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OLD DUCHY PALACE, LOSTWITHIEL, CORNWALL
DENDROCHRONOLOGICAL ANALYSIS OF OAK TIMBERS

SCIENTIFIC DATING REPORT

Ian Tyers

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SUMMARY

A tree-ring dating programme was commissioned on timbers from Old Duchy Palace. The results identified that timbers in roof were datable by tree-ring dating techniques, with the roof trusses using timbers felled in either AD 1620 or AD 1621. This dating programme was commissioned on this Grade I Listed building to inform future use, following its acquisition by the Prince's Regeneration Trust in partnership with the Cornwall Buildings Preservation Trust. This report archives the dendrochronological results.

CONTRIBUTORS

Ian Tyers

ACKNOWLEDGEMENTS

The sampling and analysis of timbers at Old Duchy Palace was funded by English Heritage (EH). Practical help and valuable discussions were provided by Francis Kelly, Historic Buildings Inspector South West Region (EH), and Eric Berry who kindly provided descriptive text and the plan used here. Michael Talbot-Smith kindly provided on-site assistance. Simon Thorpe and Rosie Fraser from the Cornwall Buildings Preservation Trust kindly made arrangements for access. The drawings on which Figures 2–5 are based were provided by Purcell Miller Tritton, architects.

ARCHIVE LOCATION

Cornwall and Scilly Historic Environment Record
Historic Environment Service
Kennall Building, Old County Hall
Station Road
Truro TR1 3AY

DATE OF INVESTIGATION

2009

CONTACT DETAILS

Dendrochronological Consultancy Ltd, 65 Crimicar Drive, Sheffield S10 4EF
Ian Tyers; ian@dendro.co.uk

CONTENTS

INTRODUCTION

This document is a technical archive report on the tree-ring analysis of oak timbers from the Old Duchy Palace, Lostwithiel, Cornwall. It is beyond the dendrochronological brief to describe the building 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 building.

The Old Duchy Palace, or Convocation Hall, stands on the corner of Quay Street and Fore Street in Lostwithiel (NGR SX 1048 5972) within the county of Cornwall (Fig 1). It is a north-south aligned stone-walled building with stone buttresses along the street front. Internally there is a large stone-arched undercroft, a very large meeting room, used as a Masonic lodge throughout the twentieth century, and above that a simple A-truss roof, of 10 trusses. The south wall of the building has a blocked rose window that was previously the north end wall of former part of the palace complex further to the south (Eric Berry pers comm).

METHODOLOGY

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.

The building was visited in May 2008. An assessment of the dendrochronological potential of timbers in the roof had been requested by Francis Kelly in order to inform future use. This assessment aimed to identify whether oak timbers with sufficient numbers of rings for analysis existed in this part of this building. This assessment concluded that the timbers in the roof contained suitable material.

The sampling took place during January 2009. The selected timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The ring sequences in the cores were revealed by sanding.

This preparation revealed the width of each successive annual tree ring. Each prepared sample could then be accurately assessed for the number of rings it contained, and at this stage it was also possible to determine whether the sequence of ring widths within it could be reliably resolved. 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 suitable sample. The complete sequence of the annual growth rings in the suitable samples 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 were 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 cannot be reliably cross-matched, even when enough rings are obtained.

Converting the date obtained for a tree-ring sequence into a date useful for the interpretation of the building 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 10 rings and a maximum of 46 rings as a sapwood estimate (see eg English Heritage 1998, 10–11).

Where bark-edge or bark survives, the season of felling can be determined by examining the completeness or otherwise of the terminal ring lying directly under the bark. Complete material can be divided into three major categories:

- 'early spring', where only the initial cells of the new growth have begun – this is equivalent to a period in March/April, when the oaks begin leaf-bud formation;

- 'later spring/summer' where the early wood is evidently complete but the late wood is evidently incomplete, which is equivalent to May-through-September of a normal year, and
- 'winter' where the latewood is evidently complete and this is roughly equivalent to September-to-March (of the following year), since the tree is dormant throughout this period and there is no additional growth put on the trunk.

These categories can overlap as, for example, not all oaks simultaneously initiate leaf-bud formation. It should also be noted that slow-growing or compressed material cannot always be safely categorised.

