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Hopton Castle
Shropshire

Tree-ring Analysis of Timbers

Nigel Nayling and Roderick Bale

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TREE-RING ANALYSIS OF TIMBERS

Nigel Nayling and Roderick Bale

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SUMMARY

Dendrochronological sampling and analysis was requested for a timber assemblage recovered from a blocked garderobe chute during restoration work on the ruined tower house. Dating was requested to help inform the context of the timbers and their place in the castle's history, as part of programme of repair and consolidation of the site. Eleven of the 21 samples taken matched against each other, and the mean ring-width sequence formed from these is dated as spanning AD 1400 to AD 1632 against a range of previously dated site master chronologies. Three of the dated samples included partial sapwood, providing a felling date range of AD1632–49, AD 1630–53, and AD1609–45 indicating a post-medieval date for the assemblage.

CONTRIBUTORS

Nigel Nayling and Roderick Bale

ACKNOWLEDGEMENTS

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ARCHIVE LOCATION

Shropshire Historic Environment Record
Historic Environment Team
Shropshire Council
Shirehall
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DATE OF INVESTIGATION

2010

CONTACT DETAILS

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CONTENTS

INTRODUCTION

This document is a technical archive report on the tree-ring analysis of samples recovered from timbers found in a blocked garderobe chute during restoration works at Hopton Castle, Shropshire. Dendrochronological sampling was requested to inform grant aided repairs to the Grade I listed building and Scheduled Ancient Monument (LEN 1054935), which was on the Heritage at Risk register. The dating progamme would also contribute to the better understanding of the history of the castle.

Hopton Castle is situated in the village of Hopton Castle, south-west Shropshire at around 150m OD (Fig 1). The castle was most likely founded in the twelfth century as a motte and bailey castle, with the stone castle being constructed in the late-thirteenth and early fourteenth century (Remfry 1994). The remains visible today are those of the early fourteenth-century stone keep standing upon the motte. Perhaps the most famous event in the history of the castle is the civil war siege of March AD 1644. Hopton was one of the few castles held in the west by Parliamentarian forces and the small garrison of around 30 were laid to siege by an estimated 500 Royalist troops. The garrison surrendered after two weeks on the understanding that the men be allowed to live. The Royalists reneged on this and killed the garrison, with 'Hopton Quarter' becoming a byword for treacherous treatment by your opponents. It would appear that the castle was uninhabited during the eighteenth and nineteenth centuries and gradually fell into disrepair and ruin.

In 1995 the Hopton Castle Preservation Trust was formed, and in 2006 the trust secured funding from the Heritage Lottery Fund and other sources to buy the castle and its surroundings. The sale was completed in 2008, and in 2009 work began on the exploration, repair, and consolidation of the ruined tower house, which was in urgent need of support.

METHODOLOGY

The site was visited by the authors in August 2010. The timbers that had been recovered from the garderobe chute were assessed for their suitability for dendrochronological dating. Timbers which were oak and thought to have at least 40–50 rings were selected for sampling. Cross-sectional slice samples were recovered using a hand saw with the assistance of Richard Morriss, building specialist.

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage (2004). The samples were cleaned using a combination of sanding and cutting with razor blades so that the ring-width sequences could be clearly discerned and measured. The complete sequence of growth rings in each sample was measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004). Cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) are employed to search for positions where the ring sequences are highly correlated against each other.

The ring-width series from cross-matching samples were combined into a site master sequence, which was compared with a range of oak reference chronologies from Britain and Northern Europe. The *t*-values reported below are 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 must be obtained from a range of independent sequences, and that satisfactory visual matching supports these positions. Correlated positions were checked visually using computerised ring-width plots.

Interpretation of any tree ring date is limited by whether sapwood or bark edge is present in a sample. Sapwood is distinguishable as lighter coloured band around the outer annual rings of a tree and represents the part of the tree that is alive. For British oaks the number of sapwood rings is estimated range from 10 to 46 (Bayliss and Tyers 2004), an estimate based on observations of many thousands of samples from living trees and archaeological wood. At a microscopic level, sapwood in oak is recognisable by the open earlywood vessels used for water and mineral transport. Heartwood earlywood vessels appear filled when viewed microscopically as the cell walls have collapsed (tyloses) and no longer form the living part of the tree. Should a sample contain sapwood and bark edge, the year and even season of felling can be inferred from a dated sample. Should partial sapwood be present the estimate of between 10 and 46 rings is used to infer a date range for the sample. In samples where there is no sapwood or microscopic sign of the heartwood/sapwood boundary a date will represent a *terminus post quem* (date after which) the parent timber must have been felled. The date in this case will refer to the date of the last complete annual ring and the felling of the timber will be at least ten years after the date of that final ring.

