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Mortar Wreck Site
Poole
Dorset

Tree-ring Analysis of Oak Timbers

Nigel Nayling and Cathy Tyers

Discovery, Innovation and Science in the Historic Environment

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Front Cover: Nigel Nayling at the wreck site (Bournemouth University)

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SUMMARY
Samples were taken as part of a designation assessment from timbers of a clinker-built shipwreck lying on the seabed in the approaches to Poole Harbour, Dorset. The dendrochronological analysis of samples from three adjoining hull planks indicates that they were derived from Irish oak trees felled in the mid-thirteenth century AD.

CONTRIBUTORS
Nigel Nayling and Cathy Tyers

ACKNOWLEDGEMENTS
This study was undertaken as part of a wider Designation Assessment of a shipwreck site led by Tom Cousins and David Parham of Bournemouth University and commissioned by Shahina Farid (Historic England Scientific Dating Co-ordinator). I would like to thank David Brown and Ian Tyers for access to unpublished data.

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INTRODUCTION

This document is a technical archive report on the dendrochronological analysis of timber samples recovered from the Mortar Wreck located off the Dorset coast (Fig 1). Tree-ring dating was integrated into an assessment of the site, undertaken by Bournemouth University and funded by Historic England, to determine its suitability for designation under the Protection of Wrecks Act 1973.

METHODOLOGY

During diving operations on the 6th and 7th August, led by a dive team from Bournemouth University, Nigel Nayling of DendroArch, undertook *in situ* assessment of exposed hull timbers of a clinker-built ship, and took samples from a section of articulating hull planks, eroded fragments of probable framing timbers, and a wood identification sample from a displaced probable stem.

Methods employed at DendroArch in general follow those described in English Heritage guidance (English Heritage 2004). The waterlogged samples were cleaned using razor blades to reveal the ring sequences. 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 sequences were also tested against a range of oak reference chronologies from Britain and elsewhere in Europe. The *t*-values reported 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 and with good overlap. Correlated positions are checked visually using computerised ring-width plots in order to identify any potential measurement errors.

The tree-ring dates produced by this process date the rings present in the timbers. Interpretation of these dates relies upon the nature of the final rings in the sequence, particularly 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. At a microscopic level, sapwood in *Quercus* spp 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 a geographically appropriate sapwood estimate needs to be applied to infer a felling date range. 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 plus the

minimum amount of missing sapwood expected for the appropriate geographical source of the timber.

The dates obtained by the technique do not, by themselves, necessarily indicate the date of the vessel. It is essential to incorporate other data and evidence before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of the vessel.

RESULTS AND INTERPRETATION

Details of the timbers either examined *in situ* or sampled and subjected to full analysis are provided in Table 1. The locations of the samples on the shipwreck site are shown in Figure 2.

A wood identification sample (MW20_14) taken from the possible stem MW02, confirmed that this timber is oak. *In situ* assessment suggests this timber has approximately 90 rings but no sapwood or heartwood sapwood boundary was observed (Fig 3).

Two highly eroded, detached fragments of oak found lying close to the articulated clinker planks, which probably represent the degraded remains of framing timbers, were recovered in their entirety (MW20_15_1 and MW20_15_2). These samples exhibited medium to fast average growth rates of 1.5mm and 3.3mm *per annum* respectively.

The three articulated hull planks were all oak and of radial to intermediate conversion with high numbers of tree-rings (Figs 4 and 5). The tree-ring series measured from these three samples, which are given in the Appendix, were initially compared with each other but no conclusive cross-matching was identified. All three individual ring-width series were therefore compared with a wide range of reference chronologies from Britain and elsewhere in Europe. All three were successfully dated against a range of previously dated Irish oak reference series (Table 2). These three dated individual series suggest felling of the trees from which the timbers represented, assuming that they are coeval, occurred in the mid-thirteenth century (AD 1242–65) when applying a sapwood estimate of 14–50 rings at 95% confidence (Baillie and Pilcher 1973; Baillie 1982, 58; 1995, 23; Fig 6).

DISCUSSION AND CONCLUSION

This initial, albeit limited, dendrochronological programme has provided valuable information with respect to enhancing interpretation and significance of this wreck as part of a Designation Assessment undertaken by Bournemouth University. It also highlights the potential of more extensive dendrochronological analysis should further investigation of this shipwreck be undertaken.

