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Ancient Monuments Laboratory
Report 25/93

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Summary

Tree-ring analysis of eight oak timbers from the stake and wattle revetment at Cricklepit Mill revealed that they were broadly contemporary. They were felled in the winters of AD1525/6 and AD1526/7, giving a construction date for the revetment of AD1526/7 or very shortly afterwards.

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TREE-RING DATING OF OAK TIMBERS FROM CRICKLEPIT MILL, EXETER, DEVON

Excavations in 1990 at the Cricklepit Mill site, Exe Island, by the Exeter Museums Archaeological Field Unit, revealed a stake and wattle primary revetment along the Lower Leat (Henderson 1991). Tree-ring samples were removed from eight of the oak stakes in the hope of providing a precise date for the construction of the revetment.

Methods

The samples were prepared by freezing them for at least 48 hours and then cleaning their cross-sections with a surform plane (Hillam 1985). When the samples had thawed, a note was made of their cross-sectional dimensions and the orientation of the annual rings (Table 1).

The ring widths were measured to an accuracy of 0.01mm on a travelling stage built in the Department of Geography, City of London Polytechnic. The stage is connected to an Atari microcomputer which uses a suite of dendrochronology programs written by Ian Tyers (pers comm 1992). The measured ring sequences were plotted as graphs using an Epson HI-80 plotter. 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 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. A complete outer ring indicates that the tree was felled during its dormant period in winter or early spring. This is referred to as "winter felled". If the ring is incomplete, felling took place during the growing season in late spring or summer (referred to as "summer 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.

Once the felling date range or *terminus post quem* has been calculated, factors such as seasoning of timber, reuse, stockpiling, or repairs have also to be taken into account. Thus whilst the tree-ring dates for the measured rings are precise and independent, the interpretation of these dates often requires other archaeological evidence.

Results

The samples contained 70-94 annual growth rings, often including a complete band of sapwood (Table 1). Samples 22 and 83 were radially split segments of wood and the remainder were probably shaped from quartered tree trunks. None

of the samples had pith present, but 22 was within 10 rings or less of the centre of the tree. This suggests that the timbers came from trees aged about 100 years old. Their diameters were probably in the range of 300-400mm.

The outer edge of many of the samples was very crumbly due to the delicate nature of the sapwood. Although all but 63 had complete sapwood, it was often difficult to determine whether the outer ring was bark edge or whether it was within a year or two of it. Three of the samples (19, 42, 89) definitely had bark edge and were felled in winter. Two others were thought to have bark edge and were also probably felled in winter. 63 was the only sample without any sapwood.

Examination of the samples prior to measurement indicated that they had similar ring patterns. All the samples, for example, showed two narrow rings separated by seven wider ones in the outer part of the heartwood, and many of those with sapwood showed a group of six narrow rings near bark edge. It was therefore no surprise to find that, after measurement, all the ring sequences crossmatched. The quality of the internal matching suggests that the timbers came from a single woodland (Table 2). The matching sets of data were averaged to produce a site master curve of 94 rings (Table 3). When this was tested against dated reference chronologies, consistent results were found when the master spanned the period AD1432-1526 (Table 4). The master showed some similarity with EXMED, the Exeter chronology produced by Coralie Mills, which includes data from other timbers excavated along Exeter Quay (Mills 1988). However it matched better with chronologies from further away. In particular, it synchronised with chronologies from Bucknell Barn in Shropshire (Leggett 1980), Nuffield in Oxfordshire (Miles pers comm), and the Welsh-English border (Siebenlist-Kerner 1978). The tree-ring evidence therefore suggests that the timbers were brought to Exeter from outside Devon. There is also a poor match between the Cricklepit Mill timbers and those from Exeter

Quay examined by Mills (1988), indicating that the two groups of timbers are not from the same woodland. This supports the view that the timbers did not come from the City's woods just outside Exeter which, according to documentary evidence, supplied timbers for the public works along Exeter Quay (Henderson pers comm). Further research, both dendrochronological and documentary, might provide more information about the provenance of the timbers.

The results show that the timbers are more or less contemporary (Fig 1). 19 and probably 22 and 44 were felled in the winter of AD1525/6. 42 and 89 were felled in the winter of AD1526/7. This gives a *terminus post quem* of AD1526/7 for the construction of the revetment. Given that it would be unnecessary to season timbers that were going to be at least partially submerged, the revetment was probably constructed in AD1526/7 or very soon afterwards.