RESULTS AND INTERPRETATION

Details of individual samples taken from oak timbers found in the garderobe chute are given in Table 1. A total of 21 samples were taken, of which 19 were subsequently found to contain sufficient rings to merit analysis. Two of these (Hop_12 and Hop_20) could, however, not be reliably measured due to bands of very narrow rings. The ring-width data of all measured series are given in the Appendix. The tree-ring series from 13 samples were correlated with each other (Table 2), and a combined 233-ring mean series calculated (Hop_T13). Two further tree-ring series (Hop_02 and Hop_18) cross-matched with a *t*-value of 5.46 and were combined to form a 127-ring mean series (Hop_T2).

Both site mean sequences, Hop_T13 and Hop_T2, and the individual tree-ring series from the two unmatched samples were compared with known-age oak tree-ring chronologies from throughout Britain. The mean sequence Hop_T13 showed significant correlations with a number of reference chronologies from previously dated historic sites when it was dated as spanning AD 1400–1632 inclusive (Table 3). The mean sequence Hop_T2 showed significant correlations with a number of reference chronologies from previously dated historic sites when it was dated as spanning AD 1524–1650 inclusive (Table 4).

All fifteen dated samples are clearly broadly coeval (Fig 2). One sample was thought to retain sapwood complete to the bark edge but the outer few sapwood rings could not be reliably measured, thus a felling date of *c* AD 1655 is obtained for this timber. Four other samples retain partial sapwood. Employing a sapwood estimate of 10–46 rings (English Heritage 2004), and allowing for extant sapwood rings on these timbers, indicates felling date ranges for these timbers ranging from AD1609–45 (Hop_09) to AD 1634–70 (Hop_02). Another sample (Hop_17) possibly retained the heartwood/sapwood boundary (dating to AD 1601), and therefore may have a felling date range of AD 1611–47. The remaining nine samples have no trace of sapwood and thus have *terminus post quem* dates for felling ranging from after AD 1545 (Hop_08) to after AD 1622 (Hop_21).

DISCUSSION

Initial inspection of the timber assemblage and subsequent analysis showed that many of the samples were well-suited to tree-ring dating. Most were radially converted and contained a relatively high number of annual rings. However, given the partially decayed, and in some cases carbonised nature of some of the timbers, it proved impossible to recover samples with complete sapwood and bark. All the dated samples are fragments of radially converted planks which, given the estimated felling date ranges of those six with sapwood or heartwood/sapwood boundary, could have been used in construction prior to or after the civil war siege of AD 1644. The extensive charring of some of these timbers, and their presence in rubble found blocking the garderobe chutes might suggest association with the events surrounding the siege, but the tree-ring dates alone cannot provide definitive evidence for this.

REFERENCES

Arnold, A, and Howard, R, 2008 *Turton Tower, Chapeltown Road, Turton, Blackburn with Darwen, Lancashire, Tree-ring Analysis of Timbers*, English Heritage Res Dept Rep Ser, **93/2008**

Arnold, A, and Howard, R, 2009 *Bentley Hall, Derby Lane, Hungry Bentley, Derbyshire, Tree-ring Analysis of Timbers*, English Heritage Res Dept Rep Ser, **33/2009**

Arnold, A, and Howard, R, 2014 *Canons Garth, Helmsley, North Yorkshire, Tree-ring Analysis of Timbers*, English Heritage Res Rep Ser, **39/2014**

Arnold, A, Howard, R, and Litton, C, 2005 *Tree-Ring Analysis of Timbers from the Riding School, Bolsover Castle, Bolsover, Derbyshire*, Centre for Archaeol Rep, **40/2005**

Arnold, A, Howard, R, and Litton, C, 2006 *Guildhall, High Street, Worcester, Tree-ring Analysis of Timbers*, English Heritage Res Dept Rep Ser, **42/2006**

Baillie, M G L, and Pilcher, J R, 1973 A simple crossdating program for tree-ring research, *Tree Ring Bull*, **33**, 7–14

Bayliss, A, and Tyers, I, 2004 Interpreting radiocarbon dates using evidence from tree rings, *Radiocarbon*, **46(2)**, 957–64

