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CANNINGTON COURT, CANNINGTON, NEAR BRIDGWATER, SOMERSET; TREE-RING ANALYSIS OF TIMBERS FROM THE NORTH RANGE ROOF

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SUMMARY

A total of eight core samples was obtained from the north range roof trusses at Cannington Court, Cannington. Upon return to the Laboratory it was confirmed, as had been intimated by the site inspection, that six of the sampled timbers were of elm, while only two of them were of oak. The elm timbers are from the principal timbers of the main roof trusses, while the oak timbers are from two wall plates to the northern dormer range extension off the north range.

At present only oak timbers can be reliable dated by dendrochronology, elm being less suitable to the process. Thus only the two oak samples were analysed, this producing a single site chronology, CANBSQ01, with an overall length of 79 rings. These rings are dated as spanning the years 1596 – 1674. Interpretation of the sapwood on these two samples, allowing for some missing ring would suggest that, in round terms, the timbers are likely to have been felled between, say, 1690–95.

Although undated by conventional tree-ring analysis, it is possible that the core samples from the elm timbers could be submitted for radiocarbon 'wiggle-matching' (see below), a process which in this case might date the timbers to a +/- range of 25 years.

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Introduction

Cannington Court lies in the pretty village of Cannington, just to the north of the A39 trunk road, a few miles west of Bridgwater in Somerset (ST 257 395, Fig 1a/b).

By the twelfth century it is known that the manor of Cannington was held by the Curci family, and that *c*.1138 Robert de Curci gave part of his estate to found a house of Benedictine nuns at Cannington. By the early sixteenth century the nuns' estate included lands round the priory, the manor, and the rectory and vicarage. By the time the priory was dissolved in 1536 some land had already been let to Sir Edward Rogers and in 1539 the Crown also granted him the site of the nunnery, the manor, rectory, and advowson and the former priory lands in the parish and elsewhere. The property remained with the Rogers family until 1672 when Cannington reverted to the Crown. The estate then passed to the Clifford family who hold the land (though not Cannington Court itself) to this day.

Cannington Court, formerly the Court House, originated in the remains of the priory and has a twelve-bayed, three-storied west front of sandstone rubble except for the top storey which is of brick with keyed oval openings. The buildings of the nunnery lay immediately to the north of the parish church to which they were linked before their post-Dissolution conversion. Whether the twelfth-century church abutted the south side of the cloister or was divided from it by an open passage is not now clear but that appears to have been the arrangement after the rebuilding of the church on a new alignment in the later-fifteenth century. The eastern claustral range has been demolished, although the outline of its gable can be seen on the church, but the western and northern ranges survive in a much-altered form. On the first floor of the west range there is a much restored and reset early sixteenth-century fireplace with a frieze of quatrefoiled panels enclosing shields and the initials of the Cliffords. The west range continues northwards and with the east and north ranges, which both appear to be of medieval origin, it now encloses a second courtyard. The north range is not aligned with the other buildings and it was not originally joined to the west range.

The conversion into a house for the Rogers family was centered on a first-floor hall in the northern half of the east range. There were service rooms to the north and other principal rooms on the first floor of the central and western ranges. The northern court was entered by a gateway with a two-storied porch in limestone ashlar. Soon after the house passed to them the lords Clifford made further alterations, extending the west range northwards and adding a second floor to the west range and porch. At its southern end the added floor is only a façade.

The description of the house as 'a ruin' in the 1790s may relate to the demolition of the southern end of the east range. A chapel in existence by 1776 was rebuilt by John Peniston in 1830. It is now a lecture room known as the Clifford Hall. The room is octagonal, with a domed and coffered ceiling rising to an octagonal lantern, and two large Corinthian columns flank the opening to the former chancel. The octagonal nave was probably constructed within the walls of the earlier chapel. In 1919 the tenth Lord Clifford granted the lease of Cannington Court to Somerset County Council. The house and buildings were adapted for Somerset College of Agriculture and Horticulture, known as Somerset Farm Institute. The successor to the institute was Cannington College, which became nationally known for its provision of land-based education. Having been altered and developed over several centuries in now forms a series of ranges round a courtyard, Figure 2.

