Historic England

Research Report Series 50/2024

Harvard House, 26 High Street, Stratford-upon-Avon, Warwickshire

Tree-ring Analysis of Oak Timbers

Martin Bridge

Scientific Dating

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National Grid Reference: SP 20113 54880

Print: ISSN 2398-3841
Online: ISSN 2059-4453

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Summary

Four primary timbers were dated and are clearly coeval, one retaining complete sapwood coming from a tree felled in summer AD 1594. This supports the ‘1596’ inscription for the construction of the building. The rear bay was mostly of elm and was not dated.

Contributors

Martin Bridge

Acknowledgements

We would like to thank the Shakespeare Birthplace Trust for access, and the *Stratfire* project team for their assistance, especially Jonathan Devereux, Ric Tyler, Bob Bearman and Nat Alcock. This study was commissioned by Shahina Farid and Emma Brownlee kindly supplied Figure 1 (both of the HE Scientific Dating Team). Cathy Tyers (HE Dendrochronologist) is thanked for her assistance throughout the production of this report.

Front cover image

Harvard House, 26 High Street, Stratford-upon-Avon, Warwickshire [photograph Martin Bridge]

Archive location

Historic England Archive, The Engine House, Fire Fly Avenue, Swindon SN2 2EH.

Historic environment record

Warwickshire Historic Environment Record, Archaeological Information and Advice, Communities, Warwickshire County Council, PO Box 43, Shire Hall, Warwick CV34 4SX

Date of investigation

2024

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Introduction

This building was investigated as part of the *StratFire* project, a project proposed by the Stratford-upon-Avon Society and subsequently supported by Historic England.

The project focuses on the impact of two major fires in the late-sixteenth century in AD 1594 and AD 1595, as well as taking into account another major fire in AD 1614. Bearman (2000) investigated the two late-sixteenth fires in detail using documentary sources. Subsequently the Stratford-upon-Avon Society have been highlighting the architectural heritage along the main thoroughfare through on-going volunteer-led research (Historic Spine (stratfordsociety.co.uk)) which has itself led to the development of the *StratFire* project (StratFire Project (stratfordsociety.co.uk)) which combines detailed archival research with comprehensive building recording and analysis, as well as dendrochronology. The project summary, as per the final agreed project design (Historic England Project number 8452) is as follows:

"The aim of this project, by means of high-level building recording and analysis, detailed archival research and dendrochronology, is to establish, following Stratford-upon-Avon's town fires of 1594 and 1595, the chronology, extent and nature of the reconstruction of buildings along High Street and Chapel Street, the epicentre of one or both of these fires. Post-fire documentary sources record damage to certain buildings, and architectural appraisal indicates that several timber-framed buildings surviving today date from the post-fire period. However, more needs to be established concerning the scale, nature and speed of this rebuilding, and the impact of the fires, both on the economic well-being of the town and the fortunes of the families most seriously affected. For many buildings there is simply no documentary evidence to draw on. Moreover, even when documentary evidence exists, it is either confusing or only establishes a date by which rebuilding had taken place. Conversely, it may record fire damage to properties that, from surviving architectural features, appear not to have been entirely rebuilt. High-level building analysis and dendrochronological investigation will resolve much of this uncertainty, provide a sound base for the interpretation of the documentary evidence, and throw definitive light on a crucial episode in the evolution of the architectural and cultural heritage of this internationally renowned town."

Harvard House

Harvard House is listed at Grade I (LEN 1298524) and occupies a narrow plot on the west side of the High Street, north of Ely Street (Fig. 1). Meeson (2001 unpubl) sets out the

development of the property, concluding that the present building was built in AD 1595/6 between two existing buildings, the south wall of Harvard House being built up against the pre-existing north wall of the Garrick Inn, and probably also up against an existing building to the rear, which has been subsequently dismantled and replaced. An inscription on the front (east) reads ‘1596’ but is of uncertain origin, with the present study aiming to assess the authenticity of this inscription. Meeson identifies several changes to the position of stairs and to the building at the rear (west), and extensive renovation of the timbers on the façade around AD 1900. This is one reason for the doubt over the provenance of the ‘1596’ carving.

Figure 1: Maps to show the location of Harvard House, 26 High Street, Stratford-upon-Avon. Scale: top-right 1:200,000; bottom 1:1000. © Crown Copyright and database right 2024. All rights reserved. Ordnance Survey Licence number 100024900.