Timber technology studies demonstrate that many of the tool marks recorded on ancient timbers can only have been done on green timber. There is little evidence for long-term storage of timber or of widespread use of seasoned, rather than green, timber in the medieval period (see eg English Heritage 1998, 11–12).

Reused timbers can only provide tree-ring dates for the original usage date, not their reuse. Identifying reused timbers requires careful timber recording which notes the presence of features which are not functional in the structure. It is always possible that some timbers exhibit no evidence of earlier usage, and are thus 'hidden reused' timbers. The dendrochronological impact of this problem is particularly acute where only single timbers have been dated from a structure.

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 between different areas within a building.

RESULTS

In January 2009 10 timbers of the roof were cored; these cores were labelled 1–10 inclusive (Figs 2–5). Each sample was assessed for the wood type, the number of rings it contained, and whether the sequence of ring widths could be reliably resolved. This assessment confirmed that all the sampled timbers were oak (*Quercus* spp.) and that all were suitable for dendrochronological analysis. There was good survival of sapwood in the roof. The details of these samples are provided in Table 1.

The samples were prepared for analysis, measured, and the resultant ring series were compared with each other. Nine of the samples from the roof were found to cross-match each other well (Table 2). This cross-matched group was then combined into a single composite data set. This site composite which was then compared with medieval and later tree-ring data from throughout England and Wales. The composite sequence was

found to cross-match strongly against data from sites elsewhere in the South-West region (Table 3). This cross-matching provided consistent calendar dates for the sequence of AD 1464–1620. A summary of the results for the component samples of this chronology are provided in Table 1 and Figure 3.

The undated sample had broken into 2 discontinuous fragments and neither of these short series were found to match consistently with the other material. This sample has failed to provide any consistent dating evidence.

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

DISCUSSION

The roof comprises 10 trusses (Fig 2). These simple A-trusses have non-diminished principal rafters, straight collars with bare-faced dovetails lapped onto the principal rafters, a diamond set threaded ridge, and three rows of threaded purlins. The principal rafters were derived from fairly slow-grown oak trees *c* 300mm in diameter. Each principal rafter was probably halved, although some may have been slabbed into four. Along most there was usually some surviving sapwood. Visual inspection suggested that it was likely that the principal rafter pairs in each truss were derived from a single tree. The trusses were mostly arranged with the outermost faces of the oaks facing outermost faces on the adjacent trusses, and the innermost faces likewise, so that the trusses have alternating alignments. Trusses T9 and T10 are south of a large chimney stack. These have a different spacing and have a different ceiling height below them. Nevertheless, they are of identical original form, although they now have some later strengthening elements added to them, and the lower ends are boxed in. Samples from these two trusses were taken to check they were not a different construction date. The wall plates, purlins, and collars of the whole roof were also oak timbers, but in these elements either the timbers contained relatively few rings, or elements like the lower purlins and wall plates were inaccessible. The main roof section, trusses T1–T8, had been extensively modified to suspend a ceiling for the hall below. These elements are softwood and probably date from the nineteenth or twentieth century.

The samples from this roof comprised 10 of the 20 principal rafters, one from each truss. Nine samples were found to cross-match, the composite sequence was found to date, and thus there are tree-ring dates for nine of these structural elements. The 157-year composite sequence was found to match composite sequences obtained from the surrounding regions at AD 1464 to AD 1620 inclusive.

The tree-ring analysis dates the rings present in the cores. The correct interpretation of those dates relies upon the characteristics of the final rings in them. Bark-edge survived on one of these timbers, significant amounts of sapwood on another one, and a small amount or the heartwood/sapwood boundaries were present on six of the remaining seven. Making allowances for minimum and maximum likely amounts of missing sapwood provides individual felling dates, or felling date ranges for each of the datable timbers.

Figure 6 and Table 1 includes the felling date or interpreted felling date ranges for each of the datable samples.

The interpretation of this material is fairly straightforward. The sample complete to bark edge retains a ring for AD 1620. The tree was growing sufficiently slowly at this stage that it did not prove possible to identify whether this was felled in mid-AD 1620 or in winter AD 1620/1. The calculated *terminus post quem* dates and felling date ranges for the remaining eight samples indicates this material is broadly, and likely to be precisely, contemporaneous. There is no suggestion any of this material is either reused or secondary. Trusses T9 and T10 are likely to be contemporary with trusses T1–T8 from the main section of the roof. This early 1620s construction date indicates that this part of the Duchy Palace complex was not destroyed in a fire reputed to have occurred during the Civil War period (Eric Berry pers comm).

