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Summary

Samples of waterlogged wood recovered during the selected excavation of this late prehistoric enclosure were examined to identify the tree species represented and the growth patterns of the parent trees. The majority of the samples were derived from immature oaks and had insufficient rings to merit measurement for tree-ring dating. Nine samples were measured, and the sequences from tree posts employed in a palisade found to cross-match providing a 70-year site mean. Neither this mean nor any of the individual tree sequences produced in this study were found to match against external, previously dated chronologies.

The growth structure of the assemblage studied suggests that should further excavation be carried out on the site, then further timbers suitable for dendrochronological analysis are likely to be encountered.

Keywords

Dendrochronology
Wood

Author's address
Lampeter Dendrochronology Laboratory, Heritage and Archaeology Research Practice, University of Wales, Lampeter, Ceredigion, SA48 7ED, 01570 424730/ 01570 422351x481, n.nayling@lamp.ac.uk

TREE-RING ANALYSIS OF TIMBERS FROM SUTTON COMMON, ASKERN, SOUTH YORKSHIRE

Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from excavations at Sutton Common, Askern, South Yorkshire (NGR SE 563 121). Analysis of the samples was requested by John Etté, Inspector of Ancient Monuments for English Heritage

It is beyond the dendrochronological brief to describe the associated contexts and structures or to undertake the production of detailed drawings. As part of a multifaceted and multidisciplinary study of the site, elements of this report may be combined with detailed descriptions, drawings, and other technical reports at some point in the future to form either a comprehensive publication or an archive deposition on the excavations. The conclusions may therefore have to be modified in the light of subsequent work.

Methodology

Methods employed at the Lampeter Dendrochronology Laboratory in general follow those described in English Heritage (1998). Details of the methods used for the dating of these samples are described below.

The samples were taken on site by members of the excavation team and forwarded to the author for assessment, measurement of suitable samples, and crossmatching to identify any internal chronological relationships between samples and attempt to provide absolute dates through correlation with previously dated prehistoric sequences. The samples were frozen and then cleaned with a Surform plane and razor blades to reveal the tree-ring sequence. Ring counts were made of all samples and those with more than 50 annual rings were selected for measurement.

The complete sequences of growth rings in the samples that were selected for dating purposes were measured to an accuracy of 0.01mm using a micro-computer based travelling stage (Tyers 1997). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. These positions were checked visually using the graphs and, where these were satisfactory, new mean sequences were constructed from the synchronised series. The *t*-values reported below 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. Timbers originally derived from the same parent tree generally have *t*-values greater than 10.0. Lower values from timbers obviously derived from the same parent tree (eg on morphological grounds) are however quite common. It is the visual similarity in medium term growth trends of the samples that is the critical factor in determining 'same tree' origin.

All the measured sequences from this assemblage were compared with each other and any found to cross-match were combined to form a site master curve. These, and any remaining unmatched ring sequences were tested against a range of reference chronologies, using the same matching criteria: high *t*-values, replicated values against a range of chronologies at the same position, and satisfactory visual matching. Where such positions are found these provide calendar dates for the ring-sequence.

The tree-ring dates produced by this process initially only date the rings present in the timber. The interpretation of these dates relies upon the nature of the final rings in the sequence. If the sample ends in the heartwood of the original tree, a *terminus post quem (tpq)* for the felling of the tree is indicated by the date of the last ring plus the addition of the minimum expected number of sapwood rings which are missing. This *tpq* may be many decades prior to the real felling date. Where some of the outer sapwood or the heartwood/sapwood boundary survives on the sample, a felling date range can be calculated using the maximum and minimum number of sapwood rings likely to have been present. The sapwood estimates applied throughout this report are a minimum of 10 and maximum of 46 annual rings, where these figures indicate the 95% confidence limits of the range. These figures are applicable to oaks from the British Isles (Tyers 1998). Alternatively, if bark-edge survives, then a felling date can be directly utilised from the date of the last surviving ring. The dates obtained by the technique do not by themselves necessarily indicate the date of the structure from which they are derived. It is necessary to incorporate other specialist evidence concerning the re-use of timbers and the repairs of structures before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