Methodology

An initial assessment of the timbers for dendrochronological potential sought accessible timbers with more than 50 rings and where possible traces of sapwood, although slightly shorter sequences are sometimes sampled if little other material is available. Initial assessment suggested that most timbers were considered marginal in terms of the number of rings available. Those timbers judged to be potentially most useful were cored in April 2024, using a 16mm auger attached to an electric drill. The cores were labelled and stored for subsequent analysis.

The cores were polished on a belt sander using 80 to 400 grit abrasive paper to allow the ring boundaries to be clearly distinguished. The samples had their tree-ring sequences measured to an accuracy of 0.01mm, using a specially constructed system utilising a binocular microscope with the sample mounted on a travelling stage with a linear transducer linked to a PC, which recorded the ring widths into a dataset. The software used in measuring and subsequent analysis was written by Ian Tyers (2004). Cross-matching was attempted by a process of qualified statistical comparison by computer, supported by visual checks. The ring-width series were compared for statistical cross-matching, using a variant of the Belfast CROS program (Baillie and Pilcher 1973). Ring sequences were plotted on the computer monitor to allow visual comparisons to be made between sequences. This method provides a measure of quality control in identifying any potential errors in the measurements when the samples cross-match.

In comparing one sample or site master against other samples or chronologies, *t*-values over 3.5 are considered significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value in the range of 5, 6 and higher, and for these to be well replicated from different, independent chronologies with both local and regional chronologies well represented, except where imported timbers are identified. Where two individual samples match together with a *t*-value of 10 or above, and visually exhibit exceptionally similar ring patterns, they may have originated from the same parent tree. Same-tree matches can also be identified through the external characteristics of the timber itself, such as knots and shake patterns. Lower *t*-values however do not preclude same tree derivation.

Ascribing felling dates and date ranges

Once a tree-ring sequence has been firmly dated in time, a felling date, or date range, is ascribed where possible. With samples which have sapwood complete to the underside of,

or including bark, this process is relatively straightforward. Depending on the completeness of the final ring (i.e. if it has only the spring vessels or earlywood formed, or the latewood or summer growth) a precise felling date and season can be given. If the sapwood is partially missing, or if only a heartwood/sapwood transition boundary survives, then an estimated felling date range can be given for each sample. The number of sapwood rings can be estimated by using an empirically derived sapwood estimate with a given confidence limit. If no sapwood or heartwood/sapwood boundary survives then the minimum number of sapwood rings from the appropriate sapwood estimate is added to the last measured ring to give a *terminus post quem* (*tpq*) or felled-after date.

A review of the geographical distribution of dated sapwood data from historic timbers has shown that a sapwood estimate relevant to the region of origin should be used in interpretation, which for oak in this area is 9–41 rings (Miles 1997). It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure or object under study.

Results and Interpretation

Details of the samples taken are shown in Table 1, with the positions of the timbers shown in Figures 2 and 3. The ring-width measurements for all samples are given in the Appendix.

Two cores broke during sampling and are treated as separate sequences, as in each case the breaks were not clean. Three complete cores had less than 50 rings and are therefore borderline in their suitability for secure dating purposes. In addition, samples harv03, harv05 and harv09 contained aberrant growth patterns, resulting in bands of very narrow rings, thus hampering secure matching and dating. Sample harv08, from a principal rafter, was elm (*Ulmus* spp) and it was noted that many other timbers in that rear bay were also of elm and were not sampled. All other samples were oak (*Quercus* spp).

Four ring-width series cross-matched (Table 2) and were combined to form a 92-year long site chronology (HARVARD1) that was subsequently dated to the period AD 1502–93, the strongest matches with reference chronologies being shown in Table 3. No cross-matching was identified for the remaining series, nor was any consistent cross-dating identified when these individual series were compared to the reference chronologies.

Four timbers have therefore been securely dated (Table 1; Fig. 4). One of these samples retained complete sapwood, coming from a tree felled in summer AD 1594. The three other dated samples are clearly broadly coeval, their felling date ranges or *terminus post quem* felling date being consistent with also having been felled in, or around, AD 1594.

Table 1: Details of samples taken from Harvard House, 26 High Street, Stratford-upon-Avon.

