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DENDROCHRONOLOGICAL ANALYSIS OF IGHTFIELD HALL FARM BARN, IGHTFIELD, WHITCHURCH, SHROPSHIRE, 1997

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Summary

Ightfield Hall Farm barn is a grade II listed timber-framed barn associated with a larger farmstead. Dendrochronological analysis of timbers associated with the initial construction produced a tree-ring chronology spanning the period AD 1341-1566. The primary timbers were felled in the spring of AD 1567, whilst two groups of reused timbers were identified with felling date ranges in the mid-fifteenth century and first half of the sixteenth century. A number of interesting growth characteristics were noted and are discussed along with evidence concerning the source of the timbers. No dating evidence was provided for the inserted floor.

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Dendrochronological Analysis of Ightfield Hall Farm Barn, Ightfield, Whitchurch, Shropshire, 1997

Introduction

This document is a technical archive report on the dendrochronological analysis of timbers from the barn at Ightfield Hall Farm, Ightfield (SJ601394), and is a component part of a comprehensive study of the building. It is beyond the dendrochronological brief to describe the building in detail or to undertake the production of detailed drawings. Timber elements are named according to the CBA handbook (Alcock *et al* 1996) but to ensure compatibility priority will be given to the terminology used in the survey in progress. As part of a multidisciplinary study of the building, elements of this report may be combined with detailed descriptions, drawings, and other technical reports to form a comprehensive publication on the building (Bond *et al* forthcoming). The conclusions presented here may therefore have to be modified in the light of subsequent work.

Ightfield Hall Farm barn is a grade II listed timber-framed structure which stands approximately 40m to the south-east of Ightfield Hall (Fig 1). The following brief description is taken partly from the listing but mainly from initial observations by those present on site on 4 August 1997 from Sheffield University, the Historical Analysis and Research Team (HART) at English Heritage, and the architects Nick Joyce and Alex Matthews. Seven cross frames, numbered from north to south, form a six bay structure (Fig 2) thought on stylistic evidence to date to the late-sixteenth/early-seventeenth century (Moran pers comm) with a nineteenth century inserted floor. Truss 1 and truss 7 are no longer complete and bays 1 and 6 are in a state of collapse. The building is of box-frame construction with normal assembly used throughout. The roof trusses include queen struts rising from the tiebeam to the collar (Fig 3). Raking struts rise from the tiebeam to the principal rafters. Further struts also rise from the collar to the principal rafters. Trusses 2 and 6 have an additional inserted vertical strut of much smaller scantling rising from the centre of the tiebeam to the collar. Truss 3 has an extant transverse beam and truss 4 has the redundant joint housings for a transverse beam at an equivalent level between the inserted floor and tiebeams. Truss 6 has an even lower transverse beam which now provides support for the inserted floor. The principal rafters are linked by a halved joint at the apex and carry two sets of purlins, but there is no ridge piece. The external side walls are timber-framed and have red brick infill. The basic design of the wall frame in each bay appears to be four panels high and four panels wide, though this has been substantially altered in many instances (Fig 4). The panel in the top corners of each bay contains an upward brace and at each of the bottom corners of the building is a downward brace.

A series of reused timbers are clearly evident in barn. These are thought to be part of the initial construction rather than later inserts. Several of the principal rafters (T2 east, T3 east, T5 east, T5 west), purlins (B4 west lower, B4 east upper, B4 east lower, B2 west upper, B2 west lower), and queen struts (T3 east, T3 west, T4 east, T4 west, T5 west) have redundant joint housings or peg holes. In some instances (eg T3 east principal rafter) peg holes cut longitudinally in half were apparent and indicate that the timbers had been further trimmed down when reused.

The dendrochronological analysis was undertaken at the request of John Yates, the English Heritage Inspector of Historic Buildings for the West Midlands team, prior to a public enquiry to determine the future of the building. The principal aims were: to provide independent dating evidence for the initial construction of the building; to determine the date of the reused structural components in the roof; and to date any major repairs or alterations. Draft truss and longitudinal section drawings were provided by Nick Joyce, the architect undertaking the measured survey, shortly after dendrochronological sampling was undertaken.

Methodology

Immediately prior to sampling an initial brief assessment survey was undertaken throughout the structure in order to identify the presence of timbers suitable for analysis and to allow a suitable sampling strategy to be formulated. Oak (*Quercus* spp) is currently the only species used for routine dating purposes in the British Isles, though research on other species is being undertaken (eg Tyers 1997a; Groves forthcoming (a)). Timbers with less than 50 annual growth rings are generally considered unsuitable for analysis as their ring patterns may not be unique (Hillam *et al* 1987). Thus timbers were sought which had at least 50 rings and if possible had either bark/bark edge or some sapwood surviving (see below). The sampling strategy was designed to take in as wide a range of structural elements as possible and was discussed in detail later that day when both the HART team and the architects had arrived at the site in order to ensure that there were no obvious omissions with respect to the current understanding of the building.

The selected timbers were sampled using a 15mm diameter corer attached to an electric drill. The cores were taken from the timbers in the direction most suitable for maximising the numbers of rings in the sample. The core holes were left open. The ring sequence of each core was revealed by a combination of paring and sanding until the annual growth rings were clearly defined.

Any samples which fail to contain the minimum number of rings or have unclear ring sequences are rejected. The sequence of growth rings in the samples selected for dating purposes were measured to an accuracy of 0.01mm using a purpose built travelling stage attached to a microcomputer based measuring system (Tyers 1997b). The ring sequences were plotted onto semi-logarithmic graph paper to enable visual comparisons to be made between them. In addition cross-correlation algorithms (Baillie and Pilcher 1973; Munro 1984) were employed to search for positions where the ring sequences were highly correlated. The Student's *t* test is then used as a significance test on the correlation coefficient and those quoted 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 (Baillie 1982, 82-5), provided that high *t* values are obtained at the same relative or absolute position with a range of independent sequences and that the visual match is satisfactory.

Dating is usually achieved by cross-correlating, or crossmatching, ring sequences within a phase or structure and combining the matching patterns to form a phase or site master curve. This master curve and any remaining unmatched ring sequences are then tested against a range of reference chronologies, using the same matching criteria as above. The position at which all the criteria are met provides the calendar dates for the ring sequence. A master curve is used for absolute dating purposes whenever possible as it enhances the common climatic signal and reduces the background noise resulting from the local growth conditions of individual trees.

During the crossmatching stage of the analysis an additional important element of tree-ring analysis is the identification of 'same-tree' timber groups. The identification of 'same-tree' groups is based on very high levels of similarity in both year to year variation and longer term growth trends, and anatomical anomalies. Such information should ideally be used to support possible 'same-tree' groups identified from similarities in the patterns of knots/branches during detailed recording of timbers for technological and woodland characterisation studies. High *t* values are not necessarily indicative of two ring sequences being derived from a single tree. Conversely low *t* values do not necessarily exclude the possibility. It is a balance of the range of information available that provides the 'same-tree' link.

The crossdating process provides precise calendar dates only for the rings present in the timber. The nature of the final (youngest) rings in the sequence determines whether the date of the youngest ring also represents the year the timber was felled. Oak consists of inner inert heartwood and an outer band of active sapwood. If the sample ends in the heartwood of the original tree, a *terminus post quem* 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 may be missing. This is the date after which the timber was felled but the actual felling date may be many decades later depending on the number of outer rings removed during timber conversion. 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. Alternatively, if bark-edge survives, then a felling date can be directly obtained from the date of the last surviving ring. In some instances it may be possible to determine the season of felling according to whether the ring immediately below the bark is complete or incomplete. However the onset of growth can vary within and between trees and this, combined with the natural variation in actual ring width, means that the determination of felling season must be treated with great caution. The sapwood estimate applied throughout this report is a minimum of 11 and maximum of 41 annual rings, where these figures indicate the 95% confidence limits of the range. This is a locally applicable estimate for Wales and the border counties (Miles forthcoming).

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 reuse of timbers and the repairs or modifications of structures, as well as factors such as stockpiling or seasoning, before the dendrochronological dates given here can be reliably interpreted as reflecting the construction date of phases within the structure.

Results

Sample selection

Three groups of timbers were identified as potentially valuable for the understanding of the building: the primary timbers from the initial construction phase; the reused timbers from the initial construction phase; and the timbers associated with the inserted floor. No other groups of timbers associated with other repairs or modifications were apparent.

