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TREE-RING ANALYSIS OF TIMBERS FROM THE GRANGE, MILL LANE, HEBDEN, NR SKIPTON, WEST YORKSHIRE

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SUMMARY

Tree-ring analysis of six samples obtained from The Grange suggests that two phases of timber felling are represented here. An earlier phase, dating to 1582, is probably represented by one of the ground floor ceiling beams and a beam buried in the south wall of the ground floor. It cannot be proven, but these timbers could possibly represent the remains of an earlier building on this site, or they could simply have been salvaged from elsewhere and be reused here.

A later phase of felling is represented by a further ground-floor ceiling beam, and a single roof timber. One timber was certainly felled in 1652, as, probably, was the other. Given the form of the building, the style of the stonework, and that there is no evidence for any later major rebuilding (the house has been extended, probably at a slightly later date, to both the south and the east), it is possible that these mid-seventeenth century timbers represent the construction date of the main body of the building.

Two samples remain undated, both of which have slightly too few rings for reliable analysis.

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Introduction

The Grange, Hebden (Fig 1), stands on the east bank of a small stream, Hebden Beck, (Fig 2) about 200 mtrs from where it joins the river Wharfe, approximately 11km north-east of Skipton in West Yorkshire. The three-storey building with attics, situated on a terraced slope which falls away towards the stream and the river, is of local stone set in random courses beneath a roof of stone slate. The primary or original part of the present building

appears to have been a relatively simple two-bay structure. The building is known to have been a water-powered corn mill, the overshot paddle being set to the north side of the building and being driven by a leet from the nearby stream.

This primary element has been extended on the south side by a single storey lean-to outshot, though, given the fall of the land here, this also has a lower 'basement' level. The building has also been extended at the east end by a one bay, two-storey, addition, slightly narrower than the primary build, the stone-work of which is slightly more worked and squared, and laid in more regular courses (Fig 3). The relative order of these two extensions is not quite clear, but the southern lean-to is probably earlier than the eastern bay addition.

The timbers

There is only a modest quantity of timber within the The Grange. This comprises a single roof truss to the middle of the primary build, consisting of principal rafters, a king post, and a tiebeam. The west face of the principal rafters appear to have bevelled edges, or chamfers, but not the east faces (this is not so well defined on the south principal rafter). There may also be chamfers on the west face of the king post.

This central truss supports a ridge beam and double purlins to each slope of the roof, these running from the truss to the gables at the east and west ends. Whilst the timbers of the central truss are all of oak, those forming the purlins are a mixture of oak and pine. The lower edge of the upper south-east purlin, which, like the principal rafters, is of oak, appears to have a simple chamfer and stop to it (the top edge is not fully visible) (Fig 4). The upper south-west purlin may also have a chamfer on it, but again, this is not certain. Some of these timbers appear to be machine sawn, particularly the pine purlins, while the oak purlins show evidence for having been trimmed with an adze.

There are no oak timbers to the first floor, and it is only on the ground floor that further beams are visible, some of these being ceiling beams, with others taking the function of 'Sampson' posts. These again consist of a mixture of oak and pine, and form something of a 'cat's cradle' arrangement, some timbers appearing to be held at one end only. A single timber, apparently reused here, is found inserted into the body of the west wall of the primary build.

Sampling

Sampling and analysis by tree-ring dating of the timbers within The Grange were commissioned by the owners, Mr and Mrs Hodge. This was undertaken out of personal interest and concern for the building, and as part of a general programme of research in to its history and development.

It was realised, however, that some of the timbers showed little structural integrity, that is they were not all jointed and pegged together to form a coherent structural frame. Some of the timbers showed signs, by way of redundant mortices and pegholes, of possible previous use. The mixing of oak and pine, and the insertion of single timbers in to walls also suggested that the existing timbers could possibly represent more than one period of felling. Despite this it was hoped that tree-ring dating, in conjunction with possible future survey and stylistic interpretation, might produce further information about the building.

Thus, from the timbers available a total of six core samples was obtained. Each sample was given the code HEB-A (for Hebden, site "A") and numbered 01 – 06. Two of these samples, HEB-A01 and A02, were obtained from the oak roof timbers with the remaining four samples being obtained from the three oak ceiling timbers of the ground floor room, and an oak timber inserted in one of the walls.

