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Summary

Eight timber samples from the lining of the pit, and an artifact which may have been deposited at the same time as the helmet, were examined. No relative dating was obtained, but one of the lining timbers was dated; it was felled some time after AD 586. A new non-destructive method of measuring the rings of wooden artifacts was tested with encouraging results.

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Introduction

The oak timbers described below came from the pit at Coppergate (site code: 1982.22) in which the 8th century helmet was discovered. Eight were from the lining of the pit, although the presence of redundant pegholes on some of them suggests that they may have been reused (Spriggs pers comm). The other timber examined was 95, a small churn dash, approximately 135mm in diameter, which had been deposited in the pit, possibly at the same time as the helmet (Fig 1).

One of the lining timbers (101) had been sampled and analysed whilst still waterlogged, although no date had been obtained (Groves & Hillam 1986). Complete slices were taken from the other timbers in 1991 by Jim Spriggs at the York Archaeological Trust's Conservation Laboratories after they had been conserved with PEG4,000. The churn dash had been freeze-dried after treatment with PEG1,500. Its annual rings were visible on the outer edge, although their real width was distorted by the curvature of the edge.

Tree-ring analysis was undertaken in the hope of providing a date for the lining of the pit and for the deposition of the helmet. Although the analysis of 101 had proved unsuccessful, the examination of more timbers from the same context offered a chance of producing a master curve for that context which might be easier to date than a single ring sequence.

The churn dash, although small and with relatively few rings, offered the only chance of obtaining a tree-ring date for the deposition of the helmet. It also provided a challenge since the analysis was to be non-destructive. A way had to be found therefore of measuring the rings without slicing the object in two.

All the timbers, except 101, were returned to York after completion of the analysis.

Methods

The surface wax had been cleared from the cross-sections of the lining timbers at York by Jim Spriggs. This provided a surface on which the ring boundaries were visible under a 10x binocular microscope, although identifying the boundaries of some of the narrow rings was sometimes difficult. The ring widths were measured twice to an accuracy of 0.01mm on a travelling stage connected to an Atari microcomputer. Two sets of measurements are always taken when samples are not to be kept at Sheffield. In this case it also helped to ensure the accuracy of the measurements of the narrow rings.

Several attempts were made to measure the rings of the churn dash (Fig 1). The object was broken diagonally across the grain but the rings on the two halves of the break were not clear enough for accurate measurement. Instead the ring widths along the top edge were measured, first with a hand lens containing a scale accurate to 0.1mm, and then using the travelling stage. Neither of these sets of measurements was a true representation of the ring widths since they were distorted for the most part by the curvature of the object. An alternative method was sought by placing the churn dash flat on the travelling stage and measuring the ring widths across the grain of the longitudinal surface (Fig 2). This technique has not been used before at Sheffield or possibly elsewhere. An opportunity to check this approach was offered by a second break which ran from the edge to the centre of the churn dash, allowing a true measurement of the widths to be obtained for part of the object.

The measured ring sequences were plotted as graphs either by hand or using an Epson HI-80 plotter with software written by Ian Tyers (pers comm 1992). The graphs were then compared with each other on a light box to check for any similarities between the ring patterns which might indicate contemporaneity. The Atari is also used to aid the crossmatching process, although it is the quality of the visual matching which dictates whether or not a match is accepted. The crossmatching routines (Tyers pers comm 1991) are based on the

Belfast CROS program (Baillie & Pilcher 1973; Munro 1984), and all the *t* values quoted in this report are identical to those produced by the first CROS program (Baillie & Pilcher 1973). Generally *t* values of 3.5 or above indicate a match provided that the visual match between the tree-ring graphs is acceptable (Baillie 1982, 82-5).

Dating is achieved by crossmatching ring sequences within a site or structure, combining the matching sequences into a site master, and then testing that master for similarity against dated reference chronologies. A site master is used for dating whenever possible because it enhances the general climatic signal at the expense of the background noise from the growth characteristics of the individual samples. Any unmatched sequences are tested individually against the reference chronologies.