The results from the analysis of just three clinker planks indicate a mid thirteenth-century date for the ship's construction. Outer hull planks, however, in clinker-built vessels are almost universally trimmed along their upper and lower edges leading to at least partial removal of sapwood. More precise dating usually requires sampling and analysis of framing timbers where full sapwood and bark edge may survive at least locally (as in floor timber MW01). Examination of the floor timber MW01, *in situ*, and assessment of the eroded framing fragments (MW20_15) indicate that floors and futtocks are likely to be oak with the potential for precise dendrochronological dating.

In addition, the analysis suggests an Irish source (possibly south-eastern Ireland, Brown pers comm), for these three clinker planks. The Irish provenance of the timbers, however should not be taken as evidence of Irish construction of the ship as the export of Irish oak boards (including specifically for shipbuilding) during the medieval period is well attested historically and dendrochronologically (Miles 2002a, 2002b; Slattery 2009; Tyers forthcoming, in press). Other clinker-built ship planks recovered in archaeological contexts in England have also, on occasion, proved to derive from Irish trees (Goodburn 2003; Tyers 1999b; Tyers 2009). Framing timbers are less likely to have been traded, so establishing their likely provenance through dendrochronological analysis is potentially crucial in determining the most likely region for the ship's construction.

The dendrochronological potential for further work is clear should additional investigation of this shipwreck be undertaken. An appropriate, more extensive, sampling strategy for further dendrochronological study should include sampling of the widest range of structural elements possible including additional hull planks but also any surviving parts of the keel, framing, keelson, stringers, ceiling, and other internal timber parts. Sampling, however, of framing timbers and other key structural elements, the shape of which is critical to any theoretical reconstruction of original hull form, should not be undertaken prior to completion of detailed recording.

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TABLES

*Table 1: Details of the tree-ring samples retrieved from the Mortar Wreck. All samples are oak (*Quercus *spp)*

Sample code	Comments	Conversion	Dimensions (mm)	Total rings	Sapwood	Average ring width (mm)	Date of series (AD)	Felling date / date range (AD)
MW20_10	Sample of hull plank MW10	Intermediate	280 x 38	146	-	1.77	986-1131	after 1145
MW20_11	Sample of hull plank MW11	Radial	285 x 42	178	7	1.58	1053-1230	1237-73
MW20_12	Sample of hull plank MW12	Radial	323 x 42	312	27	0.97	931-1242	1242-65
MW20_14	ID sample of possible stem MW02 confirmed as oak. Ring count and measurements made on *in situ* timber	Halved?	560 x 140	90	-	~6	-	-
MW20_15_1	Eroded fragment of framing timber found overlying hull planks	Whole?	85 x 45	30	-	1.5	-	-
MW20_15_2	Eroded fragment of framing timber found overlying hull planks	Whole?	100 x 85	17	-	3.3	-	-

Key: h/s? = possible heartwood/sapwood boundary

Table 2: Correlations between the three dated individual series, MW20_10 (AD 986–1131), MW20_11 (AD 1053–1230), MW20_12 (AD 931–1242) and selected reference chronologies

Reference chronology	Date span (AD)	*t*-values		
		MW20_10	MW20_11	MW20_12
Ireland				
New Ross, Co. Wexford (Brown pers. comm.)	907–1278	4.87	7.28	8.69
Cork City (Brown 2003)	957–1249	3.49	4.43	8.12
Waterford City (Brown 1997)	839–1216	5.7	5.48	7.93
Abbey Street, Kilkenny (Brown pers. comm.)	936–1240	4.29	5.41	6.82
Patrick, Dublin (Brown pers. comm.)	854–1326	5.48	8.46	8.51
High St, Dublin (Brown pers. comm.)	855–1306	5.37	8.78	7.66
Arundel Square, Dublin (Brown pers. comm.)	839–1200	5.7	5.4	7.74
Irish Timber in England				
Site LCS150, Sizewell, Suffolk. Reused boat/ship timbers (Tyers 2009)	943–1231	3.35	7.49	9.56
Eastern Chapels, Salisbury Cathedral, Wiltshire SARUM1 (Miles 2002a)	908–1221	3.55	6.93	8.49
North Nave Triforium Roof, Salisbury Cathedral, Wiltshire SARUM4 (Miles 2002a)	878–1230	5.48	9.66	10.03
West Front Door, Salisbury Cathedral, Wiltshire SARUM8 (Miles 2002b)	928–1186	4.92	8.62	6.63
TYT98 Tooley St/Battlebridge Lane boat, Southwark, London (Tyers 1999a; 1999b)	1012–1265	4.37	9.55	6.63
Trichay Street, Exeter (Tyers forthcoming)	929–1216	3.87	3.54	5.79
Trichay Street, Exeter (Tyers forthcoming)	1030–1178	5.90	4.86	6.94