The positions of these samples were marked on a sketch plans made at the time of coring, these being reproduced here as Figures 5a/b. Details of the samples are given in Table 1. In this Table, all trusses and the individual timbers have been numbered and/or identified on a north – south, or east – west basis, as appropriate.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank Mr and Mrs Hodge for their enthusiasm and interest in the history of The Grange, and for their generous personal funding of this programme of tree-ring analysis. The data obtained here will in due course help in the wider understanding of Yorkshire's building history.

Tree-ring dating

Tree-ring dating relies on a few simple, but quite fundamental, principles. Firstly, as is commonly known, trees (particularly oak trees, the most frequently used building timber in England) grow by adding one, and only one, growth-ring to their circumference each, and every, year. Each new annual growth-ring is added to the outside of the previous year's growth just below the bark. The width of this annual growth-ring is largely, though not exclusively, determined by the weather conditions during the growth period (roughly March – September). In general, good conditions produce wider rings and poor conditions produce narrower rings. Thus, over the lifetime of a tree, the annual growth-rings display a climatically influenced pattern. Furthermore, and importantly, all trees growing in the same area at the same time will be influenced by the same growing conditions and the annual growth-rings of all of them will respond in a similar, though not identical, way.

Secondly, because the weather over any number of consecutive years is unique, so too is the growth-ring pattern of the tree. The pattern of a short period of growth, 20, 30 or even 40 consecutive years, might conceivably be repeated two or even three times in the last one thousand years. A short pattern might also be repeated at different time periods in different parts of the country because of differences in regional micro-climates. It is less likely, however, that such problems would occur with the pattern of a longer period of growth, that is, anything in excess of 54 years or so. In essence, a short period of growth, anything less than 54 rings, is not reliable, and the longer the period of time under comparison the better.

The third principle of tree-ring dating is that, until the early- to mid-nineteenth century, builders of timber-framed houses usually obtained all the wood needed for a given structure by felling the necessary trees in a single operation from one patch of woodland, or from closely adjacent woods. Furthermore, and contrary to popular belief, the timber was used "green" and without seasoning, and there was very little long-term storage as in timber-yards of today. This fact has been well established from a number of studies where tree-ring dating has been undertaken in conjunction with documentary studies. Thus, establishing the felling date for a group of timbers gives a very precise indication of the date of their use in a building.

Tree-ring dating relies on obtaining the growth pattern of trees from sample timbers of unknown date by measuring the width of the annual growth-rings. This is done to a tolerance of 1/100 of a millimeter. The growth patterns of these samples of unknown date are then compared with a series of reference patterns or chronologies, the date of each ring of which *is* known. When the growth-ring sequence of a sample "cross-matches" repeatedly at the same date span against a series of different relevant reference chronologies the sample can be said to be dated. The degree of cross-matching, that is the measure of similarity between sample and reference, is denoted by a "*t*-value"; the higher the value the greater the similarity. The greater the similarity the greater is the probability that the patterns of samples and references have been produced by growing under the same conditions *at the same time*. The statistically accepted fully reliable minimum *t*-value is 3.5.

However, rather than attempt to date each sample individually it is usual to first compare all the samples from a single building, or phase of a building, with one another, and attempt to cross-match each one with all the others from the same phase or building. When samples from the same phase do cross-match with each other they are combined at their matching positions to form what is known as a "site chronology". As with any set of data, this has the effect of reducing the anomalies of any one individual (brought about in the case of tree-rings by some non-climatic influence) and enhances the overall climatic signal. As stated above, it is the climate that gives the growth pattern its distinctive pattern. The greater the number of samples in a site chronology the greater is the climatic signal of the group and the weaker is the non-climatic input of any one individual.

Furthermore, combining samples in this way to make a site chronology usually has the effect of increasing the time-span that is under comparison. As also mentioned above, the longer the period of growth under consideration, the greater the certainty of the cross-match. Any site chronology with less than about 55 rings is generally too short for reliable dating.