If a sample has bark or bark edge, the date of the last measured ring is the date in which the tree was felled. In the absence of bark edge, felling dates of oak timbers are calculated using the sapwood estimate of 10-55 rings. This is the range of the 95% confidence limits for the number of sapwood rings in British oak trees over 30 years old (Hillam *et al* 1987). Where sapwood is absent, felling dates are given as *termini post quem* by adding 10 years, the minimum number of missing sapwood rings, to the date of the last measured heartwood ring. The actual felling date could be much later depending on how many heartwood rings have been removed.

Results

1. The pit lining. Timber 103b had only 26 rings and was therefore rejected since at least 50 rings are usually needed for reliable dating (Hillam *et al* 1987). The remaining samples had 53-117 rings (Table 1). Some, such as 97, were radially split planks; others, such as 99, were intermediate between radial and tangential planks. None of the samples had sapwood.

Samples 98 and 99 were almost identical. The ring patterns on the samples looked the same and so did the tree-ring graphs. Their ring sequences crossmatched to give a *t* value of 12.5, which probably indicates that the two timbers were from the same tree. The ring sequences of 96 and 100 were also very similar (t = 9.7) and may be from the same tree. (An origin in the same tree is assumed when the ring patterns of the samples and the graphs look almost identical and the *t* value is greater than 10, but timbers from the same tree do not always meet these criteria.)

The data from 98/99 and 96/100 were averaged to give ring sequences of 70 and 106 years respectively. No relative dating was found between any of the timbers. They were therefore tested individually against dated reference chronologies for the periods 349BC-AD295 and AD404 to the present day. At first no positive results were produced but when they were compared with a newly dated ring sequence from Skerne, near Driffield in North Humberside, a *t* value of 6.4 was obtained for 97 over the period 460-576. This result was confirmed by the visual match and *t* values with other chronologies: 4.4 with Tamworth (Hillam 1981) and 3.8 with Carlisle, Tullie House (Hillam unpubl). None of the other lining timbers could be reliably dated.

The result for 97 indicates that the timber cannot have been felled before 576 and, allowing for the minimum amount of missing sapwood, it is unlikely to have been felled before 586. There is no way of knowing how much heartwood, if any, was removed when this small plank was produced, but it showed no obvious sign of reuse (Table 1).

2. The churn dash. The ring measurements made along the curved edge of the churn dash with a hand lens and travelling stage were virtually identical. The 59-year sequence produced by the travelling stage was therefore used (95A). The break from one edge to the centre gave a 30-year sequence (95B) whilst the ring measurements along the longitudinal surface gave a 70-year sequence (95C). A *t* value of 8.8 was obtained for the match between 95A, the curved cross-section measure, and 95C, the longitudinal surface measure (fig 3). A higher correlation would have been produced from two sets of measure-

ments along the same cross-section, but nevertheless the agreement is good enough to make the method worth pursuing (Hillam in prep).

The three ring sequences from 95 were averaged into a single sequence of 72 years. These ring widths are set out, along with the other tree-ring data, in the Appendix. No match was found between 95 and the ring sequences from the lining. When it was tested against the reference chronologies, the best position of fit was in the 6th century. However this tentative match cannot be confirmed at present and the churn dash remains undated.

Conclusion

Examination of the churn dash and eight samples from the timber lining produced a *terminus post quem* for felling of AD586 for one of the lining timbers. A tentative date in the 6th century was obtained for the churn dash but this has not yet been confirmed. Results from the study also suggest that it may be possible to measure the ring widths along the longitudinal surface of a timber or object without the need for sampling.

