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ROYAL COAT OF ARMS FOR EDWARD VI, FROM THE CHURCH OF ST MARY THE VIRGIN WESTERHAM, KENT
DENDROCHRONOLOGICAL ANALYSIS OF OAK BOARDS

SCIENTIFIC DATING REPORT

Ian Tyers

INTERVENTION
AND ANALYSIS

ENGLISH HERITAGE

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SUMMARY

A tree-ring assessment, measurement, and analysis programme was commissioned on a Royal Coat of Arms normally located at the Church of St Mary the Virgin, Westerham, Kent. The Westerham Coat of Arms comprises four horizontal oak boards. Direct tree-ring measurement was undertaken on these boards whilst the Coat of Arms was undergoing conservation treatment in March 2013. The results identified that three of the four oak boards were derived from timbers imported from the eastern Baltic. These timbers were felled after AD 1541, thus supporting its attribution to the reign of Edward VI. Most surviving coats of arms date from James I or later.

CONTRIBUTORS

Ian Tyers

ACKNOWLEDGEMENTS

The analysis of the Westerham Coat of Arms was funded by English Heritage (EH). Practical help and valuable discussions were provided by Treve Rosoman (EH), who also kindly provided the cover photograph, and Susan Moore (Plowden and Smith) during its conservation treatment.

ARCHIVE LOCATION

Kent Historic Environment Record
Heritage Conservation
Kent County Council
Invicta House
County Hall
Maidstone
Kent
ME14 1XX

DATE OF INVESTIGATION

2013

CONTACT DETAILS

Ian Tyers
Dendrochronological Consultancy Ltd
Lowfield House
Smeath Lane
Clarborough DN22 9JN
ian@dendro.co.uk

CONTENTS

INTRODUCTION

This document is a technical archive report on the tree-ring analysis of oak timbers from a Royal Coat of Arms normally located at the Church of St Mary the Virgin at Westerham, Kent. It is beyond the dendrochronological brief to describe the object in detail or to undertake the production of detailed drawings. Elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the object.

Royal Coats of Arms began to appear in churches during the reigns of Henry VIII and Edward VI, but many of the earliest examples were destroyed during the reign of Mary I.

METHODOLOGY

The Westerham Royal Coat of Arms is nearly square. It is *c* 1062mm wide and *c* 1054mm high. It is constructed of four horizontally aligned oak boards (Fig 1). Each of the boards tapers slightly from one end to the other with the upper three being relatively uniform. They have widths of *c* 283mm, 280mm and 272mm respectively at their widest ends, and each is *c* 20mm thick. The lower board is slightly narrower than the others, it is 238mm at its widest end, and slightly thicker at *c* 26mm. Visual examination indicated that all four boards are radial sections of slow-growing, straight-grained oaks.

Tree-ring dating employs the patterns of tree-growth to determine the calendar dates for the period during which the sampled trees were alive. The amount of wood laid down in any one year by most trees is determined by the climate and other environmental factors. Trees over relatively wide geographical areas can exhibit similar patterns of growth, and this enables dendrochronologists to assign dates to some samples by matching the growth pattern with other ring-sequences that have already been linked together to form reference chronologies.

Dendrochronological samples need to be free of aberrant anatomical features such as those caused by physical damage to the tree, which may prevent or significantly reduce the chances of successful dating.

Standard dendrochronological analysis methods (see eg English Heritage 1998) were applied to each of the four boards. The complete sequence of the annual growth rings in the right-hand edge of the four boards was measured to an accuracy of 0.01mm using a micro-computer based travelling stage. The sequences of ring widths were then plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition, cross-correlation algorithms (eg Baillie and Pilcher 1973) were employed to search for positions where the ring sequences were highly correlated. Highly correlated positions were checked using the graphs and, if any of these were satisfactory, new composite sequences were constructed from the synchronised sequences. Any *t*-values reported below were 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 need to have been obtained from a range of independent sequences, and that these positions are supported by satisfactory visual matching.