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FIGURES

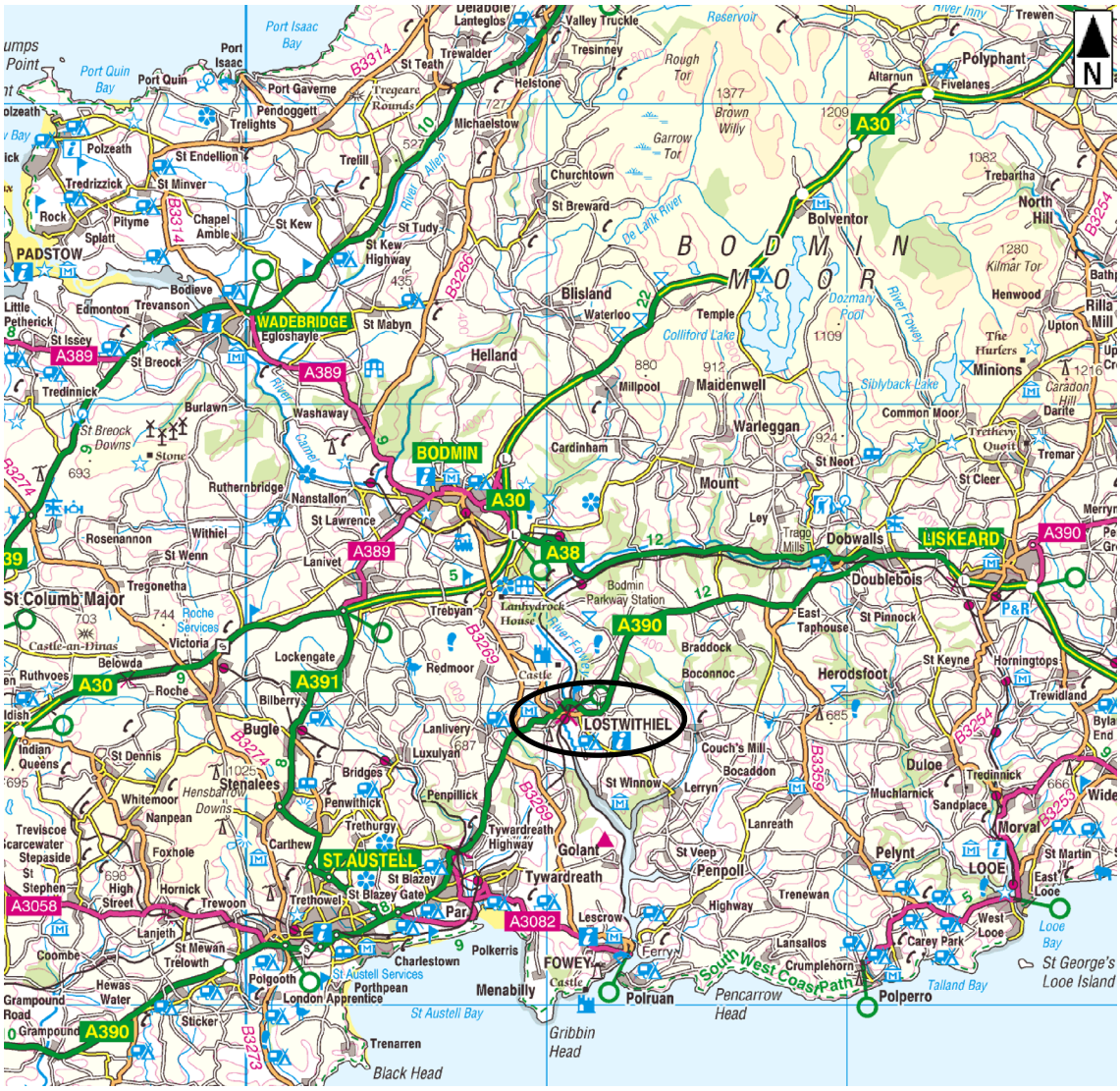

Figure 1. Location of Old Duchy Palace (circled).