Sample No	Location	No rings	Date of measured sequence AD	Sapwood	Mean ring width (mm)	Mean sensitivity	Felling date range AD
Second Floor							
harv01	North wallplate on east end of roof (Rm S1)	83	1502–84	10 (+8NM)	2.01	0.16	1592–1615
harv02	North purlin (Rm S1)	48	-	10	2.83	0.21	-
harv03	North post, truss 2	72	1507–78	h/s (+12NM)	2.24	0.30	1590–1619
harv04	North principal rafter, truss 2	42	-	h/s (+16NM)	1.69	0.28	-
harv05	North wallplate (Rm S2)	60	-	13½C	1.71	0.17	-
harv06i	North post, truss 3 (inner rings)	32	-	-	2.34	0.23	-
harv06ii	North post, truss 3 (outer rings)	47	1526–72	-	1.74	0.24	after 1581
harv07i	Tiebeam, truss 4 (inner rings)	36	-	-	1.79	0.16	-
harv07ii	Tiebeam, truss 4 (outer rings)	12	-	-	2.88	0.27	-
harv08	South principal rafter, truss 4 (elm)	32	-	6	3.44	0.34	-
First Floor							
harv09	South door jamb at top of stairs	75	-	15 (+1NM)	1.64	0.28	-
harv10	East door jamb in north wall	89	1505–93	27½C	1.16	0.23	summer 1594

Key: h/s = heartwood/sapwood boundary; ½C = complete sapwood, felled the following summer; NM = not measured

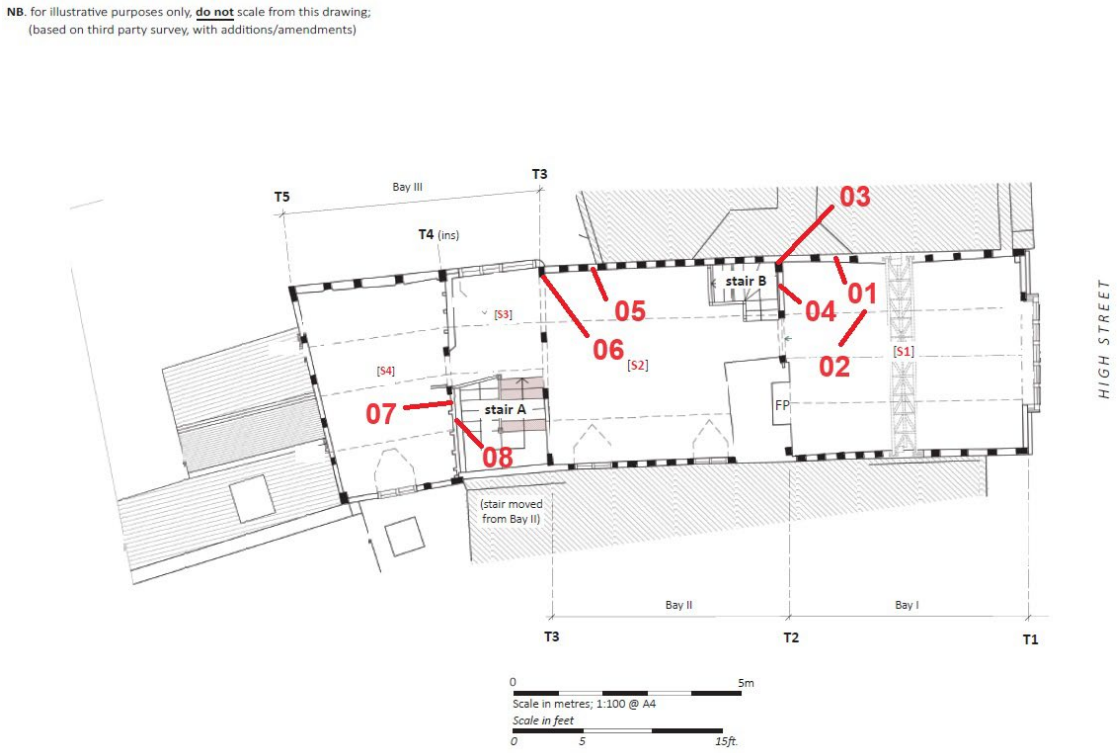

Figure 2: Plan of the second floor, showing the locations of timbers sampled for dendrochronology. [adapted from an original drawing by Ric Tyler]