Not every tree can be correlated by the statistical tools or the visual examination of the graphs. There are thought to be a number of reasons for this: genetic variations; site-specific issues (for example a tree growing in a stream bed will be less responsive to rainfall); or some traumatic experience in the tree's lifetime, such as injury by pollarding, defoliation events by caterpillars, or similar. These could each produce a sequence dominated by a non-climatic signal. Experimental work with modern trees shows that 5–20% of all oak trees, even when enough rings are obtained, cannot be reliably cross-matched.

Converting the date obtained for a tree-ring sequence into a date for the object requires a record of the nature of the outermost rings of the sample. If bark or bark-edge survives, a felling date precise to the year or season can be obtained. If no sapwood survives, the date obtained from the sample gives a *terminus post quem* for its use. If some sapwood survives, an estimate for the number of missing rings can be applied to the end-date of the heartwood. This estimate is quite broad and varies by region. This report uses a minimum of 8 rings as a sapwood estimate based on comparative data from other groups of eastern Baltic data (eg Tyers 1998; Sohar *et al* 2012).

The analysis may highlight potential same-tree identifications if two or more tree-ring sequences are obtained that are exceptionally highly correlated. Such pairs, or sometimes more, are then used as a same-tree group and each can be given the interpreted date of the most complete of the samples. They are most useful where several timbers date but only one has any sapwood, or where same-tree identifications yield linkages within or between objects.

RESULTS

The Coat of Arms was examined at the conservation studio of Plowden and Smith in London in March 2013. The Westerham Coat of Arms comprised four oak boards (Table 1), labelled A to D from the top, all of which were suitable for measurement. The ring width sequences were derived from the right-hand edge of each board as viewed from the front of the Coat of Arms. Two of the tree-ring series, from boards A and C, were found to cross-match each other strongly (*t*-value = 23.01), and these were combined into a single composite sequence of 253 years, mathematically constructed from the matched series at their synchronised positions. This, and the remaining two individual series, were compared with reference data of historic date from throughout England and northern Europe. A number of statistically significant matches were obtained between the sequences and reference series, along with other contemporaneous objects. These indicate that the board A and C composite sequence dates from AD 1281–1533 inclusive (Fig 2; Table 2), and that the board B series dated to AD 1311–1524 inclusive (Fig 2;

Table 3). The board D series did not give significant correlations to reference data and remains undated.

The dated boards are all of eastern Baltic origin (ie none are of either English or western European origin). The analysed board which was not dated is not obviously different from the other boards in the Coat of Arms.

The measurement data for the measured boards are listed in Appendix 1.

DISCUSSION

None of the boards retained sapwood and thus the interpretations given to the dated boards are *terminus post quem* dates based on the minimum estimate of eight missing sapwood rings. At this stage the interpreted dates represent the earliest possible felling dates for each of the individual boards. Combining these interpreted felling dates for the boards identifies the latest of these which indicates that the boards were all felled after AD 1541. However where panels are concerned it is necessary to turn this earliest possible felling date into a usage date. Hence it is necessary to make assumptions based on minimum amounts of sapwood being originally present, and that the transport and utilisation of the boards occurred relatively rapidly.

Most groups of panels from English collections that have been examined are dominated by eastern Baltic oak boards and very few retain any sapwood. The Westerham Coat of Arms thus contains a commonly identified source for the boards, and a common construction methodology where the panel makers appear to be deliberately removing sapwood. This latter feature has been identified in many other panel paintings from both England and the rest of western Europe, and is known to be a formal statute of the panel-makers guild in seventeenth-century Antwerp (Wadum 1998).

Eastern Baltic boards of *c* 250–300mm wide are likely to have been minimally trimmed as this appears to have been the 'standard' size of the traded boards. The tree-ring results obtained from boards of these sizes thus appear to be broadly indicating the usage period for these panels. In this case an estimated usage date based on a range of 8–40 trimmed rings is normally used following Baillie (1984). Any additional technical evidence for either seasoning or reuse of these boards would make these panels later, possibly much later than the dates given here. However, it is of note that the analysis of panels with good historical attributions has demonstrated that the earliest possible dates identified from dendrochronology usually indicate that the panels were most likely made from unseasoned oak. Thus a usage date of after AD 1541 but by *c* AD 1573 is suggested for the Royal Coat of Arms panel.