Acknowledgements

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Table 1: Details of the tree-ring samples. Sketches are not drawn to scale; none of the samples had sapwood.

timber	context	no of rings	average ring width (mm)	sketch	cross-sectional dimensions (mm)	comments
95	1783	72	1.74	-	-	churn dash; see Fig 1
96	1832	53	1.49		85x20	lining
97	1833	117	1.26		150x20	lining; AD460-576
98	1834	69	1.99		145x30	lining; pegholes
99	1831	63	1.99		135x25	lining; pegholes
100	1819	106	1.27		135x20	lining; pegholes
101	1835	114	1.27		150x40	lining; insect damage
103a	1787	73	1.57		120x30	lining
103b	1788	26	-		95x25	lining; rejected

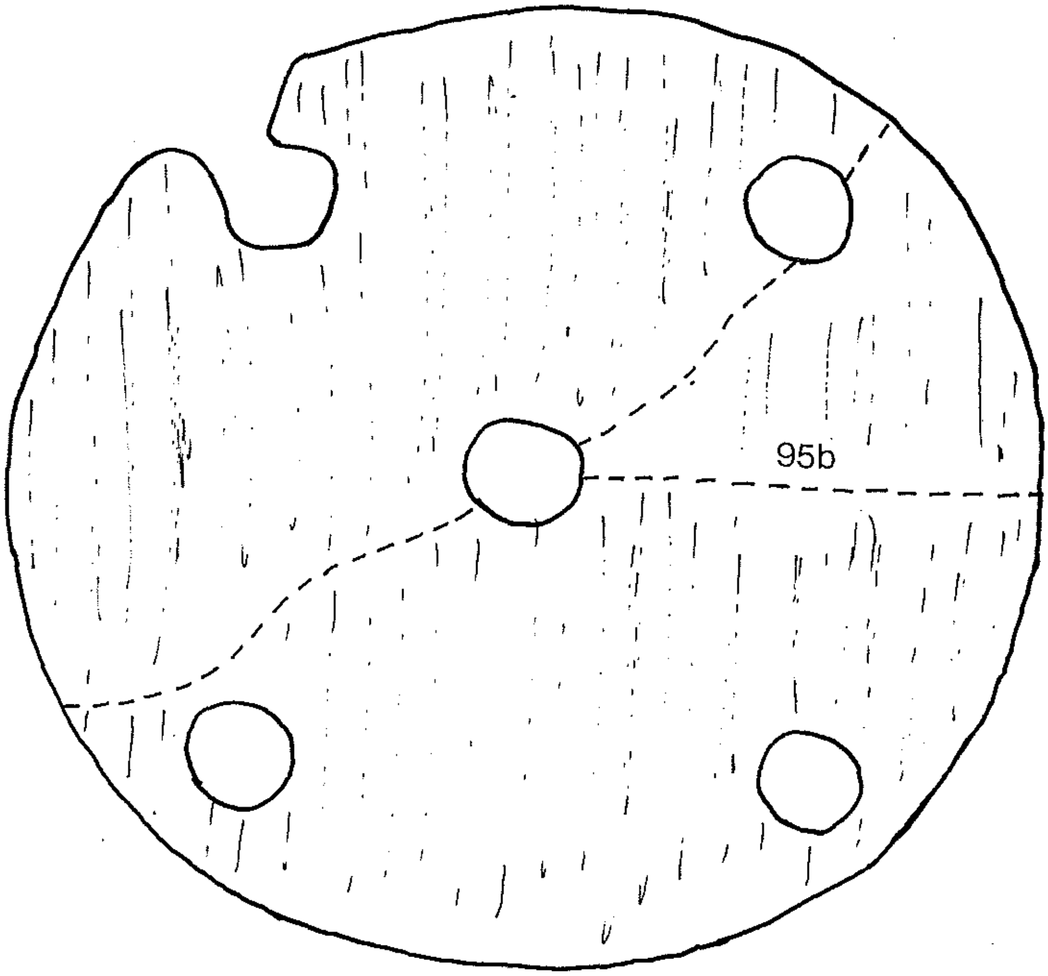

Fig 1: Sketch of the oak churn dash, timber sample 95. Dotted lines indicate breaks; the rings of the shorter break were measured, 95B. Scale 1:1.