FIGURES

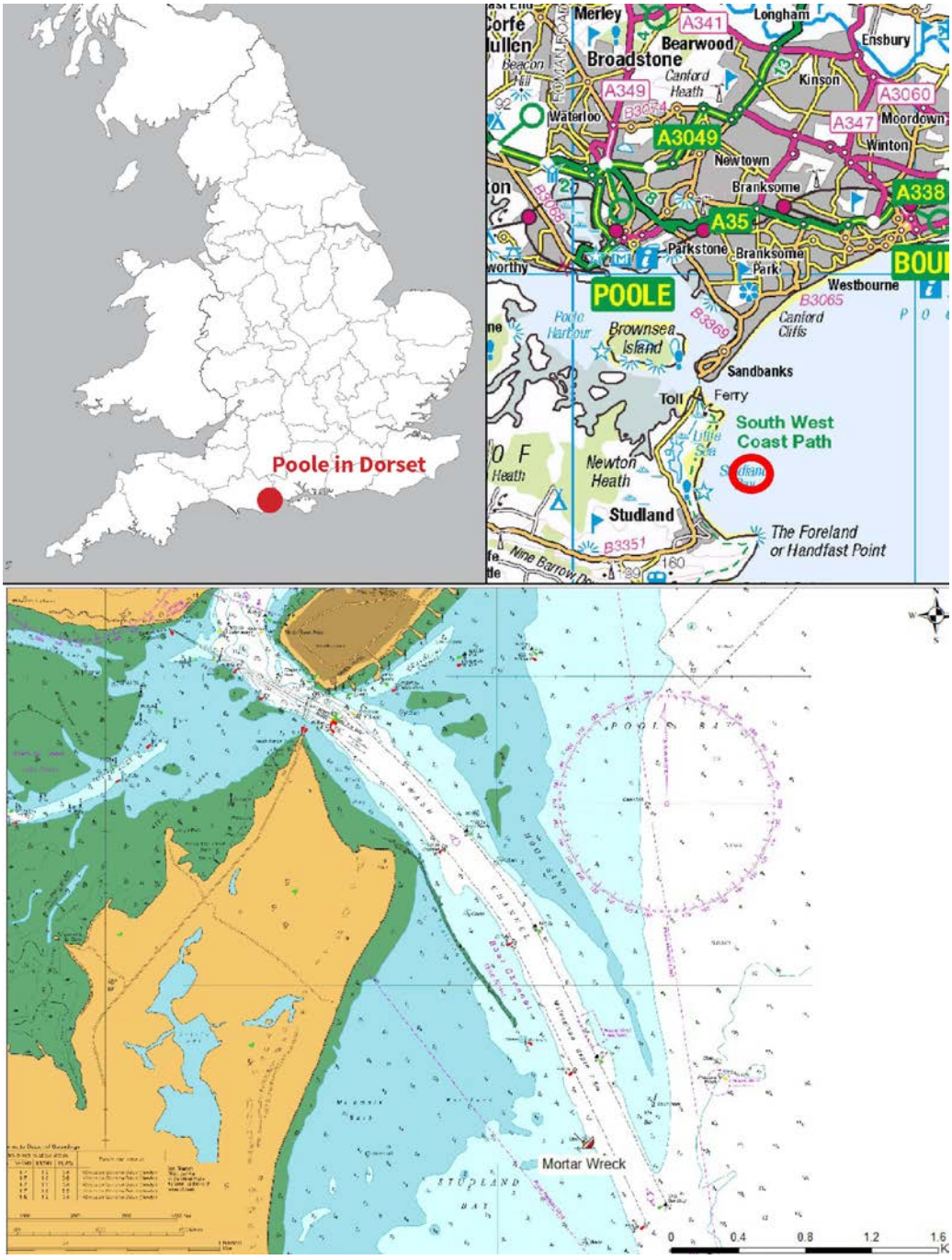

Figure 1: Maps to show the location of Poole in Dorset top marked in red; top right scale 1:160,000 © Crown Copyright and database right 2020. All rights reserved. Ordnance Survey Licence number 100024900. © British Crown and SeaZone Solutions Ltd 2020. All rights reserved. Licence number 102006.006. © Historic England.