The structural elements, both primary and reused, thought to be associated with the initial construction were clearly all oak. In view of the outside possibility of some of the timbers being of a different date (Bond pers comm), a broad sampling strategy including as many types of element as possible was considered important. Trusses 1 and 7, both in an advanced state of collapse, were not sampled. The extant timbers in these trusses were exposed leaving them in such a poor state of degradation that it was highly unlikely that sampling by coring would be successful. In addition the clear presence of deep cracks on some of these timbers, as well as various others, would have severely hampered successful coring. A number of timbers stacked in bay 1, assumed to be from truss 1 and bay 1 were also rejected due to their condition. The state of collapse in bay 1 and associated problems in bay 2 meant that truss 2 was also excluded from sampling partly due to access problems but also as the condition of the timbers had been adversely affected by the collapse of bay 1. Timbers at collar height and above were inaccessible as far as sampling was concerned due to access difficulties caused by the unsound, and in some areas, collapsed floor. Sampling concentrated on the east side of the structure which was in a far better state of repair, although some samples were taken from the west side to ensure contemporaneity. In addition samples were taken almost exclusively at first-floor level as the timbers were in far better condition than at ground-floor level, presumably reflecting previous use. The primary oak timbers usually contained sufficient numbers of rings and had frequently retained their full complement of sapwood out to the bark surface, although coring showed that the sapwood was usually in a rather fragile state, mainly due to attack by woodworm. Several of the primary oak timbers, including the truss 5 tiebeam, were rejected on the grounds that the timbers were extremely knotty. Such a feature would result in the distortion of the ring sequence and reduce the chances of crossmatching and dating the sample. Others were rejected as they had clearly lost all their sapwood and in some instances, particularly the rails and studs in the wall framing, the timbers were simply not accessible in the direction required to maximise the ring sequence. The obviously reused oak timbers were generally wider grained and, where redundant joint housings allowed the annual growth rings to be seen, they were often obviously unsuitable for dating purposes. All of the timbers reused as purlins were rejected but three of the reused principal rafters and a queen strut were selected as they appeared likely to contain sufficient numbers of rings.

The third major group of timbers, associated with the inserted floor, were clearly not oak. The larger elements were identified on site as coniferous and were therefore not sampled as conifers are currently not used for routine dating purposes in the British Isles.

Dating the timbers

A total of 21 timbers from various truss and wall frame elements, including four clearly reused timbers, were sampled. The samples were labelled **01** to **21** in the order that they were taken. All were thought likely to be associated with the initial construction of the barn though confirmation of contemporaneity was considered important for some elements (eg **21**). Details of each sample including its location are recorded in Table 1 and will be indicated on a three-dimensional drawing produced by Richard Bond in Bond *et al* (forthcoming). All 21 samples were measured and then analysed in two groups according to whether they were primary or reused. The outermost rings upto the bark edge on four samples, **04**, **05**, **15**, and **18**, could not be measured due to a combination of the presence of a band of very narrow growth rings and the fact that the sapwood was in an extremely poor state because of attack by woodworm.

The ring sequences of 15 of the 17 primary timbers were found to match and were combined to form a 194-year master curve, IGHT-A (Fig 5; Table 2). This and the individual ring sequences from timbers **09** and **11** were tested against an extensive range of dated reference chronologies spanning the last two millennia from the British Isles. It was immediately apparent that IGHT-A dated to the period AD 1373-1566 inclusive (Table 3). However no consistent results were obtained for samples **09** and **11**.

The ring sequences from the four reused timbers were compared with each other and a tentative match found between **12** and **16**. All four sequences were compared individually to IGHT-A and a comprehensive collection of dated reference chronologies. Dates were obtained for **12** and **16**, confirming the intra-site tentative match and **17** was also dated. The outermost rings from these three samples all date to the first half of the fifteenth century (Fig 5; Tables 2 and 4). A date was also obtained for the ring sequence from **19** which ends in the late fifteenth century (Fig 5; Tables 2 and 4).

The four reused timbers overlap and match IGHT-A and were therefore combined with it to produce a 226-year site master chronology, IGHTFIELD, containing data from 19 samples (Tables 3; 5). The two other samples, **09** and **11**, remain undated. The tree-ring date of the measured ring sequence from each individual sample is given in Table 1.

Interpretation

Primary timbers

Bark edge was present on five of the dated samples. All show either the first signs of spring growth for AD 1567 (ie the spring vessels are just starting to form) or an apparently complete row of spring vessels for AD 1567 (Fig 6). This indicates that these timbers were felled during the early part of the growing season during spring AD 1567. Of the remaining ten dated primary timbers, sapwood was present on four and the heartwood-sapwood transition on a six (Fig 5). The felling date ranges calculated for these timbers are consistent with a felling date in the spring of AD 1567 and indeed the range of dates for the heartwood-sapwood transitions is consistent with a group of timbers which were felled at the same time (Baillie 1982, 57). It should also be noted that all four samples with sapwood actually had the bark edge present but the outermost sapwood rings were unmeasureable (see above). It therefore seems likely that the felling of the primary material used in the construction of the barn took place in spring AD 1567. Evidence indicates that seasoning of timber was a fairly rare occurrence until relatively recent times and medieval timber was generally felled as required and used whilst green (eg Rackham 1990). Physical evidence for the rapid use of trees is widespread in buildings as many show clear evidence of warping or splitting after having undergone conversion. Thus a construction date at this point or shortly afterwards is implied for the barn.

Reused timbers

None of the reused timbers had bark edge, though this is unsurprising as many of them appeared to have been trimmed further for use in the barn. One, **17**, does however have some sapwood and the remaining three have the heartwood-sapwood transition. The three reused principal rafters (**12**, **16**, and **17**) have overlapping felling dates in the mid-fifteenth century and there is no reason why they should not have been felled contemporaneously. Assuming contemporaneity their combined felling date would be AD 1438-1454. The lack of bark edge, and hence the lack of precise felling dates, does not allow the technique to prove that they are precisely contemporary but they are all clearly broadly contemporary and hence felled and primarily used about a century before being incorporated into the present barn. The reused queen strut, **19**, was felled and primarily used during the period AD 1510-1540 and demonstrates that there are at least two phases of reused timbers incorporated into the barn.

Discussion

Dating

The tree-ring dates obtained for all of the primary oak timbers are compatible with the felling date of spring AD 1567 indicated by those samples with bark edge and are thus all associated with the initial construction phase. The samples with bark edge show some variation in the extent of the formation of the spring vessels. The spring vessels are just beginning to form on **02** and **13**, where as they are potentially virtually complete on **01**, **07**, and **10**, though the onset of the formation of the denser summer wood has not apparently started (Fig 6). This variation could be due to felling having occurred over a couple of months or due to natural variation within and between trees, in that some trees come into leaf much earlier than others, or a combination of these two factors.

The available evidence indicates that the primary timbers are all likely to be the product of a single felling phase which may provide some support for the use of green timber, as stockpiling and seasoning of timber is likely to lead to mixing and therefore potentially variable felling years. Further circumstantial evidence for the use of green timbers is provided by the visual appearance of the tiebeams from trusses 5 and 6. These tiebeams are clearly halves of the same trunk. Although dendrochronology has not provided support for this as the truss 5 tiebeam was not selected for sampling, the cut faces show a mirror image of the centre shake of the tree wandering from side to side. Other features such as knots can also be rejoined and the saw marks or anomalies in them clearly match up. The cut faces are however both convex which implies that they have seasoned after cutting and it seems unlikely that the timbers would be cut before their specific use had been determined.

Overall the evidence from the dendrochronological analysis and additional observations implies that the primary timbers were likely to have been used in the construction of the barn shortly after felling in spring AD 1567 which compares favourably with the late sixteenth/early seventeenth century date indicated by stylistic evidence. The construction of the barn appears to coincide with a period of much building activity in the mid-late sixteenth century identified by dendrochronology the Shropshire buildings project carried out under the direction of Madge Moran. However this project has concentrated on dwellings rather than agricultural buildings.

The tree-ring dates from the reused timbers suggest that there are at least two groups of material. The three reused principal rafters were felled and originally used in the mid-fifteenth century, whilst the reused queen strut was felled in the first half of the sixteenth century. Structural evidence suggests that the reused timbers are part of the initial construction phase of the barn. Features such as the carpentry marks were observed to be consistent and agree with the pattern of marks found throughout the building, though truss 3 noticeably has chisel rather than scribe marks. It should also be noted that whilst the trusses are marked up individually they are not numbered in sequence along the building. The felling dates obtained support this structural evidence as clearly these timbers could have been available for reuse in the mid-late sixteenth century, if their original building had been demolished by then.

It is thought that the reused timbers were derived from a cruck structure (Bond pers comm) for which a construction date in the mid-fifteenth century would be implied from the reused principal rafters, assuming that they were from the initial phase of construction. The original use of the queen strut in the first half of the sixteenth century could imply a repair/modification of the proposed cruck building or it could relate to a second building which was also demolished and then used to provide timber for the present barn.

The tree-ring analysis has not been able to provide dating evidence for the coniferous inserted floor. It is almost certainly constructed from imported conifer timbers and if the suggested nineteenth century date is correct then it is most likely to be constructed from timbers imported from North America. The use of imported softwoods on any scale only began in the mid-late seventeenth century. The initial major supply region was Northern Europe but by about the 1820s well over 60% of imported timber was obtained from North America (Dollinger 1970; Fedorowicz 1980; Groves forthcoming (a)).