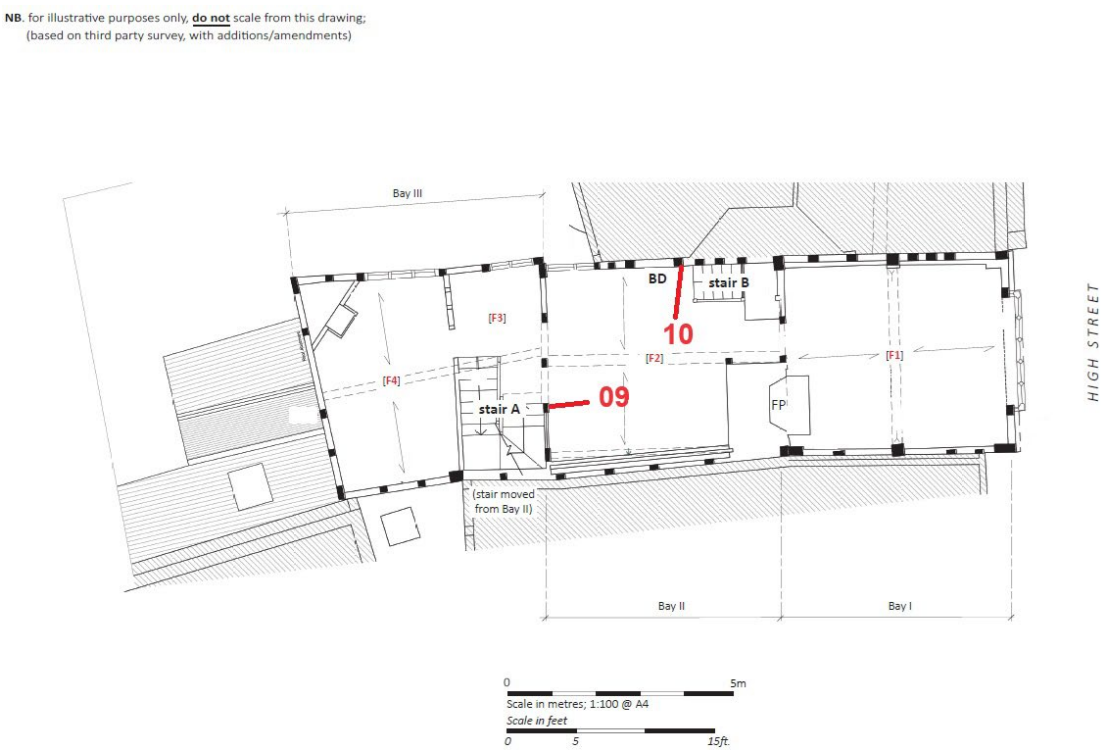

Figure 3: Plan of the first floor, showing the locations of timbers sampled for dendrochronology. [adapted from an original drawing by Ric Tyler]

Table 2: Cross-matching between the dated series from Harvard House, Stratford-upon-Avon (*t*-values above 3.5 are significant).

	t-values		
Sample No	harv03	harv06ii	harv10
harv01	4.5	3.5	6.0
harv03		5.3	3.8
harv06ii			3.7

Table 3: Strongest matches for site chronology HARVARD1, dated AD 1502–93.

Source region	Chronology	Publication reference	Filename	Span of chronology (AD)	Overlap (years)	*t*-value
Warwickshire	Palmer's Farm, Wilmcote	Miles and Worthington 2000	ARDEN3	1454–1580	79	9.7
Warwickshire	Halls Croft, Stratford-upon-Avon	Miles and Worthington 1999	HLSCROFT	1429–1648	92	9.7
Warwickshire	Falcon Inn, Stratford-on-Avon	Bridge and Miles 2018	FALCt10	1398–1621	92	9.3
Warwickshire	Middleton Hall	Arnold et al. 2006	MIDHSQ02	1390–1646	92	9.0
Warwickshire	Baddesley Clinton	Miles and Worthington 2002	BADESLY3	1423–1577	76	8.7
Warwickshire	Shakespeare Hotel, Stratford-upon-Avon	Bridge and Tyers 2024	SHAKAt4	1506–1622	88	8.4
Warwickshire	Wellesborne Granary	Miles and Haddon-Reece 1996	WELLSBRN	1431–1639	92	8.1
Shropshire	Cherrington Manor	Miles and Worthington 2000	CHERGTN	1386–1635	92	8.1
Herefordshire	Mynde, Dewchurch	Nayling 2001	MYNDEt10	1392–1619	92	8.0
Shropshire	High Ercall Hall	Miles and Worthington 2002	HIERCALL	1390–1607	92	7.9

