Centre for Archaeology Report 46/2001

Tree-Ring Analysis of Oak timbers from the Outbuildings at Prior's Hall, Widdington, Essex

Ian Tyers

ISSN 1473-9224

The Centre for Archaeology Reports Series incorporates the former Ancient Monuments Laboratory Report Series. Copies of Ancient Monuments Laboratory Reports will continue to be available from the Centre for Archaeology (see back of cover for details).

Centre for Archaeology Report 46/2001

Tree-Ring Analysis of Oak timbers from the Outbuildings at Prior's Hall, Widdington, Essex

Ian Tyers

Summary

A tree-ring dating programme was commissioned on an outbuilding at Prior's Hall, Widdington, by English Heritage in the early spring of AD 2001. The building has a complex sequence of modifications which it was hoped that tree-ring dating would help elucidate. The results indicate the original five-bay structure and its three-bay western floor use trees felled in AD 1490/91. The dated timbers appear to be primary to the structure in both areas. Subsequent modifications using trees felled in AD 1563/4 for an eastern extension and in the AD 1580s for a western extension were identified. An area of inserted floor in the eastern part of the original structure and the eastern extension contained no material suitable for tree-ring analysis.

Keywords

Dendrochronology
Standing Building

Author's address
Sheffield Dendrochronology Laboratory, Archaeology & Archaeological Science Research School, Department of Archaeology & Prehistory, University of Sheffield, 2 Mappin Street, Sheffield, S1 4DT, tel: 0114 2225107, email: i.tyers@sheffield.ac.uk

Introduction

This document is a technical archive report on the tree-ring analysis of oak timbers from the outbuilding at Prior's Hall, Widdington, Essex (NGR TL 5373 3173). It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. 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 building.

Prior's Hall, Widdington, lies in the north-west corner of the county of Essex (Figs 1 and 2). The site includes a barn, a farmhouse, and the building that is the subject of this report. The land was owned by the French priory of St Valery sur Somme from the time of the conquest until its seizure in AD 1377. The land was given as an endowment to New College Oxford by William of Wykeham *c* AD 1379 and it remained in their hands run as a tenant farm until AD 1920 when the site was sold. The building is aligned east-west and is *c* 65m south of the great barn, and just to the south of the farmhouse. The central five bays seem to be the original structure. It has jowled storey posts and a crown-post type roof (Fig 3), with a coherent carpenters numbering system on both the roof trusses themselves and the bracing on the crown-posts. There is a one-bay eastern extension, and a two-bay western extension (see plan Fig 4). Both extensions have side purlin type roofs, but the eastern extension has the same roof profile as the main part of the building whilst the western extension has a higher roof. The flooring arrangements are complex, and made more so by the replacement of the south wall to girding beam height which has removed much of the structural evidence for the phases of modification. It appears the western three bays of the original structure were floored with the girding beams resting on jowls on, and pegged into, the storey posts. The joists of the central of these three bays are fully pegged into both the girding beams. These features may indicate this is an original floor. The two eastern bays of the original structure and the eastward extension are now floored throughout but there are no jowls for the girding beams and there are decorative chamfer stops on these beams where there are none in the western half. The westward extension is also floored through, although the relationship of the western extension floor to the western extension itself is obscure. None of the timbers in the entire structure appear to be replaced or re-used.

A tree-ring sampling programme of the five potentially different phases of the timbers in the outbuilding was requested by John Etté, the local English Heritage Inspector, in order to help elucidate the dates and sequence of modifications of this complex structure.

Methodology

The general methodology and working practises used at the Sheffield Dendrochronology Laboratory are described in English Heritage (1998). The methodology used for this building was as follows.

An initial assessment had been undertaken the year before during the sampling of the barn (Tyers 2000) to ensure that there were some suitable timbers visible in the building. This assessment aimed to identify those oak timbers with the most suitable ring sequences for analysis. Those with more than 50 annual rings and some survival of the original sapwood and bark-edge were sought. This assessment and then the sampling

request identified five phases with some potential for analysis, though it should be noted that the floors in the extensions were thought to be of fairly marginal potential. The dendrochronological sampling programme attempted to cover these phases by obtaining samples from as broad a range of timbers, in terms of structural element types, scantling sizes, carpentry features, and surface condition as was possible within the terms of the request.

The most promising timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken as closely as possible along the radius of the timbers so that the maximum number of rings could be obtained for subsequent analysis. The core holes were left open to aid ventilation. The ring sequences in the cores were revealed by sanding.

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 1999a). The ring sequences were plotted onto semi-log graph paper to enable visual comparisons to be made between sequences. In addition a cross-correlation algorithm (Baillie and Pilcher 1973) was 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 sequences. 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 these positions are supported by satisfactory visual matching.

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 (Tyers 1998). These figures are applicable to oaks from England and Wales. 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

During sampling the truss numbering scheme used in the plans by John Walker was employed. This labels each original truss T1-T6 from the east (Figs 4 and 5). Sample locations in this area were recorded by a combination of the truss number and the structural element description (Table 1; Figs 3 - 5). The timbers from the two extensions are labelled using simple compass directions.

To cover the terms of the request a series of core samples was taken. The initial assessment had identified that there were clear differences in suitability of the timbers in different parts of the structure. A total of 27 timbers were selected as most suitable for sampling (Table 1). These samples were numbered **1-27** inclusive. Samples **1-9** are from the five-bay original structure, **19-24** are from its possibly original western flooring, samples **10-14** are from the eastern extension, and **15-18** are from the western extension, including one from the floor in this part. Samples **25-27** are from the eastern floor of the original structure and the floor of the eastern extension. Sampling was limited in some of these areas due to the shortage of suitable timbers.