A total of 40 samples were examined from a variety of contexts and phases (Table 1). All samples were identified as oak (*Quercus* spp.) with the exception of two pieces of alder (*Alnus* spp.) and a single piece of ash (*Fraxinus excelsior* L.). Of these, only nine had sufficient rings to merit measurement. Growth ring data were produced for the remaining ring-porous samples (oak and ash) including ring count, average ring width, sapwood, and bark presence.

Bark was present on two samples (051 and K9-004) with the former sample having been felled during the tree's dormant phase ('winter' ie September to April). A further four samples possibly retained the bark edge, identified by conformity between the outermost sapwood rings and the curve of the surviving edge in transverse section, and the presence of slightly raised medullary rays on the outer face of the timber sample. One sample retained partial sapwood (301) whilst a further seven samples retained the possible heartwood/sapwood boundary.

Three of the measured samples (D10-004 to D10-006) crossmatched (Table 2a; Fig 1). A 70-year mean calculated from these three ring sequences (Table 3), and the individual tree-ring sequences, have not dated against British or northern European site masters or regional chronologies. A possibly significant computer correlation between two samples (301 and G9-027), with an overlap of 37 years was observed (Table 2b) but with no further correlations, this apparent match should be treated with caution, and can not be considered a definitive relative date.

Interpretation

The condition of the samples probably reflects partial survival of the original timber with less robust sapwood on some timbers having decayed in the post-depositional environment rather than being a function of woodworking prior to use. The samples are considered in relation to archaeological phases and structural groups.

Phase 1

A total of 24 samples were assigned to phase 1, with 19 coming from the palisade.

The palisade samples comprised five from trench 4, nine from the eastern edge of the enclosure, and five from the northern edge of the enclosure. Ring counts vary between 10 and 70 years with a mean of 27 years (rounded) reflecting the predominant use of immature oak trees and/or branches (Fig 2). This is also seen in the average ring width for this group, ranging between 1.3mm and 6.7mm with a mean of 3.9mm. The majority of the timbers are derived from fast-grown, immature oaks. Given the poor condition of many samples, it is not possible to give exact ages at felling, but most could have come from trees between 20 and 50 years old. The three measured, cross-matching samples (D10-004 to D10-006) are clearly derived from more mature, slowly-grown timber with average ring widths of less than 2mm.

The remaining five samples, possibly from Phase 1 (Table 1), include a 38-year old oak felled in winter from the causeway (051), three oaks from the entrance with moderate to fast growth rates (311, 313, and 317) but insufficient rings for measurement, and a single, measured sample (301) from an oak probably between 79 and 115 years old when felled given present sapwood estimates (Tyers 1998). The ring sequence from the latter sample shows no significant correlation with any of the other measured samples from Phase 1 but does exhibit an apparent crossmatch with sample G9-027 from the northern row of posts in the causeway, tentatively assigned to phase 2. *If* this was correct, it might suggest a time difference between phases 1 and 2 of between 3 and 39 years. This match is not replicated and so must be treated with caution.

Phase 2

A total of 11 samples were assigned, with varying degrees of confidence, to Phase 2. All were oak with the exception of a fragment of alder found in the base of a ditch (450). Seven samples came from the causeway, all but one from the northern row of posts. Six of these, with ring counts of less than 25 years, form a distinct cluster in a plot of average ring width against ring count for Phase 2 (Fig 3). Three of these posts appeared to retain all their rings indicating felling ages of 16, 19, and 24 years. No samples from this group contained sufficient rings to merit measurement.

The remaining three oak samples from this phase (034, 444, and G9-027) appear to derive from substantial posts. The parent trees are relatively fast-grown with average ring widths in excess of 3.5mm and probable ages at felling of between 60 and 120 years. All three had just sufficient rings for measurement but their ring width sequences have not dated. A correlation between sample G9-027 and sample 301 from Phase 1 is considered above.

