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The Tree-Ring Dating of Timbers from Newport Parish Church (St Luke's or Old Brick Church), Smithfield, Isle of Wight County, Virginia

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Summary:

ISLE OF WIGHT, Smithfield; St Luke's Church (36° 56' 25"N; -76° 35' 07"W)

Felling dates: **Shortly after 1677**

Lintel over west doorframe 1676(9); Moulded west door head 1672(10); balusters 1633, 1619. *Site Master* 1532-1671 STC (t = 8.03 VBVMTV; 5.88 VA021; 4.93 MTVx1; 4.11 VA023).

Only two oak timbers remained within the structure at St Luke's Church: the moulded door frame head and lintel above the west door. Although neither of the timbers retained bark edge, both had some sapwood, suggesting that very few rings were lost in the conversion. As such, the dates were entirely consistent with the brick inscribed '1682' (now lost). It is also consistent with the 1685 date found inscribed in lead cames found on the site. Two *ex situ* balusters, one in the collection of MESDA at Winston-Salem, and the other reused in the present communion rail, were photographed and the sequences dated. Although neither retained any sapwood, the last measured ring dates of 1619 and 1633 were entirely consistent with the presumed early 1680s construction date. The best match with the site master was with the composite chronology VBVMTV made up three oak chronologies from Virginia Beach and one from Mount Vernon.

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retains stored food and is therefore attractive to insect and fungal attack once the tree is felled and therefore is often removed during conversion.

Methodology: The Dating Process

All timbers sampled were of oak (*Quercus* spp.) from what appeared to be primary first-use timbers, or any timbers which might have been re-used from an early phase. Those timbers which looked most suitable for dendrochronological purposes with complete sapwood or reasonably long ring sequences were selected. *In situ* timbers were sampled through coring, using a 16mm hollow auger. Details and locations of the samples are given in the summary table.

The dry samples were sanded on a linisher, or bench-mounted belt sander, using 60 to 1200 grit abrasive paper, and were cleaned with compressed air to allow the ring boundaries to be clearly distinguished. They were then measured under a x10/x30 microscope using a travelling stage electronically displaying displacement to a precision of 0.01mm. Thus each ring or year is represented by its measurement which is arranged as a series of ring-width indices within a data set, with the earliest ring being placed at the beginning of the series, and the latest or outermost ring concluding the data set.

As indicated above, the principle behind tree-ring dating is a simple one: the seasonal variations in climate-induced growth as reflected in the varying width of a series of measured annual rings is compared with other, previously dated ring sequences to allow precise dates to be ascribed to each ring. When an undated sample or site sequence is compared against a dated sequence, known as a reference chronology, an indication of how *good* the match is must be determined. Although it is almost impossible to define a visual match, computer comparisons can be accurately quantified. Whilst it may not be the best statistical indicator, Student's (a pseudonym for W S Gosset) *t*-value has been widely used amongst British dendrochronologists. The cross-correlation algorithms most commonly used and published are derived from Baillie and Pilcher's CROS programme (Baillie and Pilcher 1973), although a faster version (Munro 1984) giving slightly different *t*-values is sometimes used for indicative purposes.

Generally, *t*-values over 3.5 should be considered to be significant, although in reality it is common to find demonstrably spurious *t*-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, or higher, and for these to be well replicated from different, independent chronologies with local and regional chronologies well represented. Users of dates also need to assess their validity critically. They should not have great faith in a date supported by a handful of *t*-values of 3's with one or two 4's, nor should they be entirely satisfied with a single high match of 5 or 6. Examples of spurious *t*-values in excess of 7 have been noted, so it is essential that matches with reference chronologies be well replicated, and that this is confirmed with visual matches between the two graphs. Matches with *t*-values of 10 or more between individual sequences usually signify having originated from the same parent tree.