Having obtained a date for the site chronology as a whole, the date spans of the constituent individual samples can then be found, and from this the felling date of the trees represented may be calculated. Where a sample retains complete sapwood, that is, it has the last or outermost ring produced by the tree before it was cut, the last measured ring date is the felling date of the tree. In the Tables and bar diagrams of this report, the retention of complete sapwood on a sample is denoted by upper case 'C'.

Sometimes, complete sapwood is found on a timber, but, because of its soft condition, some, or all of it, crumbles as the sample is cored. It is possible to measure how much of the sapwood part of the core has been lost and from this it is sometimes possible to estimate the number of rings the lost portion might have represented, From this it is possible to make a reasonable estimate the felling date of the timber. Such a state is represented by lower case 'c' in the Tables and bar diagrams.

Where the sapwood is not complete it is necessary to calculate a likely felling date range for the tree. Such an estimate can be made with a high degree of reliability because oak trees generally have between 15 to 40 sapwood rings. For example, if a sample with, say, 12 sapwood rings has a last sapwood ring date of 1400, it is 95% probable that the tree represented was felled sometime between 1403 (1400+3 sapwood rings (12+3=15)) and 1428 (1400+28 sapwood rings (12+28=40)).

Given that in a timber-framed building the trees required for each phase are almost certainly to have been cut in a single felling operation especially for that building, it is usual to calculate the average date of the heartwood/sapwood boundary, not on the basis of each single individual sample, but from *all* the dated samples from each phase of a building and add 15 to 40 rings to this average to get the likely overall felling date of all the timbers used. In this calculation, wide variations in the position/date of the heartwood/sapwood boundary (possibly suggesting different felling dates) must be noted and taken into consideration.

Analysis

In the case of the six samples obtained from The Grange, each was prepared by sanding and polishing (Fig 6), and their annual growth-ring widths were measured. The data of these measurements were then compared with each other as described in the notes on tree-ring dating above. There was, however, no cross-matching between any of them, and a site chronology of several cross-matching samples could not be made.

Each of the six samples were then compared individually to the full collection of reference material available for oak, this process indicating satisfactory cross-matches and dates for four of them. The evidence for this dating is given in the *t*-values of Table 2. This shows the level of cross-matching, that is the degree of similarity, between each sample and a selection of reference chronologies at the date span indicated. In all cases the date span indicated is repeated consistently against many different reference chronologies and the *t*-value given is the maximum to be found, ie, these are the 'best' cross-matches (cross-matches at other random dates may be found, but the date span is not repeated and the *t*-values are lower). This analysis is summarised below:

Sample	Timber	First ring date	Last ring date
HEB-A01	South-east purlin	1510	1633
HEB-A03	West ground-floor ceiling beam	1431	1582
HEB-A05	East ground-floor ceiling beam	1503	1649
HEB-A06	Wall beam	1416	1544

Interpretation

Analysis by dendrochronology of six measured samples from The Grange has resulted in four of them being dated, and it may be seen from Tables 1 and 2, that it is likely that two phases of timber felling are represented.

The earlier phase of felling is represented by samples HEB-A03 and A06, respectively the western ground-floor ceiling beam and the beam buried in the wall. Sample HEB-A03 retains complete sapwood (denoted by 'C' in Table 1). This means that it has the last ring produced by the tree it represents before it was felled. This last, complete, sapwood ring, and thus the felling of the tree, is dated to 1582.

Sample HEB-A06, the wall beams, has only the heartwood/sapwood boundary (the boundary ring being dated to 1544), ie, all the sapwood rings are missing (but only the sapwood rings), and thus its exact felling date cannot be determined precisely. However, (as discussed in the notes on tree-ring dating above), most oak trees have between 15 and 40 sapwood rings. This number would suggest that sample HEB-A06 represents a tree felled between 1559 and 1584. Such a felling date range encompasses that for sample HEB-A03, and suggests the possibility that both timbers were felled at the same time. It may be noted from Table 1, furthermore, that the heartwood/sapwood boundary on both samples, HEB-A03 and A06, is at exactly the same date, giving strong support to the possibility of a single felling date.

