Historic England

Wreck at Minehead, Somerset
Tree-ring analysis and wood species identification of timbers

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Discovery, Innovation and Science in the Historic Environment

Research Report Series no. 98/2022

WRECK AT MINEHEAD
SOMERSET

Tree-ring analysis and wood species identification of timbers

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NGR: SS 98513 46734

ISSN 2059-4453 (Online)

SUMMARY
A timber shipwreck, thought to be early nineteenth century in date, that was located in the intertidal zone at Madbrain sands, Minehead, Somerset was sampled for dendrochronology. Anatomical wood identification of the dendrochronological samples shows the vessel incorporated both softwood (*Larix/Picea* spp.) and hardwood (*Castanea/Acer* sp.). Suitable samples of the softwood timbers were selected for tree-ring analysis, although the *Castanea* sample was also analysed. None of the measured ring-width series from the timbers cross-matched against each other or provided secure absolute dates against the available reference chronologies.

CONTRIBUTORS
Roderick Bale and Nigel Nayling

ACKNOWLEDGEMENTS
Serena Cant and Hefin Meara of Historic England arranged access, Kate Griffiths of the University of Wales at Lampeter Archaeological Services assisted with wood species identification. Bisserka Gaydarska (Historic England) assisted with the production of this report and Cathy Tyers (Historic England) provided advice on the analysis and reporting.

ARCHIVE LOCATION
Historic England
The Engine House
Fire Fly Avenue
Swindon SN2 2EH

HISTORIC ENVIRONMENT RECORD
North Somerset Historic Environment Record
Heritage and Design Team
Town Hall
Walliscote Grove Road
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DATE OF INVESTIGATION
2015

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CONTENTS

INTRODUCTION

The sampled timbers were taken from a shipwreck located in the intertidal zone off Warren point at Madbrain Sands, Minehead, Somerset (Fig 1). The wreck comprises the remains of a timber sailing vessel thought to date to the early nineteenth century. When visible under the shifting sediments on the foreshore, one side of the vessel with occasional timbers amidships is exposed.

The wreck has been seen at various times during the twentieth and twenty-first century and the site is a scheduled ancient monument (LEN 1437202). Research suggests it may be the remains of the *Bristol Packet*, a ship built in America in AD 1801 and lost at Minehead in AD 1808. Its construction, using both softwood and hardwood, trenails and metal (copper) fastenings provide a plausible evidence for its attribution to an American vessel of the late eighteenth or early nineteenth century. Historic England commissioned tree-ring dating to provide independent evidence of the date and provenance of the wreck and thus to inform its future management.

METHODS

Sampling of potentially suitable timbers, those with more than 40 rings, was undertaken using a chainsaw and where appropriate a hand saw. The samples obtained represent a selection of all visible ship elements, including framing timbers, hull planking and sheathing, ceiling planks, a stringer, a futtock, and floor timber (Table 1). Each sample was given a unique identifier (MBW). Sample locations were noted by the authors using a basic offset survey (Figs 2–3) and with photographs of the sample locations (Figs 4–18).

For wood species identification the cell structure of all samples was examined in three planes under a high-power microscope and identified using reference texts (Schweingruber 1982) and reference slides. Identification has only been taken as far as genus in cases where the cell structure of the wood is not sufficiently diagnostic to separate a number of different species (eg *Larix/Picea* spp.).

Methods employed at the Trinity St David Dendrochronology Laboratory in general follow those described in Historic England guidance (English Heritage 1998). All samples were waterlogged, and clean radial surfaces were achieved by hand cleaning using razor blades. Those samples which preserved a half or full section were then frozen and surformed to scan for possible locally absent rings, a common feature of *Larix/Picea* spp. (Cook and Kairiukstis 1990; Stokes and Smiley 1996). The complete sequence of growth rings in those larch/spruce samples with more than 40 growth rings were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 2004). Multiple radii were measured for some *Larix/Picea* spp. samples to aid identification of such locally absent rings. Once the ring-width series from radii in a sample had been cross-matched against each other satisfactorily (Tables 2–7), they were combined to form a mean series for each individual sample. Up to five radii per sample were measured to identify any added, missing, or locally absent rings in each measurement. These measured ring-width data are provided at the end of the report. Cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were then employed to search for positions where the ring sequences are highly correlated against each other.

Dating is dependent on trees over large geographical areas showing a similar relative pattern of wide and narrow annual rings as a result of climate during the growing season. Of course, tree growth is not only affected by climate, and individual tree growth, or that of trees in one cohort or area can be affected by a whole host of other environmental variables. For example, a tree growing on a flat area close to a stream with abundant water is less likely to exhibit a narrow ring in a dry year than a tree on a steep slope with thin soils and the ring-width series would be termed complacent. Competition, age trends, injury, and human/animal interference (such as pollarding or foliage defoliation by insects) can result in a ring-width pattern unrelated to climate. Even in regions with harsh climate up to a quarter of trees within a woodland will contain ring-width patterns that do not correspond to the wider climate and therefore do not date. In order to eliminate some of the background, non-climate driven 'noise' in individual tree/timber data, multiple radii are measured from a single tree or timber, followed by the creation of a multiple sample mean ring-width series that contains less of the 'noise' associated with individual trees, which is more likely to cross-date against external reference chronologies. The likelihood of a sample dating is further increased by the availability of well-replicated tree-ring series from the time period and geographical source that a given timber sample comes from, with some time periods and geographical areas less well represented in terms of tree-ring data.