In reality, the probability of a particular date being valid is itself a statistical measure depending on the *t*-values. Consideration must also be given to the length of the sequence being dated as well as those of the reference chronologies. A sample with 30 or 40 years growth is likely to match with high *t*-values at varying positions, whereas a sample with 100 consecutive rings is much more likely to match significantly at only one unique position. Samples with ring counts as low as 50 may *occasionally* be dated, but only if the matches are very strong, clear and well replicated, with no other significant matching positions. This is essential for intra-site matching when dealing with such short sequences. Consideration should also be given to evaluating the reference chronology against which the samples have been matched: those with well-replicated components which are geographically near to the sampling site are given more weight than an individual site or sample from the opposite end of the country.

It is general practice to cross-match samples from within the same phase to each other first, combining them into a site master, before comparing with the reference chronologies. This has the advantage of averaging tyloses in the spring vessels (Gerry 1914; Kato and Kishima 1965). Out of some 50 or so samples, only a handful had more than 3 rings of sapwood without tyloses. The actual sapwood band is differentiated sometimes by a lighter colour, although this is often indiscernible (Desch 1948). In archaeological timbers, the lighter coloured sapwood does not collapse as it does in the European oak (*Q robur*), but only the last ring or two without tyloses shrink tangentially. In these circumstances the only way of being able to identify the heartwood/sapwood boundary is by recording how far into the timber wood boring beetle larvae penetrate, as the heartwood is not usually susceptible to attack unless the timber is in poor or damp conditions. Despite all of these drawbacks, some effort has been made in recording sapwood ring counts on white oak, although the effort is acknowledged to be somewhat subjective.

As for red oaks (*Quercus rubra*) it will probably not be possible to determine a sapwood estimate as these are what are known as 'sapwood trees' (Chattaway 1952). Whereas the white oak suffers from an excess of tyloses, these are virtually non-existent in the red oak, even to the pith. Furthermore, there is no obvious colour change throughout the section of the tree, and wood-boring insects will often penetrate right through to the centre of the timber. Therefore, in sampling red oaks, it is vital to retain the final ring beneath the bark, or to make a careful note of the approximate number of rings lost in sampling, if any meaningful interpretation of felling dates is to be made.

Similarly, no study has been made in estimating the number of sapwood rings in tulip-poplar or black ash, or for any of the pines.

Therefore, if the bark edge does not survive on any of the timbers sampled, then only a *terminus post quem* or *felled after* date can be given. The earliest possible felling date would be the year after the last measured ring date, adjusted for any unmeasured rings or rings lost during the process of coring.

Some caution must be used in interpreting solitary precise felling dates. Many instances have been noted where timbers used in the same structural phase have been felled one, two, or more years apart. Whenever possible, a *group* of precise felling dates should be used as a more reliable indication of the *construction period*. It must be emphasised that dendrochronology can only date when a tree has been felled, not when the timber was used to construct the structure under study. However, it is common practice to build timber-framed structures with green or unseasoned timber and that construction usually took place within twelve months of felling (Miles 1997).

Details of Dendrochronological Analysis

The results of the dendrochronological analysis for the building under study are presented in a number of detailed tables. The most useful of these is the summary **Table 1**. This gives most of the salient results of the dendrochronological process, and includes details for each sample, its species, location, and its felling date, if successfully tree-ring dated. This last column is of particular interest to the end user, as it gives the actual year and season when the tree was felled, if bark is present, and an estimated felling date range if the sapwood was complete on the timber but some was lost in coring, or a *terminus post quem*. Often these *terminus post quem* dates begin far earlier than those with precise felling dates. This is simply because far more rings have been lost in the initial conversion of the timber.

It will also be noticed that often the precise felling dates will vary within several years of each other. Unless there is supporting archaeological evidence suggesting different phases, all this would indicate is either stockpiling of timber, or of trees which have been felled or died at varying times but not cut up until the commencement of the particular building operations in question. When presented with varying precise felling dates, one should always take the *latest* date for the structure under study, and it is likely that construction will have been completed for ordinary vernacular buildings within twelve or eighteen months from this latest felling date (Miles 1997).