Sources and woodland composition

The intra site crossmatching suggests a single source of woodland was used to provide the primary timbers and, although the overlaps between the reused and primary material are short, there is no reason to believe that the reused timber came from a markedly different source (Table 2). The results from comparisons with dated reference chronologies also indicate no particular difference in source between the primary and reused timber and also suggest that the timbers are likely to be from relatively local woodland (Tables 3 and 4). (Note that IGHT-B was produced by combining the sequences from the reused principal rafter group specifically to determine whether any differences in source were apparent.)

The conversion of the timbers ranged through whole trunks to halved trunks to quartered trunks, trimmed to a greater or lesser extent (Fig 7), though it was noted that halved trunks were predominant in the major structural elements. When allowance is made for unmeasured rings or lost rings the primary timbers appear to have been derived from trees approximately 150-200 years old when felled which is comparable with other material derived from this county in the mid-late sixteenth century (eg Miles and Haddon-Reece 1996). The diameters of these trees appear to have varied from about 350mm to over 700mm. The age and size of the reused timbers is more difficult to determine due to the lack of bark edge and pith, which is at least in part due to them having apparently been trimmed again for reuse in the present barn. Figure 8 shows a comparison between the sequence length and average growth rate of both the primary and reused timbers, although clearly with only four reused timbers the data is insufficient for statistical comparison. It should be noted that sequence length is generally an under estimate of tree age, particularly when timbers are heavily trimmed or sections of the ring sequence are unmeasured. Figure 8 shows no obvious differences apart from the reused samples possibly normally having shorter ring sequences but it must be remembered that many of the reused timbers were rejected prior to sampling as they clearly were too fast grown to have sufficient numbers of rings for analysis. Consequently it seems reasonable to suggest that the reused material appears to have been derived from faster grown and possibly younger trees that the primary material.

The majority of the timbers have a series of bands of narrow rings where growth is suddenly severely retarded (Fig 9). This relatively uncommon feature provides additional support for the suggestion that all of the timbers were from the same source. Although these bands occur throughout their life and usually coincide between at least some of the assemblage, the most noticeable and most prevalent are just at the heartwood/sapwood boundary (around AD 1530) and in the sapwood (around AD 1555). Prior to this the bands consist of 2-3 narrow rings and are less pronounced but the latter two are longer and more severe indicating that the trees are suffering extreme stress. The onset of these two pronounced events differs by a few years between some of the trees. The possible causes of these growth retardation events followed by a period of recovery, range from anthropogenic to local environmental to general environmental effects. Reasons include management regimes such as pollarding or shredding, localised defoliation by pests, or more generalised environmental factors such as severe weather conditions (eg drought or long hard winters and late frosts). No definitive answer can be provided from the tree-ring analysis but clearly the event is repetitive and severe and may or may not be confined to the tree population. Detailed analyses of contemporary tree-ring data from the region would be of value in determining whether this is a local or more regional effect. It may be worth pursuing documentary sources to see if local records have any suggestion of crop failures or particularly severe weather conditions.

Another noticeable feature of the timbers observed during sampling was the high incidence of knots, particularly on the primary timbers, indicating the presence of relatively low branches on the trunks that ultimately were required for the long straight structural elements such as principal rafters and tiebeams. The tiebeams from trusses 5 and 6 are particularly knotty at their upper end indicating that a suitable length of timber could only be obtained by cutting into the crown. As mentioned earlier the centre shake of many of the larger elements wanders noticeably from side to side. The tiebeams and posts, in particular, also give the impression that the trunks tapered away quite drastically from a large wide base. This, along with the average growth rates usually varying between about 1.5-3.5 mm per year, suggests the use of trees growing in a relatively open environment where competition is less severe, such as hedgerows or open woodland. The only notable exception to this is the undated **09** which has an average growth rate of 0.81 mm per year.

The primary timber certainly doesn't appear to have been derived from top quality timber trees. This, combined with the heavy use of reused timbers could suggest a shortage of top quality timber tree availability, either as it was expensive or unobtainable, or it may merely reflect the buildings status as not worthy of top quality timber. The presence of chamfer stops on purlins and tiebeams, and the generally high quality structural carpentry throughout the building, is however contradictory as it would imply a relatively important building. The use of secondary timber may also be quite simply due to the fact that it was readily available from a structure or structures close to the site that had been recently demolished.

The sawmarks observed on the timbers indicate that they were pit sawn and interestingly are far more noticeable on some timbers than others. Some of the obviously reused timbers have very pronounced sawmarks and have clearly been trimmed down (eg peg hole cut in half on truss 3 east principal rafter).

It may be that the sawmarks are providing additional evidence for reused timbers that have been trimmed again prior to incorporation in the barn and therefore sawn when seasoned.

The tree-ring analysis did not positively identify any timbers derived from the same tree but as indicated earlier other features were apparent which clearly indicated some same tree pairs (see above). The lack of positive evidence from the tree-ring analysis may be partly due to the narrow bands, recovery period and distortion of the growth pattern decreasing the *t* values obtained between sequences and partly due to the fact that it is beyond the brief of the analysis to undertake sampling of every suitable timber in the building.

One final observation made was that the truss 4 west post had 'included sapwood' now in a state of severe degradation. 'Included sapwood' occurs in the midst of the heartwood, potentially where the tree has been badly wounded and then gradually healed over leaving sapwood on the inside. This although uncommon is not a rare characteristic and has been seen relatively regularly on large archaeological assemblages. It could also be taken to suggest the use of second rate quality timber.

Further work

The dendrochronological sampling was undertaken early on in the project and therefore although neither the dendrochronologists, the architects, or HART team could see any obvious omissions that day it was accepted that as the project progressed it may become apparent that additional samples would have been useful. The recognition of a second phase of reused material during this analysis means that it may well have been useful to obtain samples from other reused struts. If the opportunity arises additional sampling is recommended.

The sampling strategy excluded trusses 1 and 7, bays 1 and 6, and all timbers at or above collar height. Although at this stage the author is not aware of any discrepancies in these areas further sampling may be considered if safe access is provided or it becomes possible to remove cross-sectional slices from the *ex situ* timbers or those in poor condition.

A more extended research orientated sampling program may allow the evidence for a single phase of felling confined to a single season to be further substantiated and would also provide information on how widespread the growth retardation events were and how frequently they coincide throughout the assemblage. It would also allow the conifer timbers in the inserted floor to be sampled and incorporated into the English Heritage funded research project underway on the dating of imported conifer timbers (Groves forthcoming (a)).

Clearly any further work is highly dependent on the outcome of the public enquiry to determine the future of the barn. The barn is part of a farmstead some of which stands within a moated site. If the opportunity arises it may therefore prove interesting to extend the analysis to other extant buildings in order to place the barn in the wider context of the farmstead.

Conclusion

The tree-ring analysis has shown that the primary timbers associated with the initial construction of the barn were probably all felled in spring AD 1567. If, as seems likely, they were used whilst green a construction date shortly after this is implied. Two phases of reused timbers were identified. The earlier group were felled in the mid-fifteenth century, whilst the second phase consisting of only one timber has a felling date range in the first half of the sixteenth century. Thus both groups are consistent with the construction date implied by the primary timbers. The structure, evidently a cruck building, from which the reused timbers were derived was no more than about a century old when demolished, assuming that the first phase of reused timbers were associated with its initial construction. If the queen strut is from a different structure this would have stood for less than 50 years. The tree-ring analysis has also provided evidence that both the primary and reused timbers were obtained from a local source and suggests that they were not derived from high quality timber trees.

No dating evidence was provided for the inserted floor as it was constructed from conifer timbers and no other major phases of repair or modification were identified.