Bottom Location of the wreck in relation to Chart 2611 © British Crown and OceanWise, 2020. All rights reserved. Licence No. EK001-20180802. Not to be used for Navigation

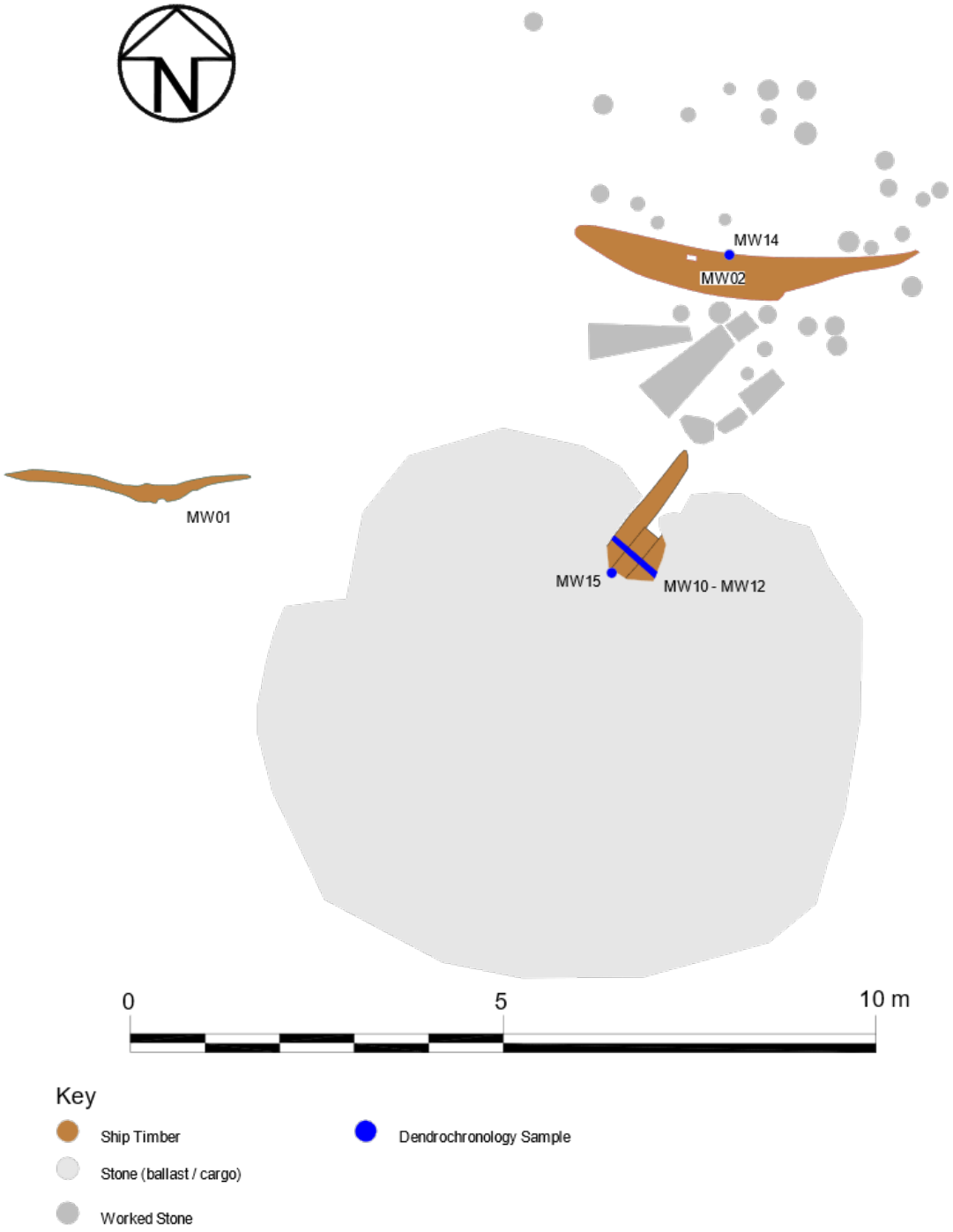

Figure 2: Mortar Wreck site plan indicating location of timbers and samples. Based on a plan provided by Tom Cousins, Bournemouth University

Figure 3: Nigel Nayling examining stem timber MW02 with cargo of Purbeck stone grave slabs and mortars in the foreground (Bournemouth University)

Figure 4: Hull planks MW10 (top), MW11 and MW12 (bottom) prior to sampling (Bournemouth University)