Phase 3

A single oak stake from Phase 3 (063), probably 49 years old when felled, had as relatively slow average growth rate of 1.69mm per annum.

Unphased samples

Two non-oak samples from a 'deep feature' were identified as alder (K9-001) and ash (K9-004). The latter sample came from a tree with a felling age of 34 years and relatively slow growth rate (1.2mm per annum). The remaining, two oak samples included one from a post within the large enclosure with the longest tree-ring sequence recorded from any sample (I11-001) and the slowest average growth rate (0.8mm per annum).

Conclusions

The majority of the timbers examined had insufficient rings for tree-ring dating. The assemblage examined suggests widespread use of relatively immature oak stems. Nonetheless, approximately one quarter of the samples supplied did contain more than fifty rings and were measured. Whilst no dating was achieved between the tree-ring sequences generated and external, previously-dated chronologies, some internal crossmatching between samples was carried out. If the assemblage reported on here is representative of the unexcavated archaeological resource, then further fieldwork could reasonably be expected to recover additional timbers suitable for analysis. Such analysis might be able to confirm the possible chronological relationship between Phases 1 and 2 hinted at by the computer correlation between samples G9-027 and 301. If data can be recovered from further samples which replicate and extend any of the existing tree-ring sequences from the site, this would enhance the possibility of producing absolute dates through correlation with dated chronologies.

Should new excavations be carried out on the site, consideration might be given to including visits from a dendrochronologist to assess and sample timber *in situ* in order to optimise the recovery of suitable tree-ring sequences.

Acknowledgements

Henry Chapman of the Centre for Wetland Archaeology, University of Hull provided details on the context of the samples. The sampling and analysis programme was funded by English Heritage.

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Figure 1 Sutton Common. correlated relative positions of ring sequences from samples D10-004 to D10-006

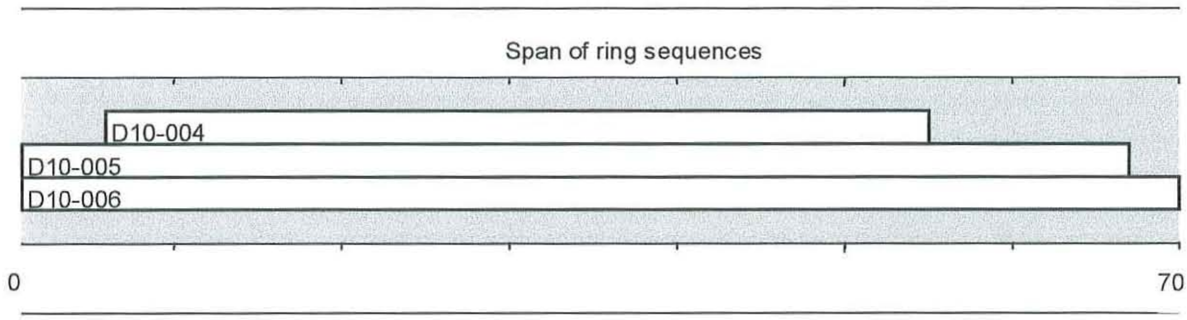

Figure 2 Scatter plot of Phase 1 palisade samples.