Four of the samples (numbers **14**, **16**, **18**, and **26**) when examined in the laboratory were rejected because they had too few rings for reliable analysis. These rejected timbers are all from the later modifications. The remaining 23 samples were measured and the resultant series were then compared with each other. Twenty sequences were found to match together to form an internally consistent group (Table 2; Fig 6). A 218-year site mean chronology was calculated, named WIDD_PHO. The site mean, and the three unmatched samples were then compared with dated reference chronologies from throughout the British Isles and northern Europe. A single well correlated position was identified for the WIDD_PHO sequence. Table 3 shows example correlations of the WIDD_PHO mean sequence at the dating position identified, AD 1361 - 1578 inclusive, against independent reference chronologies. Table 4 lists the site mean chronology. The remaining three measured samples did not match either the rest of the material from Widdington nor dated reference chronologies and are thus undated by this analysis.

Discussion

The 218-year chronology WIDD_PHB is dated AD 1361 to 1578 inclusive. It was created from twenty timbers from four different parts of the structure. Sixteen of the dated samples were complete to the original bark surface (two of these samples retain the bark itself). One other dated sample includes some sapwood and sampling notes indicate relatively little sapwood was lost during the sampling of this timber. The remaining three dated samples are complete to the heartwood/sapwood boundary (Table 1). The results need to be reviewed by the structural origin of the samples.

Original five-bay building. All nine samples from this part of the building were dated. All nine include complete sapwood and the original bark surface, two retain the bark itself. All nine samples end with an

apparently complete ring for AD 1490 indicating all this material was felled in the winter of AD 1490/91. These dated samples include six of the twelve storey posts, a tiebeam, a wall plate, and a crown post. The results indicate the roof and wall structures use timbers felled at the same time.

Western floor of original building. All six samples from this part of the structure were dated. Four are complete to the original bark surface, whilst the other two are complete to the original heartwood/sapwood boundary. The four complete samples end with an apparently complete ring for AD 1490 indicating this material was also felled in the winter of AD 1490/91. The dates for the two samples complete to the heartwood/sapwood boundary are compatible with this interpretation. These dated samples include all four girding beams and two of the many joists from the three-bay floor. The results indicate this floor uses timbers felled at the same time as those used for the roof and walls.

Eastern extension. All four measured samples of the five taken from this part of the structure were dated. Three are complete to the original bark surface, whilst the other is complete to the original heartwood/sapwood boundary. The three complete samples end with an apparently complete ring for AD 1563 indicating this material was felled in the winter of AD 1563/4. The date for the sample complete to the heartwood/sapwood boundary is compatible with this interpretation. The dated samples include three of the four storey posts and an end wall post, and thus the results indicate all of this structure uses timbers felled at the same time.

Western extension. Only two samples of the four taken from this part of the structure contained enough ring to warrant analysis, and only one of these was found to date. This sample (sample **17**) ends at AD 1578 and includes 11 sapwood rings, indicating it was probably felled between AD 1578 and AD 1613. This can be further refined since the sampling record indicates that around 5mm of sapwood otherwise complete to the bark-edge disintegrated during the sampling of this timber. This sequence is fairly fast growing just prior to the end and assuming the lost piece was also growing between 1mm and 2mm/year clearly indicates a felling date sometime in the AD 1580s is the most credible interpretation of the result. This single dated timber probably provides a date of the western extension. The girding beam in this extension unfortunately contained too few rings for analytical purposes, although the interpretation of this is further discussed below.

Eastern floor. The two girding beams at this end of the original structure and the east-west spine beam in the eastern extension were the only three timbers considered suitable for sampling in these areas, since the joists do not contain sufficient rings. The T1 girding beam has a different 'bar' chamfer stop compared to the stop moulding present on the T2 girding beam, the samples all contain relatively few rings, the T1 girding beam has insufficient rings for analytical purposes, and no relative cross matching or absolute dating has been identified for this material.

An AD 1540s event in the trees used in the extensions to the outbuilding

It was noted during the measurement of the timbers from the eastern extension that these trees experienced a long period of unusually slow growth from *c* AD 1430 through to *c* AD 1540 after which they rapidly recovered to a more 'normal' growth rate. The single datable sample from the western extension also exhibits this pattern. In contrast the latter part of the sequences from the material felled in AD 1490/91 for the original structure does not exhibit any marked growth reduction in the AD 1430s (Fig 7). This observation may indicate the two later modifications to the original building used the same or similar areas of woodland, and that this woodland source was different from that used for the trees employed it its original construction.

It was also noted that, although the only sampled girding beam from the western extension floor has a core that is not useful for dendrochronological analysis, it had an unresolvable band of narrow rings followed by around 30 heartwood rings. This may indicate that this timber exhibits a more extreme version of the same features observed in the datable timbers and that the floor is thus of similar date, and woodland origin, as those in the structural timbers of the western extension. In contrast the cores from the floor inserted in the eastern half of the original structure and the eastern extension do not exhibit this characteristic pattern, perhaps indicating they are of quite different date or source.

Can the pattern observed tell us anything else? We cannot make a precise interpretation since many factors influence a trees growth trends and it would be naïve of us to assume that we yet fully appreciate the complexity of their responses. However, narrow bands of growth usually equate to poor growing conditions and for it to have affected several different trees the likely causes are overcrowding through a failure to thin out coppice reverting to woodland, or extended overcropping leading to badly damaged productivity. The century or so of 'poor' growth observed in this material may favour the first interpretation. The 'release' from these 'poor' conditions occurred *c* AD 1540 when, possibly coincidentally, vast amounts of land were changing ownership due to the Dissolution. It is therefore possible that the source of these timbers is not this or any other New College estate but a monastic property undergoing either woodland clearance or having a new woodland management regime imposed upon it by new non-monastic owners. Another possibility is that the extended period of economic downturn witnessed by New College through this period (Pam Walker pers comm) is being reflected in the management of their woodlands.