The ring-width sequences for each sample in this instance were tested against a range of reference chronologies from Britain, Europe and the Americas. 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 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 that the overlap is at least 50 years. With oak, a *t*-value of over 10 between samples is indicative of originating from the same parent tree, though *t*-values of far less than 10 are often observed from measuring different radii across a single oak tree cross section. Correlated positions are 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. With oak samples, 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. Sapwood was not discernible in any of the *Larix/Picea* spp. samples analysed. Only suitable *Larix/Picea* spp. were measured as there is a network of relevant reference chronologies for these two species. In addition, a single sample of *Castanea* spp. was measured for future reference, should reference chronologies become available in the future.

RESULTS

Details of all the samples obtained can be found in Table 1, and photographs of the samples are shown in Figures 19–33. The cross-matching of the individual ring-width series from multiple radii for the six samples for which multiple radii were measured is detailed in Tables 2–7.

None of the ring-width series from the individual timbers provide a convincing cross-matching position between each other, nor do they cross-match against British, European, or American reference chronologies. While it was possible to cross-match different radii within each of the samples, the *t-v*alues between different radii were in some instances below 3.5 though no locally absent rings could be found, and more importantly the visual matches between the radii are satisfactory, and no obvious problems could be identified. The relatively low inter-radii correlation and lack of dating amongst the samples may in part be due to the equable nature of the environment in which the trees grew, possibly one of wet lowland bog, for which *Larix* and *Picea* species native to the north eastern United States and Canada have a preference.

DISCUSSION

It is regarded as probable that this wreck is that of the *Bristol Packet,* the first ship to be launched from the Badgers Island shipyard of Kittery, Maine, USA in AD 1801 (this shipyard produced hundreds of sailing ships in the years to follow). Unfortunately, the absence of tree-ring dating does not clarify whether the wreck is likely to be the *Bristol Packet* or not.

The shipyard owner at the time, William Badger would have had convenient access to the wood species utilised in the construction of the vessel from Minehead and had apprenticed as a master carpenter with responsibility for timber harvesting and upriver timber transportation to build the frigates *Congress* and *Crescent* between AD 1794 and AD 1799 (Kurtz 2013). All the species used in the ship's construction grow throughout Maine (Natural Resources Council of Maine 1995) and the species utilised may be evidenced in William Badger's preserved accounts of timber purchasing between the AD 1790s and his death in AD 1830 (William Badger Papers, 1768-1830). White oak was the preferred timber of choice for shipbuilding at the time in Maine (Kurtz 2013), though many other species were also utilised. With this in mind, all available appropriate tree-ring reference chronologies from the eastern United States and Canada were used in this study in an attempt to date the wreck.

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TABLES

Table 1: Details of samples. R denotes number of radii measured per sample. H/S = heartwood/sapwood boundary. ARW= average ring width. nm=not measured

Timber	Location	Conversion	Dimensions	Sspecies	Rings	Bark/Sapwood	ARW (mm)	Relative span
MBW01	Framing timber	halved	330x200	*Acer* sp.	nm	-	-	-
MBW02 4R	Framing timber	halved	300 x 200	*Larix/Picea* spp.	77	+H/S?	2.82	1–77
MBW03 5R	Framing timber	sub whole	295 x 190	*Larix/Picea* spp.	85	-	1.93	1–85
MBW04 4R	Framing timber	sub whole	350 x 180	*Larix/Picea* spp.	110	-	1.58	1–110
MBW05 4R	Framing timber	halved	300x180	*Larix/Picea* spp.	120	-	1.67	1–120
MBW06 4R	Framing timber	halved	300 x 185	*Larix/Picea* spp.	112	-	1.60	1–112
MBW07 2R	Futtock scarfed to mbw08	halved	110 x 80	*Larix/Picea* spp.	78	+H/S?	1.83	1–78
MBW08	Floor or lower futtock scarfed to mbw07	halved	280x85	*Acer* sp.	nm	-	-	-
MBW09	Ceiling plank	tangential	220+x70	*Larix/Picea* spp.	59	-	1.73	1–59
MBW10	stringer	halved	220 x 100	*Larix/Picea* spp.	46	-	2.40	1–46
MBW11	Hull plank	radial	200 x 60	*Castanea* sp.	116	+H/S?	1.51	1–116
MBW12	Hull plank	tangential	200x65	*Acer* sp.	nm	-	-	-
MBW13	Hull plank	tangential	230x60	*Acer* sp.	nm	-	-	-
MBW14	Sheathing on mbw13	tangential	200x20	*Larix/Picea* spp.	nm	-	-	
MBW15	Hull plank	radial	140 x 65	*Larix/Picea* spp.	69	-	1.97	1–69
MBW16	Sheathing attached to mbw15	tangential	140+x55+	*Larix/Picea* spp.	nm	-	-	-

Table 2: t-*values between measured radii of MBW02 (relative years).* - = t-*value less than 3.00;* \ = *overlap of less than 25 years*

Filenames	-	-	MBW02_1	MBW02_2	MBW02_3	MBW02_4
-	start	dates	1	1	5	12
-	dates	end	73	76	77	72
MBW02_1	1	73	*	9.01	-	3.51
MBW02_2	1	76	*	*	5.11	-
MBW02_3	5	77	*	*	*	-
MBW02_4	12	72	*	*	*	*

Table 3: t *values between measured radii of MBW03 (relative years).* - = t-*value less than 3.00;* \ = *overlap of less than 25 years*

Filenames	-	-	MBW03_1	MBW03_2	MBW03_3	MBW03_4	MBW03_5
-	start	dates	1	24	1	1	1
-	dates	end	61	85	79	83	54
MBW03_1	1	61	*	\	8.91	7.15	6.80
MBW03_2	24	85	*	*	3.76	5.79	\
MBW03_3	1	79	*	*	*	6.12	5.64
MBW03_4	1	83	*	*	*	*	4.61
MBW03_5	1	54	*	*	*	*	*

Table 4: t-*values between measured radii of MBW04 (relative years).* - = t-*value less than 3.00;* \ = *overlap of less than 25 years*