Acknowledgements

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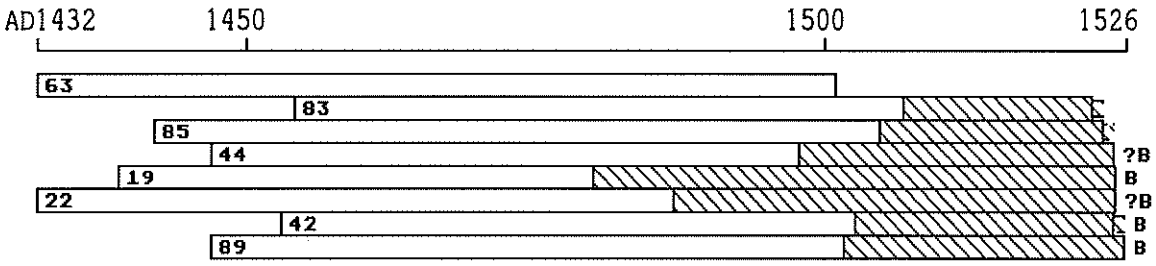


Fig 1: Bar diagram showing the relative positions of the matching ring sequences. White bars - heartwood rings; hatching - sapwood; broken lines - unmeasured rings; B - bark edge.

Table 1: Details of the tree-ring samples. Sketches are not to scale; shading on the sketches indicates sapwood.

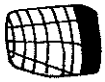
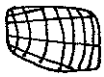
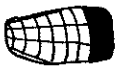
sample	context	total no of rings	sapwood rings	average ring width (mm)	sketch	cross-sectional dimensions (mm)	date span of rings	commnets
19	1215	87	45	1.15		120x110	1439-1525	felled winter
22	1217	94	38	1.39		130x80	1432-1525	?felled winter
42	1264	73	22	1.26		100x100	1453-1525	plus 1 ring to bark edge; felled winter
44	1262	79	27	1.31		110x100	1447-1525	?bark edge
63	1272	70	-	1.46		100x75	1432-1501	
83	1224	70	16	1.92		135x85	1454-1523	plus at least 1 ring
85	1239	83	19	0.97		100x100	1442-1524	plus at least 1 ring
89	1223	80	24	0.93		100x70	1447-1526	bark; felled winter

Table 2: Internal crossmatching showing the *t* values between the individual ring sequences. Values less than 3.5 are not printed.

	19	22	42	44	63	83	85	89
19	*	9.5		4.2	4.8	5.1	6.3	5.9
	22	*	3.6	5.1	6.0	4.0	5.5	4.7
		42	*	5.7	5.4	7.7	4.6	4.7
			44	*	5.6	5.2	6.0	7.0
				63	*	6.3		3.9
					83	*	4.8	4.7
						85	*	7.4
							89	*

Table 3: The Cricklepit Mill master chronology, AD1432-1526.

date	ring widths (0.01mm)										no of samples									
AD1432		262	230	293	334	257	290	200	213	251		2	2	2	2	2	2	2	3	3
	279	183	231	205	153	144	176	190	174	145	3	4	4	4	4	4	6	6	6	6
AD1451	152	96	130	163	110	159	157	134	111	170	6	6	7	8	8	8	8	8	8	8
	144	129	141	104	108	118	144	119	123	123	8	8	8	8	8	8	8	8	8	8
	111	125	113	125	169	139	125	122	122	118	8	8	8	8	8	8	8	8	8	8
	147	123	138	137	154	140	129	150	110	142	8	8	8	8	8	8	8	8	8	8
	95	58	92	133	118	182	127	98	108	64	8	8	8	8	8	8	8	8	8	8
AD1501	89	107	115	123	131	104	108	134	118	73	8	7	7	7	7	7	7	7	7	7
	121	121	119	118	68	78	90	62	95	80	7	7	7	7	7	7	7	7	7	7
	122	139	121	94	88	85					7	7	7	6	5	1				

Table 4: Dating the Cricklepit Mill master; *t* values with reference chronologies.

chronology	*t* value
Bucknell Barn, Shropshire (Leggett 1980)	5.0
Devizes B, Oxon (Haddon-Reece *et al* 1990)	4.2
Droitwich, Upwich 3 (Groves & Hillam 1992)	3.9
EXMED, Exeter (Mills 1988)	4.0
Llynn Peris boat (Tyers pers comm)	4.6
London, Sutton House (Tyers 1991)	3.7
Nuffield, Oxon (Haddon-Reece *et al* 1989)	5.4
Southern England (Bridge 1988)	4.0
Welsh/English border (Siebenlist-Kerner 1978)	5.9
Yorkshire Buildings 2 (Hillam unpubl)	5.1