Conclusion

The dendrochronological analysis of timbers from the Priors Hall outbuilding at Widdington has identified that fifteen of the principal timbers in the five-bay structure and its western area of flooring were felled in a single year, AD 1490/91. This reduces slightly the complexity of the structure, and yields the hope that documentary records may be extant in the New College archives that identify the original purpose of this otherwise mysterious structure. The dating of the two extensions to different points in the later sixteenth century point to its continued economic value and again provides some possibility that documentary or map evidence may put a function to the structure after these modifications. The final, or at least what is probably another, phase of change cannot be precisely dated using current techniques.

Acknowledgements

The sampling and analysis programme was funded by English Heritage. Mr and Mrs Webb kindly facilitated access to their property. John and Pam Walker came to the building during the initial assessment and explained the complexity of the phasing. John Walker and Adrian Gibson were present at various points during the sampling and provided useful observations on the phasing. John Walker provided his original diagrams, modified versions of which as used for Figures 3-5 of this report. Pam Walker discussed the range of documentary evidence available from the New College archives. Peter Marshall from English Heritage put together the request documentation, and Cathy Groves provided useful discussion of the results.

References

Baillie, M G L and Pilcher, J R, 1973 A simple crossdating program for tree-ring research, *Tree Ring Bulletin*, **33**, 7-14

Bridge, M C, 1998 *Tree-ring analysis of timbers from Gosfield Hall, Essex*, Anc Mon Lab Rep, **19/98**

English Heritage, 1998 *Dendrochronology: guidelines on producing and interpreting dendrochronological dates*, London

Groves, C, and Hillam, J, 1993 *Tree-ring analysis of oak timbers from the Abbey Farm Cottage and Barn, Thetford, Norfolk, 1992*, Anc Mon Lab Rep, **34/93**

Howard, R E, Laxton, R R, and Litton, C D, 1998 *Tree-ring analysis of timbers from Chicksands Priory, Chicksands, Bedfordshire*, Anc Mon Lab Rep, **30/98**

Howard, R E, Laxton, R R, and Litton, C D, 1999 *Tree-ring analysis of timbers from the Dower House, Fawsley Park, Fawsley, nr Daventry, Northamptonshire*, Anc Mon Lab Rep, **29/99**

Laxton, R R, and Litton, C D, 1988 *An East Midlands master tree-ring chronology and its use for dating vernacular buildings*, University of Nottingham, Dept of Classical and Archaeological Studies, Monograph Series, **III**

Laxton, R R, and Litton, C D, 1989 Construction of a Kent master chronological sequence for oak, 1158-1540 AD, *Medieval Archaeol*, **33**, 90-8

Tyers, I, 1995 *Tree-ring analysis of the bellframe at St Andrews, Sutton-in-the-Isle, Cambs*, Anc Mon Lab Rep, **15/95**

Tyers, I, 1996a *Draft Dendrochronology Assessment: Rosary sites*, ARCUS Rep, **256**

Tyers, I, 1996b *Draft Dendrochronology Assessment: Fastolfs sites*, ARCUS Rep, **255**

Tyers, I, 1996c *Tree-ring analysis of six secular buildings from the City of Hereford*, Anc Mon Lab Rep, **17/96**

Tyers, I, 1997 *Tree-ring analysis of timbers from Sinai Park, Staffordshire*, Anc Mon Lab Rep, **80/97**

Tyers, I, 1998 *Tree-ring analysis and wood identification of timbers excavated on the Magistrates Court Site, Kingston upon Hull, East Yorkshire*, ARCUS Rep, **410**

Tyers, I, 1999a *Dendro for Windows program guide 2nd edn*, ARCUS Rep, **500**

Tyers, I, 1999b *Dendrochronological Analysis of Timbers from Moyns Park, Birdbrook, Essex*, ARCUS Rep, **471**

Tyers, I, 1999c *Tree-ring analysis of timbers from Paston Great Barn, Norfolk*, Anc Mon Lab Rep, **54/1999**

Tyers, I, 1999d *Tree-ring analysis of three buildings from the Clarendon Estate, Wiltshire*, ARCUS Rep, **429**

Tyers, I, 2000 *Tree-ring analysis of oak timbers from the Prior's Hall barn, Widdington, Essex*, Anc Mon Lab Rep, **29/2000**

Tyers, I, and Groves, C, 2000 Tree-ring dates from Sheffield University: List 114, *Vernacular Architect*, **31**, 120-129

Figure 1 Location of Widdington within England and Wales, based upon Ordnance Survey map