Figure 5: Hull planks after sampling: MW12 (left of scale), MW11 (middle), MW10 (right) after sampling (Bournemouth University)

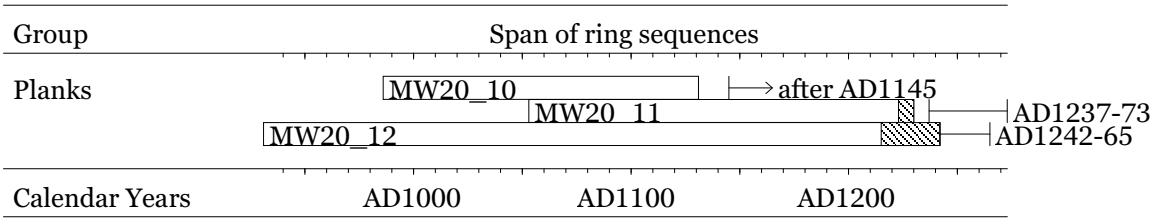

Figure 6: Bar diagram of dated plank samples, indicative felling dates based on an Irish sapwood estimate of 14–50 years. Sapwood is shaded

APPENDIX

Ring width values (0.01mm) for the measured series

MW20_10

77	161	87	83	104	97	105	108	118	106
159	215	114	87	88	104	176	240	466	449
366	426	183	132	295	431	255	341	201	232
168	188	232	162	210	210	193	153	115	183
130	149	254	214	207	385	210	147	194	168
181	102	156	140	271	230	259	157	121	211
181	169	106	100	92	118	112	131	77	112
184	151	140	283	265	236	152	223	153	195
280	211	195	197	302	319	268	235	182	175
124	81	179	159	136	142	133	109	63	146
129	177	161	93	75	56	50	126	87	142
115	216	185	226	170	98	126	98	100	153
189	158	219	299	245	183	219	214	139	223
256	246	225	149	160	160	201	219	123	108
109	159	126	104	171	202				

MW20_11

166	96	226	140	124	141	159	143	206	118
131	206	160	187	144	182	212	228	232	208
252	265	216	203	142	125	117	108	103	109
176	125	150	100	45	85	94	118	122	124
263	177	166	171	243	242	223	206	122	243
183	159	309	211	198	237	186	158	209	282
199	192	140	117	102	154	101	112	131	104
113	111	142	178	232	160	77	233	179	145
103	93	164	160	131	205	114	251	218	170
132	176	254	230	126	123	184	148	165	199
243	165	141	204	182	163	249	198	178	215
212	172	156	158	139	147	176	115	163	173
218	159	88	147	91	122	252	200	191	222
97	87	131	152	180	128	123	115	156	116
103	116	156	122	111	110	98	127	107	95
127	87	99	128	114	140	138	154	147	203
178	211	176	106	122	115	131	116	201	184
167	99	117	108	75	126	131	110		

MW20_12

180	179	164	144	131	147	183	164	203	231
225	263	184	158	160	127	97	127	100	173
183	137	112	170	116	94	198	153	177	148
214	128	164	187	135	114	108	127	102	102
107	108	59	72	97	121	117	83	110	99
80	120	200	165	151	141	225	169	105	127
139	112	95	104	121	123	112	115	136	103
145	146	123	70	101	119	94	102	121	84
60	70	112	97	104	92	98	99	79	79
98	105	114	109	68	82	104	95	84	96

104	75	64	74	83	65	63	65	60	65
73	67	67	51	55	68	72	57	52	57
91	101	90	74	106	102	88	140	82	124
115	109	122	113	66	116	94	97	121	115
111	126	142	149	188	113	104	136	148	109
97	71	99	85	89	66	83	89	84	92
88	86	191	97	122	89	117	89	85	81
88	67	66	107	141	107	101	153	92	97
120	82	67	92	143	111	114	109	84	96
94	72	61	80	91	77	105	109	87	106
84	79	68	62	81	82	89	85	82	112
85	103	79	72	86	122	100	79	88	79
87	79	107	95	97	109	89	90	80	85
75	75	101	81	90	93	88	83	94	80
68	42	42	44	54	48	57	75	61	68
54	78	70	70	66	63	71	63	68	74
69	65	65	50	74	58	55	58	68	54
69	67	73	50	59	66	66	62	75	134
65	79	66	96	84	69	55	62	57	61
86	79	54	44	41	67	49	71	80	78
51	49	47	73	65	52	47	51	47	44
39	62								

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