **butt4i,** establishing the initial working site master chronology. The *x*-axis is in relative years, the *y*-axis is a logarithmic scale of ring width in mm.

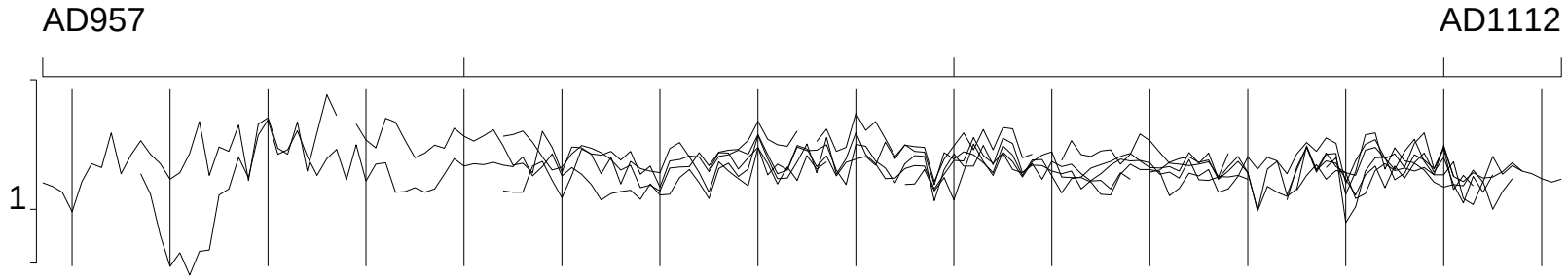

Figure 7: The final set of overlapping curves from measured sections of the 5 boards. The *x*-axis is in relative years, the *y*-axis is a logarithmic scale of ring width in mm.

Table 3a: Dating evidence for series **BUTTSBRY AD 956–1112** against regional multi-site chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
London	London Master Chronology	(Tyers pers comm)	**LONDON**	413–1728	156	11.7
Southern England	South Master Chronology	(Hillam and Groves 1994)	**SOUTH**	406–1594	156	8.4
England	Ref6 Master Chronology	(Fletcher 1977)	**REF6**	778–1199	156	8.1
Wales	Welsh Master Chronology	(Miles 1997a)	**WALES97**	404–1981	156	7.7
Hampshire	Hampshire Master Chronology	(Miles 2003)	**HANTS02**	443–1972	156	7.3

Table 3b Dating evidence for series **BUTTSBRY AD 956–1112** against individual site chronologies

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap (yrs):*	*t-value:*
Essex	Greensted Church	(Tyers 1996)	GREENSTD	1278–1453	97	9.6
Hertfordshire	Westwick	(Howard *et al* 1997)	WESTWICK	940–1179	156	8.9
London	Billingsgate	(Hillam 1990)	BLLNGSGT	997–1243	116	8.9
Gloucestershire	West Door, Kempley Church	(Miles and Worthington 1999)	KEMPLEY2	959–1099	140	8.0
London	Westminster Abbey, Long Chest	(Miles and Bridge 2008)	WMNSTR9	850–1161	156	7.8
London	White Tower, Tower of London	(Miles 2007)	WHTOWR2	816–1092	136	7.3
Norfolk	Norwich Quay	(Groves 1993 unpublished)	NORWCHQY	972–1145	141	7.0
Bedfordshire	Warren Villas, Sandy	(Hillam 1991)	WARREN	960–1125	153	6.7
London	Westminster Abbey, Pyx Canopy	(Miles and Bridge 2008)	WMNSTR15	827–1148	156	6.3

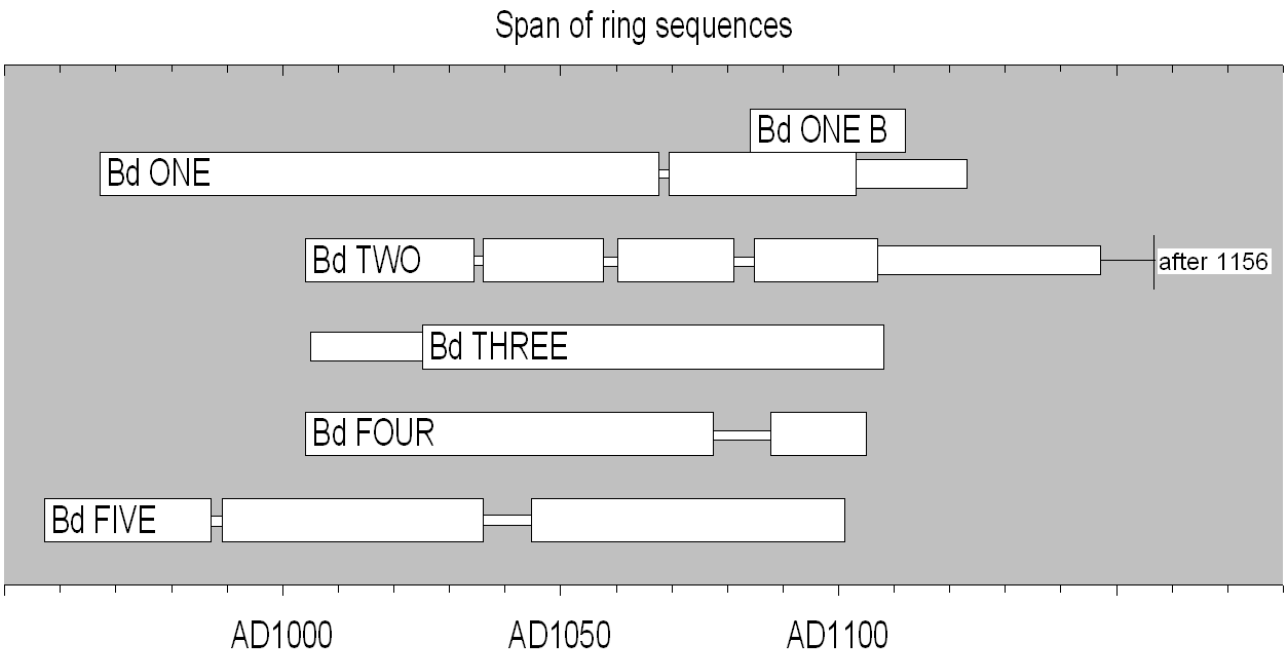

Figure 8: Bar diagram showing the relative positions of overlap of the dated sections of ring-width series from the five boards of the Buttsbury door. The thinnest bars represent missing rings and the slightly thicker bars represent additional rings present on the board but not incorporated in the cores extracted.

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