Bridge, M, and Miles, D, 2011 *The Reader's House, Ludlow, Shropshire, Tree-ring Analysis of Timbers*, English Heritage Res Rep Ser, **108/2011**

English Heritage, 2004 *Dendrochronology: guidelines on producing and interpreting dendrochronological dates*, London

Howard, R E, Laxton, R R, and Litton, C D, 1999 *Tree-ring analysis of timbers from Bretby Hall, Bretby, Derbyshire,* Anc Mon Lab Rep, **43/99**

Howard, R E, Laxton, R R, and Litton, C D, 2000 *Tree-ring analysis of timbers from the buildings and living trees at Stoneleigh Abbey, Stoneleigh, Warwickshire,* Anc Mon Lab Rep, **80/2000**

Howard, R E, Laxton, R R, and Litton, C D, 2001 *Tree-ring analysis of timbers from the Solar and Chapel, St Briavel's Castle, Gloucestershire,* Centre for Archaeol Rep, **42/99**

Miles, D, Haddon-Reece, D, and Moran, M 1995 Tree-ring dates for buildings: List 64, *Vernacular Architect* , **26**, 60–74

Miles, D, 2007 *HM Tower of London (TOL((& TOL100), London Borough of Tower Hamlets, Tree-ring Dating of the White Tower*, English Heritage Res Dept Rep Ser, 35/2007

Munro, M A R, 1984 An improved algorithm for crossdating tree-ring series, *Tree Ring Bull*, 44, 17–27

Nayling, N, 2000 *Tree-ring analysis of oak timbers from the nave roof of the church of St Mary the Virgin, Bromfield, Shropshire*, Anc Mon Lab Rep, 69/2000

Nayling, N, 2001 *Tree-ring analysis of timbers from Lower Brockhampton Gatehouse, near Bromyard, Herefordshire*, Centre for Archaeol Rep, 98/2001

Remfry, P M, 1994 *Hopton Castle 1066 to 1305*, SCS Publishing, Edern

Tyers, I, 1999 *Dendrochronological analysis of timbers from Black Ladies, near Brewood, Staffordshire,* ARCUS Rep, 484

Tyers, I, 2002a *Tree-ring analysis of oak timbers from the Abbot's Hall and Parlour at Wigmore Abbey, near Adforton, Herefordshire*, Centre for Archaeol Rep, 112/2002

Tyers, I, 2002b *Dendrochronological analysis of timbers from the Croft Castle, Croft, Herefordshire*, Centre for Archaeol Rep, 574

Tyers, I, 2004 *Dendro for Windows Program Guide 3rd edn*, ARCUS Report, 500b

Tyers, I, 2010 *Old Manor House, Manningham, Bradford, Dendrochronological Analysis of Oak Timbers*, English Heritage Res Dept Rep Ser, 4/2010

Tyers, I, and Boswijk, G, 1998 *Tree-ring analysis of oak timbers from Dore Abbey, Abbey Dore, Hereforshire,* Anc Mon Lab Rep, 18/98

TABLES

Table 1: Details of the samples taken from oak (Quercus spp) timbers from Hopton Castle Total rings: +nn = unmeasured rings; ARW = average ring width of the measured rings; Sapwood: +?HS = possible heartwood/sapwood boundary; B = bark edge;. All samples were oak (Quercus spp)