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FIGURES

Figure 1: The construction of the Royal Coat of Arms from the Church of St Mary the Virgin, Westerham, Kent. The frame obscures parts of the boards, photo kindly supplied by Plowden and Smith.

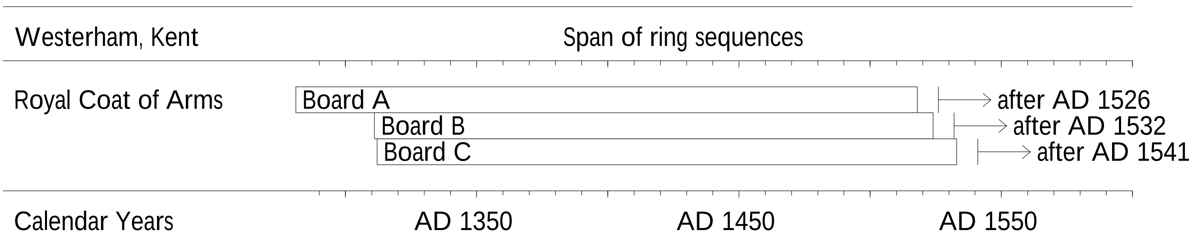


Figure 2: Bar diagram showing the absolute dating positions of the dated tree-ring sequences for boards from the Royal Coat of Arms from the Church of St Mary the Virgin, Westerham, Kent. The interpreted felling dates are also shown for each board.

KEY. White bars are oak heartwood.

TABLES

Table 1: Details of the four oak boards from the Royal Coat of Arms panel from the Church of St Mary, Westerham, Kent

Board	Width (mm)	Rings	AGR (mm)	Date of measured sequence	Interpreted result
Board A r	275–283	238	1.17	AD 1281–1518	after AD 1526
Board B r	269–280	214	1.24	AD 1311–1524	after AD 1532
Board C r	256–272	222	1.15	AD 1312–1533	after AD 1541
Board D r	226–238	147	1.60	undated	-

KEY: r = sequences obtained from the right hand edges of the boards; AGR = average growth rate per year

Table 2: Showing example t-values (Baillie and Pilcher 1973) between the composite sequence from boards A and C from the Royal Coat of Arms panel from the Church of St Mary, Westerham, Kent and eastern Baltic oak reference data.

	Boards A & C AD 1281–1533
Fletcher panels archive Baltic area 1 (Hillam and Tyers 1995)	10.25
Old London Bridge, de Jongh, Kenwood House, board B (Tyers 2014)	9.62
Netherlandish panels composite (Eckstein *et al* 1975)	9.46
Massacre of the Innocents, Rubens (Tyers 2002)	8.34
Henry VIII full-length, Holbein, Petworth (Tyers 2001)	7.85
Elizabeth 1, NPG542 boards B and C (Tyers 2010)	7.61

Table 3: Showing example t-values (Baillie and Pilcher 1973) between the sequence from board B from the Royal Coat of Arms panel from the Church of St Mary, Westerham, Kent and eastern Baltic oak reference data.

	Board B AD 1311–1524
Fletcher panels archive Baltic area 2 (Hillam and Tyers 1995)	8.08
Netherlandish panels composite (Eckstein *et al* 1975)	7.10
Phineus Potts, NPG2035 (Tyers 2012)	7.06
Suffolk, Otley Hall, Baltic wall panelling (Tyers 2000)	7.05
Elizabeth 1, NPG542 boards B and C (Tyers 2010)	6.53
Mystic Marriage of St Catherine, Nicolas Poussin, NG Scotland (Tyers 2009)	6.31