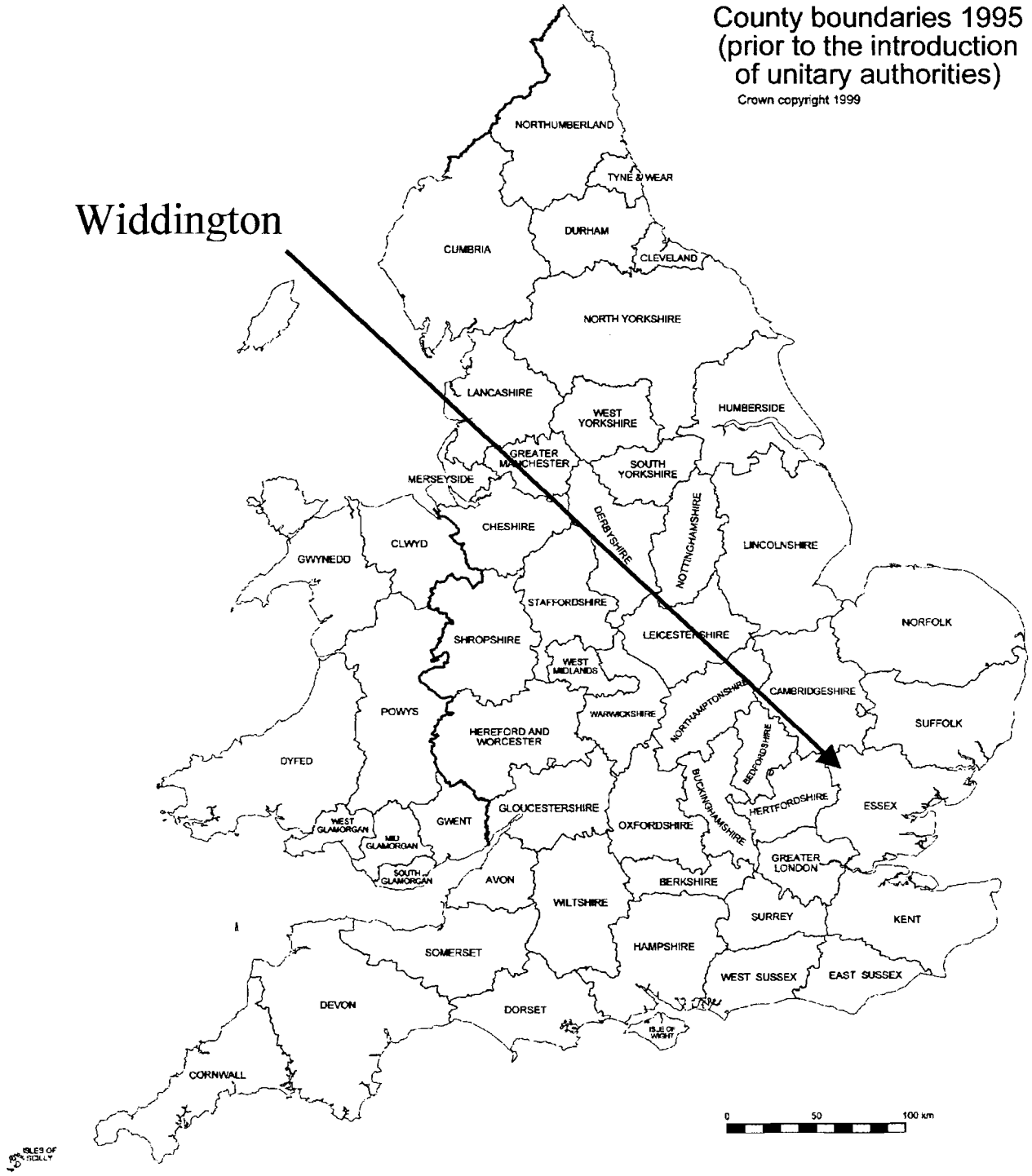


Figure 2 Location of Prior's Hall Outbuilding, Widdington (based upon 1:25,000 Ordnance Survey map

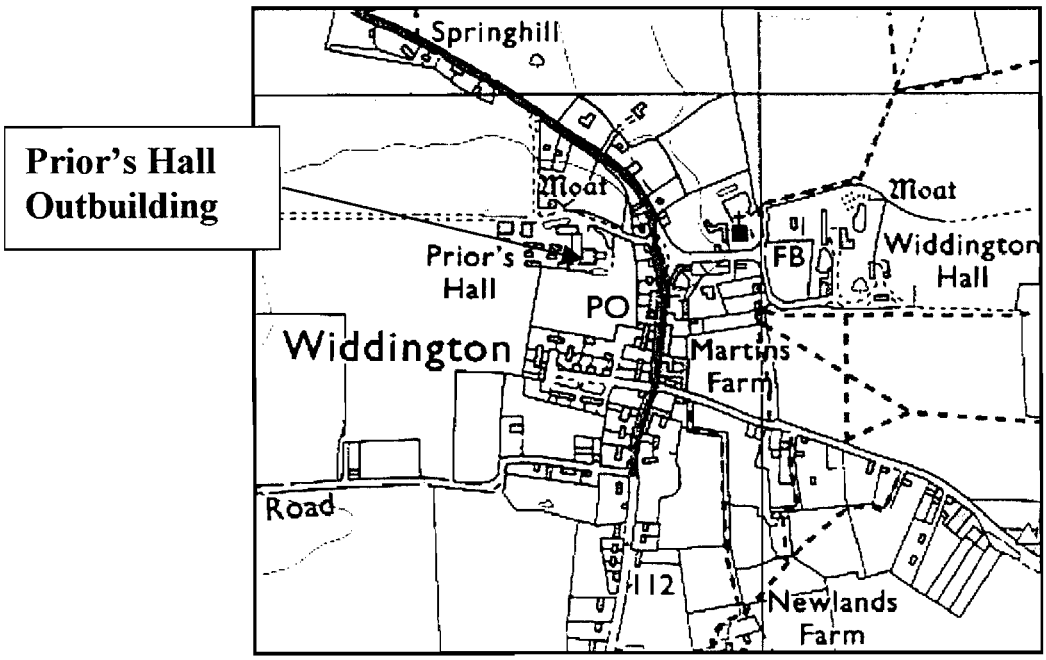


Figure 3 Reconstruction of a typical cross-section of the five-bay outbuilding and floor at Priors Hall, Widdington (after John Walker pers comm) showing the nomenclature for the structural elements employed in this report