Figure 2. Longitudinal section through the Old Duchy Palace, looking east, with approximate location of the roof trusses (T1–T10) (based on a drawing by Purcell Miller Tritton LLP)

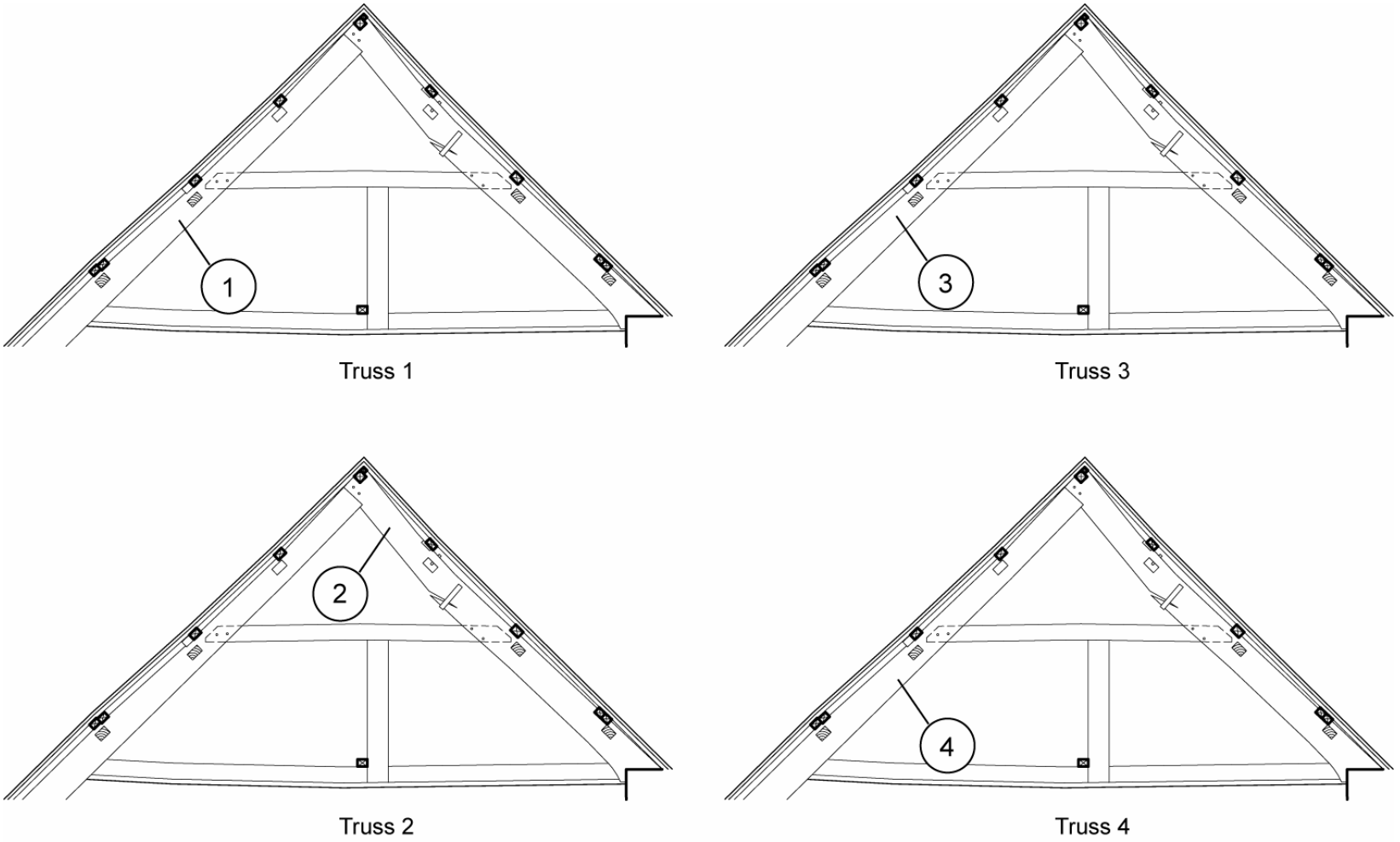

Figure 3. Sections through Trusses 1–4, looking north, indicating the positions of samples 1–4 (based on a drawing of Truss 4 by Purcell Miller Tritton LLP)