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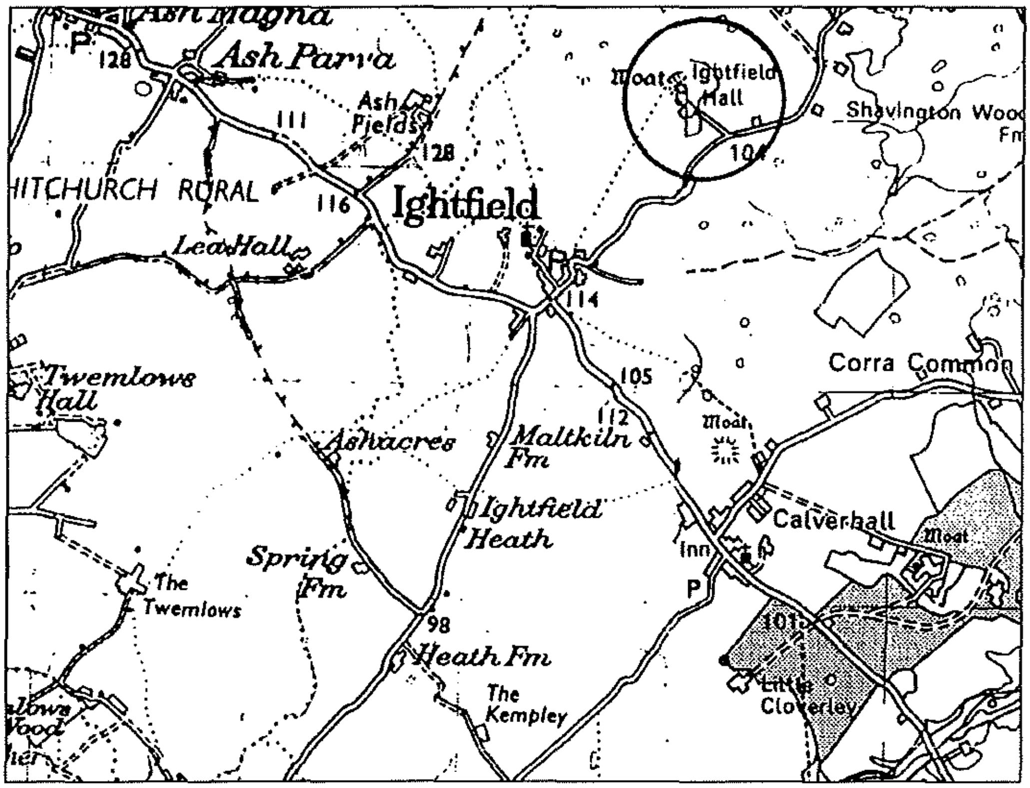
Figure 1: Maps showing the location of Ightfield Hall Farm barn (SJ601394) a) relative to the village of Ightfield based on the Ordnance Survey 1:50000 map b) relative to Ightfield Hall.

a)



b)

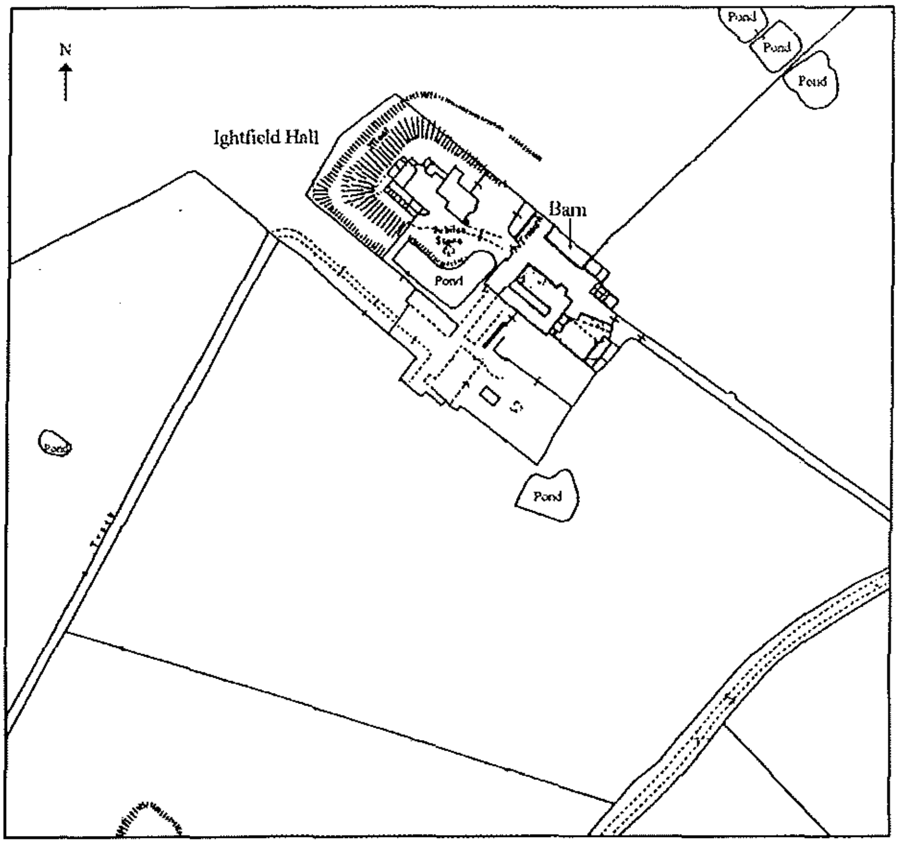


Figure 2: Ightfield Hall Farm barn. Sketch plan showing the truss and bay numbering scheme used during sampling. Not to scale.

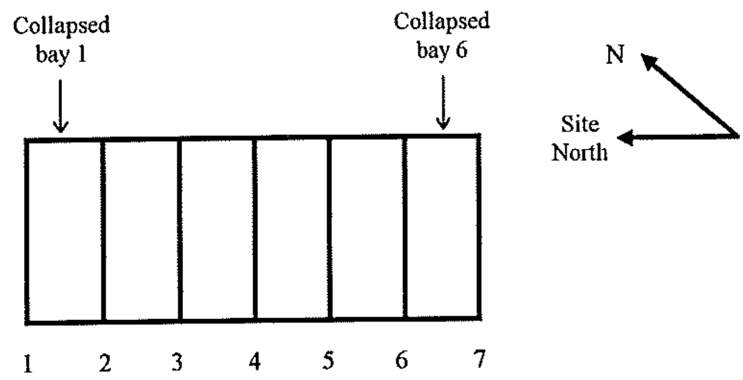


Figure 3: The upper (north) face of Truss 4 showing the typical form of the roof trusses, reproduced from draft drawing by Nick Joyce.

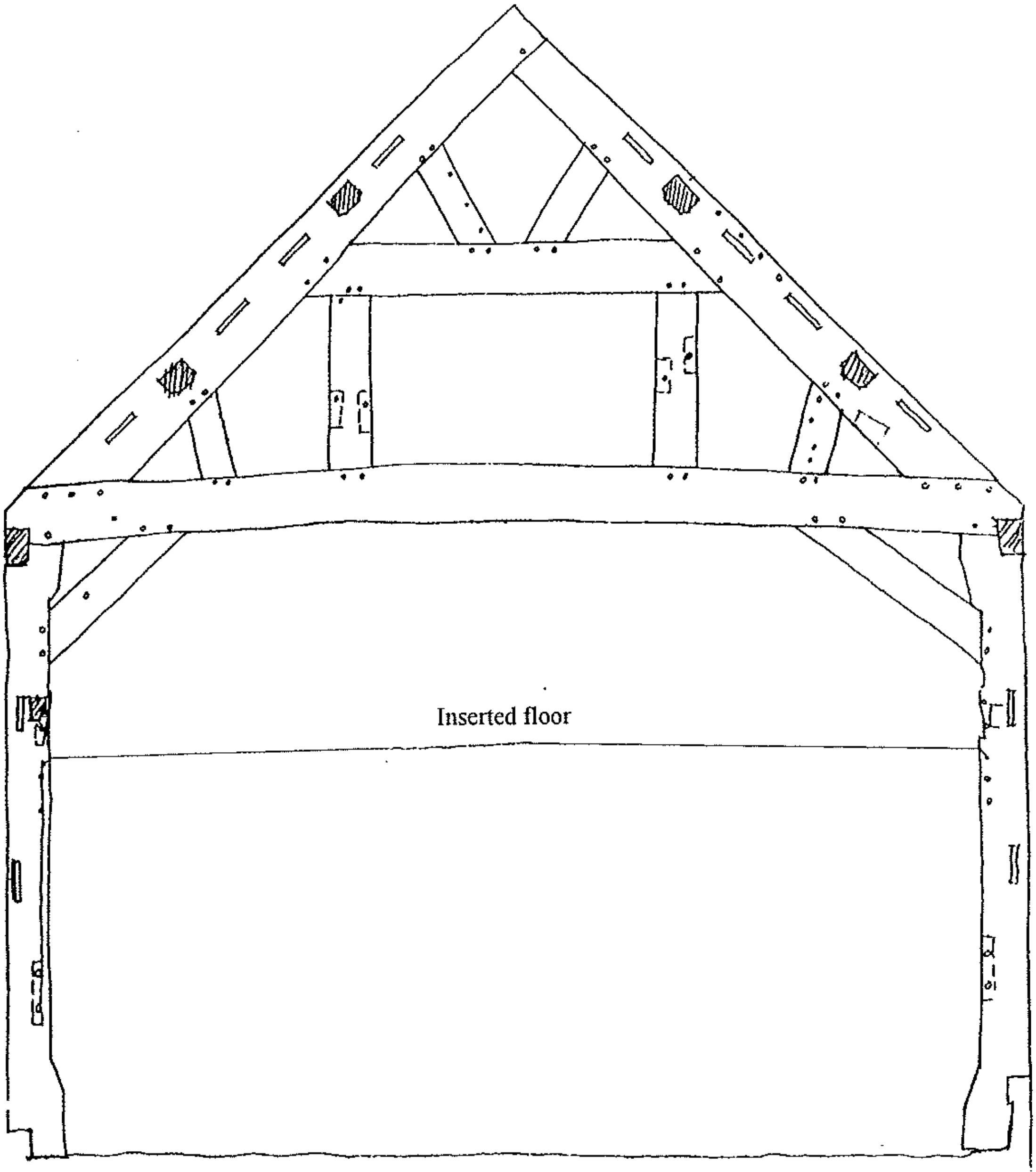


Figure 4: The inside (west) face of Bay 1 East showing the typical form of the wall frame, reproduced from draft drawing by Nick Joyce.