Summary of Dating

The dendrochronological dating of the remaining *in situ* timbers over the west door at St Luke's Church was requested by Historic St Luke's Restoration Inc. through Carl Lounsbury of the Colonial Williamsburg Foundation. The church had been visited during a recent conference and two potential timbers were assessed. As these timbers were integral to the doorframe and the adjoining brickwork, it was felt that they would give a representative date for the construction of the church. Two timbers in particular had potential – the moulded west door head, and the oak lintel above. The upper part of the latter timber was covered by a board on the inside, and it was possible that behind this board some waney edge might just survive, thus allowing a precise date to be determined. Although no sapwood was immediately evident on the moulded door head, it did appear to be of slow-grown oak, which would help to build up a site master, thus improving the chances of dating the site sequence.

The cover board was carefully removed from the inside face of the lintel by St Luke's Restoration Inc. and it was discovered that the upper part of the lintel had been cut away and replaced by a steel beam. However, a small area of sapwood (not complete to bark edge however) was found to have survived and a short core was taken (**stc1**), which yielded 91 growth rings.

The moulded door head below was also sampled. Due to the moulding, two cores were taken to avoid defacing the decorative face of the door head. This allowed the maximum number of rings to be obtained from the timber. Fortunately this too yielded some sapwood on the outermost core. The two cores (**stc2a** and **stc2b**) were cross-matched together and combined to form the 140-ring mean **stc2**.

These were the only two primary phase timbers that remained *in situ*. However, there was a turned baluster at MEDSA in Old Salem which was reputed to have originated from the original gallery at St Luke's. This was made available and was photographed and a photo mosaic was produced which was then measured and produced the 64-ring sample **stc3**.

A second baluster of similar profile was found reused in the present communion rail at St Luke's and this too was photographed and measured, and produced the 52-ring sample **stc4**.

The four ring sequences were then compared with each other, and the first three timbers were found to match together consistently, and were thus combined to form the 145-year site master **STC**. This was compared with a series of dated reference chronologies from the eastern seaboard of the United States and the best matches were with those from Virginia, including two bald cypress chronologies. The best match was with a chronology made up of a number of local oak chronologies from Virginia Beach and Mount Vernon, all of which appeared to represent the local coastal climate of the Tidewater region of Virginia. This dated the site master to span the years 1532-1676.

The fourth timber, the baluster from the communion rail, was found to match conclusively with the first baluster from MESDA with a t-value of 6.55, and with the site master **STC** with a t-value of 5.60, spanning the years 1568-1619. However, due to the shortness of the sequence, and the distortions inherent in the photographs, it was found to diminish the matches with the reference chronologies and was therefore left out of the site master.

Unfortunately none of the timbers sampled retained bark edge, thus making a precise felling date impossible to determine. However, we were extremely fortunate to have nine and ten rings of sapwood on samples **stc1** and **stc2**. These gave last measured ring dates of 1676 and 1671 respectively for the lintel and the door head below. Whilst there are still some sapwood rings lost due to the conversion and subsequent modifications of the lintel, this is not likely to be very many, probably between 5 and 10 rings, although there are no studies in sapwood numbers in American white oak (*Quercus alba*). This consistency of dates proves conclusively that the two timber elements are coeval, and could not have been felled any earlier than 1677.

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Explanation of terms used in Table 1

The summary table gives most of the salient results of the dendrochronological process. For ease in quickly referring to various types of information, these have all been presented in Table 1. The information includes the following categories:

Sample number: Generally, each site is given a two or three letter identifying prefix code, after which each timber is given an individual number. If a timber is sampled twice, or if two timbers were noted at time of sampling as having clearly originated from the same tree, then they are given suffixes 'a', 'b', etc. Where a core sample has broken, with no clear overlap between segments, these are differentiated by a further suffix '1', '2', etc.