Sampling

Cannington Court has recently been purchased by EDF Energy with a view to developing the buildings into a national training centre for the company's staff. This development includes the restoration of the Court buildings to bring them back into beneficial use, the landscaping of the central courtyard to improve the setting of the listed building with replacement car parking provided nearby, a new single-storey building in place of the Amory Block, together with the restoration and refurbishment of several existing buildings, and a 'green travel' plan to minimise additional traffic, including a pick up and drop off service at local railway stations and airports for EDF Energy staff using the training facility.

As part of this restoration and development, a research programme of investigation, survey, and recording, has sought to establish the date and sequential development of the building in order to reassess its significance, with tree-ring analysis being employed in an attempt to date the timbers. To this end tree-ring analysis has already been undertaken on timbers to the roofs of the southern range (Arnold and Howard 2013), and an inspection made of the roof to the west range. It was hoped that further dendrochronology on the timbers of the recently exposed north range roof would shed further light on the date of this part of the building and enhance the understanding of the development of the site overall. It was hoped that this work would inform a greater archaeological understanding of the significance of Cannington Court in the preparation of conservation proposals. This programme of tree-ring dating was thus commissioned on behalf of EDF Energy by Kier Construction.

With the aim of fulfilling this brief, an inspection was made of the roof trusses to the north range. It was seen at this time that although a considerable quantity of timber was to be found here in the form of several principal rafter trusses with upper and lower collars, triple purlins, and short arched brackets between the principal rafters and the main posts (hidden in the walls (Fig 3a–c), the majority of timbers appeared to be of elm, with only two timbers, the east and west wall plates of a northern dormer extension to the north range, being of oak (Fig 4). Although attempts have been made in the past to date elm timbers by tree-ring analysis, currently, probably due to the variation and erratic nature of the annual growth rings of this tree, it is not possible to reliably date this wood. However, to check this initial visual determination and to provide samples for possible radiocarbon 'wiggle-matching' (see below) core samples were obtained from what were thought to be elm beams, with samples being taken from the two oak timbers for conventional tree-ring analysis.

The sampled oak timbers are located on the photograph Figure 4, with the elm timbers being located on simple schematic drawings of Figures 5a–c (note that the trusses of the north range roof being numbered from west to east). Details of the samples are given in Table 1, including the timber sampled and its location, the total number of rings each measured sample has, and how many of these, if any, are sapwood rings. The individual date span of each dated sample is also given.

Radiocarbon 'wiggle-matching'

Wiggle-matching is the process by which the radiocarbon level of individual trees rings separated by a known number of years, are matched to the annual/short-term variations (the 'wiggles') in the radiocarbon calibration curve – the separation the individual tree-rings being maintained in the calibration curve. Although this matching can be done visually, statistical methods, particularly by Bayesian analysis, are usually employed. Wiggle-matching is particularly suited to undated, or ‘floating’, tree-ring sequences as the calendar age separation (in years) of different blocks of wood submitted for dating is known precisely by simply counting the number of rings (ie, the years) between the rings.

Recent advances in the accuracy and precision of radiocarbon measurements produced by Accelerator Mass Spectrometry now make this approach feasible for small wood samples, such as those available from cores taken for tree-ring dating. Thus, it would in theory be possible to submit the elm samples for ‘wiggle-match’ analysis, the degree of accuracy of the felling of the timbers being enhanced due to the samples having complete sapwood.

The Nottingham Tree-ring Dating Laboratory would like to take this opportunity to thank EDF Energy for generously funding this programme of tree-ring analysis, along with Matt Coates, Roger Pearce, and Mitch Ross of Kier Construction (Western & Wales), plus all on-site contractors and staff who helped and cooperated with sampling, and made the site work both safe and productive.

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 timber most commonly used in building construction until the introduction of pine from the late eighteenth century onwards) 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 (Fig 6).

Secondly, because the weather over a certain number of consecutive years (the statistically reliable minimum calculated as being 54 years) is unique, so too is the growth-ring pattern of the tree. The pattern of a shorter 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, and is considered less reliable. 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 45 years or so. In essence, a short period of growth, anything less than 45 rings, is not reliable, and the longer the period of time under comparison the better.

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 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.