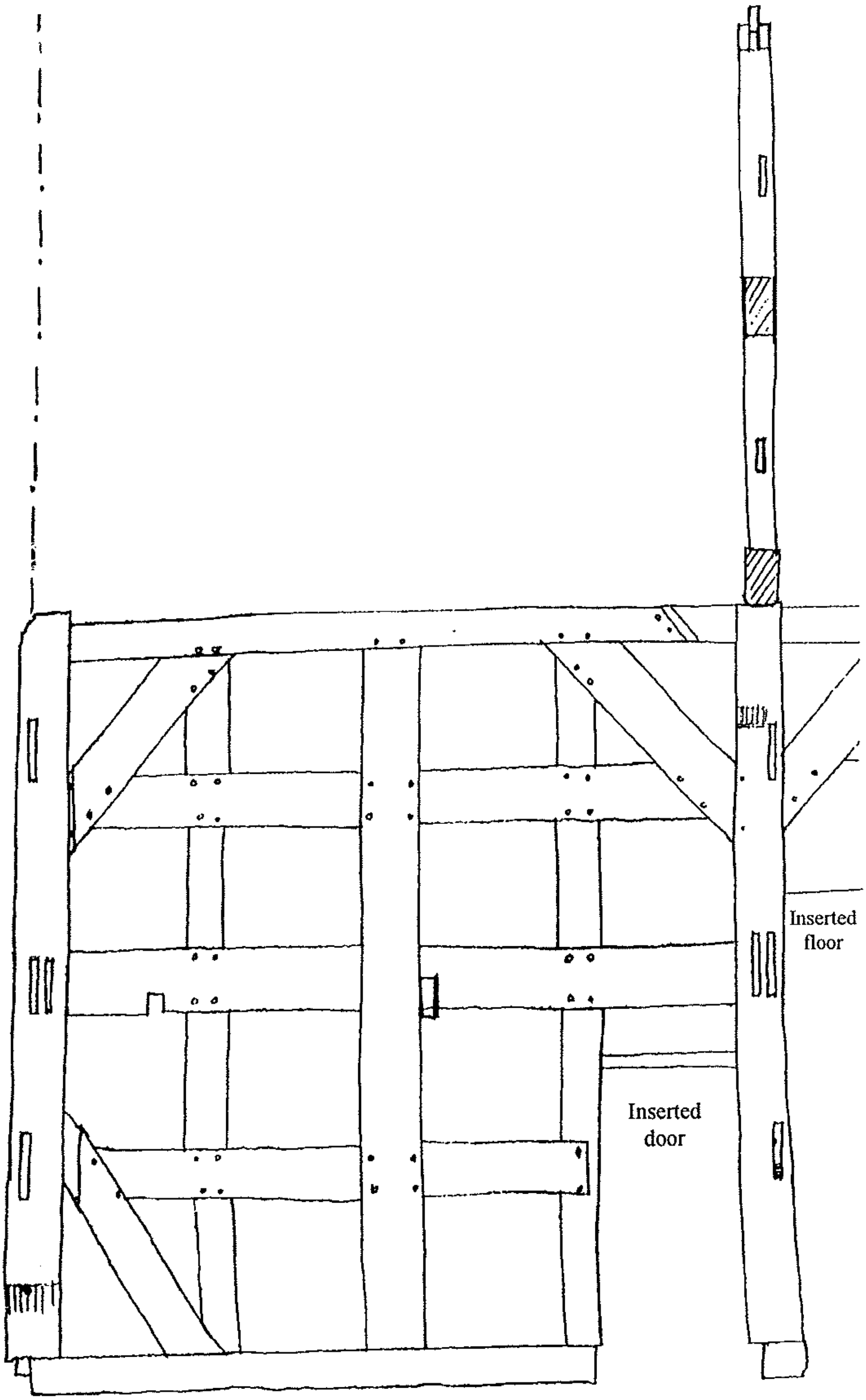


Figure 5: Bar diagram showing the relative positions of the dated ring sequences.

white bar - heartwood
hatched bar - sapwood
thin bar - unmeasured rings, the number of which has been estimated
line - felling date/felling date range

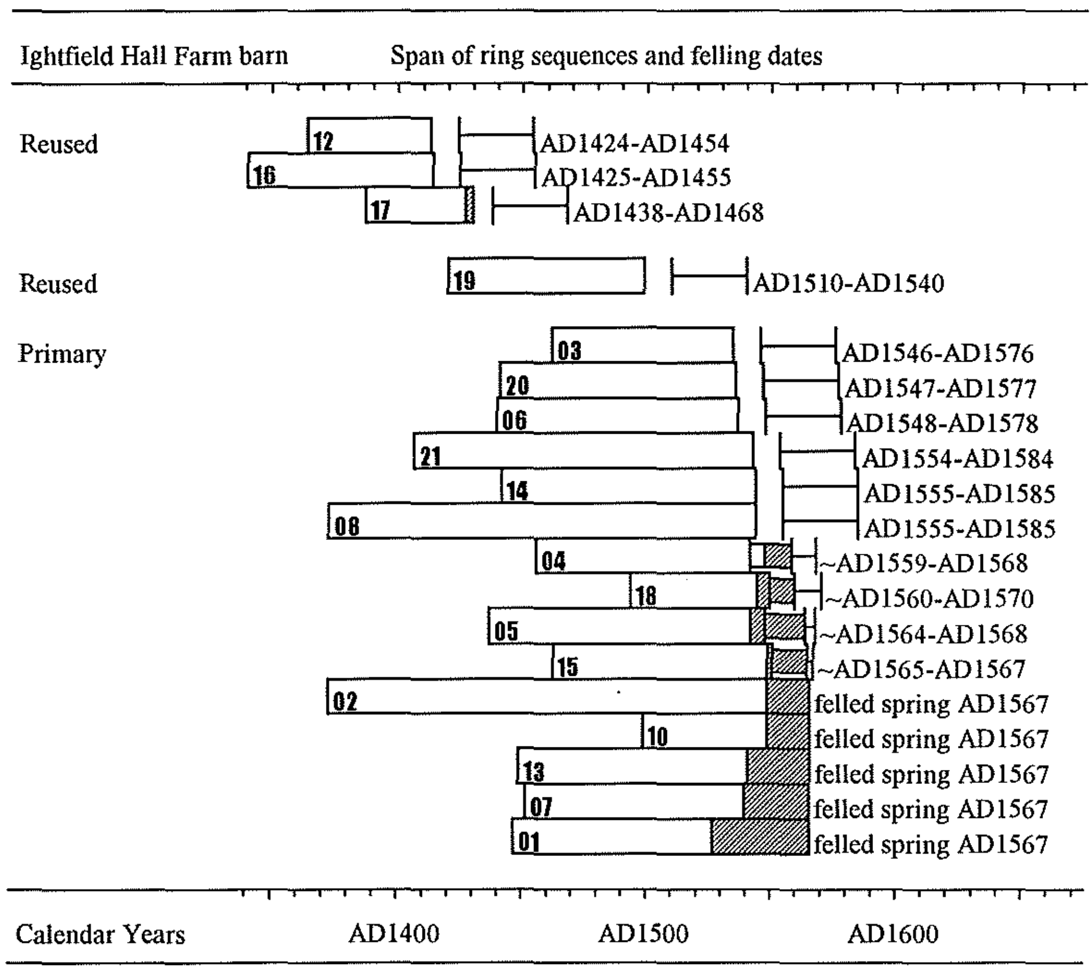


Figure 6: Diagrams showing a) cross-section of an annual growth ring on a oak sample (magnification approximately x30), b) schematic cross-section of the outermost rings immediately below the bark of samples **01**, **07**, and **10**, c) schematic cross-section of the outermost rings immediately below the bark of samples **02** and **13**.