Sample code	Origin of sample	Cross-section	Dimensions (mm)	Total rings	Sapwood	ARW mm/year	Date of sequence (AD)	Felling date / date range (AD)
hop_01	Timber 1. Fragment 360 x 300mm	Radial	300 x 25	152	-	1.78	1400–1551	after1561
hop_02	Timber 2. Rectangular fragment with 2 holes at one end, 425 x100mm	Quartered	90 x 80	94	7	1.19	1538–1631	1634–1670
hop_03	Timber 3. Fragment. 390 x 250mm	Radial	250 x 20	126	-	1.60	1450–1575	after 1585
hop_04	Timber 4. Sawn plank with split at one end. 1040 x 300mm	Radial	300 x 20	192	29	1.04	1441–1632	1632–1649
hop_05	Timber 5. Sawn plank with split at one end. 2070 x 290mm.	Radial	290 x 28	162	-	1.56	1437–1598	after 1608
hop_06	Timber 6. Sawn plank fragment. 510 x 220mm	Radial	210 x 25	124	23	1.36	1507–1630	1630–1653
hop_07	Timber 7. Fragment. 220 x 140mm	Radial	140 x 15	71	-	1.69	1473–1543	after 1553
hop_08	Timber 8. Fragment. 195 x 130mm.	Radial	140 x 20	47	-	2.70	1489–1535	after 1545
hop_09	Timber 9. Fragment. 1020 x 140mm.	Radial	140 x 20	86	8	1.65	1522–1607	1609–1645
hop_10	Timber 10. Fragment. 1020 x 200mm.	Radial	200 x 20	*c*15+115	-	1.49	undated	-
hop_11	Timber 11. Fragment with Fe fitting. 380 x 300mm.	Radial	300 x 25	*c*25+137	-	1.50	undated	-
hop_12	Timber 12. Fragment. 270 x 180mm.	Radial	300 x 25	*c*180	-	-	unmeasured	-
hop_13	Timber 13. Charred fragment with hole in middle. 310 x 160mm.	Radial	160 x 20	94	-	1.67	1468–1561	after 1571
hop_14	Timber 14. Charred fragment. 380 x 145mm.	Radial	145 x 20	86	-	1.65	1471–1556	after 1566
hop_15	Timber 15. Fragment. 740 x 170mm.	Tangential	170 x 20	20	-	-	unmeasured	-
hop_16	Timber 16. Charred fragment with vertical line of holes. 810 x 250mm.	Radial	250 x 20	128	-	1.72	1456–1583	after 1593
hop_17	Timber 17. Charred fragment. 850 x 290mm.	Radial	290 x 20	202	?HS	1.34	1400–1601	1611–1647?
hop_18	Timber 18. Fragment. 500 x 85mm.	Quartered	85 x 70	127+	39+*c*5B	0.56	1524–1650	*c*1655
hop_19	Timber 19. Fragment 330 x 100mm.	Radial	100 x 20	35	-	-	unmeasured	-
hop_20	Timber 20. Fragment 225 x 100mm. Unmeasurable	Radial	100 x 10	*c*85	-	-	unmeasured	-

hop_21	Timber 21. Partially charred fragment. 420 x 130mm.	Radial	130 x 22	53	-	1.31	1560–1612	after 1622

nn+ or +nn = unmeasured rings; ARW = average ring width of the measured rings; +?HS = possible heartwood/sapwood boundary; B = bark edge

Table 2: Correlation between eleven dated samples. These tree ring series were combined to form a single mean series Hop10_T11. *\ = overlap < 30 years, - = t-value less than 3.00, * = empty triangle*

	Hop_03	Hop_04	Hop_05	Hop_06	Hop_07	Hop_08	Hop_09	Hop_13	Hop_14	Hop_16	Hop_17	Hop_21
Hop_01	3.12	4.52	4.06	3.36	6.69	3.50	-	7.31	4.60	6.42	5.60	\
Hop_03	*	4.74	7.42	3.26	-	-	4.42	-	-	-	-	\
Hop_04	*	*	4.86	6.32	-	-	5.15	-	-	4.44	6.10	5.22
Hop_05	*	*	*	5.35	3.34	-	4.08	-	-	3.59	3.36	4.83
Hop_06	*	*	*	*	3.54	\	5.00	-	-	3.79	3.20	4.32
Hop_07	*	*	*	*	*	4.91	\	7.15	6.45	5.57	-	\
Hop_08	*	*	*	*	*	*	\	5.00	3.45	3.75	-	\
Hop_09	*	*	*	*	*	*	*	-	4.30	5.08	3.65	4.56
Hop_13	*	*	*	*	*	*	*	*	4.87	6.61	3.02	\
Hop_14	*	*	*	*	*	*	*	*	*	4.44	-	\
Hop_16	*	*	*	*	*	*	*	*	*	*	3.61	\
Hop_17	*	*	*	*	*	*	*	*	*	*	*	-

Table 3: Correlations between site master sequence Hop_T13 (AD 1400–1632) and reference chronologies from previously dated sites

Site Master	*t*-value
Wigmore Abbey, Herefordshire (Tyers 2002a)	12.53
Croft Castle, Herefordshire (Tyers 2002b)	11.77
Church of St Mary, Bromfield, Shropshire (Nayling 2000)	10.24
Black Ladies, near Brewood, Staffordshire (Tyers 1999)	10.07
The Guildhall, Worcestershire (Arnold *et al* 2006)	9.87
The Readers House, Ludlow, Shropshire (Bridge and Miles 2011)	9.82
Bedstone Manor Farm, Shropshire (Miles 1995)	9.82
Dore Abbey Church, Herefordshire (Tyers and Boswijk 1998)	9.61
St Briavels Castle, Gloucestershire (Howard *et al* 2001)	9.00
Lower Brockhampton Gatehouse, Bromyard, Herefordshire (Nayling 2001)	8.91