Filenames	-	-	MBW04_1	MBW04_2	MBW04_3	MBW04_4
-	start	dates	1	2	2	21
-	dates	end	110	110	84	79
MBW04_1	1	110	*	10.74	7.01	-
MBW04_2	2	110	*	*	6.83	3.71
MBW04_3	2	84	*	*	*	3.42
MBW04_4	21	79	*	*	*	*

Table 5: t-values between measured radii of MBW05 (relative years). - = t-value less than 3.00; \ = overlap of less than 25 years

Filenames	-	-	MBW05_1	MBW05_2	MBW05_3	MBW05_4
-	start	dates	1	1	1	2
-	dates	end	96	97	105	120
MBW05_1	1	96	*	3.84	-	5.95
MBW05_2	1	97	*	*	4.35	5.75
MBW05_3	1	105	*	*	*	3.49
MBW05_4	2	120	*	*	*	*

Table 6: t-values between measured radii of MBW06 (relative years). - = t-value less than 3.00; \ = overlap of less than 25 years

Filenames	-	-	MBW06_1	MBW06_2	MBW06_3	MBW06_4
-	start	dates	1	47	4	4
-	dates	end	111	112	55	89
MBW06_1	1	111	*	7.39	4.64	4.76
MBW06_2	47	112	*	*	\	5.49
MBW06_3	4	55	*	*	*	3.42
MBW06_4	4	89	*	*	*	*

Table 7: t-values between measured radii of MBW07 (relative years). - = t-value less than 3.00; \ = overlap of less than 25 years

Filenames	-	-	MBW07_1	MBW07_2
-	start	dates	29	1
-	dates	end	78	56
MBW07_1	29	78	*	7.50
MBW07_2	1	56	*	*

FIGURES

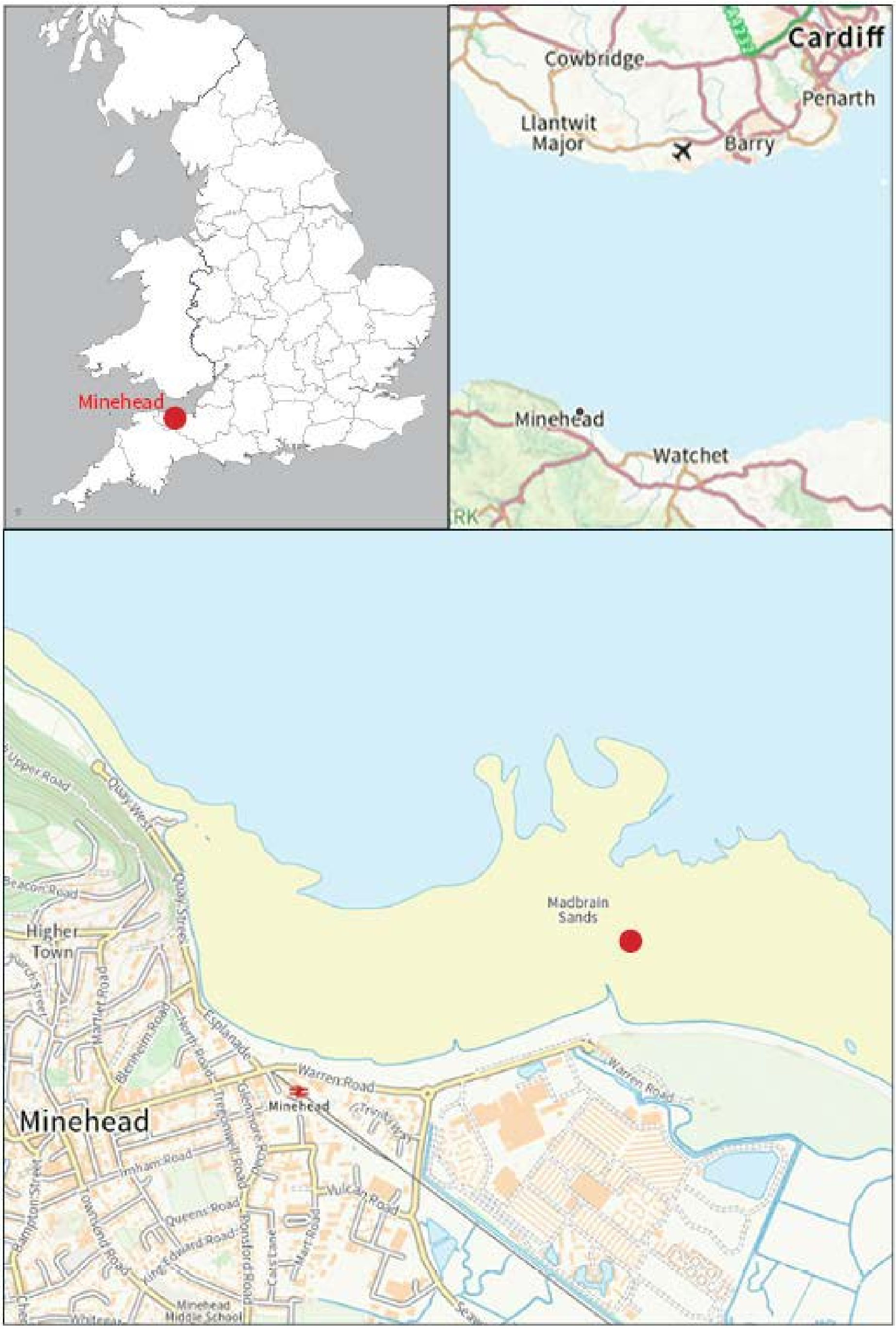

Figure 1: Maps to show the location of the wreck at Minehead, possibly the 'Bristol Packet' in red. Scale: top right 1:400,000; bottom 1:15,000. © Crown Copyright and database right 2023. All rights reserved. Ordnance Survey Licence number 100024900

Figure 2: Photograph showing baseline for rapid offset survey (view to north), with the locations of hull planks MBW11, MBW12, and MBW13 indicated (photograph by Rod Bale).