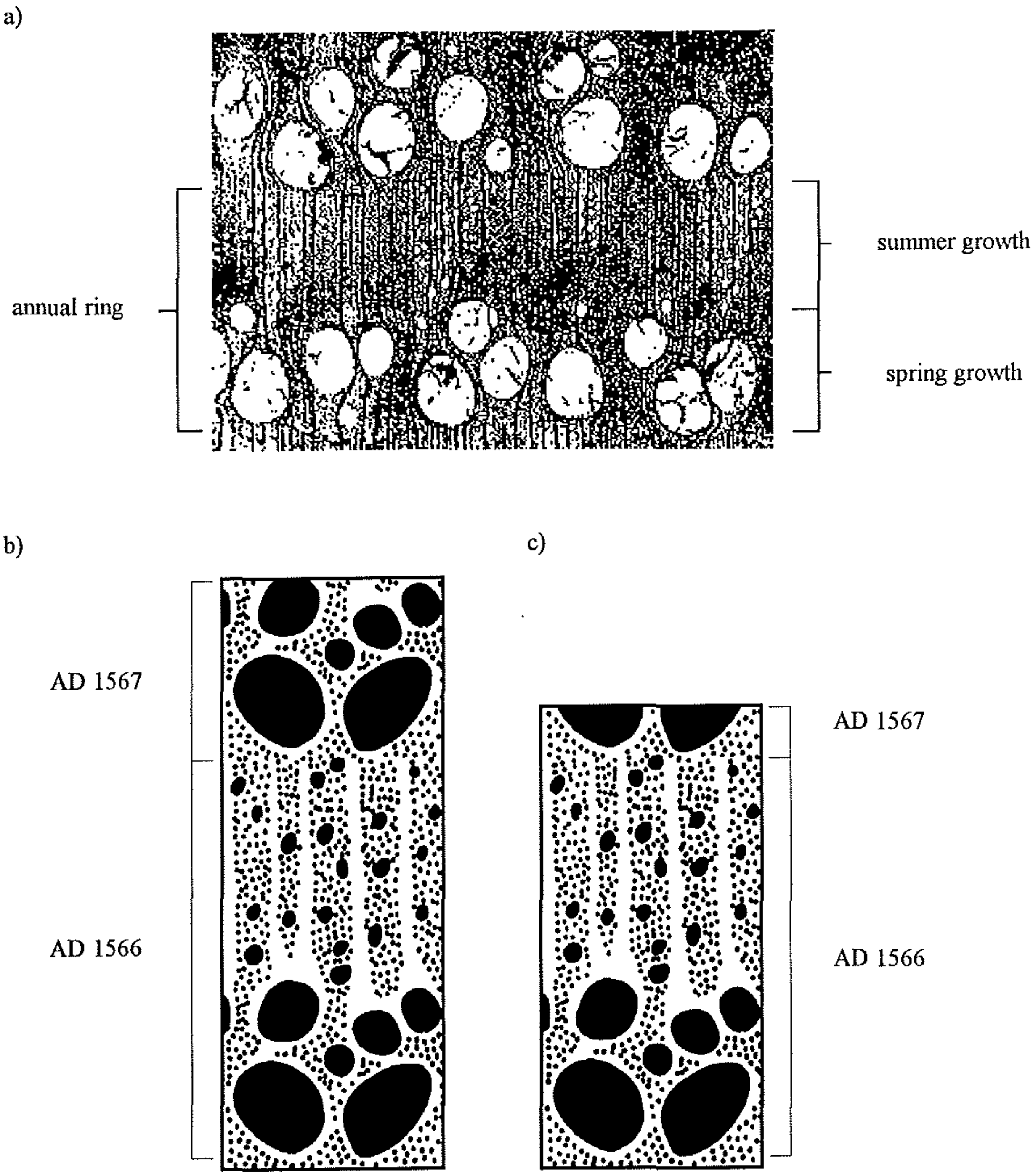


Figure 7: Schematic diagram showing the method of conversion of timbers shaped from a) whole trunks b) halved trunks c) quartered trunks.

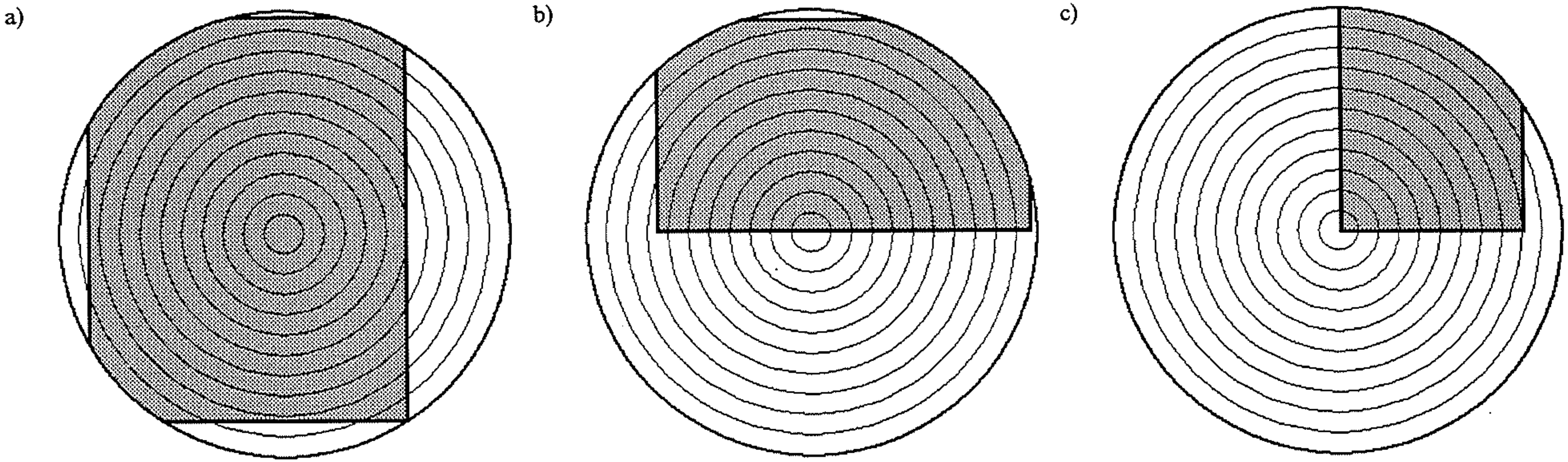


Figure 8: Diagram comparing the ring sequence length and average growth rates of the primary and reused timbers.

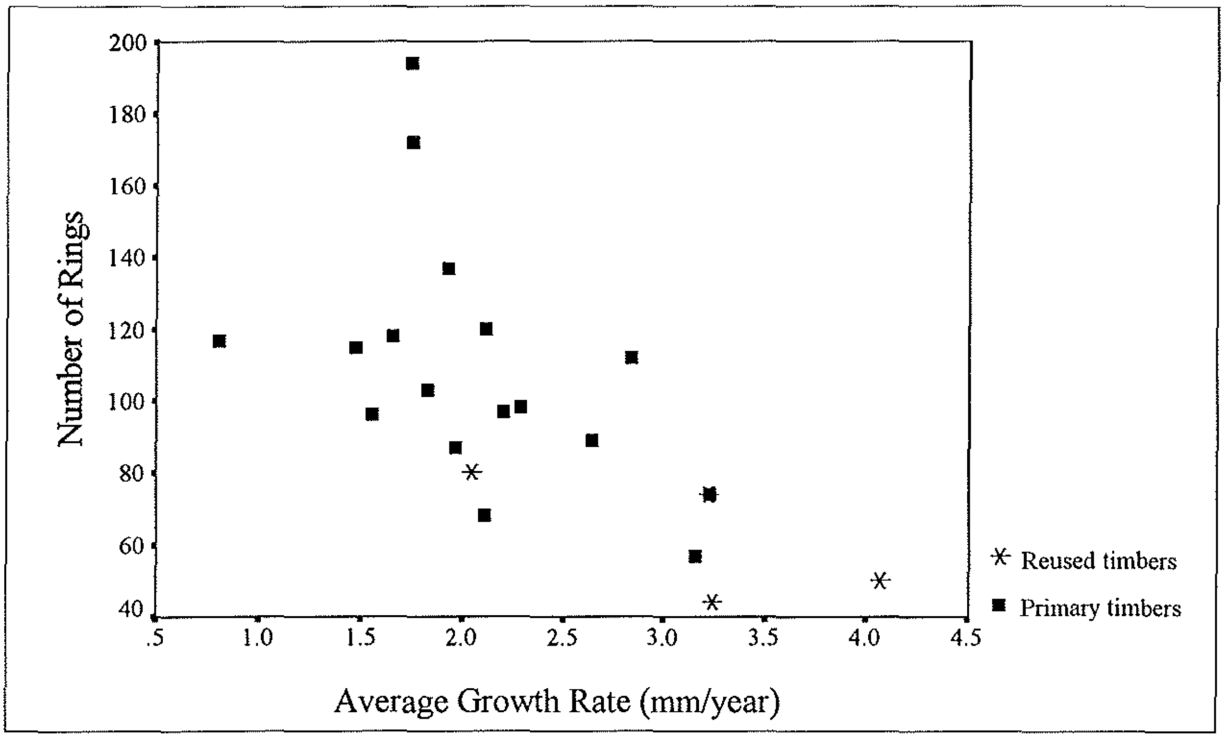


Figure 9: The ring sequences from all dated samples showing the incidence of bands of narrow rings where growth is suddenly retarded.