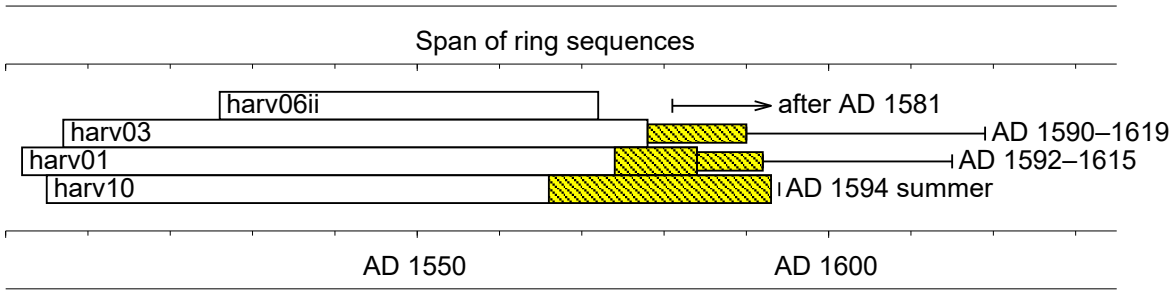

Figure 4: Bar diagram showing the relative positions of overlap of the dated timbers from Harvard House, 26 High Street, Stratford-upon-Avon. White sections represent heartwood rings, yellow hatched bars represent sapwood rings, narrow sections represent additional unmeasured rings.

Discussion

The four dated timbers were most likely felled at the same time in, or around, summer AD 1594. This supports the construction date of AD 1595/6 proposed by Meeson (2001 unpubl) and the ‘1596’ carving on the front of the building. The felling of the timbers coincides with the major fire in 1594.

The cross-matching with available site chronologies shows the strongest similarities (Table 3) with sites in Warwickshire, including three in Stratford-upon-Avon itself, and one just a few miles away (Wilmcote), suggesting that the timber was sourced very locally.

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Appendix

Ring width values (0.01mm) for the sequences measured

harv01

347	330	401	441	284	277	316	403	375	363
410	409	328	389	260	282	273	299	263	242
306	212	233	187	242	244	240	198	168	244
141	119	94	114	155	151	159	186	220	236
190	187	150	175	178	177	208	197	182	198
176	163	174	183	114	118	117	157	118	143
101	109	142	114	102	93	121	152	145	177
148	128	119	141	124	144	103	142	159	87
77	114	123							

harv02

396	330	324	206	206	246	257	185	297	428
421	242	320	177	138	187	320	425	342	389
256	301	285	238	317	342	421	367	377	228
233	215	184	195	242	196	143	174	208	231
280	385	367	356	342	262	352	231		

harv03

196	322	542	322	320	276	435	347	453	325
563	615	362	301	113	62	50	44	64	105
116	148	159	90	305	204	270	274	428	374
455	448	444	502	389	194	264	237	237	209
121	89	84	83	145	111	209	264	234	96
115	119	299	270	338	293	203	263	121	44
38	52	58	74	134	134	123	128	105	78
79	69								

harv04

217	164	306	204	197	247	91	199	180	158
203	185	189	183	141	170	233	192	205	283
199	114	152	289	257	211	86	94	102	100
81	145	191	150	178	164	86	99	150	152
86	76								

harv05

267	307	255	245	260	304	234	278	226	236
310	211	110	55	59	139	179	201	239	251
307	284	249	240	143	167	131	143	132	210
185	233	204	175	175	180	107	99	111	120
110	115	116	106	126	158	125	121	136	101
117	124	109	108	103	106	111	113	111	97

harv06i

110	197	216	284	152	191	241	193	226	225

197 205 183 172 190 223 190 221 104 131
297 335 224 282 361 337 236 223 199 257
453 425

harv06ii
90 112 135 113 109 237 182 147 169 261
231 285 345 293 372 307 159 141 139 131
132 155 104 106 109 85 137 198 224 198
95 84 93 173 213 278 235 178 145 134
93 78 143 173 301 209 170

harv07i
292 236 317 303 277 210 234 215 229 206
175 102 91 111 99 85 119 156 133 143
176 150 188 231 199 213 216 185 211 150
161 174 139 113 101 109

harv07ii
329 452 387 496 380 220 128 123 165 245
296 230

harv08
227 377 431 320 490 293 529 623 411 279
428 582 603 507 135 153 243 229 288 309
344 125 193 393 262 370 297 201 274 246
433 405

harv09
137 106 456 286 138 127 139 128 247 217
138 133 148 172 174 156 268 98 56 85
92 104 86 88 108 121 149 80 129 72
66 39 45 78 93 155 164 205 242 182
181 138 110 231 147 208 244 234 334 348
227 204 208 254 267 325 230 283 258 216
196 267 132 50 47 49 89 112 141 131
171 138 159 152 120

harv10
331 189 74 82 129 97 116 127 140 119
87 100 57 94 136 127 144 101 94 96
75 115 124 97 97 60 131 112 104 82
143 161 148 134 128 127 170 78 123 132
140 112 102 147 138 126 151 140 126 126
157 98 95 100 115 158 141 190 120 163
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ISSN 2398-3841 (Print)
ISSN 2059-4453 (Online)