Table 4: Correlations between site master sequence Hop_T2 (AD 1524–1650) and reference chronologies from previously dated sites

Site Master	*t*-value
Old Manor House, Manningham, Bradford, West Yorkshire (Tyers 2010)	6.87
Bentley Hall, Hungry Bentley, Derbyshire (Arnold and Howard 2009)	6.75
Stoneleigh Abbey, Warwickshire (Howard et al 2000)	6.73
Black Ladies, near Brewood, Staffordshire (Tyers 1999)	6.64
Wigmore Abbey, Herefordshire (Tyers 2002a)	6.48
Canons Garth, Helmsley, North Yorkshire (Arnold and Howard 2014)	6.13
Riding School, Bolsover Castle, Derbyshire (Arnold *et al* 2005)	5.87
Turton Tower, near Bolton, Lancashire (Arnold and Howard 2008)	5.80
Bretby Hall, Bretby, Derbyshire (Howard *et al* 1999)	5.73
White Tower, Tower of London, Tower Hamlets, London (Miles 2007)	5.72

FIGURES

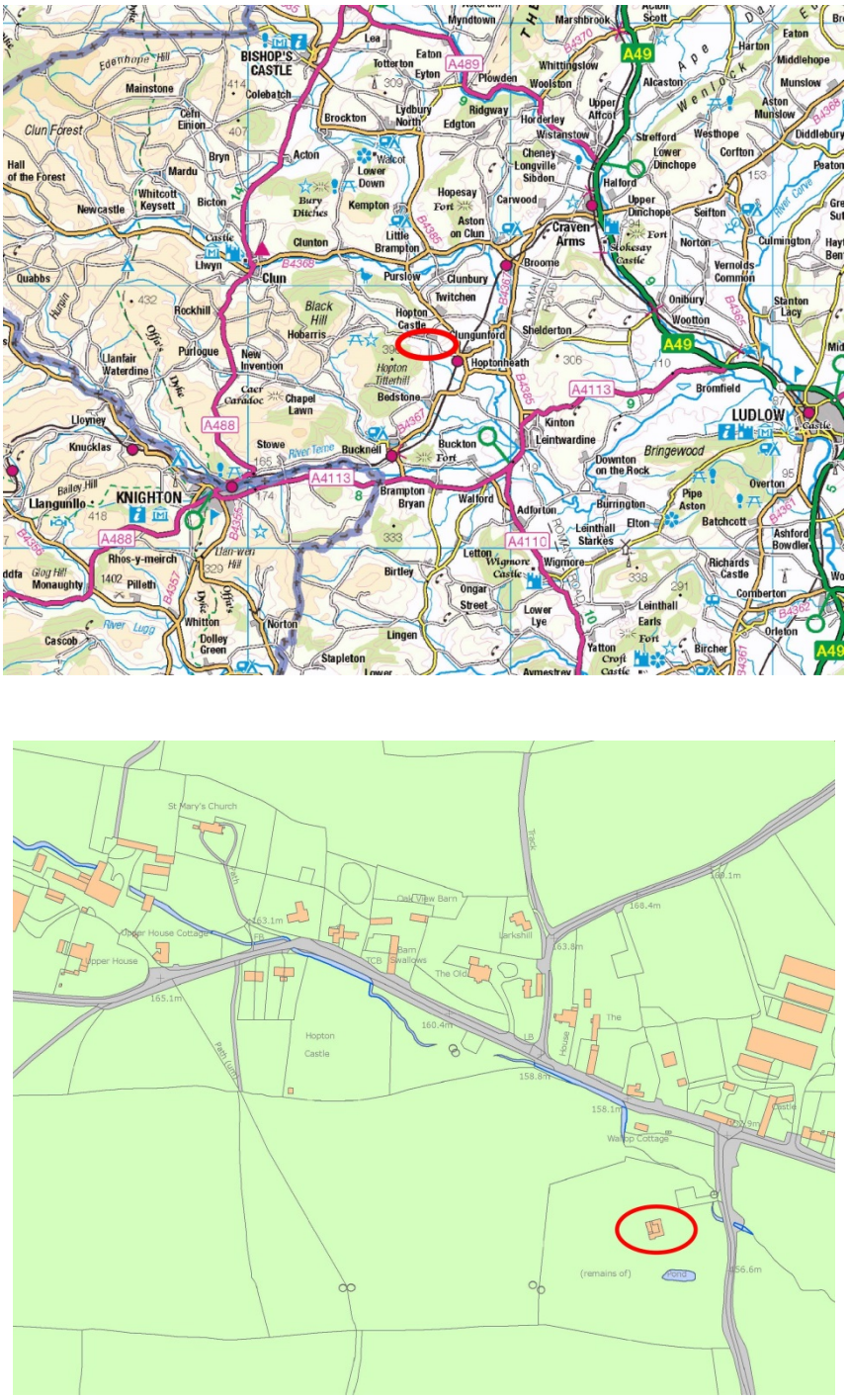

Figure 1a/b: Location of Hopton Castle circled in red. Scale (top) 1:150000 (bottom) 1:3000. © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England

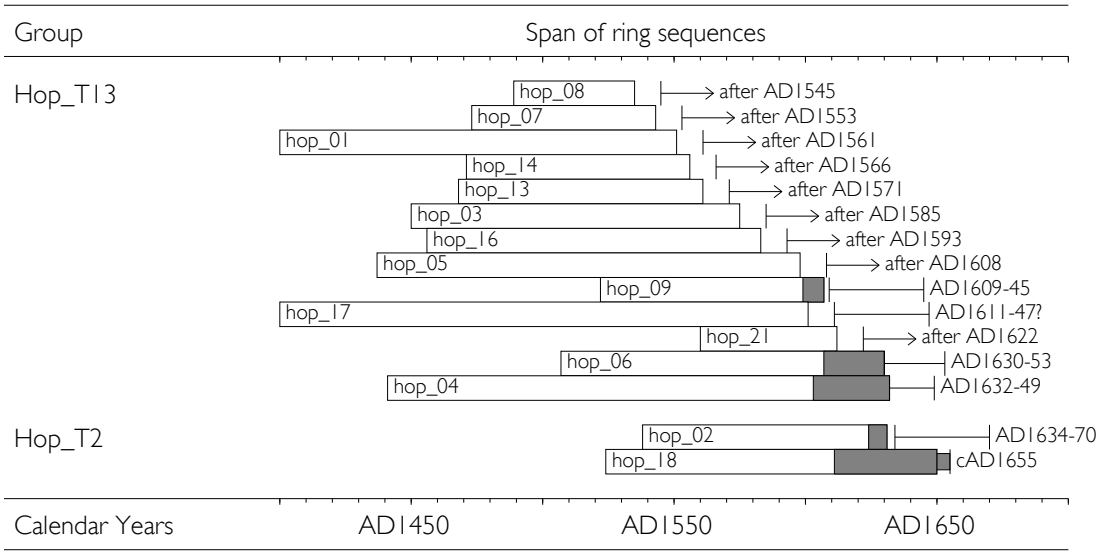