Where the sapwood is not complete it is necessary to estimate the likely felling date of 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 (and therefore a heartwood/sapwood boundary ring date of 1388), it is 95% certain 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)).

Analysis

All the core samples obtained from the north range roof timbers of the north range roof were prepared by sanding and polishing. It was seen at this time that six of these were of elm, thus confirming the suspicion of the initial sampling visit. These samples were rejected from this programme of analysis.

The annual growth ring widths of the two remaining, oak, samples were, however, measured and the data were then compared with each other as described in the notes above. By this process a single group, comprising both oak samples could be formed, the samples cross-matching with each other as shown in the bar diagram, Figure 7.

The two cross-matching samples were combined at their indicated off-set to form CANBSQ01, a site chronology with an overall length of 79 rings. This site chronology was then satisfactorily dated by repeated and consistent cross-matching with a large number of relevant reference chronologies for oak as spanning the years 1596 to 1674. The evidence for this dating is given in the *t*-values of Table 2.

Interpretation

Neither of the two samples in site chronology CANBSQ01 retain complete sapwood (the last ring produced by the tree immediately before it was cut down) and it is thus not possible to say precisely when either of the two trees represented were felled. One sample however, CAN-B01, is from a timber which does have complete sapwood on it but from which, due to the soft and fragile nature of this part of the wood, a portion of the sapwood was lost from the sample in coring. It was noted at the time of sampling that this lost sapwood portion amounted to only 15–20mm. Judging by the amount of sapwood still found on sample CAN-B01, it is estimated that this loss represents about 15 – 20 further sapwood rings. Given that the last extant ring on this sample is dated to 1674 such a lost would suggest that, in round terms, the source tree for the beam was felled in, say, 1690–95.

Given the level of cross-matching between sample CAN-B01 and B02, it is likely that the tree represented by sample B02 was growing in the same copse or stand of woodland as that represented by sample B01. It is thus likely that the two trees were felled at the same time as each other (it being very unlikely that two trees, originally growing so close together in the same copse or stand of woodland but felled at different times, would come to be used in the same part of a building for the same purpose).

Conclusion

Given the positions of these timbers in the roof of the north range, as wall plates, and showing no clear sign of reuse, it would seem likely that they were felled in 1690–95 specifically for its construction. As such, it is possible that this date might seem a little later than would perhaps be otherwise expected. The date, however, would appear to belong to the works undertaken by the Clifford family who came into possession of Cannington Court in the later seventeenth century.

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Table 1: Details of tree-ring samples from the north range roof, Cannington Court, Cannington, near Bridgwater, Somerset

Sample number	Sample location	Total rings	Sapwood rings*	First measured ring date (AD)	Heart/sap boundary (AD)	Last measured ring date (AD)
CAN-B01	West wall plate to northward extension	79	11 + 15-20 nm C	1596	1663	1674
CAN-B02	East wall plate to northward extension	55	h/s	1607	1661	1661
CAN-B03	Lower collar, truss 3 (elm)	nm	---	------	------	------
CAN-B04	North principal rafter, truss 3 (elm)	nm	---	------	------	------
CAN-B05	North principal rafter, truss 5 (elm)	nm	---	------	------	------
CAN-B06	South principal rafter, truss 5 (elm)	nm	---	------	------	------
CAN-B07	North principal rafter, truss 6 (elm)	nm	---	------	------	------
CAN-B08	South principal rafter, truss 6 (elm)	nm	---	------	------	------

*h/s = heartwood/sapwood boundary, i.e., only the sapwood rings are missing
nm = sample not measured
C = complete sapwood is found on the sampled timber

NB. The roof trusses have been numbered from west to east)

Table 2: Results of the cross-matching of site chronology CANBSQ01 and the reference chronologies when the first ring date is 1596 and the last ring date is 1674		
Reference chronology	*t*-value	
Apethorpe Hall, Apethorpe, Northants	9.0	(Arnold and Howard forthcoming a)
East Midlands Master Chronology	8.2	(Laxton and Litton 1988)
De Grey Mausoleum, Flitton, Beds	8.1	(Arnold *et al* 2003)
Worcester Cathedral, Worcs	7.8	(Arnold *et al* 2003)
Bretby Hall, Bretby, Derbys	7.6	(Howard *et al* 1999)
Wren Wing, Easton Neston, Northants	6.9	(Arnold *et al* 2008)
Oakham Castle, Oakham, Rutland	6.7	(Arnold and Howard forthcoming b)
Kenilworth Castle, Kenilworth, Warwicks	5.8	(Arnold and Howard 2007)