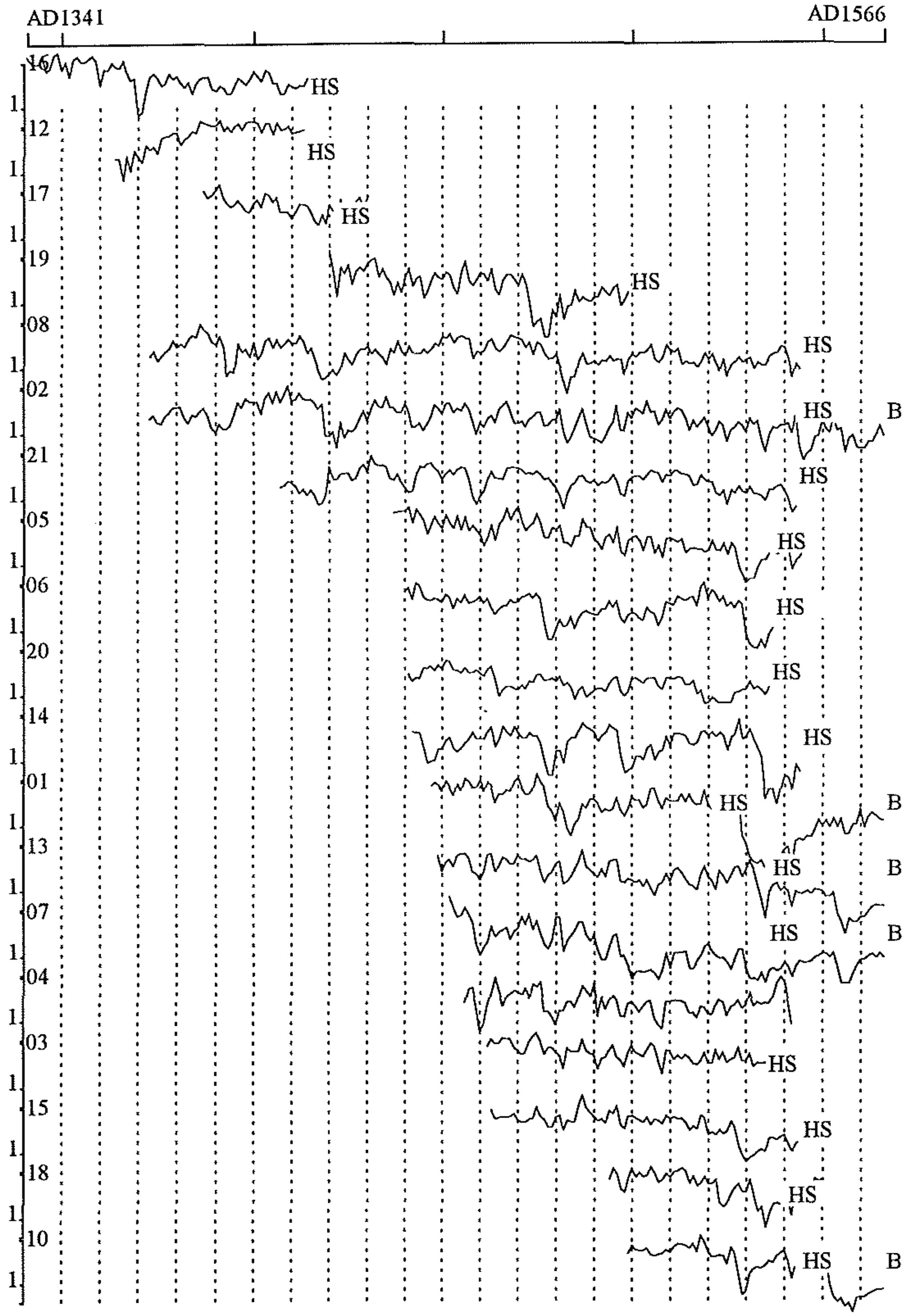


Table 1: Details of the samples from Ightfield Hall Farm barn. The location indicates the distance from a fixed point where the sample was taken and also the face on which coring started.

+ - unmeasured rings
hs - heartwood/sapwood boundary
AGR - average growth rate in millimetres per year
dimensions - width and depth of the timber in millimetres

Sample	Timber	Location	Total number of rings	Sapwood rings	AGR	Dimensions	Date span of measured ring sequence (AD)	Comment
01	Truss 4 east post	1175mm below tiebeam; south face	120	39	2.12	360x240	1447-1566	bark edge, spring vessels of AD1567 present
02	Truss 3 east post	1050 down from tiebeam, north face	194	17	1.74	335x280	1373-1566	bark edge, spring vessels of AD1567 just forming
03	Truss 4 tiebeam	1905mm west of east post,, south face	74	hs	3.23	400x220	1462-1535	-
04	Truss 3 transverse beam	2110mm west of east post, south face	87+	-	1.97	340x220	1456-1542	plus approximately 17-26 unmeasured rings, including 6 heartwood, to bark edge
05	Truss 3 tiebeam	3140mm west of east post, north face	112+	6+	2.84	400x255	1437-1548	plus approximately 16-20 unmeasured rings to bark edge
06	Bay 3 east wall, northern most upper stud	910mm below wall plate, north face	98	hs	2.29	300x?	1440-1537	second dimension unobtainable as timber was embedded in the wall
07	Bay 2 east wall, upward brace from truss 3 post	735mm below wall plate, west face	115	26	1.47	335x105	1452-1566	bark edge, spring vessels of AD1567 present
08	Truss 6 east post	275mm below tiebeam, south face	172	hs	1.75	360x275	1373-1544	-
09	Truss 6 tiebeam	east wall plate/post junction, south face	117	28	0.81	385x220	-	bark edge, spring vessels of 118 present

Sample	Timber	Location	Total number of rings	Sapwood rings	AGR	Dimensions	Date span of measured ring sequence (AD)	Comment
10	Bay 2 east wall, central stud	710mm down from wall plate, north face	68	17	2.11	300x100	1499-1566	bark edge, spring vessels of AD1567 present
11	Truss 6 east principal rafter	55mm above tiebeam, north face	97	hs?	2.20	285x165	-	-
12	Truss 5 east principal rafter	910mm above tiebeam; north face	50	hs	4.07	300x180	1364-1413	reused
13	Bay 4 west wall plate	495mm south of truss 4 west post, east face	118	25	1.66	250x175	1449-1566	bark edge, spring vessels of AD1567 just forming
14	Truss 4 east principal rafter	260mm above tiebeam, south face	103	hs	1.83	380x145	1442-1544	-
15	Truss 5 west post	1040mm down from tiebeam, south face	89+	2+	2.64	255x250	1463-1551	plus approximately 14-16 unmeasured rings to bark edge
16	Truss 3 east principal rafter	75mm above tiebeam, south face	74	hs	3.22	410x170	1341-1414	reused
17	Truss 5 west principal rafter	95mm above tiebeam, north face	44	3	3.24	335x180	1387-1430	reused
18	Bay 4 east wall plate	1890mm south of truss 4 east post, west face	57+	5+	3.16	235x170	1494-1550	plus approximately 10-20 unmeasured rings to bark edge
19	Truss 4 east queen strut	70mm above tiebeam, south face	80	hs	2.05	290x105	1420-1499	reused
20	Bay 3 west wall, southern most upper stud	445mm below wall plate, east face	96	hs	1.55	320x125	1441-1536	-
21	Truss 6 transverse beam	2590mm west of east post, south face	137	hs	1.93	400x180	1407-1543	-

Table 2: Matrix showing the *t* values obtained between the matching samples.

\ = overlap < 15 years
- = *t* values less than 3.00

	Primary timbers														Reused timbers			
Core	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**10**	**13**	**14**	**15**	**18**	**20**	**21**	**12**	**16**	**17**	**19**
1	4.64	-	-	5.65	4.74	-	3.78	3.14	3.76	4.10	4.07	4.45	3.00	-	\	\	\	-
2		3.09	-	4.69	5.22	5.11	5.48	-	8.60	6.06	4.89	3.11	3.69	4.01	4.22	4.20	4.91	5.23
3			6.28	3.05	3.60	-	3.97	-	3.15	4.29	3.31	3.95	4.32	5.88	\	\	\	-
4				-	-	-	-	-	-	-	3.77	3.33	3.45	3.60	\	\	\	-
5					4.70	-	4.62	3.07	4.71	5.22	5.71	3.19	4.23	3.68	\	\	\	3.11
6						4.13	4.46	-	3.02	5.39	4.37	-	3.61	3.28	\	\	\	4.35
7							4.08	-	5.96	5.95	3.34	-	-	3.91	\	\	\	-
8								-	5.79	5.09	4.15	3.90	5.03	5.68	-	4.28	3.36	3.29
10									-	-	8.84	-	-	-	\	\	\	\
13										8.29	6.36	4.31	3.52	6.08	\	\	\	-
14											5.19	5.17	4.02	4.50	\	\	\	-
15												3.62	3.97	4.62	\	\	\	-
18													3.47	3.11	\	\	\	\
20														4.51	\	\	\	-
21															\	\	-	3.66
12																-	4.10	\
16																	4.41	\
17																		\

Table 3: Dating the Ightfield Hall Farm barn chronologies. All reference chronologies are independent.