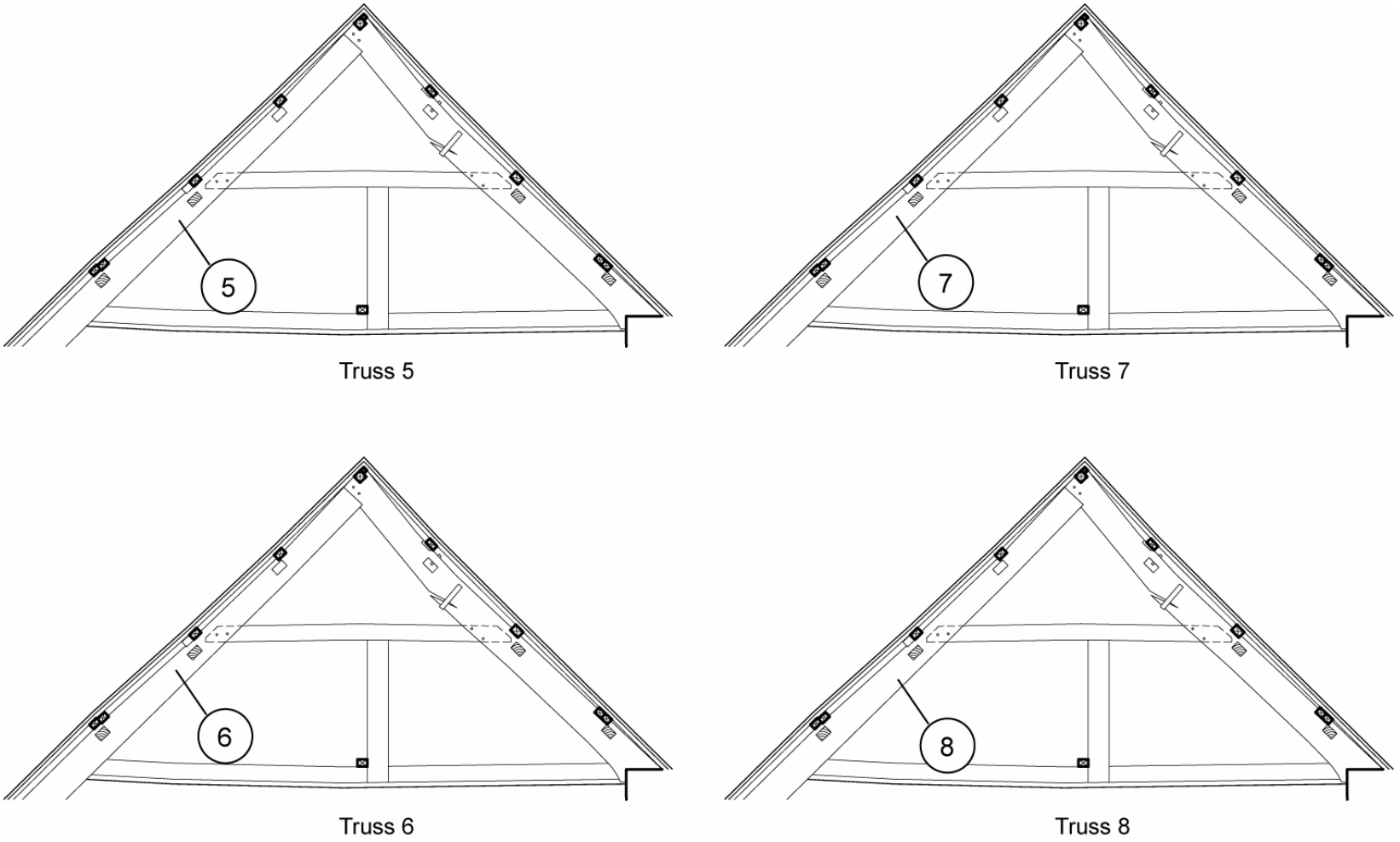

Figure 4. Sections through Trusses 5–8, looking north, indicating the positions of samples 5–8 (based on a drawing of Truss 4 by Purcell Miller Tritton LLP)