Site chronology CANBSQ01 is a composite of the data of the relevant cross-matching samples as seen in the bar diagram Figure 7. This composite data produces an 'average' tree-ring pattern, where the overall climatic signal of the growth is enhanced, and the possible erratic variations of any one individual sample are reduced. This 'average' site chronology is then compared with several hundred reference patterns covering every part of Britain for all time periods, cross-matching with a number of these only at the time span indicated, the table giving only a small selection of the very best matches as represented by '*t*-values' (ie, degrees of similarity). It may be noticed from this Table that the resultant *t*-values are well in excess of the *t*=3.5 value usually taken as the minimum acceptable level for satisfactory dating. These values, along with the many other slightly lower, unlisted, cross-matches, indicate a very firm and reliable date for the Cannington Court timbers.

Figure 1a/b: Maps to show location of Cannington (top) and Cannington Court (bottom)

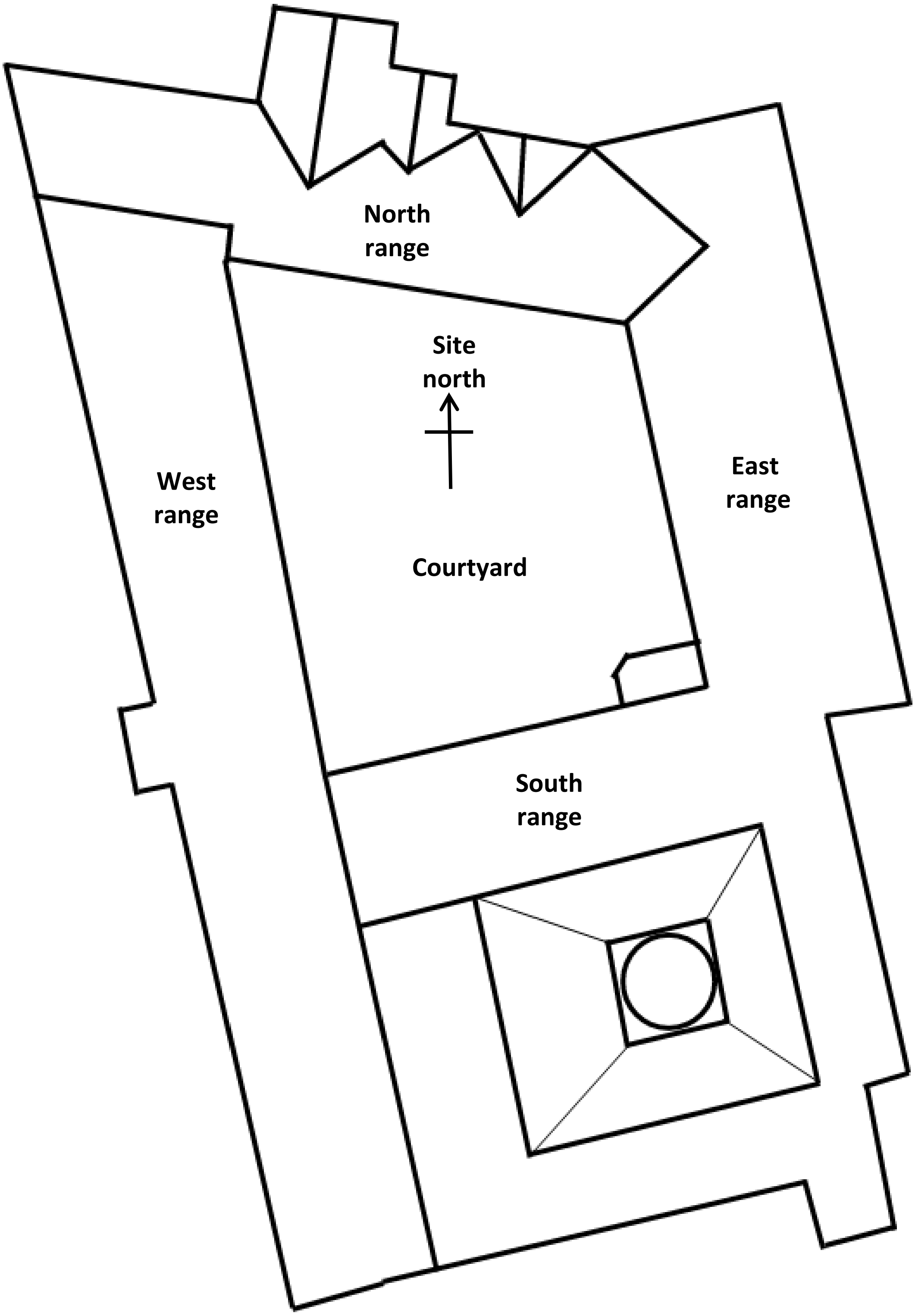


Figure 2: Simple schematic plan to show layout and arrangement of the building

Figure 3a–c: Views of the elm trusses to the north range

Figure 4: Views of the western wall plate of the northward extension of the north range. The other wall plate is to the eastern side of the extension (this photo also used to help locate sample positions - see Table 1)