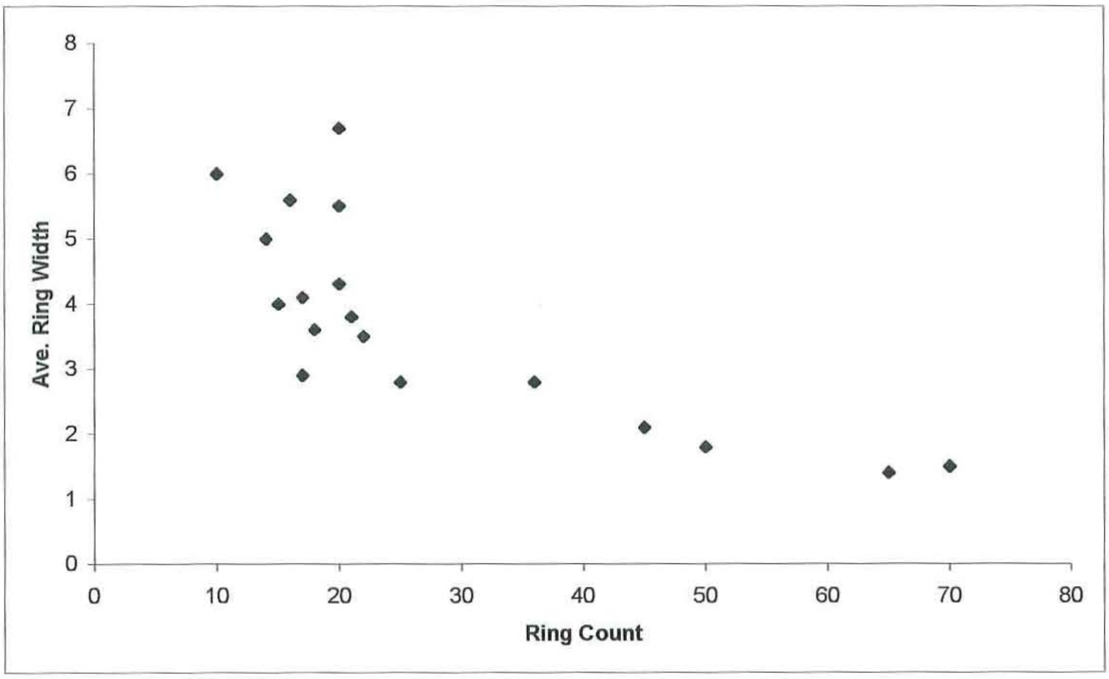

Figure 3 Scatter plot of Phase 2 samples

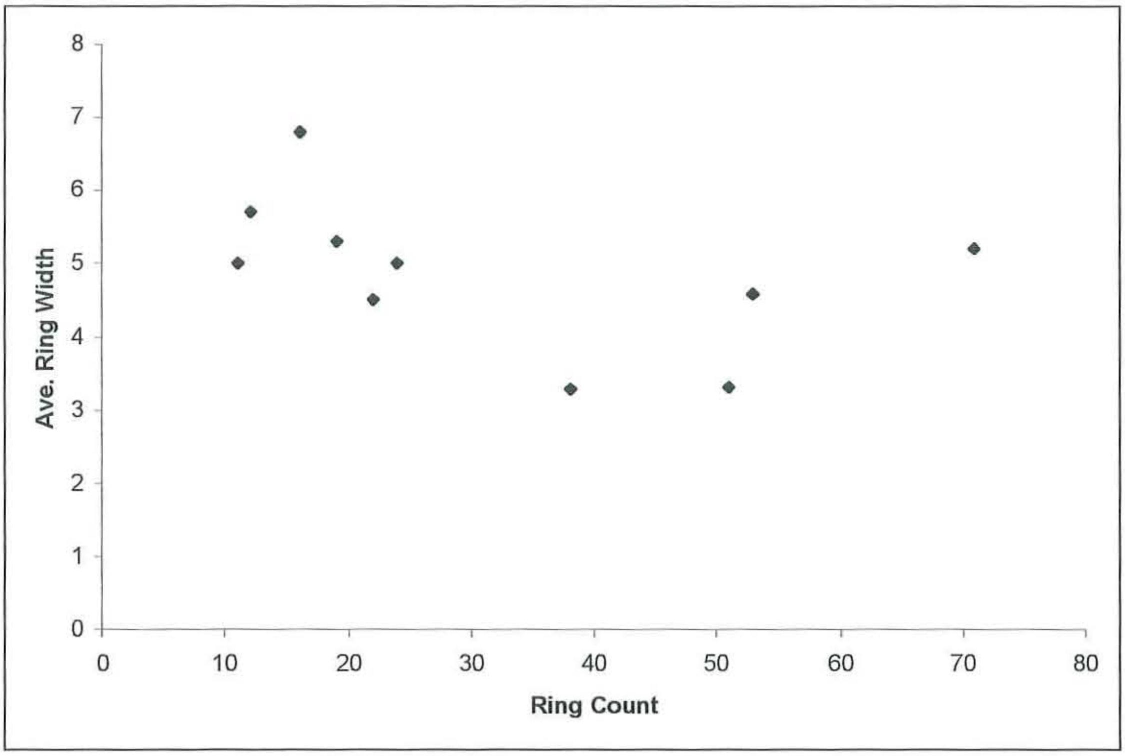

Table 1

List of samples ordered by phase, structural group, and sample number

Sample	Phase/Structure/Location/Context	Dimensions	Species	Rings	ARW (mm)	Date
439	Phase 1, Palisade, Trench 4	101 x 74	Oak	15H	4.0	unmeasured
440	Phase 1, Palisade, Trench 4	122 x 71	Oak	20H	4.3	unmeasured
449	Phase 1, Palisade, Trench 4	144 x 135	Oak	20H	6.7	unmeasured
446	Phase 1, Palisade, Trench 4	122 x 91	Oak	22H	3.5	unmeasured
448	Phase 1, Palisade, Trench 4	108 x 102	Oak	20H	5.5	unmeasured
G9-024	Phase 1, part of palisade, eastern edge of enclosure, G9-064	100 x 95	Oak	45H	2.1	unmeasured
G9-008	Phase 1, part of palisade, eastern edge of enclosure, G9-066	150 x 60	Oak	10H + H/S?	6.0	unmeasured
I9-003	Phase 1, part of palisade, eastern edge of enclosure, I9-024	155 x 125	Oak	36H	2.8	unmeasured
I9-002	Phase 1, part of palisade, eastern edge of enclosure, I9-028	125 x 50	Oak	17H	2.9	unmeasured
I9-010	Phase 1, part of palisade, eastern edge of enclosure, I9-029	135 x 120	Oak	17H	4.1	unmeasured
I9-005	Phase 1, part of palisade, eastern edge of enclosure, I9-030	135 x 105	Oak	21H + H/S?	3.8	unmeasured
I9-006	Phase 1, part of palisade, eastern edge of enclosure, I9-031	90 x 60	Oak	10H	6.0	unmeasured