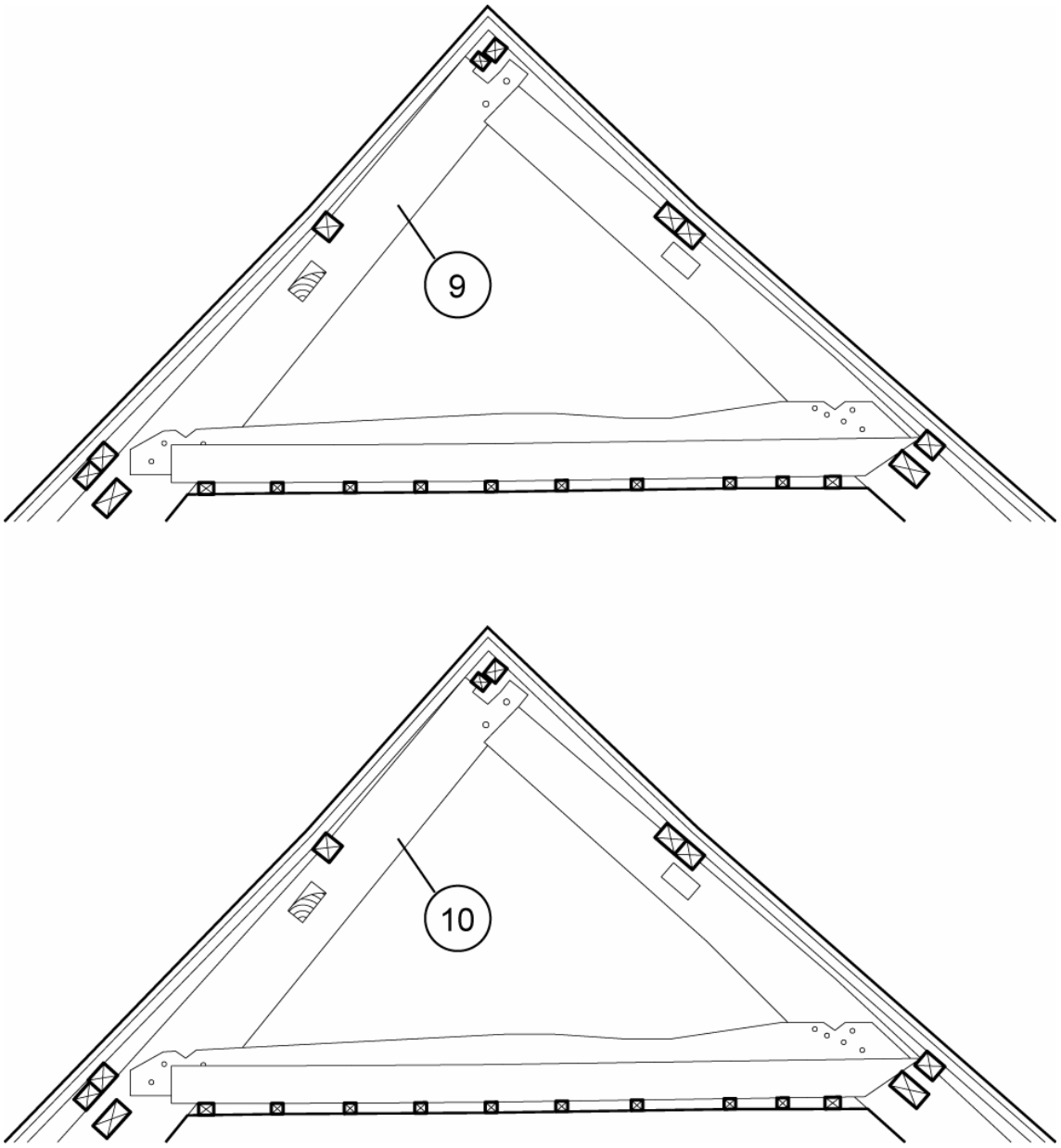

Figure 5. Sections through Trusses 9 and 10,, looking south, indicating the positions of samples 9 and 10 (based on a drawing of Truss 10 by Purcell Miller Tritton LLP)