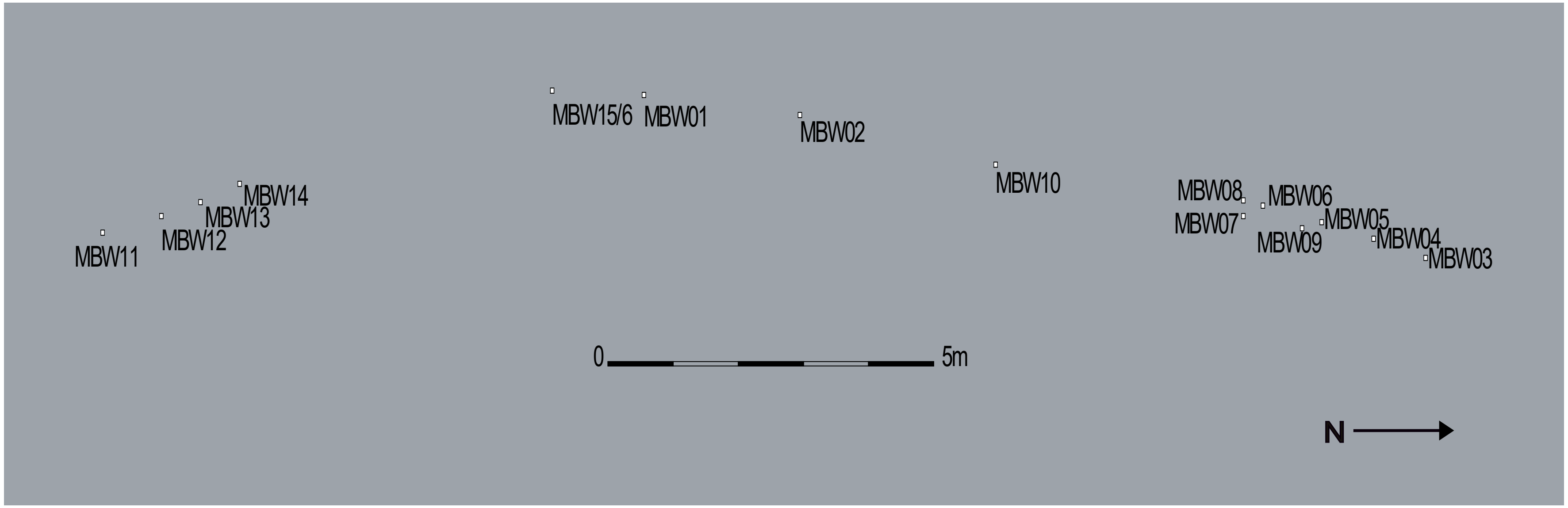

Figure 3: Offset survey to show relative positions of sampled timbers (R Bale and N Nayling)

Figure 4: Location of frame MBW01, from north-east (photograph by Rod Bale)

Figure 5: Close-up photograph of frame MBW01 with scale, from east (photograph by Rod Bale)

Figure 6: Sampling framing timber MBW02, from north-east (photograph by Rod Bale)

Figure 7: MBW01 and MBW02, from east (photograph by Rod Bale)

Figure 8. Locations of frames MBW03, MBW04, and MBW05, from north (photograph by Rod Bale)

Figure 9: Sampling framing timber MBW06, from south-east (photograph by Rod Bale)

Figure 10: Photograph from east showing from left to right MBW04, MBW05 (both with white tags) and sampled frame MBW06 (no tag) (photograph by Rod Bale)

Figure 11: Photograph from south-east showing from background to foreground tagged timbers MBW03, MBW04, MBW05, and MBW06 (photograph by Rod Bale)

Figure 12: Photograph from east showing from right to left tagged timbers MBW05, MBW06, MBW07 (furthest right foreground) and MBW08 (furthest right background) (photograph by Rod Bale)

Figure 13: Sampling ceiling plank MBW09, from south-east (photograph by Rod Bale)

Figure 14: Sampled ceiling plank MBW09, from east (photograph by Rod Bale)

Figure 15: Photograph from south showing sampled stringer MBW10 (tagged timber in foreground), which was sampled at the foreground end. Timbers MBW06, MBW07, and MBW08 are visible at the point where the stringer enters the sand (photograph by Rod Bale)

Figure 16: Photograph from north-east showing (from left to right) sampled hull planking MBW11, MBW12, and MBW13 (photograph by Rod Bale)

Figure 2: Sampled sheathing timber MBW14 from north-east (photograph by Rod Bale)

Figure 3: Sampled hull plank (MBW15) and adjacent sheathing timber (MBW16) from east (photograph by Rod Bale)

Figure 49: Sample MBW01 (photograph by Rod Bale)