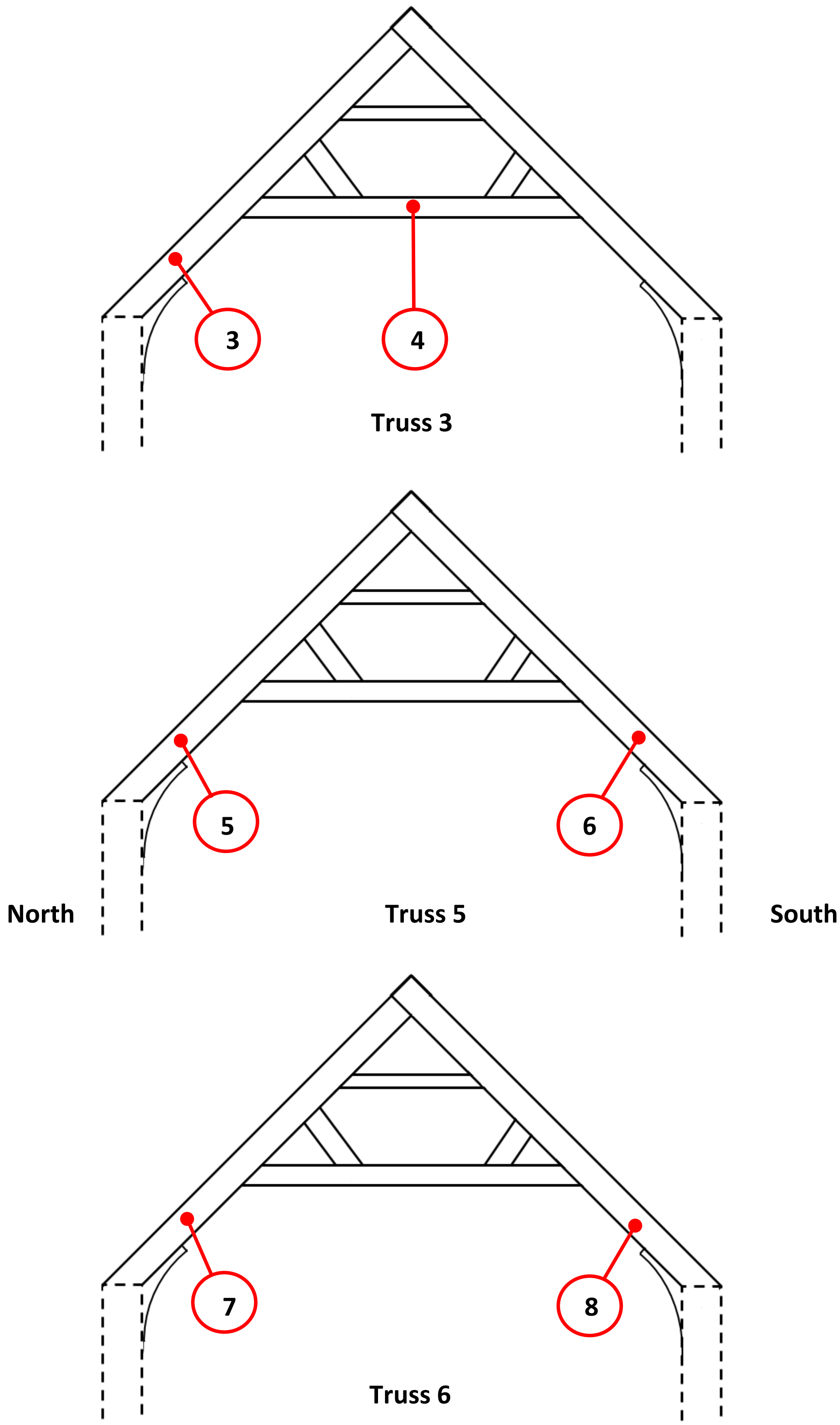


Figure 5a–c: Simple schematic drawings of the roof trusses to the north range to help locate the sampled