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Tudor House, 23 and 24 High Street, Stratford-upon-Avon, Warwickshire

Tree-ring Analysis of Oak and Elm Timbers

Martin Bridge

Scientific Dating

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Summary

A very limited number of the accessible timbers of interest were considered potentially suitable for dendrochronological analysis. Only eight samples were taken, five from oak timbers and three from elm timbers.

Contributors

Martin Bridge

Acknowledgements

The *StratFire* project team are thanked, especially Ric Tyler who made available his drawings of the property and Jonathan Devereux, who made arrangements for access and assisted during the fieldwork. The restaurant staff are also thanked for their facilitation of the dendrochronological work. The investigation was commissioned by Shahina Farid (Historic England), whilst Emma Brownlee (Historic England) collated the maps reproduced as Figure 1. Cathy Tyers (HE Dendrochronologist) is thanked for her assistance throughout the production of this report.

Front cover image

Tudor House, 23–24 High Street, Stratford-upon-Avon, Warwickshire [photograph Martin Bridge]

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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-century fires in detail using documentary sources. Subsequently the Stratford-upon-Avon Society have been highlighting the architectural heritage along the main thoroughfare through ongoing 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."

23 and 24 High Street

The Grade II* listed Tudor House, 23 and 24 High Street (LEN 1298523), sits on the west side of the High Street, on the junction with Ely Street (Fig. 1). It is believed to have been

built in AD 1595–6, and was heavily restored in AD 1903, when much of the façade was renewed (Tyler 2022 unpublished). It is of three storeys, jettied on consoles at two levels. The corner-post remains and is carved with a human mask and other parts, but this is in the restaurant and is not readily accessible.

Figure 1: Maps to show the location of 23 and 24 High Street. Scale: top-right 1:200,000; bottom 1:1200. © Crown Copyright and database right 2024. All rights reserved. Ordnance Survey Licence number 100024900.

Methodology

An initial assessment of the timbers for dendrochronological study 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. Those timbers judged to be potentially useful were cored 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 series. 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*-values 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 early wood 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* 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 Discussion

Very few accessible timbers were identified during the assessment as potentially having enough rings for conventional dendrochronology but limited sampling of both oak (*Quercus* spp) and elm (*Ulmus* spp) timbers was undertaken to provide samples for possible investigation using other complementary scientific dating techniques (stable isotope analysis and/or radiocarbon dating) should this be deemed appropriate. Details of the samples taken are given in Table 1, with the positions of the sampled timbers shown in Figures 2 and 3. The ring-width measurements for all samples are given in the Appendix.

All ring series over 30 years were compared with each other, identifying a potential match (*t*-value of 4.7) between two of the oak series, tudh03 and tudh05. However, this potential match is for an overlap of only 24-years between the two series and therefore not considered secure without further supporting evidence. These same individual ring series were also compared to the reference chronologies but, unsurprisingly for such short series, no secure dating evidence was identified.

Thus, unfortunately, no dating evidence has been obtained for this building through ring-width dendrochronology.

Table 1. Details of samples taken from Tudor House, 23 and 24 High Street, Stratford-upon-Avon.

Sample No	Location	Number of rings	Date of sequence (AD)	Sapwood	Mean ring width (mm)	Mean sensitivity	Felling date range (AD)
First Floor							
tudh01	Ceiling beam, room F6	25	-	h/s	1.73	0.33	-
tudh02i	North-west corner post (F6) inner rings (elm)	65	-		2.03	0.26	-
tudh02ii	North-west corner post (F6) outer rings (elm)	18	-	?bark	1.19	0.24	-
tudh03	Post, south-west corner of F5	39	-	h/s	2.73	0.27	-
tudh04	East post in F5	15	-	-	5.10	0.27	-
tudh05	East post T2	39	-	5	3.30	0.27	-
tudh06	Post T1 (elm)	56	-	-	1.41	0.34	-
tudh07	Post T7	15	-	-	6.49	0.27	-
Second floor							
tudh08	Half truss T8 (elm)	37	-	-	2.59	0.28	-