The later phase is represented by samples HEB-A01 and A05, respectively the south-east purlin in the roof and the eastern ground-floor ceiling beam. Again one sample, sample HEB-A05, retains complete sapwood, meaning that it too has the last ring produced by the tree it represents before it was felled. In this case this last, complete, sapwood ring, and thus the felling of the tree, is dated to 1652.

Likewise, sample HEB-A01, the purlin, has only the heartwood/sapwood boundary, this being dated to 1633, and its exact felling date cannot be determined. Using the same number of probable missing sapwood rings as above, 15 – 40, however, would suggest that sample HEB-A01 represents a tree felled between 1648 and 1673. Such a felling date range again encompasses that indicated by sample HEB-A05 and, whilst the heartwood/sapwood boundary date on this sample is different to that on sample HEB-A05 (1620), it would again suggest a similar, if not identical, felling date for the two timbers.

Conclusion

It would appear, therefore, that The Grange contains oak timbers of at least two different dates. It is certainly possible that the late-sixteenth century timbers represent a primary, or at least an earlier, building on this site. There is, however, no certainty of this and it is possible that the timbers have simply been salvaged from another building and reused here in a mid-seventeenth century building, the date of which is evidenced by the later-phase timbers. Again, there is no certainty of this and it is possible that both sets of timbers have been salvaged and used in a still later phase building. There is, however, no evidence for such a later-phase building, the combination of pine and oak, the mixing of adzed and sawn timber, and the stylistic evidence of the form of the house and the features such as the windows and stonework pointing to the probability that The Grange is of mid-seventeenth century date. It certainly contains timber of this date.

Table 1: Details of tree-ring samples from The Grange Hebden, Skipton, North Yorkshire

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Last heartwood ring date (AD)	Last measured ring date (AD)
HEB-A01	South-east purlin	124	h/s	1510	1633	1633
HEB-A02	South principal rafter, roof truss 1	47	h/s	------	------	------
HEB-A03	West ground-floor ceiling beam	152	38C	1431	1544	1582
HEB-A04	Middle ground-floor ceiling beam	51	17C	------	------	------
HEB-A05	East ground-floor ceiling beam	147	32C	1503	1620	1652
HEB-A06	Wall beam	129	h/s	1416	1544	1544

*h/s = The last ring on the sample is at the heartwood/sapwood boundary

C = complete sapwood is retained on the sample; where dated, this is the felling date of the tree represented

Table 2: *t*-values of the cross-matches

HEB-A01 first ring date 1510 last-ring date 1633

Reference chronology	*t*-value
Church of the Holy Trinity, Kirk Ireton, Derbys	4.7
Rushall Hall Barn, Rushall, Walsall	4.5
St Peter's Church, Saltby, Leics	4.2
Spring House Farm, Walton, Derbys	4.1
Aston Hall, Aston, Birmingham	4.1
Frith Hall, Brampton, Derbys	3.7

HEB-A03 first ring date 1431 last-ring date 1582

Reference chronology	*t*-value
Church of the Holy Trinity, Kirk Ireton, Derbys	5.1
Wakelyn Old Hall, Hilton, Derbys	5.1
Offerton Hall, Offerton, Derbys	5.0
Manor House, Sutton in Ashfield, Notts	4.8
England Master Chronology	4.7
Donington-le-Heath Manor House, Leics	4.7

HEB-A05 first ring date 1503 last-ring date 1652

Reference chronology	*t*-value
Hipper Hall, Walton, Derbys	5.6

Old Manor, Hartshorne, Derbys	5.4
Grange Farm, Norton, Sheffield, S Yorks	5.1
Raynor House, Bradfield, S Yorks	5.1
Oakwell House, Birstall, W Yorks	4.8
Unthank Hall, Holmesfield, Derbys	4.6

HEB-A06 first ring date 1416 last-ring date 1544

Reference chronology	*t*-value
Cobermere Abbey, Cheshire	5.5
Dilston Castle, Corbridge, Northumberland	5.0
Ordsall Hall, Stockport, Cheshire	4.8
Brook Farm, Knutsford, Cheshire	4.6
Speak Hall, Speake, Cheshire	4.5
England Master Chronology	4.3