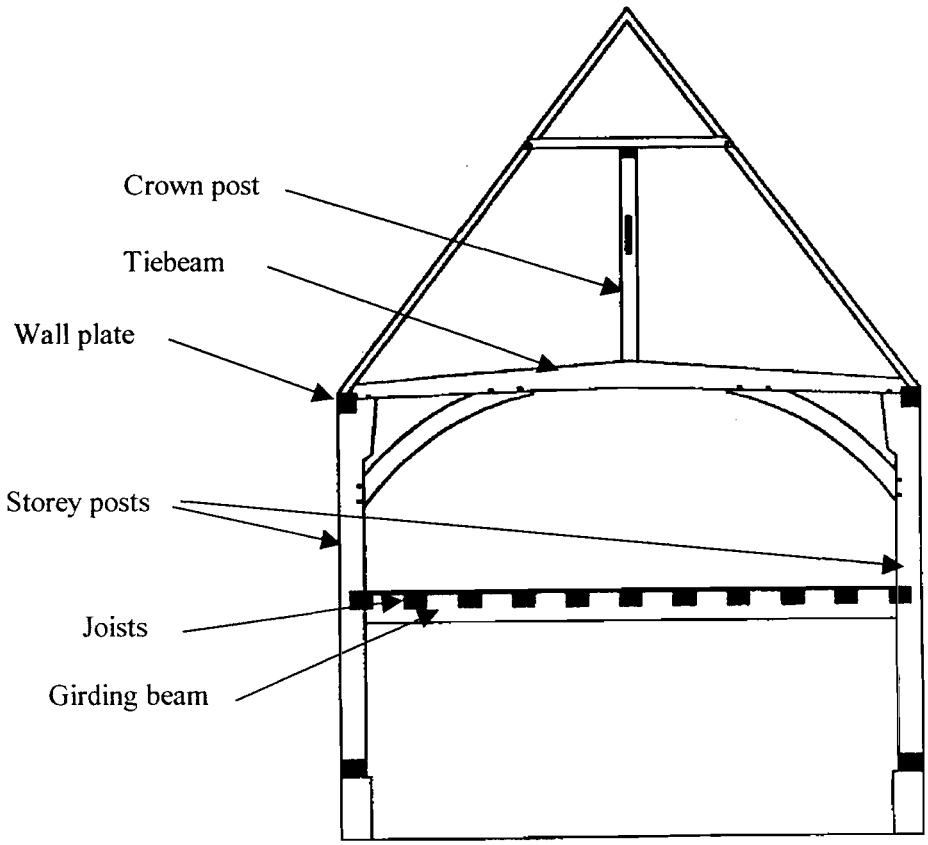


Figure 4 Sketch plan of the upper storey of the outbuilding at Prior's Hall, Widdington showing the layout of the building, the extensions, and the flooring. Original structure trusses were labelled T1-T6 from the east in this report (after John Walker pers comm). The approximate location and direction of sampling for samples **1-17** are also shown. Scale approx 1:150

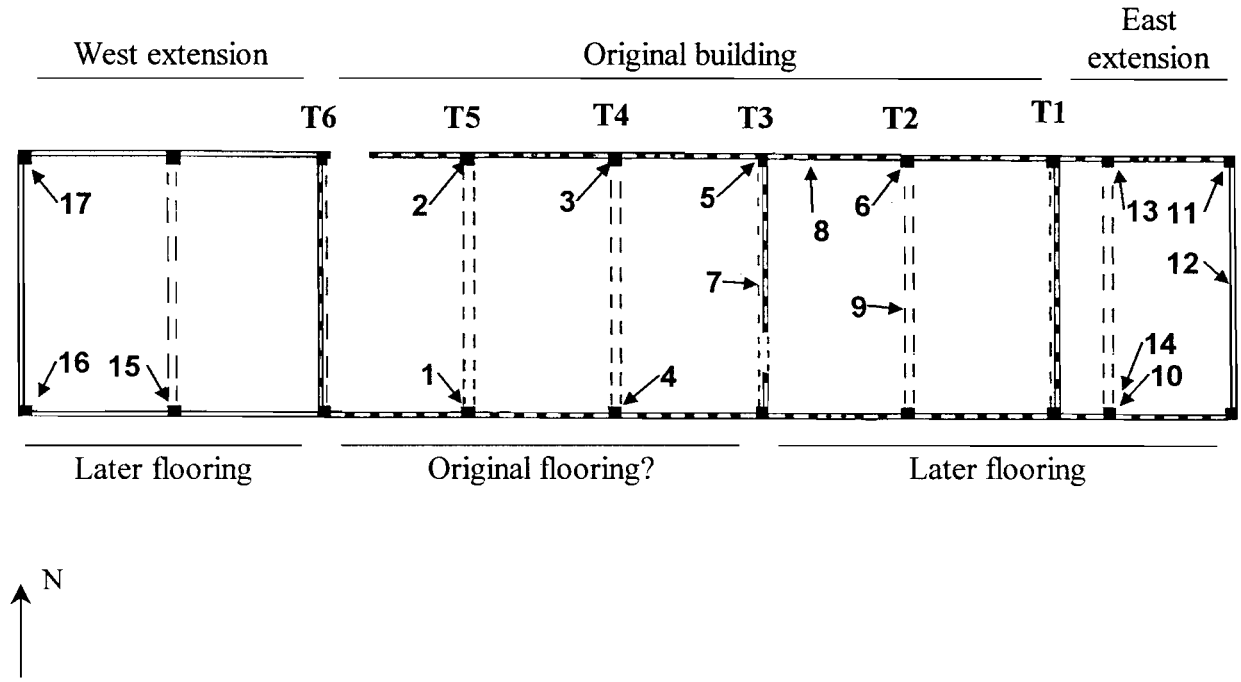


Figure 5 Sketch plan of the floor structure of the outbuilding at Prior's Hall, Widdington showing the layout of the building, the extensions, and the flooring. Original structure trusses were labelled T1-T6 from the east in this report (after John Walker pers comm). The approximate location and direction of sampling for samples **18-27** are also shown. Scale approx 1:150