Figure 2: Bar diagram showing the relative positions of overlap of the ring series in both site master chronologies (Hop_T13 and Hop_T2) and their individual felling dates/date ranges. White bars: heartwood rings; grey bars: sapwood rings; narrow grey bars: unmeasured sapwood rings

APPENDIX

Measurements in 0.01mm units

Hop_01

366	358	449	579	399	473	334	263	327	430
379	263	383	278	335	301	357	273	262	143
158	228	214	286	281	261	250	351	368	383
286	239	354	242	285	281	192	250	198	121
208	231	172	169	201	178	152	152	268	201
151	183	158	169	185	174	161	141	132	88
89	58	69	89	82	75	87	107	93	123
120	101	77	111	135	187	171	148	154	129
110	128	79	88	145	110	172	173	120	96
114	100	80	109	140	130	174	122	106	111
116	111	93	132	117	119	139	145	106	87
85	93	79	123	101	96	102	134	122	151
89	195	194	137	146	111	104	78	123	132
167	182	122	119	127	194	148	121	150	143
198	163	154	121	94	143	133	105	131	181
130	160								

Hop_02

115	153	153	138	80	142	168	145	120	111
150	192	203	211	186	197	171	181	217	153
88	178	165	198	164	161	126	85	119	145
121	104	126	160	115	133	93	55	103	112
97	135	131	128	75	109	142	151	169	136
61	95	80	67	119	98	115	117	103	104
103	56	70	73	93	130	122	48	112	84
74	71	85	90	102	123	80	85	140	148
132	107	118	135	83	76	59	67	88	101
106	104	88	74						