I9-007	Phase 1, part of palisade, eastern edge of enclosure, I9-032	105 x 65	Oak	18H	3.6	unmeasured
I9-001	Phase 1, part of palisade, eastern edge of enclosure, I9-033	125 x 100	Oak	16H	5.6	unmeasured
D10-002	Phase 1, part of palisade, northern edge of enclosure, D10-002	100 x 90	Oak	14H	5.0	unmeasured
D10-004	Phase 1, part of palisade, northern edge of enclosure, D10-020	105 x 70	Oak	50H	1.8	Felled after relative year 65 cf samples d10-005 and d10-006
D10-006	Phase 1, part of palisade, northern edge of enclosure, D10-024	120 x 95	Oak	70H	1.5	Felled after relative year 77 cf samples d10-004 and d10-005
D10-005	Phase 1, part of palisade, northern edge of enclosure, D10-024	125 x 105	Oak	65H	1.4	Felled after relative year 80 cf samples d10-004 and d10-006
D10-003	Phase 1, part of palisade, northern edge of enclosure, D10-039	78 x 72	Oak	25H	2.8	unmeasured
051	Phase 1?, Causeway	165 x 155	Oak	25H + 13S + BW	3.4	unmeasured
313	Phase 1?, Entrance, Trench 3	163 x 141	Oak	30H	2.5	unmeasured
311	Phase 1?, Entrance, Trench 3	237 x 236	Oak	43H	3.6	unmeasured
317	Phase 1?, Entrance, Trench 3	169 x 109	Oak	23H	3.5	unmeasured
301	Phase 1?, Front, Trench 3	206 x 181	Oak	69H+ 5S	1.32	matches G9-027?
034	Phase 2, Post	340 x 190	Oak	51H	3.31	undated