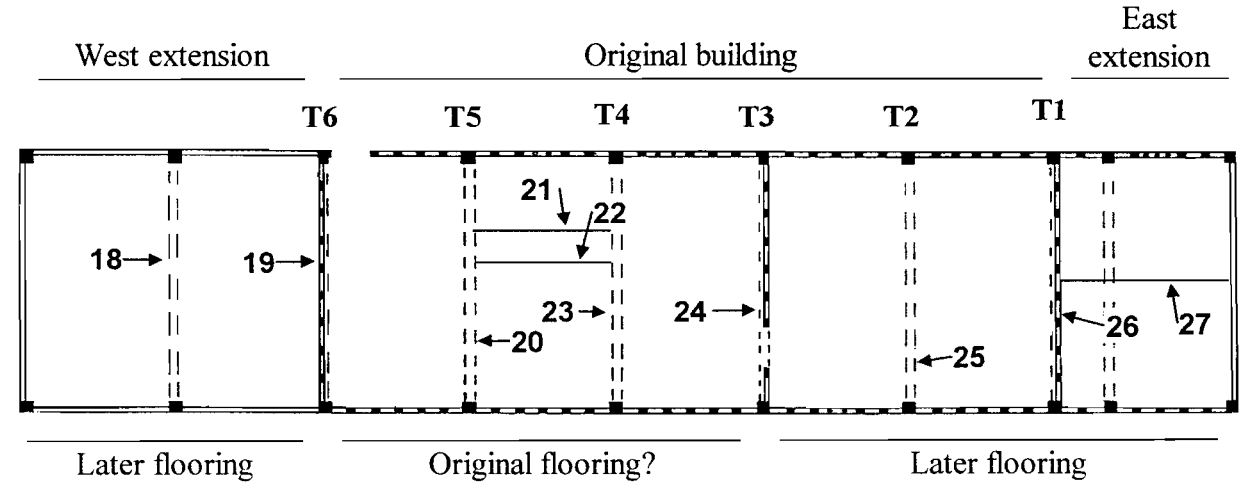
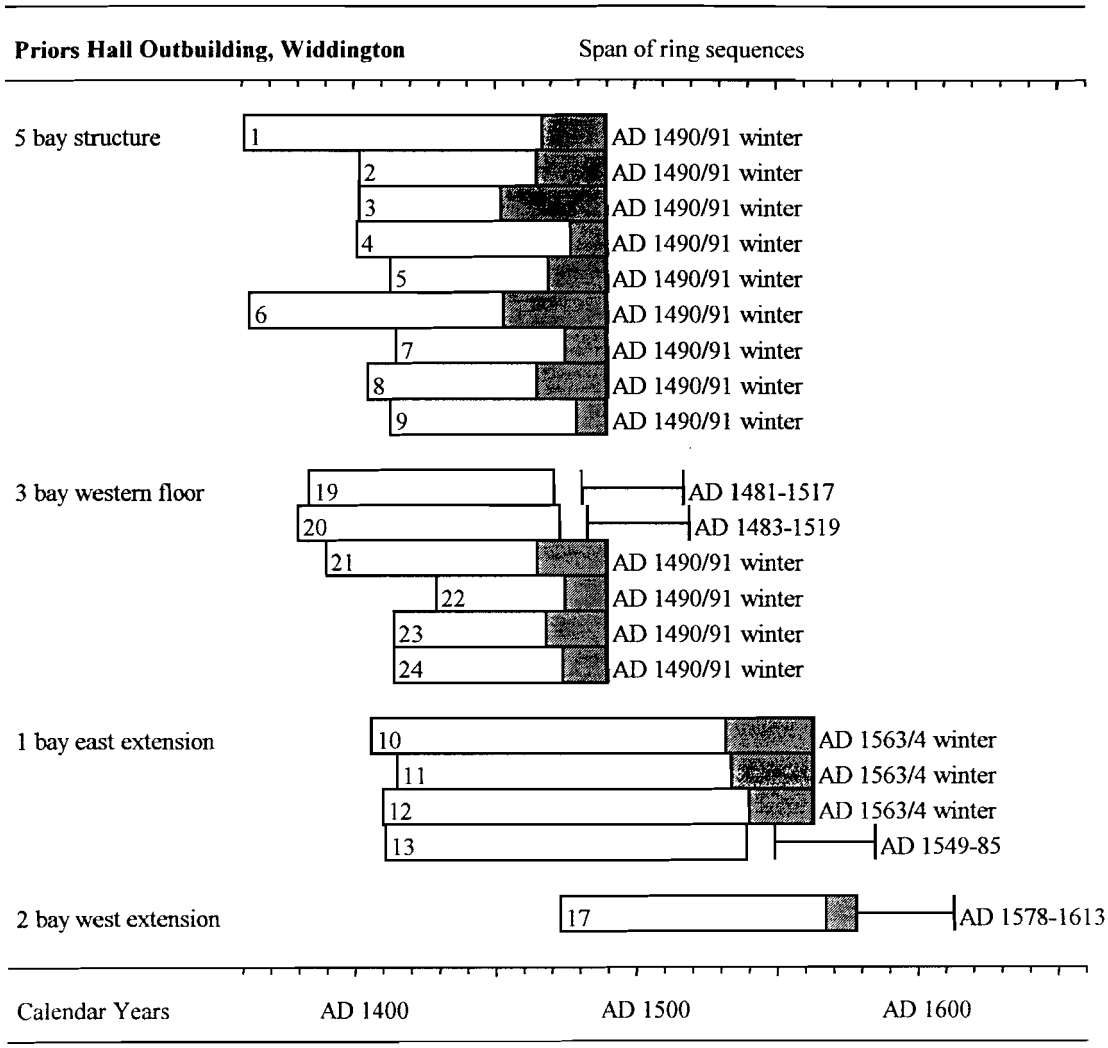