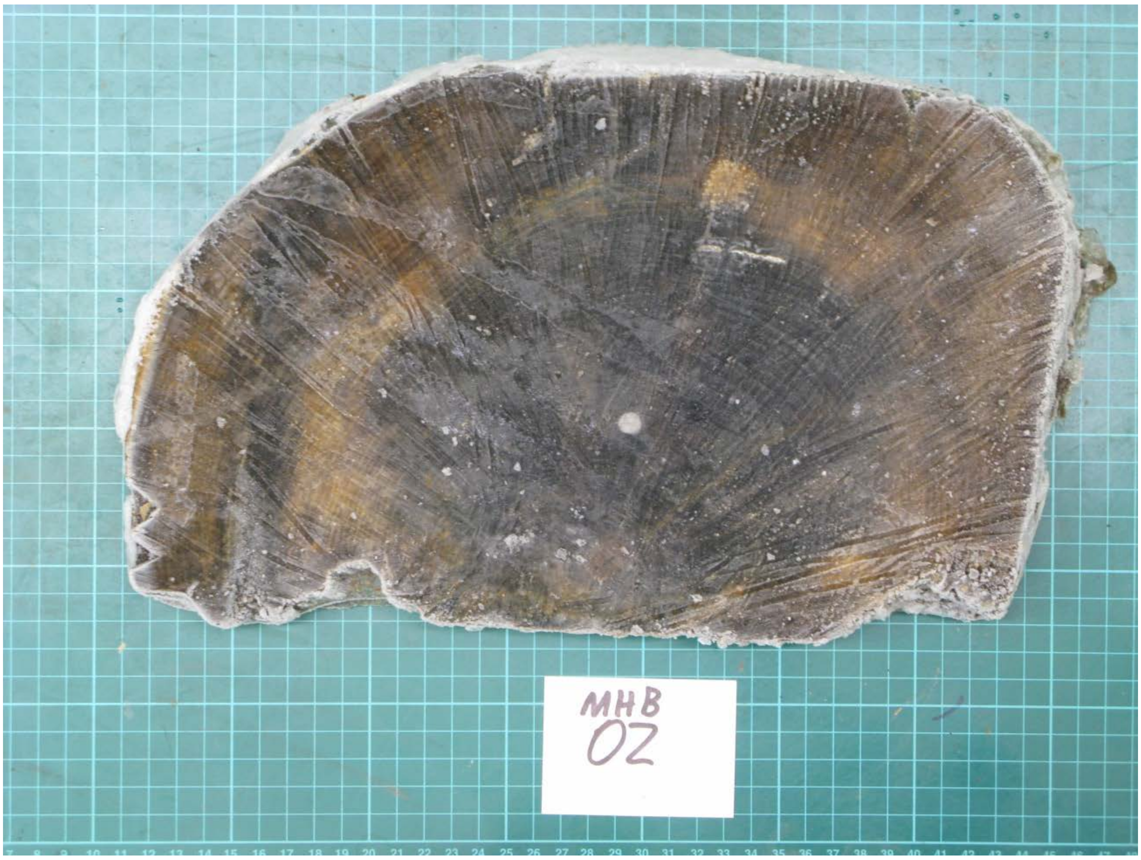

Figure 205: Prepared sample MBW02 (photograph by Rod Bale)

Figure 21: Sample MBW03 (photograph by Rod Bale)

Figure 6: Sample MBW04 (photograph by Rod Bale)

Figure 23: Sample MBW05 (photograph by Rod Bale)

Figure 74: Sample MBW06 (photograph by Rod Bale)

Figure 8: Sample MBW07 (photograph by Rod Bale)

Figure 9: Sample MBW08 (photograph by Rod Bale)

Figure 10: Sample MBW09 (photograph by Rod Bale)

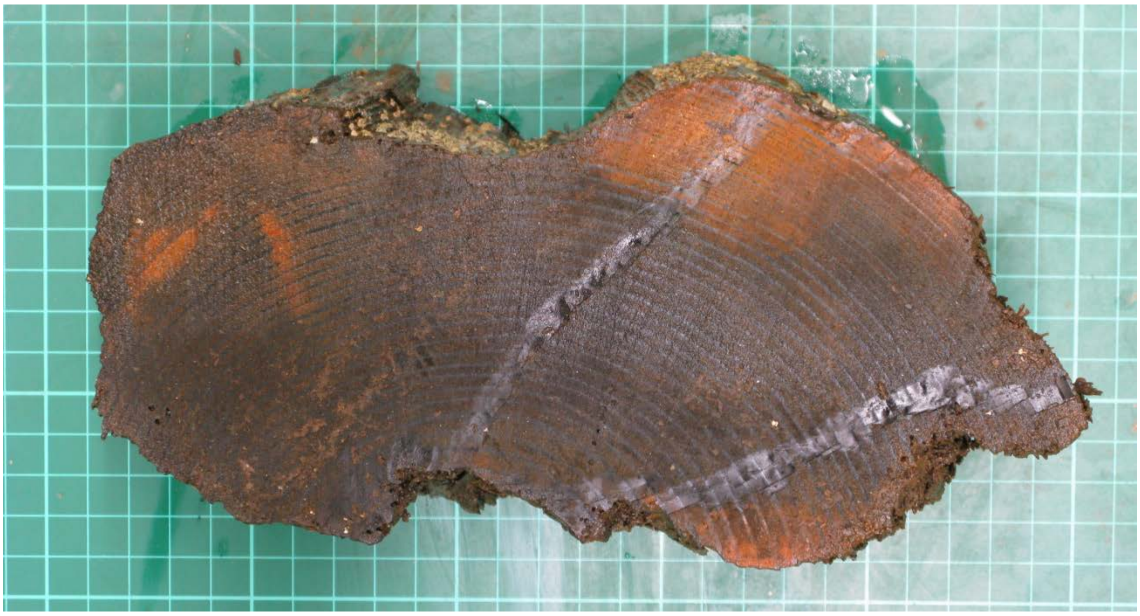

Figure 2811: Sample MBW10 (photograph by Rod Bale)

Figure 2912: Sample MBW11 (photograph by Rod Bale)

Figure 13: Sample MBW12 (photograph by Rod Bale)