Sample	Phase/Structure/Location/Context	Dimensions	Species	Rings	ARW (mm)	Date
444	Phase 2, Post	500 x 500	Oak	53H + H/S?	4.59	undated
450	Phase 2, wood in base of ditch, Trench 4	85 x 31	Alder	-		unmeasured
G9-027	Phase 2?, large timber from entranceway (several samples), G9-229	350 x 320	Oak	71H +H/S?	5.2	matches 301?
G9-001	Phase 2?, northern row of posts from causeway, G9-136	230 x 170	Oak	12H + H/S?	5.7	unmeasured
G9-005	Phase 2?, northern row of posts from causeway, G9-137	200 x 200	Oak	11H+5S+B?	6.8	unmeasured
G9-006	Phase 2?, northern row of posts from causeway, G9-138	210 x 190	Oak	38H	3.3	unmeasured
G9-003	Phase 2?, northern row of posts from causeway, G9-139	160 x 150	Oak	22H+H/S?	4.5	unmeasured
G9-002	Phase 2?, northern row of posts from causeway, G9-140	1280 x 155	Oak	17H+7S+B?	5.0	unmeasured
G9-007	Phase 2?, northern row of posts from causeway, G9-216	160 x 130	Oak	15H+4S+B?	5.3	unmeasured
G9-011	Phase 2?, southern row of posts from causeway, G9-184	65 x 50	Oak	11H	5.0	unmeasured
063	Phase 3, Stake, Trench 1	215 x 210	Oak	38H+ 11S +B?	1.69	undated
K9-001	Phase uncertain, horizontal "rail" from "deep feature", K9-142	120 x 115	Alder			unmeasured
K9-004	Same phase as K9-001?, post from "deep feature", K9-130	85 x 78	Ash	34 +B	1.2	unmeasured
I11-001	Phase uncertain, post from inside large enclosure, I11-010	140 x 75	Oak	91H+ H/S?	0.8	undated
J10-001	Same Phase as I11-001?, post from inside large enclosure, J10-047	100 x 95	Oak	24H	4.2	unmeasured

'Rings': H = heartwood rings, where neither sapwood nor the h/s boundary are also noted only a *tpq* can be inferred; H/S heartwood/sapwood boundary, H/S? possible heartwood/sapwood boundary; +S =sapwood rings; +B = bark edge, +B? = possible bark edge, +BW = bark-edge winter felled
'ARW' = average ring width of the measured rings

Table 2

a) *t*-value matrix for samples from D10

Samples	**D10-005**	**D10-006**
D10-004	5.59	5.62
D10-005	*	6.78

b) *t*-value matrix for samples 301 and G9-27

Samples	**G9-27**
301	7.86

Table 3 Ring-width data from the floating, three timber site mean SCOMD10

Date	**Ring widths (0.01mm)**										**No of samples**									
1	351	300	300	342	267	295	291	249	225	186	2	2	2	2	2	3	3	3	3	3
-	219	258	221	147	178	180	120	156	169	169	3	3	3	3	3	3	3	3	3	3
-	170	131	151	167	126	130	135	158	167	147	3	3	3	3	3	3	3	3	3	3
-	136	151	160	144	140	133	170	159	157	142	3	3	3	3	3	3	3	3	3	3
-	125	113	105	95	128	120	120	102	90	123	3	3	3	3	3	3	3	3	3	3
51	94	97	117	109	117	101	119	103	94	104	3	3	3	3	3	2	2	2	2	2
-	94	84	72	79	82	62	85	99	119	103	2	2	2	2	2	2	2	1	1	1