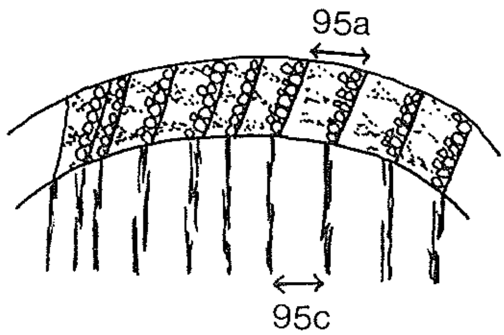

Fig 2: Schematic drawing of the wood structure on the churn dash. Arrows denote the boundaries of the same annual growth ring in cross-section (top) and longitudinal section (bottom).

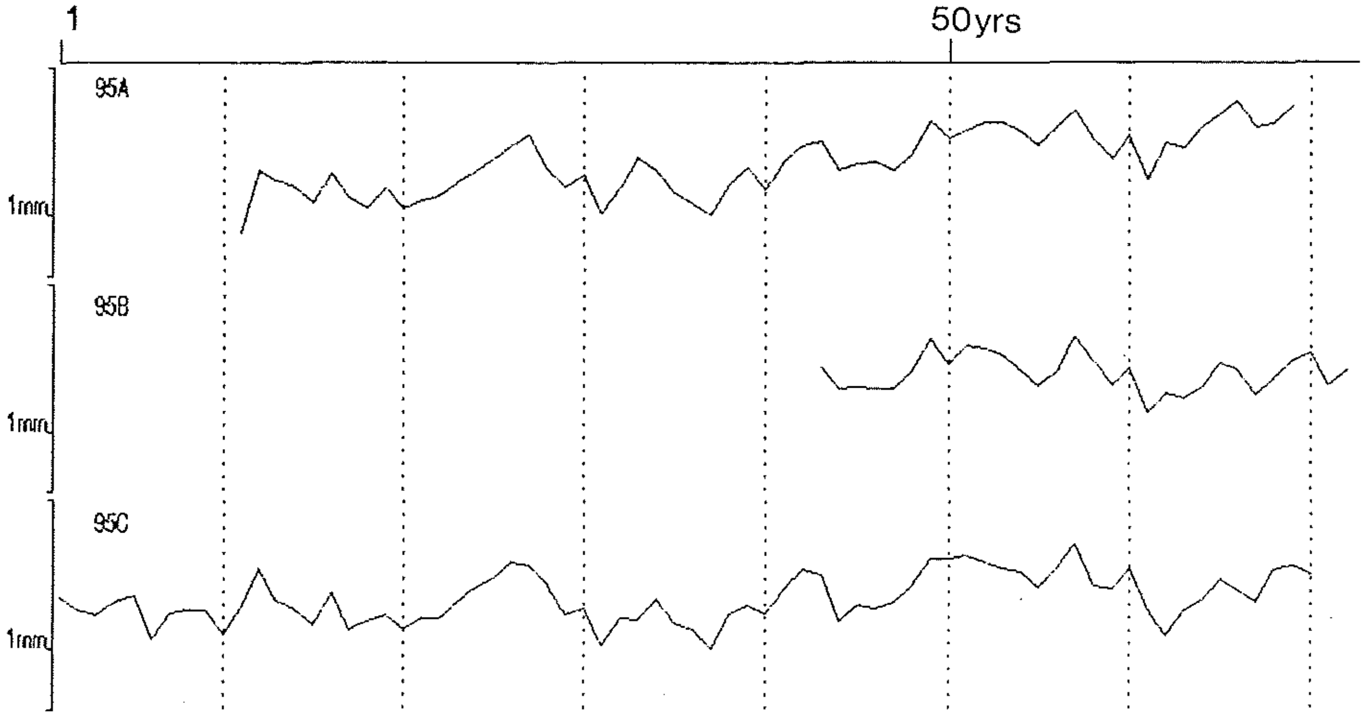

Fig 3: Matching ring sequences from the churn dash. 95A - curved cross-sectional measurements from the top of the artifact; 95B - ring measurements along the short cross-sectional break from edge to centre; 95C - measurements along the longitudinal grain.