timbers (see Table 1), trusses viewed from the west looking east

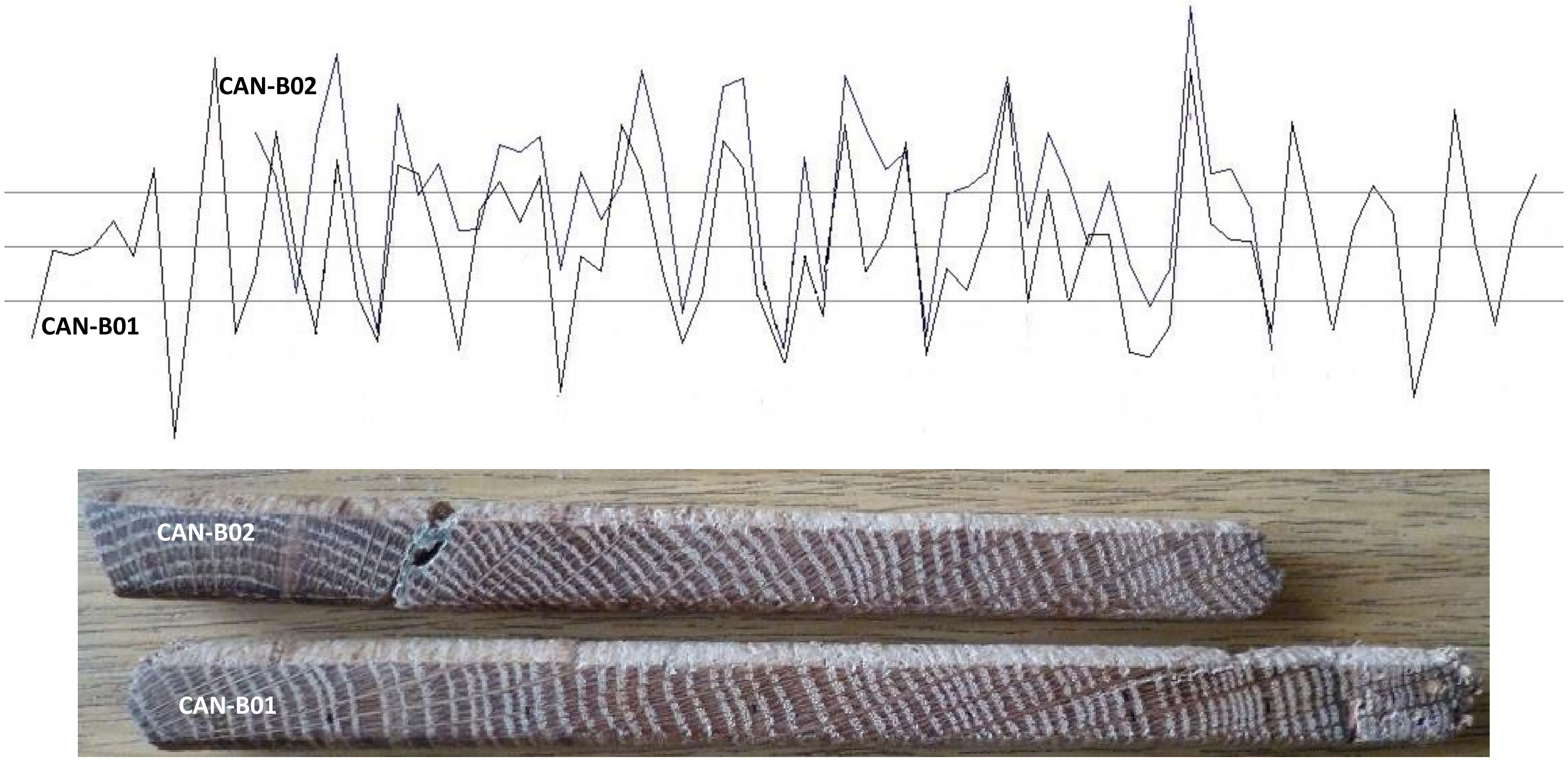
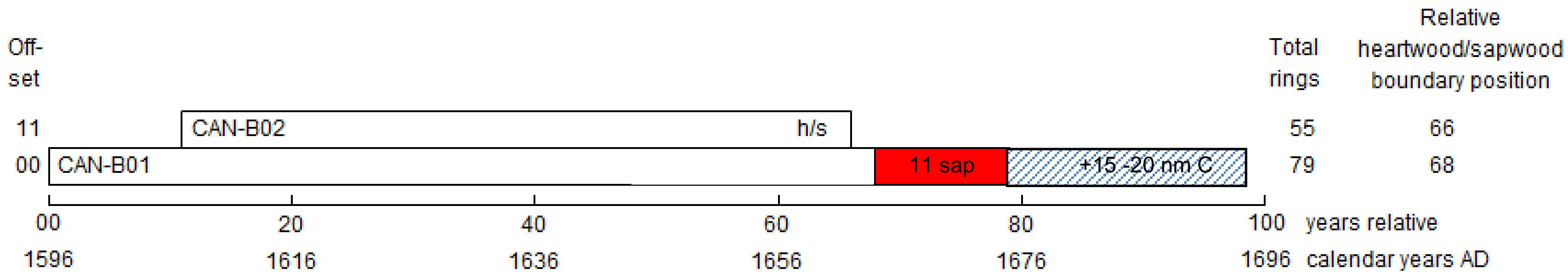