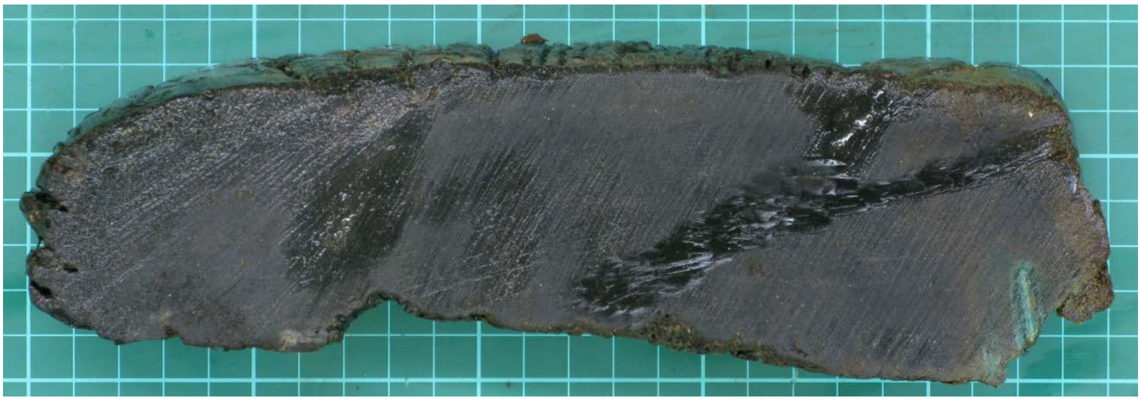

Figure 14: Sample MBW13 (photograph by Rod Bale)

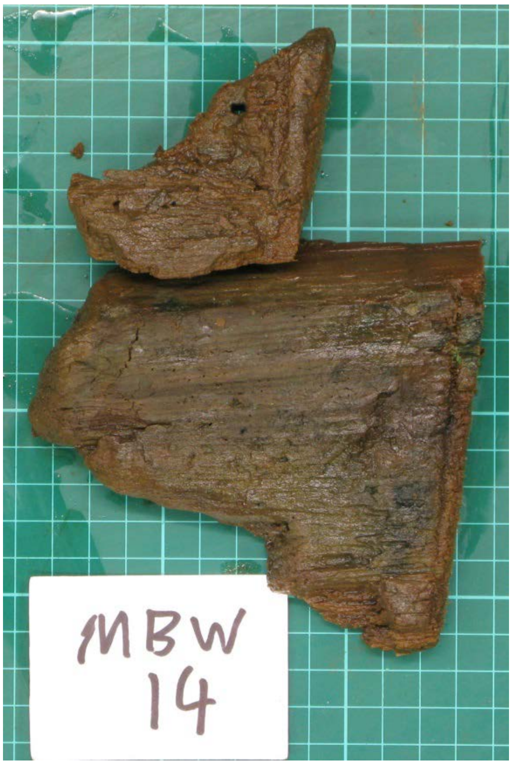

Figure 3215: Sample MBW14 (photograph by Rod Bale)

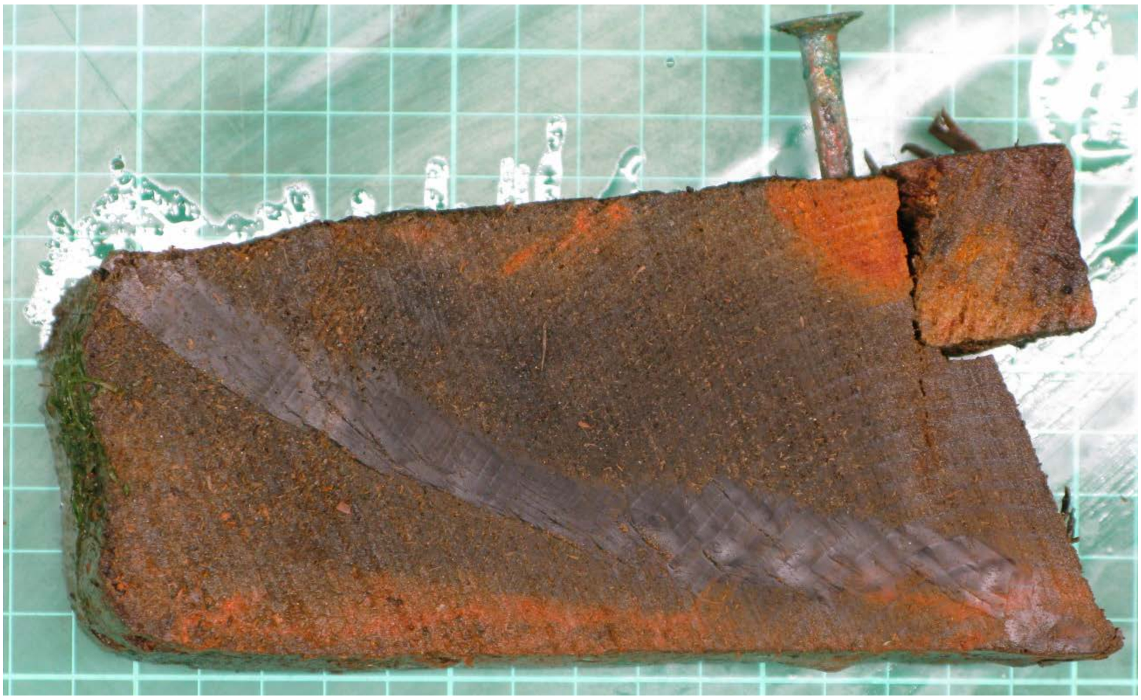

Figure 3316: Samples MBW15 and MBW16 (small timber in top right) (photograph by Rod Bale)

RING-WIDTH DATA OF MEASURED SAMPLES

Measurements in 0.01mm units

Ring widths for MBW02 radius 1

331	348	304	409	744	545	326	170	323	265
256	181	303	252	130	163	143	157	167	284
236	296	201	190	234	313	413	358	277	289
326	295	411	555	500	531	481	301	304	312
305	284	413	370	193	341	356	275	305	410
397	280	246	308	320	303	346	278	374	325
237	402	324	407	230	314	292	277	353	312
313	269	375							