APPENDIX

<u>Ring width data in units of 0.01mm.</u>

Coppergate helmet pit #97 - 2 measures
117 years length
Dated AD460 to AD576

165	162	165	171	142	154	125	106	92	85
108	129	143	196	179	203	162	176	170	160
114	98	86	125	104	114	103	94	116	115
65	122	136	193	167	122	151	136	99	145
149	159	197	146	126	112	119	135	124	160
125	147	123	100	129	116	153	163	125	144
114	141	156	164	177	161	136	196	110	151
92	63	79	101	114	121	114	156	114	85
71	86	118	115	98	74	97	113	78	80
95	77	101	126	75	83	101	117	111	139
142	113	132	98	101	133	79	63	101	139
165	144	114	130	151	126	126			

Coppergate helmet pit #95 - 3 radii
Churn dash
72 years length

171	150	144	163	174	109	143	148	150	116
119	197	154	144	122	168	122	119	139	114
128	130	152	173	196	227	238	183	137	153
102	134	160	164	129	117	99	141	161	138
183	217	212	150	163	162	162	192	267	229
253	253	243	220	188	224	293	207	177	220
138	161	166	193	235	238	187	221	257	227
165	191								

Coppergate helmet pit #96 - 2 measures
53 years length

71	123	94	127	130	141	152	161	154	213
183	235	185	168	257	230	200	195	219	178
186	141	115	160	193	172	152	162	144	106
72	65	89	92	93	96	115	88	90	99
98	154	144	173	205	218	173	122	134	105
201	174	164							

Coppergate helmet pit #98 - 2 measures
69 years length

136	194	322	186	308	178	213	218	255	269
177	248	283	228	302	318	241	184	255	234
318	305	225	200	210	171	209	163	272	216
252	204	222	225	288	238	274	228	187	143
136	113	111	132	130	162	179	157	107	117
141	131	197	162	216	160	188	143	163	162
143	160	154	186	129	115	145	226	151	

Coppergate helmet pit #99 - 2 measures
63 years length

174	156	210	430	223	367	204	211	208	208
262	165	264	235	189	240	293	225	154	239
242	312	279	242	197	195	154	204	197	310
227	322	145	164	178	228	185	222	229	180
125	135	108	100	142	111	129	144	123	80
88	121	91	145	144	222	208	231	196	208
189	201	250							

Coppergate helmet pit #100 - 2 measures
106 years length

81	77	91	68	58	98	85	76	79	57
63	74	58	86	77	87	87	144	76	46
42	46	48	63	74	74	96	73	80	86
123	70	70	110	92	109	104	96	129	150
162	204	169	219	179	140	204	173	195	154
174	144	152	124	111	135	175	152	124	175
125	111	69	57	68	87	76	96	110	80
102	121	85	159	166	134	182	208	164	119
137	105	205	210	177	134	168	139	165	155
186	210	168	135	264	181	241	193	194	242
182	124	186	121	141	173				

York, Coppergate 1982.22 #101
114 years length

132	114	142	116	182	134	130	166	178	152
148	160	170	176	114	190	158	150	122	106
70	92	74	62	52	60	76	98	98	110
112	100	122	154	116	138	128	122	122	144
132	124	164	114	154	144	122	160	126	130
72	46	64	126	138	106	98	136	142	122
104	148	170	132	148	150	150	150	124	80
88	108	152	128	92	112	108	142	124	116
98	66	64	108	86	120	112	114	96	82
120	134	132	108	96	108	130	102	108	104
132	210	224	196	182	154	156	206	170	212
138	92	144	200						

Coppergate helmet pit #103A - 2 measures
73 years length

96	141	173	214	241	193	172	131	102	57
44	62	59	113	182	197	228	177	145	203
232	221	165	136	249	322	235	186	215	166
137	203	173	183	196	201	278	220	201	227
143	96	96	127	165	220	163	171	244	248
121	54	55	53	63	81	66	44	57	70
89	107	128	145	145	133	147	169	236	201
237	175	132							