\ = overlap < 15 years

Reference sequences	IGHTFIELD	IGHT-A	IGHT-B
Avon, Tickenham Court (Miles & Haddon-Reece 1994)	5.10	4.25	6.08
Devon, Broomham (Groves forthcoming)	5.66	4.17	4.44
Devon, Chilverton (Groves forthcoming)	5.93	4.98	4.81
Devon, Exeter Bowhill (Groves & Hillam unpubl)	8.54	6.63	7.05
Gloucestershire, Gloucester Mercers Hall, (Howard *et al* 1996)	10.73	7.95	9.60
Gloucestershire, Gloucester Westgate St, (Howard *et al* forthcoming)	9.05	8.57	4.45
Hereford/Worcester, Bayton (Bridge pers comm)	7.32	7.15	3.55
Hereford/Worcester, Gatley (Hibberd & Tyers pers comm)	7.99	6.59	5.29
Hereford/Worcester, Hereford Cathedral Barn 2 (Tyers 1996)	9.28	8.70	6.01
Hereford/Worcester, Hereford Farmers Club, (Tyers 1996)	9.07	8.23	5.94
Hereford/Worcester, Kings' Pyon (Groves & Hillam 1993)	8.59	7.10	6.76
Hereford/Worcester, Lower Sapey (Tyers 1995)	7.06	6.71	4.89
Hereford/Worcester, Mamble B (Tyers 1996)	5.66	4.90	3.48
Hereford/Worcester, Staplow (Tyers pers comm)	6.31	5.67	6.36
Shropshire, Brookgate Farm (Miles & Haddon-Reece 1993)	11.47	9.85	6.02
Shropshire, Easthope (Miles & Haddon-Reece 1994)	7.21	4.27	6.06
Shropshire, Langley Gatehouse (Hillam & Groves 1993)	8.28	8.34	\
Shropshire, Much Wenlock 4 (Miles & Haddon-Reece 1994)	6.09	4.04	6.00
Shropshire, Shrewsbury Nags Head (Miles & Haddon-Reece 1995)	7.64	5.91	6.85
Shropshire, Upton Cressett (Miles & Haddon-Reece 1994)	7.84	6.47	5.84
Staffordshire, Sinai Park (Tyers forthcoming)	12.99	10.16	8.14
N Ireland/Ireland, Belfast (Baillie 1977a)	7.90	5.89	5.26
N Ireland/Ireland, Dublin (Baillie 1977b)	5.82	5.47	3.14
Wales, Anglesey Hafoty Llansadwen 1 (Hillam & Groves unpubl)	6.01	5.16	5.91

Table 4: Dating the reused timbers. All reference chronologies are independent.

\ = overlap < 15 years
- = *t* values less than 3.00

Reference sequences	12	16	17	19
Avon, Tickenham Court (Miles & Haddon-Reece 1994)	5.03	-	5.19	-
Devon, Broomham (Groves forthcoming b)	3.74	-	4.06	3.39
Devon, Chilverton (Groves forthcoming b)	-	-	5.57	3.46
Devon, Exeter Bowhill (Groves & Hillam unpubl)	5.21	3.33	4.31	3.37
Gloucestershire, Gloucester Mercer's Hall (Howard et al 1996)	4.56	5.01	6.27	3.92
Gloucestershire, Gloucester Westgate St. (Howard et al forthcoming)	-	-	4.39	4.93
Hereford/Worcester, Bayton (Bridge pers comm)	-	-	3.28	4.00
Hereford/Worcester, Gatley (Hibberd & Tyers pers comm)	4.13	-	4.16	3.43
Hereford/Worcester, Hereford 14 Church St (Tyers 1996)	-	-	3.18	3.55
Hereford/Worcester, Hereford Cathedral Barn 2 (Tyers 1996)	3.11	-	5.64	3.99
Hereford/Worcester, Hereford Farmers Club (Tyers 1996)	-	3.57	4.97	3.07
Hereford/Worcester, Kings' Pyon (Groves & Hillam 1993)	3.22	4.41	4.17	3.89
Hereford/Worcester, Lower Sapey (Tyers 1995)	3.96	-	4.27	3.43
Hereford/Worcester, Staplow (Tyers pers comm)	4.67	3.99	4.08	3.34
Oxfordshire, Mapledurham Hall (Haddon-Reece *et al* 1987)	4.43	-	5.13	4.28
Oxfordshire, Mapledurham Pithouse (Miles & Haddon-Reece 1993)	3.90	-	7.24	3.58
Shropshire, Brookgate Farm (Miles & Haddon-Reece 1993)	-	3.95	3.81	4.44
Shropshire, Easthope (Miles & Haddon-Reece 1994)	4.47	3.98	-	3.55
Shropshire, Ludlow Broad St/King St (Miles & Haddon-Reece 1995)	-	3.11	-	\
Shropshire, Much Wenlock 4 (Miles & Haddon-Reece 1994)	4.21	4.00	-	\
Shropshire, Shrewsbury Nags Head (Miles & Haddon-Reece 1995)	3.94	4.73	-	\
Shropshire, Upton Cressett (Miles & Haddon-Reece 1994)	3.19	3.25	3.66	-
Staffordshire, Sinai Park (Tyers forthcoming)	-	5.69	6.27	4.58
Warwickshire, Warwick Masters House (Howard *et al* 1996)	\	\	-	6.27
Yorkshire, Elland Old Hall (Hillam 1984)	3.73	-	4.71	3.61
Yorkshire, Netherfold Farm (Hillam 1981)	-	-	4.64	5.48
Yorkshire, Sheffield, Bishops House (Morgan 1980)	-	-	4.70	3.83
Wales, Anglesey, Hafoty Llansadwen 1 (Hillam & Groves unpubl)	5.73	3.02	3.89	-

Table 5: The ring width data from the site master chronology IGHTFIELD, dated AD1341-1566 inclusive.

Date	Ring widths (0.01mm)										Number of samples									
AD 1341	592	491	454	454	628	359	404	620	689	379	1	1	1	1	1	1	1	1	1	1
AD 1351	497	297	548	604	502	498	552	616	502	217	1	1	1	1	1	1	1	1	1	1
	378	374	480	291	281	295	268	183	247	127	1	1	1	2	2	2	2	2	2	2
	116	223	208	237	190	212	240	276	298	293	2	2	4	4	4	4	4	4	4	4
	249	230	256	276	279	390	405	357	311	319	4	4	4	4	4	4	5	5	5	5
	394	273	241	222	264	349	290	319	312	368	5	5	5	5	5	5	5	5	5	5
AD 1401	337	265	403	411	290	387	249	275	327	254	5	5	5	5	5	5	6	6	6	6
	261	301	283	235	226	176	140	161	108	278	6	6	6	5	4	4	4	4	4	5
	188	124	241	201	234	166	226	277	265	280	5	5	5	5	5	5	5	5	5	5
	322	328	243	257	250	210	262	301	263	302	4	4	4	4	4	4	5	5	5	6
	316	212	302	292	238	212	265	299	283	245	7	8	8	8	8	8	9	9	10	10
AD 1451	326	355	257	297	287	347	283	239	206	209	10	11	11	11	11	12	12	12	12	12
	188	259	318	229	243	277	312	288	301	303	12	13	14	14	14	14	14	14	14	14
	277	249	274	269	340	272	177	159	171	191	14	14	14	14	14	14	14	14	14	14
	214	123	156	161	175	223	306	221	204	203	14	14	14	14	14	14	14	14	14	14
	155	174	170	229	246	263	144	128	192	234	14	14	14	15	15	15	15	15	16	15
AD 1501	216	212	190	234	247	212	177	165	248	221	15	15	15	15	15	15	15	15	15	15
	241	256	250	224	194	198	168	231	252	186	15	15	15	15	15	15	15	15	15	15
	190	188	176	181	137	187	184	202	138	125	15	15	15	15	15	15	15	15	15	15
	163	121	116	107	90	110	127	140	155	159	15	15	15	15	15	14	13	12	12	12
	125	70	116	106	121	134	133	163	165	176	12	12	11	10	8	8	8	8	7	7
AD 1551	139	88	109	70	72	43	54	60	63	81	6	5	5	5	5	5	5	5	5	5
	64	81	88	89	96	84					5	5	5	5	5	5				