Ring widths for MBW02 radius 2

334	353	278	409	606	440	373	168	306	264
241	153	183	165	147	120	193	118	133	162
163	170	152	166	242	283	263	192	142	211
187	204	239	324	325	361	305	258	247	269
291	273	289	307	209	251	286	239	199	310
231	267	207	247	300	296	388	339	330	277
220	311	290	297	202	255	295	292	319	247
363	259	329	262	290	201				

Ring widths for MBW02 radius 3

557	461	305	261	230	219	117	127	115	132
148	163	168	118	116	175	168	136	107	207
255	262	241	119	130	209	157	171	233	325
308	301	254	167	247	203	200	216	197	241
181	170	273	226	193	257	261	289	208	279
356	313	369	305	326	284	259	290	321	285
285	236	246	323	324	307	275	264	332	347
304	346	269							

Ring widths for MBW02 radius 4

69	124	106	228	198	113	132	280	246	205
265	182	296	284	304	315	334	253	302	314
369	439	608	562	648	520	317	283	318	404
361	455	267	248	280	299	227	165	360	363
234	251	357	288	304	348	304	354	269	190
384	333	297	196	240	262	313	349	252	260
220									

Ring widths for MBW03 radius 1

182	170	304	336	293	413	325	373	405	381
256	315	384	334	323	354	311	330	291	385
433	348	349	416	306	295	326	232	211	202
199	155	194	175	141	151	170	137	124	122
175	131	155	126	136	87	113	147	110	132
123	87	95	132	148	110	199	144	133	71
97									

Ring widths for MBW03 radius 2

167	95	181	146	189	232	183	180	169	200
152	107	172	153	176	129	131	207	160	213
162	129	109	148	142	99	105	88	112	90
130	144	154	217	154	118	72	74	65	66
64	106	87	93	95	106	54	103	118	86
40	62	87	55	90	66	80	54	53	57
56	93								

Ring widths for MBW03 radius 3

207	190	305	296	303	371	335	425	369	314
265	307	399	346	383	343	273	317	376	406
470	362	343	428	302	312	318	236	205	189
171	148	165	180	146	133	157	160	135	137

173	152	194	147	118	110	108	118	98	96
105	80	79	116	130	113	196	144	118	70
77	63	53	69	86	80	74	83	130	74
101	102	67	75	52	52	48	66	51	

Ring widths for MBW03 radius 4

271	246	318	338	328	453	375	487	455	390
391	386	465	282	383	337	327	338	411	502
436	325	381	396	375	317	305	231	182	180
185	157	153	149	136	144	174	148	127	153
200	144	174	133	128	95	129	129	110	103
118	103	99	155	161	139	190	194	116	84
87	51	71	63	93	92	86	110	106	77
65	94	83	51	54	72	52	77	56	72
69	60	75							

Ring widths for MBW03 radius 5

235	258	398	387	371	544	367	414	454	405
357	445	561	436	544	461	420	414	386	306
360	430	458	520	383	394	356	240	223	217
223	230	223	207	150	174	251	209	209	177
213	168	269	175	162	112	139	176	106	127
120	86	86	168						

Ring widths for MBW04 radius 1

182	190	236	175	303	327	318	306	279	243
256	294	243	263	224	129	116	190	171	219
185	193	148	146	74	125	94	164	155	153
186	144	139	149	238	162	174	149	160	125
162	155	174	124	182	195	156	148	128	173
209	178	210	208	147	169	165	148	130	134
126	87	154	143	152	129	155	140	152	173
172	149	121	97	153	129	151	112	74	93
157	174	233	253	179	154	83	65	58	74
98	72	75	79	107	110	127	83	89	82
74	63	50	73	74	84	138	117	154	225

Ring widths for MBW04 radius 2

299	210	189	295	351	274	329	308	229	233
248	280	236	228	145	113	194	185	239	182
147	137	138	92	101	105	181	167	167	130
168	190	160	233	189	139	170	156	120	176
154	151	144	169	233	167	144	119	147	188
179	205	199	135	165	127	126	137	129	124
121	143	150	133	143	155	156	148	158	147
187	115	107	151	166	181	116	51	80	149
186	185	266	165	165	103	62	47	64	85
76	74	84	102	101	91	98	86	64	86
55	61	75	83	69	124	98	158	127	

Ring widths for MBW04 radius 3

298	274	155	326	266	295	293	266	280	221
229	262	270	172	122	161	190	216	207	162
142	178	145	97	138	117	162	153	180	113
135	161	136	202	207	128	173	176	159	187
173	233	89	196	233	234	210	193	235	281
238	246	234	177	159	139	123	167	140	119
88	189	159	123	122	195	173	147	188	119
144	87	76	99	76	81	74	45	69	78
109	135	167							

Ring widths for MBW04 radius 4

210	207	244	208	126	119	207	265	255	211
192	201	218	138	162	259	131	156	130	136
173	134	228	180	204	178	145	133	135	205
166	147	159	153	163	183	180	180	170	163
120	139	140	132	100	114	157	177	134	131
185	223	227	204	263	238	343	308	329	

Ring widths for MBW05 radius 1

116	102	113	183	207	187	222	192	322	305
256	421	392	236	248	255	148	100	107	233
152	146	165	177	172	144	100	143	145	117
129	141	138	142	131	131	123	122	93	74
87	162	113	117	94	101	141	101	200	127
125	157	157	144	177	219	182	143	213	202
218	214	205	202	217	177	182	207	138	156
138	172	219	193	138	166	232	215	176	149
139	151	158	237	129	140	162	166	167	156
152	155	113	172	207	229				