Hop_03

124	158	112	133	140	142	296	267	145	110
106	191	148	214	126	114	169	163	225	276
179	118	91	104	121	159	169	205	267	205
122	176	121	165	191	215	213	209	239	296
228	190	106	146	212	180	226	198	145	159
138	125	125	136	114	132	155	279	184	110
57	110	155	185	141	118	121	139	130	238
226	215	164	111	140	91	132	134	194	174
158	191	152	175	149	157	166	142	154	151
203	166	135	153	144	164	109	115	136	186
210	201	132	130	105	108	130	148	171	158
199	177	174	142	167	135	95	104	128	167
175	167	131	125	127	113				

Hop_04

162	118	114	142	155	118	132	175	144	105
114	123	137	125	109	148	149	131	120	130

142 132 131 105 90 125 128 118 110 104
79 66 89 94 122 167 257 167 161 173
142 103 100 141 169 140 183 146 193 164
100 71 96 204 171 96 78 86 93 81
131 100 112 97 103 128 100 99 81 78
130 141 122 101 85 95 89 112 92 78
119 166 104 109 85 90 83 97 88 103
113 98 133 125 160 128 104 98 114 141
143 113 108 100 87 79 57 97 77 94
102 102 93 90 81 70 106 94 103 117
104 92 83 92 74 54 56 70 98 94
108 100 90 87 83 84 102 91 91 115
109 90 86 110 98 87 89 87 94 81
93 98 96 98 99 89 73 79 77 73
65 65 90 100 70 105 90 84 77 81
91 71 113 67 62 61 53 83 71 82
84 87 95 53 55 68 60 67 69 66
91 64

Hop_05
164 150 110 175 217 146 206 194 212 199
195 210 182 162 233 184 227 292 207 247
244 148 134 155 260 432 292 117 80 157
176 150 182 157 125 257 234 212 231 221
176 289 234 192 141 109 152 154 201 141
328 249 235 223 136 96 125 153 173 171
117 136 124 175 149 129 123 141 117 158
334 205 114 95 128 146 125 146 119 91
117 149 290 151 151 162 121 117 84 93
99 278 187 131 159 102 86 104 126 133
95 125 106 155 143 102 120 106 129 96
96 112 140 132 199 118 103 94 102 102
137 142 163 128 144 161 135 158 110 83
71 101 167 181 139 116 130 117 115 128
135 124 134 169 123 116 106 155 158 139
136 119 130 86 128 169 114 133 141 143
179 136

Hop_06
133 105 116 99 117 119 95 98 78 103
113 109 129 119 150 171 114 139 108 108
85 131 152 165 210 151 140 162 180 181
169 183 156 226 243 109 116 109 129 122
178 167 203 170 137 108 99 90 87 71
107 126 120 150 130 162 109 125 96 70
66 84 134 288 152 118 84 91 95 94
147 119 89 142 127 120 88 145 137 136
134 114 147 103 140 171 154 144 168 153
149 156 130 137 121 151 206 186 159 173
154 167 155 162 146 126 203 193 107 110
112 171 155 165 147 168 136 97 112 116
121 135 155 126

Hop_07

150	186	244	196	213	273	348	253	232	147
152	186	188	199	262	172	131	144	130	90
167	126	157	181	220	128	173	158	126	144
128	128	134	156	171	142	148	120	134	130
136	160	158	177	167	177	166	125	187	203
147	155	143	120	114	119	137	125	182	147
178	150	242	225	175	166	178	211	192	176
164									

Hop_08

274	336	273	153	250	282	249	337	244	129
125	256	243	327	276	228	345	327	506	311
420	285	259	288	292	251	231	249	311	296
381	269	307	366	206	331	253	272	175	157
149	176	294	255	248	271	220			

Hop_09

157	81	134	111	93	75	112	101	104	188
201	176	156	191	195	243	221	199	231	238
157	191	151	150	137	132	158	184	164	209
157	153	111	151	110	153	168	165	268	211
167	143	152	119	65	88	105	202	201	303
192	189	156	92	84	122	109	122	179	177
150	106	161	156	150	186	171	241	158	157
227	294	239	168	140	117	155	115	112	122
244	244	407	216	203	138				