Key: h/s = heartwood/sapwood boundary; NM = not measured

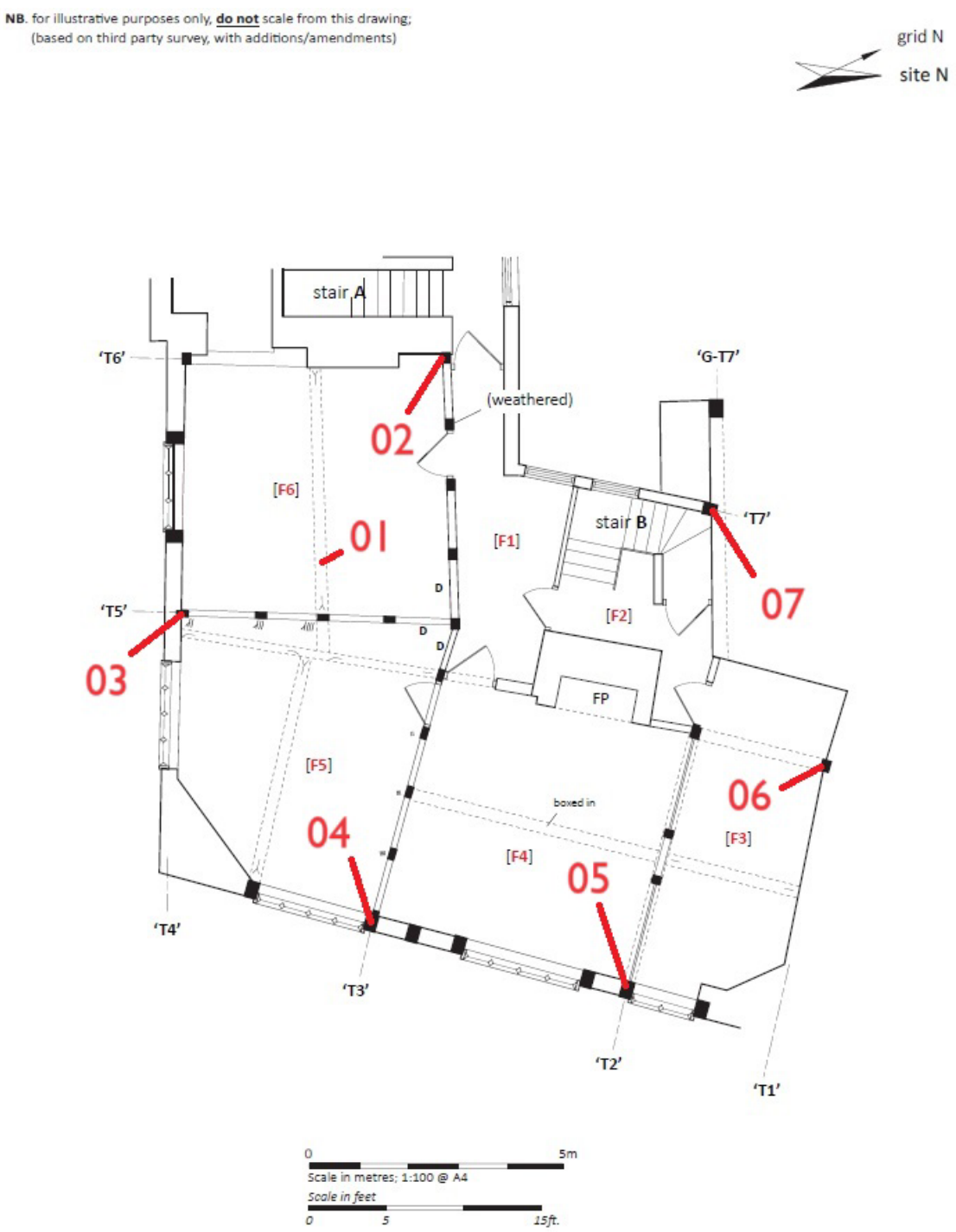

Figure 2: Plan of the first floor, showing the location of the timbers sampled for dendrochronology. [adapted from an original drawing by Ric Tyler]