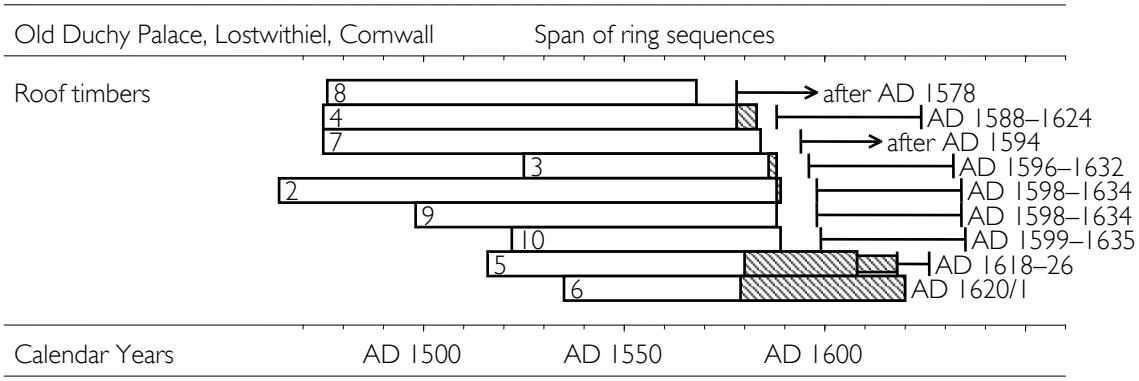

Figure 6 Bar diagram showing the absolute dating positions of the 9 dated tree-ring sequences for samples from the Old Duchy Palace. The interpreted felling dates are also shown for each sample

KEY White bars are oak heartwood, hatched bars are sapwood, the narrow bar represents unmeasured sapwood.

TABLES

Table 1. Details of the 10 samples from timbers from the Old Duchy Palace.

Sample	Location	Rings	Sap	Date of measured sequence	Interpreted result
1 (inner) 1 (outer)	T1, W principal rafter	54 44	- -	not dated not dated	- -
2	T2, E principal rafter	126	1	AD 1464–1589	AD 1598–1634
3	T3, W principal rafter	64	2	AD 1525–1588	AD 1596–1632
4	T4, W principal rafter	109	5	AD 1475–1583	AD 1588–1624
5	T5, W principal rafter	93	28+*10*	AD 1516–1608	AD 1618–26
6	T6, W principal rafter	86	41B	AD 1535–1620	AD 1620/1
7	T7, W principal rafter	110	-	AD 1475–1584	after AD 1594
8	T8, W principal rafter	93	-	AD 1476–1568	after AD 1578
9	T9, E principal rafter	91	h/s	AD 1498–1588	AD 1598–1634
10	T10, E principal rafter	68	h/s	AD 1522–1589	AD 1599–1635

KEY For approximate locations see Figures 2–5. T1–T10 roof trusses from north to south, E east, W west, H/S is heartwood/sapwood edge, B bark season indistinguishable, *italics* gives the estimated numbers of unmeasured rings.

Table 2. The t-values (Baillie and Pilcher 1973) between 9 sampled timbers from the roof of the Old Duchy Palace. – t-value less than 3.0.

	3	4	5	6	7	8	9	10
2	6.08	7.01	6.15	4.52	7.16	5.28	11.01	3.75
3		3.64	3.45	3.72	4.48	–	7.34	4.93
4			4.86	7.05	7.14	6.77	6.97	–
5				5.08	5.01	4.80	4.58	–
6					7.52	4.33	–	3.80
7						5.83	5.30	5.22
8							4.04	–
9								3.42

Table 3. Showing example t-values (Baillie and Pilcher 1973) between the final composite sequence constructed from the Old Duchy Palace and oak reference data.

Reference chronology	Lostwithiel ODP AD 1464–1620
Cornwall, Pendennis Castle nr Falmouth (Tyers 2004b)	5.79
Cornwall, St Martins Church East Looe 1 (Arnold *et al* 2006)	6.07
Cornwall, St Martins Church East Looe 2 (Arnold *et al* 2006)	4.64
Cornwall, The Gildhouse Poundstock (Arnold and Howard 2007)	4.41
Cornwall, Welltown Manor nr Boscastle (Tyers 2004c)	4.75
Devon, Crediton Holy Cross church (Tyers 2004a)	5.36
Devon, Ivy Cottage Bremridge Sandford (Groves 2005)	4.18
Devon, Warleigh House Tamerton Foliot (Howard *et al* 2006)	5.42