APPENDIX 1

os842ar

97	46	81	80	130	178	149	108	146	80
137	63	172	191	211	202	185	127	130	59
104	119	135	116	119	64	58	123	107	109
140	201	172	161	136	206	128	209	171	196
179	220	157	106	191	171	209	120	58	63
88	78	67	67	96	109	91	109	121	139
177	162	101	96	125	106	124	73	79	153
175	171	220	207	174	118	107	87	156	171
119	123	125	135	119	140	151	150	161	102
141	69	126	99	117	111	158	167	126	163
183	149	125	145	137	119	82	119	113	120
99	108	101	116	104	141	80	85	124	128
169	177	116	164	170	189	186	180	171	119
156	167	168	98	165	111	124	102	67	64
61	72	53	68	46	70	46	41	87	77
60	85	74	84	86	92	107	88	90	102
120	115	162	90	160	106	123	143	167	160
93	87	76	142	129	115	133	78	91	69
95	70	81	109	89	110	89	117	105	96
101	108	95	94	102	83	56	54	71	76
112	90	58	71	70	103	99	113	107	140
84	83	99	75	112	109	98	114	106	89
142	96	104	99	100	111	89	100	90	87
106	105	89	108	123	95	99	95		

os842br

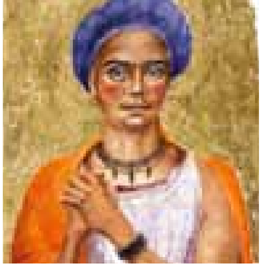
153	202	275	159	171	180	101	139	162	108
148	155	184	107	109	130	141	153	178	168
149	163	145	231	157	162	157	207	144	104
116	129	110	163	171	142	115	122	143	176
167	134	164	146	141	141	127	127	174	171
125	190	180	154	152	193	184	194	142	116
115	103	90	113	140	126	107	127	107	132
128	108	121	113	105	109	145	134	155	142
165	157	113	130	121	113	103	130	144	144
144	137	107	139	134	151	105	96	78	93
95	117	124	131	117	119	113	120	85	89
85	94	82	76	117	104	75	84	88	85
101	108	93	100	103	102	109	115	99	91
106	131	138	122	85	91	100	123	119	128
100	103	54	84	58	103	95	111	87	103
103	107	60	77	76	105	90	128	110	67
86	96	108	81	103	113	106	92	108	135
126	127	120	182	115	172	152	132	142	135
105	87	117	109	145	130	101	84	70	120
154	126	101	97	114	101	118	109	118	84
100	124	88	108	140	146	139	120	105	97
137	159	122	107						

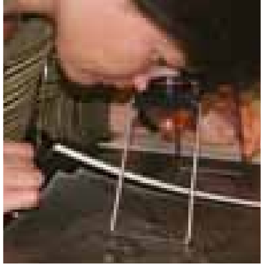
os842cr

217	203	162	144	253	123	211	181	218	217
243	158	114	161	167	187	99	61	51	80
63	53	63	78	102	83	91	96	113	141
142	93	95	119	87	103	69	68	138	158
148	198	175	149	113	100	82	120	144	114
126	115	128	116	141	156	177	145	103	121
71	108	102	107	125	167	191	150	160	200
141	113	130	125	119	81	118	107	128	102
118	118	112	91	107	87	88	156	128	157
173	140	219	185	208	167	156	195	84	182
166	161	104	172	111	128	144	71	56	58
57	56	55	49	65	54	48	69	74	68
73	73	73	70	93	92	92	65	109	112
94	140	86	173	99	108	131	173	149	74
94	83	142	132	118	131	85	103	75	93
86	98	95	87	113	97	107	118	81	120
119	92	92	121	85	60	64	74	105	129
91	72	62	74	90	90	106	108	182	87
78	89	67	118	116	94	108	112	101	135
99	116	104	112	125	84	113	79	90	108
130	98	101	126	108	114	127	98	96	114
114	140	106	110	105	119	97	89	92	70
60	73								

os842dr

178	190	175	226	166	253	169	245	216	231
203	248	230	219	214	220	207	169	161	107
162	145	226	231	201	150	184	167	184	177
183	175	196	191	197	171	211	205	181	218
196	180	226	131	165	142	225	147	152	151
141	142	223	196	205	171	174	180	164	191
125	174	158	119	122	145	137	124	185	185
163	151	131	174	135	108	126	131	103	124
104	91	118	106	99	82	84	93	94	94
151	127	164	143	141	157	164	138	140	160
171	158	184	122	128	162	132	117	153	129
183	160	173	218	169	147	138	132	157	201
133	132	136	113	153	156	137	140	145	192
216	141	152	120	146	157	162	131	183	171
146	131	106	120	86	132	130			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