Figure 6: Graphic representation of the cross-matching of two samples, CAN-B01 and B02

When cross-matched at the correct positions, as here, the variations in the rings of these two samples correspond with a high degree of similarity. As the ring widths of one sample increase (represented by peaks in the graph), or decrease (represented by troughs), so too do the annual ring widths of the second sample. This similarity in growth pattern is a result of the two trees represented having grown in the *same area* at the *same time.* The growth ring pattern of two samples from trees grown at different times would never correspond so well.



blank bars = heartwood rings; filled bars = sapwood rings

hatched bars = estimated missing sapwood to bark

h/s = heartwood/sapwood boundary; C = complete sapwood is found on the sampled timber

Figure 7: Bar diagram of the samples in site chronology CANBSQ01

The two samples of site chronology CANBSQ01 are shown here in the form of a bar diagram at positions where the ring variations of the cores cross-match with each other. This similarity is produced by the trees represented sharing both a common period and place of growth (i.e., they grew at the same time and in the same woodland). The samples are combined at these offsets to form a 'site chronology' which is compared with a large database of reference chronologies for all time periods for all parts of England. The site chronology cross-matches only with a date span of 1596 to 1674.

It is estimated that there might approximately be a further 15–20 sapwood rings between the last extant sapwood on sample CAN-B01 (dated 1674) and the bark, which is retained on the timber, but was lost from the sample during coring due to the soft and fragile nature of this part of the wood. Taking the date of the last extant ring on sample CAN-B01, and adding to it the estimated lost number of sapwood rings would suggest that the tree represented was felled, in round terms between, say, 1690–95 (along with, given its cross-match with sample B01, the tree represented by sample CAN-B02). It would thus appear that both trees were felled at the same time towards the very end of the seventeenth century, specifically for their use in the north range roof at Cannington Court.