Hop_10

134	113	92	117	105	103	105	105	128	123
132	135	174	155	160	125	127	208	348	252
196	126	102	121	83	93	109	136	281	230
128	101	91	120	105	89	134	138	126	244
199	137	125	141	155	141	117	107	112	127
119	120	138	221	160	202	128	197	88	97
99	173	140	150	182	134	139	144	192	199
200	168	168	195	206	184	159	183	133	118
114	139	180	170	180	153	146	102	117	113
160	190	171	167	203	223	143	164	157	80

Hop_11

118	120	170	153	134	107	114	154	150	190
183	193	156	248	332	249	198	219	286	249
175	291	232	191	160	102	99	113	115	154
186	136	107	148	141	107	138	133	147	140
269	197	178	163	129	174	179	136	158	228
115	107	128	113	195	151	157	140	176	115
116	80	140	140	98	189	124	168	168	181
248	180	171	167	168	228	136	117	129	136
127	165	174	173	267	262	167	125	110	102
67	106	129	132	105	102	140	120	137	111
86	63	87	178	278	130	125	112	102	86
99	72	77	109	81	111	112	101	90	123

108 92 118 105 168 115 143 164 175 309
208 151 144 166 88 123 124

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196 200 275 154 135 159 200 209 201 200
187 334 270 270 115 138 182 142 205 226
149 130 147 132 79 122 143 162 203 205
142 121 168 138 137 162 165 183 179 217
107 148 150 114 117 151 122 187 214 153
127 146 106 199 200 135 165 152 153 105
132 127 144 179 143 187 201 270 208 176
138 168 230 197 176 154 138 129 126 127
184 146 177 152 140 147 120 111 147 153
183 194 226 209

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119 115 138 171 179 164 180 172 260 97
274 130 171 166 163 248 346 253 147 157
96 86 152 158 150 205 288 166 188 171
100 149 132 136 168 170 208 141 163 183
182 129 159 150 138 121 119 165 160 118
146 198 144 161 135 123 99 147 134 154
182 156 170 157 190 204 229 236 236 231
222 155 153 148 142 153 151 190 162 175
160 171 149 106 92 94

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250 179 201 175 175 178 118 133 123 155
117 299 263 222 170 163 132 160 226 229
243 243 181 189 185 206 125 139 198 217
160 275 210 160 179 107 107 155 130 180
191 175 142 142 173 163 133 176 157 204
207 251 158 143 155 124 127 159 150 131
198 174 167 230 115 199 253 194 247 219
144 127 146 174 147 239 191 204 196 309
178 198 196 183 234 207 157 169 137 153
145 134 165 191 191 208 172 176 129 85
126 177 150 184 242 169 196 177 201 145
93 114 105 174 137 133 134 140 129 106
115 145 98 125 220 168 182 126

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377 440 474 570 506 457 420 343 228 180
126 90 136 128 114 124 107 141 122 65
70 125 132 159 145 141 125 144 211 234
165 203 227 140 160 194 179 153 146 95
127 148 97 112 117 168 173 172 177 148
85 120 134 139 155 139 152 186 147 139
152 162 188 150 117 142 150 160 150 125
118 116 98 139 182 145 176 252 165 197
139 136 110 100 158 173 189 180 130 143
137 119 118 128 154 181 279 169 200 172
144 122 117 130 116 126 163 113 81 105

116	125	214	202	129	104	82	105	124	119
94	106	130	85	93	96	88	75	86	76
86	88	98	130	97	131	107	110	89	86
97	113	99	93	98	70	82	82	95	114
93	97	90	96	100	107	99	97	112	110
125	94	97	80	99	72	50	48	66	83
85	86	84	64	60	70	64	52	46	65
64	82	62	74	89	81	85	91	90	104
63	83	84	93	79	103	81	83	80	63
78	81								

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83	49	61	66	91	82	65	91	95	74
74	95	89	96	73	79	107	81	67	44
48	45	40	58	70	96	97	70	57	85
69	66	70	62	34	73	74	78	67	45
31	32	29	45	63	45	63	72	69	51
38	36	37	41	37	52	60	63	40	48
52	59	64	59	31	30	31	26	40	33
38	61	63	46	37	27	28	41	34	52
40	40	36	42	41	37	47	34	31	52
39	31	43	39	62	55	60	49	52	31
32	43	39	47	57	72	84	72	70	45
29	46	41	100	133	72	98	75	51	23
26	28	48	57	76	79	62			

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137	205	201	151	134	132	86	74	104	166
128	135	127	119	114	96	109	151	129	121
158	176	173	120	147	146	157	144	110	166
82	110	160	139	136	160	117	103	106	109
84	119	102	147	164	122	140	111	126	97
125	139	143							

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