Figure 6 Bar diagram showing the chronological positions of the dated timbers from the outbuilding at Prior's Hall, Widdington. The estimated felling period for each sequence is also shown



KEY

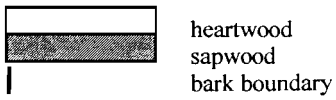


Figure 7 Diagram showing the unusual growth trends of the timbers used in the two extensions to the outbuilding at Prior's Hall, Widdington. KEY the black line is the 10-year average ring width values of the 15 dated timbers from the original structure, the red line is the 10-year average ring width values of the four dated timbers from the eastern extension, the blue line the 10-year average ring width values of sample 17 from the western extension, see text for discussion

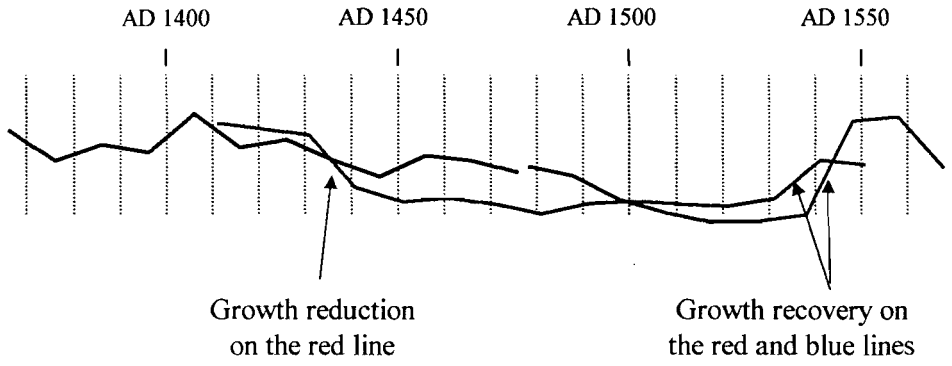


Table 1

List of core samples from the Prior's Hall Outbuilding, Widdington

Core No	Origin of core	Cross-section size (mm)	Cross-section of tree	Total rings	Sapwood rings	ARW (mm/year)	Date of sequence	Felling period
1	South storey post T5	290 x ?	Whole	130	23+Bw	1.51	AD 1361-AD 1490	AD 1490/91 winter
2	North storey post T5	330 x 270	Whole	89	25+Bw	1.77	AD 1402-AD 1490	AD 1490/91 winter
3	North storey post T4	330 x 300	Whole	89	38+Bw	1.32	AD 1402-AD 1490	AD 1490/91 winter
4	South storey post T4	300 x ?	Whole	90	13+Bw	2.68	AD 1401-AD 1490	AD 1490/91 winter
5	North storey post T3	350 x 300	Whole	78	21+Bw	2.32	AD 1413-AD 1490	AD 1490/91 winter
6	North storey post T2	300 x 280	Whole	128	37+Bw	1.46	AD 1363-AD 1490	AD 1490/91 winter
7	Tiebeam T3	240 x 180	Whole	76	15+Bw	1.56	AD 1415-AD 1490	AD 1490/91 winter
8	North wall plate between T2/T3	190 x 180	Whole	86	25+BW	1.70	AD 1405-AD 1490	AD 1490/91 winter
9	Crown post T2	190 x 130	Half	78	11+BW	1.91	AD 1413-AD 1490	AD 1490/91 winter
10	East extension SW post	300 x 240	Whole	158	31+Bw	1.14	AD 1406-AD 1563	AD 1563/4 winter
11	East extension NE post	240 x 150	Half	149	29+Bw	1.25	AD 1415-AD 1563	AD 1563/4 winter
12	East extension E central post	230 x 160	Half	154	23+Bw	1.11	AD 1410-AD 1563	AD 1563/4 winter
13	East extension NW post	240 x 180	Whole	129	H/S	0.89	AD 1411-AD 1539	AD 1549-85
14	East extension S principal of W truss	150 x 150	Quarter	-	-	-	Not measured	-
15	West extension S central post	280 x 270	Whole	76	18	2.32	Not dated	-
16	West extension SW post	220 x ?	Whole	-	-	-	Not measured	-
17	West extension NW post	300 x ?	Whole	106	11	1.19	AD 1473-AD 1578	AD 1578-1613
18	West extension girding beam	300 x 280	Whole	-	-	-	Not measured	-
19	Girding beam T6	270 x 260	Whole	88	H/S	1.54	AD 1384-AD 1471	AD 1481-1517
20	Girding beam T5	300 x 240	Whole	94	H/S	1.53	AD 1380-AD 1473	AD 1483-1519
21	Joist 4 from N T4/T5	180 x 120	Half	101	25+Bw	1.03	AD 1390-AD 1490	AD 1490/91 winter
22	Joist 5 from N T4/T5	180 x 120	Half	62	15+Bw	1.50	AD 1429-AD 1490	AD 1490/91 winter
23	Girding beam T4	330 x 250	Whole	77	22+Bw	1.45	AD 1414-AD 1490	AD 1490/91 winter
24	Girding beam T3	260 x 260	Whole	77	16+Bw	2.11	AD 1414-AD 1490	AD 1490/91 winter
25	Girding beam T2	280 x 280	Whole	62	H/S	1.81	Not dated	-
26	Girding beam T1	270 x 240	Whole	-	-	-	Not measured	-
27	East extension spine beam	250 x 250	Whole	68	14	1.85	Not dated	-

KEY for Table 1

Total rings = all measured rings
Sapwood rings: H/S heartwood/sapwood boundary, Bw bark-edge present, with complete ring indicating winter felling, BW bark present, with complete ring indicating winter felling, ARW = average ring width of the measured rings