Ring widths for MBW05 radius 2

140	84	218	178	189	226	212	209	317	346
309	409	464	322	392	344	249	286	308	257
160	154	164	178	196	131	150	98	106	124
173	142	175	125	130	146	137	108	71	82
80	115	141	133	98	101	103	110	149	122
110	143	147	177	185	210	207	157	171	189
236	218	182	140	170	154	167	173	138	196
133	171	207	187	177	161	154	238	192	153
116	155	214	248	151	187	155	146	172	173
143	146	146	195	233	236	323			

Ring widths for MBW05 radius 3

117	71	189	167	192	202	229	227	329	331
363	416	420	297	308	389	263	388	447	241
240	174	190	156	244	70	164	198	221	158
159	197	163	182	150	160	144	164	109	96
83	127	130	102	79	88	87	85	120	104
102	90	92	101	128	100	114	86	112	119
150	158	139	126	121	131	141	166	143	122
155	169	202	138	152	130	166	189	174	159
125	160	164	134	127	162	152	157	205	124
158	174	126	165	145	198	198	272	162	152
77	68	77	67	144					

Ring widths for MBW05 radius 4

218	185	166	211	209	219	223	334	324	332
474	428	352	395	387	268	279	292	238	148
168	189	196	193	178	154	94	142	103	118
145	109	174	136	140	124	131	93	88	78
119	112	104	91	90	95	91	139	108	95
126	133	130	142	198	162	140	161	166	197
191	139	122	119	165	151	172	140	170	150
166	242	221	149	158	204	232	179	171	146
179	160	179	162	187	155	189	154	139	177
155	157	182	226	207	197	246	216	176	105
147	65	75	219	151	149	171	187	178	120
140	105	121	96	95	88	78	94	104	

Ring widths for MBW06 radius 1

185	240	200	230	228	233	234	234	251	253
250	205	181	182	172	146	107	148	187	238
160	238	136	160	169	202	225	240	221	343
379	400	353	313	328	309	272	247	354	360
437	362	400	287	292	246	288	290	241	288
218	256	224	193	178	110	138	123	138	172
173	162	156	154	81	109	111	119	117	129
117	151	142	144	149	189	122	101	95	93
76	101	109	99	108	116	62	106	69	86
97	61	70	74	33	52	28	11	10	26
17	30	26	42	28	25	28	32	33	51
26									

Ring widths for MBW06 radius 2

307	251	177	235	182	207	229	253	175	95
172	126	132	150	124	148	156	106	82	75

91	106	92	88	70	118	102	109	111	105
84	85	67	101	127	125	110	96	64	93
74	79	83	81	75	91	94	101	57	82
52	14	15	41	30	34	39	45	43	50
59	42	51	48	67	68				

Ring widths for MBW06 radius 3

177	228	227	237	254	259	292	232	168	164
198	167	142	148	155	193	184	171	229	129
157	173	206	284	250	176	288	319	320	319
416	350	381	307	282	286	277	302	323	328
264	307	255	267	223	159	249	214	235	154
225	215								

Ring widths for MBW06 radius 4

205	240	208	257	240	225	279	238	188	175
206	203	118	88	133	180	234	184	225	167
202	190	239	232	256	222	263	369	347	353
355	325	266	305	285	309	253	284	315	401
281	320	292	270	284	245	251	223	230	234
239	176	94	122	127	133	107	119	99	113
86	63	83	76	96	75	57	64	83	60
69	62	61	66	56	58	78	86	91	117
73	49	82	70	75	68				

Ring widths for MBW07 radius 1

179	270	343	367	293	314	318	197	192	282
223	321	207	193	147	130	183	214	226	248
226	143	97	37	66	81	96	169	148	161
174	133	146	149	181	154	179	175	196	194
192	189	132	240	242	174	166	157	149	110

Ring widths for MBW07 radius 2

121	155	119	111	138	76	129	92	125	126
121	115	112	131	87	140	129	171	187	174
192	233	202	262	191	170	209	264	290	248
300	331	335	361	439	288	211	255	219	316
185	189	148	164	264	353	279	302	286	170
105	73	127	174	232	187				

Ring widths for MBW09

294	231	249	219	222	148	138	165	205	211
268	213	231	267	226	227	225	241	145	156
238	252	189	197	215	161	192	214	190	166
169	153	192	147	127	108	133	139	132	119
141	118	104	103	109	153	175	144	164	103
76	101	86	102	147	167	145	179	178	

Ring widths for MBW10

367	373	424	393	483	307	273	332	243	331
394	307	265	297	304	236	277	281	334	284
214	261	355	246	288	153	84	132	143	99
162	201	103	156	144	150	133	72	95	158
151	284	188	152	215	177				

Ring widths for MBW11

72	53	44	59	81	151	116	136	127	151
167	131	109	112	136	153	167	168	122	160
155	103	87	109	101	103	113	98	101	107
147	151	156	155	151	135	87	91	127	152
208	142	199	170	117	135	154	153	152	251
142	175	210	212	198	228	247	219	263	215
146	176	161	187	164	138	74	115	125	122
163	220	205	176	215	153	162	197	188	254
147	169	210	151	251	198	105	200	124	104

148	160	182	208	196	166	137	135	132	145
156	137	112	206	186	178	159	104	151	171
123	119	119	117	116	82				

Ring widths for MBW15

444	367	384	404	431	304	406	325	285	225
197	296	289	379	333	281	184	219	104	112
140	173	183	175	171	170	185	196	191	189
113	112	90	112	157	170	147	86	139	137
208	150	139	165	151	142	123	135	127	187
113	138	158	166	182	204	163	177	140	157
147	141	118	173	171	150	184	168	203	

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ISSN 2398-3841 (Print)
ISSN 2059-4453 (Online)