Type shows whether the sample was from a core 'c', or a section or slice from a timber 's'. Sometimes photographs are used 'p', or timbers measured *in situ* with a graticule 'g'.

Species gives the four-letter species code used by the International Tree-Ring Data Bank, at NOAA. These are identified in the key at the bottom of the table.

Timber and position column details each timber sampled along with a location reference. This will usually refer to a bay or truss number, or relate to compass points or to a reference drawing.

Dates AD spanning gives the first and last measured ring dates of the sequence (if dated),

H/S bdry is the date of the heartwood/sapwood transition or boundary (if identifiable).

Sapwood complement gives the number of sapwood rings, if identifiable. The tree starts growing in the spring during which time the earlywood is produced, also known also as spring growth. This consists of between one and three decreasing spring vessels and is noted as *Spring* felling and is indicated by a ¼ C after the number of sapwood ring count. Sometimes this can be more accurately pin-pointed to very early spring when just a few spring vessels are visible. After the spring growing season, the latewood or summer growth commences, and is differentiated from the proceeding spring growth by the dense band of tissue. This summer growth continues until just before the leaves drop, in about October. Trees felled during this period are noted as *summer* felled (½ C), but it is difficult to be too precise, as the width of the latewood can be variable, and it can be difficult to distinguish whether a tree stopped growing in autumn or *winter*. When the summer growth band is clearly complete, then the tree would have been felled during the dormant winter period, as shown by a single C. Sometimes a sample will clearly have complete sapwood, but due either to slight abrasion at the point of coring, or extremely narrow growth rings, it is impossible to determine the season of felling.

Number of rings: The total number of measured rings included in the samples analysed.

Mean ring width: This, simply put, is the sum total of all the individual ring widths, divided by the number of rings, giving an average ring width for the series.

Mean sensitivity: A statistic measuring the mean percentage, or relative, change from each measured yearly ring value to the next; that is, the average relative difference from one ring width to the next, calculated by dividing the absolute value of the differences between each pair of measurements by the average of the paired measurements, then averaging the quotients for all pairs in the tree-ring series (Fritts 1976). Sensitivity is a dendrochronological term referring to the presence of ring-width variability in the radial direction within a tree which indicates the growth response of a particular tree is "sensitive" to variations in climate, as opposed to complacency.

Standard deviation: The mean scatter of a population of numbers from the population mean. The square root of the variance, which is itself the square of the mean scatter of a statistical population of numbers from the population mean. (Fritts 1976).

Felling seasons and dates/date ranges is probably the most important column of the summary table. Here the actual felling dates and seasons are given for each dated sample (if complete sapwood is present). Sometimes it will be noticed that often the precise felling dates will vary within several years of each other. Unless there is supporting archaeological evidence suggesting different phases, all this would indicate is either stockpiling of timber, or of trees which have been felled or died at varying times but not cut up until the commencement of the particular building operations in question. When presented with varying precise felling dates, one should always take the *latest* date for the structure under study, and it is likely that construction will have been completed for ordinary vernacular buildings within twelve or eighteen months from this latest felling date (Miles 1997).

Table 3: Dating of site master STC (1532-1671) against reference chronologies at 1671

County or region:	*Chronology name:*	*Short publication reference:*	*File name:*	*Spanning:*	*Overlap:*	*t-value:*
Virginia	Tidewater Oak Chronology	*(Miles unpubl)*	**VBVMTV**	1535-1674	143	8.03
Virginia	Blackwater River Baldy Cypress	*(Stahle, Cleaveland, & Hehr; World Data Bank)*	VA021	932-1985	145	5.88
Virginia	Spinning House Mt Vernon	*(Miles & Worthington 2005)*	MTVx1	1555-1764	122	5.03
Virginia	Dragon Run Baldy Cypress	*(Stahle, Cleaveland, & Hehr; World Data Bank)*	VA023	1372-1984	145	4.33

Bar diagram showing dated timbers in chronological position

Span of ring sequences