Table 2

t-value matrix for the timbers forming the chronology WIDD_PHO. KEY - = *t*-value less than 3.0, \ = overlap less than 15 years

	2	3	4	5	6	7	8	9	10	11	12	13	17	19	20	21	22	23	24
1	5.73	3.66	-	-	4.68	5.20	-	3.97	-	-	4.41	-	4.45	4.37	-	5.65	3.10	3.50	9.00
2		3.75	-	5.38	4.37	5.65	-	5.15	3.65	3.70	5.36	3.60	4.39	3.47	5.89	5.13	3.38	5.20	6.72
3			3.27	-	-	5.16	3.35	5.10	3.69	4.05	3.41	4.36	-	6.39	3.95	-	-	-	5.41
4				-	-	3.22	3.54	3.63	-	-	-	-	5.20	4.13	-	-	-	-	4.05
5					-	3.46	3.52	3.47	-	-	-	-	-	-	3.63	-	4.77	3.93	5.09
6						-	-	-	3.53	3.38	-	5.01	-	-	-	7.11	-	4.57	-
7							3.41	5.77	3.17	-	3.41	-	-	5.38	3.22	-	3.21	3.67	6.17
8								-	-	-	-	-	-	3.31	-	-	-	-	-
9									4.32	5.09	5.43	-	5.86	3.04	-	-	4.03	3.67	4.69
10										7.35	4.09	7.42	3.85	-	3.59	4.02	-	-	-
11											6.10	6.78	4.49	-	-	-	-	-	3.74
12												3.77	-	-	3.14	-	-	-	3.64
13													3.97	-	3.82	-	-	3.98	3.02
17														\	\	-	-	-	5.21
19															-	-	-	-	5.34
20																-	-	4.39	4.33
21																	-	4.43	3.91
22																		-	4.26
23																			3.09

Table 3

Dating the mean sequence WIDD_PHO, AD 1361-1578 inclusive. *t*-values with independent reference chronologies

Area	Reference chronology	*t*-values
Bedfordshire	Chicksands Priory (Howard *et al* 1998)	7.60
Cambridgeshire	Sutton-in-the-Isle Bellframe (Tyers 1995)	6.46
Essex	Gosfield Hall nr Halstead (Bridge 1998)	7.32
Essex	Moyns Park Birdbrook (Tyers 1999b)	7.16
Essex	Stambourne Church (Tyers and Groves 2000)	10.17
Essex	Widdington Barn timber (AML-831501) (Tyers 2000)	8.25
Greater London	Hays Wharf (Tyers 1996a; Tyers 1996b)	8.36
Herefordshire	Hereford Cathedral Barn (Tyers 1996c)	6.89
Kent	Kent regional master (Laxton and Litton 1989)	7.18
Midlands region	East Midlands regional master (Laxton and Litton 1988)	8.04
Norfolk	Paston Great Barn (Tyers 1999c)	6.21
Norfolk	Abbey Farm Barn Thetford (Groves and Hillam 1993)	6.38
Northants	Dower House Fawsley (Howard *et al* 1999)	7.08
Oxfordshire	Stanton St John Manor Farm panels (author unpubl)	6.54
Staffordshire	Sinai Park nr Burton (Tyers 1997)	7.18
Wiltshire	The Old Mansion Clarendon (Tyers 1999d)	6.94

Table 4

Ring-width data from site master WIDD_PHO dated AD 1361-1578 inclusive

Date	Ring widths (0.01mm)										No of samples									
AD 1361	308	365	286	184	188	175	147	150	236	173	1	1	2	2	2	2	2	2	2	2
	155	248	139	124	131	150	127	157	178	172	2	2	2	2	2	2	2	2	2	3
	189	172	163	163	183	218	221	205	202	192	3	3	3	4	4	4	4	4	4	5
	208	107	92	82	94	135	147	212	270	400	5	5	5	5	5	5	5	5	5	5
AD 1401	235	241	224	279	272	265	216	264	243	283	6	8	8	8	9	10	10	10	10	11
	258	241	202	168	165	149	151	185	170	253	12	12	14	16	18	18	18	18	18	18
	254	175	219	220	177	168	194	229	219	234	18	18	18	18	18	18	18	18	19	19
	208	232	165	139	140	167	146	130	116	127	19	19	19	19	19	19	19	19	19	19
	119	137	138	139	109	114	117	88	109	111	19	19	19	19	19	19	19	19	19	19
AD 1451	134	121	122	168	161	183	167	137	134	172	19	19	19	19	19	19	19	19	19	19
	162	146	150	111	132	139	138	142	141	149	19	19	19	19	19	19	19	19	19	19
	124	120	120	116	165	122	94	100	106	112	19	18	19	18	18	18	18	18	18	18
	131	128	105	98	100	120	151	139	141	121	18	18	18	18	18	18	18	18	18	18
	66	68	72	70	81	98	102	66	55	61	5	5	5	5	5	5	5	5	5	5
AD 1501	73	72	73	77	69	76	54	61	61	67	5	5	5	5	5	5	5	5	5	5
	71	94	64	67	63	76	53	69	79	61	5	5	5	5	5	5	5	5	5	5
	50	51	47	62	52	52	52	79	70	73	5	5	5	5	5	5	5	5	5	5
	82	61	62	81	135	92	94	82	93	126	5	5	5	5	5	5	5	5	5	4
	175	138	164	157	202	177	198	204	254	174	4	4	4	4	4	4	4	4	4	4
AD 1551	181	145	219	205	211	131	92	110	126	117	4	4	4	4	4	4	4	4	4	4
	121	140	125	124	152	144	159	172	151	173	4	4	4	1	1	1	1	1	1	1
	144	87	113	196	164	167	197	188			1	1	1	1	1	1	1	1		