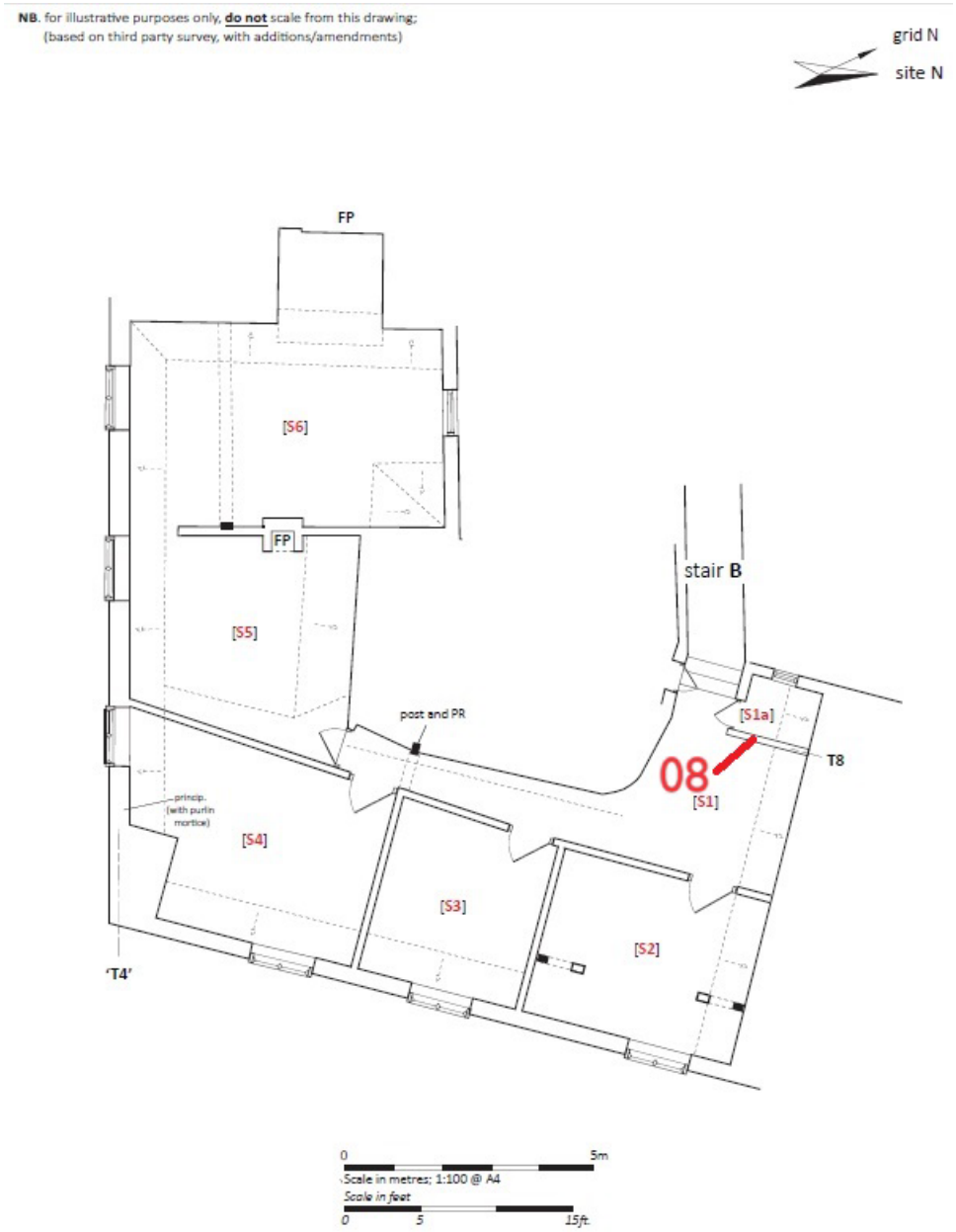

Figure 3: Plan of the second floor, showing the location of the timber sampled for dendrochronology. [adapted from an original drawing by Ric Tyler]

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Appendix

Ring width values (0.01mm) for the sequences measured

tudh01

151	217	356	235	318	174	152	257	361	194
108	133	178	94	73	70	87	114	146	92
81	126	178	237	198					

tudh02i

434	415	388	307	296	279	306	406	314	276
207	233	357	358	260	329	207	258	222	200
203	211	92	161	105	92	186	305	241	240
270	188	168	129	204	106	143	98	158	135
262	494	421	398	292	87	47	39	48	44
47	49	50	49	109	135	157	238	183	182
85	81	61	65	64					

tudh02ii

57	62	91	100	99	96	134	201	185	186
208	294	68	51	73	69	64	98		

tudh03

417	439	425	455	330	406	500	74	110	130
96	115	152	247	329	433	340	426	486	385
438	401	351	80	95	97	145	98	177	214
201	290	202	207	203	293	231	285	325	

tudh04

440	809	734	412	620	588	463	702	554	348
377	539	328	364	375					

tudh05

390	297	422	378	391	443	475	303	132	173
308	345	298	490	294	353	258	290	277	346
407	491	599	423	386	371	270	259	393	230
285	355	199	252	286	276	217	352	155	

tudh06

208	83	69	81	117	159	170	95	147	190
65	64	87	102	114	70	56	55	49	42
46	43	69	124	53	35	46	57	48	37
39	52	182	110	127	205	366	419	376	309
187	163	108	74	41	77	209	225	233	82
103	293	360	368	293	309				

tudh07

899	1062	821	836	665	617	252	207	247	759
606	873	765	622	510					

tudh08

396	331	191	146	258	618	649	649	306	187
346	351	236	236	182	178	191	778	468	274
309	191	225	95	96	80	93	90	92	98
120	134	219	195	174	205	199			

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