APPENDIX 1

odp1i

235	248	243	212	180	142	130	98	77	113
117	86	95	139	104	65	83	66	69	85
88	92	89	135	124	157	226	219	291	236
218	148	130	98	84	91	95	128	105	114
121	100	140	120	101	89	88	96	105	138
143	123	115	136						

odp1o

94	96	101	177	141	138	121	79	64	94
92	73	60	83	84	84	114	111	97	84
99	92	79	94	106	163	151	182	169	134
199	195	222	211	201	210	179	162	106	114
184	237	190	168						

odp2

144	192	213	215	196	155	170	145	122	117
143	188	178	141	97	83	111	138	138	168
186	244	277	252	206	177	169	192	144	150
152	203	218	177	132	161	117	124	115	113
134	133	125	122	133	128	117	134	118	120
156	123	127	110	119	94	125	158	214	138
129	128	117	130	143	149	124	175	128	94
133	119	164	179	151	139	146	154	126	190
110	95	108	115	100	126	94	87	87	100
74	68	73	85	79	104	90	89	122	101
88	110	100	84	82	118	114	121	87	99
110	85	68	77	65	80	84	72	72	82
94	75	94	111	90	89				

odp3

167	145	144	183	154	205	238	197	177	188
236	267	297	258	211	197	143	121	168	117
95	122	125	137	189	165	132	126	163	131
121	157	196	221	213	160	158	180	143	132
101	196	119	146	130	184	249	180	154	191
154	121	142	111	133	130	129	94	141	139
108	151	136	103						

odp4

121	162	99	105	82	103	88	57	89	116
173	171	153	146	109	125	158	90	134	130
141	154	144	102	87	90	105	91	124	137
138	101	61	84	102	44	69	98	107	141
98	96	108	88	97	93	141	191	125	142
116	96	113	199	176	82	167	153	108	136
171	241	338	196	145	169	131	119	132	121
66	102	97	111	132	83	97	90	101	90
97	91	92	79	93	75	81	107	77	87
91	109	70	70	106	83	122	113	93	140
124	107	95	72	67	80	79	95	96	

odp5

199	189	195	190	232	213	201	167	190	188
195	203	200	174	138	193	198	207	241	197
175	227	172	174	176	174	143	151	163	104
148	167	121	164	129	142	117	133	119	95
107	123	99	103	83	82	112	98	89	130
126	77	94	102	98	106	84	80	94	94
72	71	63	82	67	61	66	72	82	69
67	99	53	65	76	67	75	87	112	87
66	49	53	51	47	62	49	43	47	40
38	29	32							

odp6

169	212	187	121	102	138	104	104	148	129
83	105	99	100	112	67	86	84	89	87
95	100	148	142	111	100	120	119	93	75
86	104	70	79	106	74	108	95	78	83
97	90	80	75	98	93	82	67	73	104
88	113	224	170	144	103	112	113	119	130
126	99	103	118	74	84	72	71	82	82
75	89	57	55	41	63	82	58	54	45
42	49	37	49	50	36				

odp7

125	125	108	105	77	132	109	81	92	123
151	157	98	102	86	73	98	67	58	81
96	88	76	61	69	73	54	70	62	72
77	82	41	60	76	66	82	80	84	90
69	68	85	76	71	69	71	107	74	67
69	66	93	85	78	68	86	79	78	106
83	126	116	86	96	114	95	82	141	78
49	76	81	69	104	55	81	81	76	80
91	99	164	155	138	108	131	132	130	93
152	188	141	120	139	136	181	141	109	119
114	90	90	95	74	63	60	69	90	93

odp8

124	102	75	100	91	106	72	109	122	164
174	211	171	137	124	174	162	176	158	168
209	159	99	137	109	112	96	117	109	102
108	60	80	104	46	74	77	85	117	92
98	96	69	74	72	108	105	103	79	81
60	89	98	105	109	203	153	194	184	142
150	180	116	113	138	105	115	203	200	154
151	140	91	123	92	93	60	73	81	71
56	78	70	58	52	61	102	91	73	99
78	73	74							

odp9

114	111	108	91	104	110	101	114	105	104
144	153	104	177	152	157	185	134	135	113
165	113	116	210	229	108	130	135	127	153
192	189	167	245	216	168	254	223	244	283
184	142	166	128	108	149	106	79	114	123
118	155	122	107	126	139	120	101	117	132
129	205	170	152	168	135	133	120	117	89
98	86	145	152	124	112	150	120	93	105
91	100	108	90	98	121	154	110	136	112
116									

odp10

268	184	190	167	192	213	213	193	268	247
162	185	208	237	237	262	187	235	191	150
144	249	147	129	174	145	124	175	120	156
145	117	132	172	200	227	174	193	168	175
141	153	123	112	146	127	101	105	120	162
136	146	134	122	126	149	103	123	101	85
77	90	112	86	173	183	103	108		