Dendrochronology of St. Cuthbert's coffin.

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Prior to display in the new museum of Durham Cathedral, much time was spent on the reconservation of St. Cuthbert's oak coffin - a process which offered a unique opportunity for other studies in 1978. Dendrochronology is primarily a dating method depending on the measurement and synchronisation of the patterns of wide and narrow annual rings of a tree. By examining successively older wood samples from the present day back in time, each annual ring can be assigned a calender date. In Britain, such absolute chronologies extend back to c. AD800; before that only floating chronologies are available. Indeed, although numerous sequences have been established for Roman times, very little wood has been found from the 5th to 8th centuries. As St. Cuthbert's coffin was known to have been constructed in AD 698, the resulting tree-ring data could be of considerable importance to British dendrochronology.

Apart from being a dating technique - unecessary in this case, since the construction date is already known - tree-ring analysis often provides other information about the use of timber in the past. It may answer questions as to the number of trees involved in a structure, the type of carpentry techniques employed, the age and size of the trees and so on. During the present conservation, there was debate as to whether the coffin was made up of several pieces of wood per board but dendrochronology proved that this was unlikely.

Preparation and measurement of the tree-rings involved several problems. Normally a thin section of wood is removed and sent to the DoE's dendrochronology laboratory at Sheffield to be



measured, after the surfaces have been cleaned with a sharp knife or plane. The coffin obviously could not be moved and it was desirable that the edges should be tampered with as little as possible.

In its long history, the coffin underwent many travels before coming to rest in Durham Cathedral and, after that, was opened and 'conserved' numerous times. Consequently, the boards had disintegrated into over a hundred small pieces (Figures 1 and 2), and were now heavily impregnated with wax. The most recent breaks were chosen for examination and air abrasion equipment was used to clean the end surfaces. This showed up the individual annual rings clearly with minimum damage to the wood. If an old break had to be studied, some of the wax had first to be removed with a scalpel before air abrasion could make any impression. Measurements were made with a hand lens containing a 0.1mm scale, but often the uneven nature of the surface meant that the ring widths had to be estimated. Pieces from all the boards were examined to determine the number of trees involved. Those measured are listed in Table 1 and are denoted by asterisks in Figures 1 and 2.

The timber was very narrow-ringed, which made measurement even more difficult. In many cases, where exceptionally narrow bands occurred, the rings were practically impossible to resolve. By examining many pieces, these potential sources of error could often be avoided. The number of rings in each piece is given in Table 1; it should be noted that it was not always possible to measure the complete section. Normally, over 50 rings are needed for confident dating but when dealing with samples from the same tree, less than 50 can frquently be crossmatched.

The ring widths were plotted on transparent semi-log recorder paper, which enabled them to be compared visually by

sliding one graph over another until the position of best fit was found. The agreement between the pieces of wood was almost perfect and indicated that only one tree was used in the construction of the coffin. The samples fell into two groups (Figures 3 and 4), caused by the breaks in the middle of each board (Figures 1 and 2). An extra effort was made to bridge the break by measuring further pieces of the coffin lid. Unfortunately the main link, Top 7, was difficult to resolve so that it was not possible to overlap the two groups with confidence. The tentative position shown in Figure 3 and Figure 5 was confirmed by comparison of Top 5 and Top 7, but their ring measurements were not reliable enough to join the two: it could easily have introduced an error into the sequence, so rendering it useless for tree-ring work.

Mean curves were constructed for both groups by averaging the widths of the matching ring plots. Not all the pieces studied were used as this would lead to unecessary repetition; for these included see Figures 3 and 4. Mean 1, 107 years long, and Mean 2, 180 years, were compared by computer with existing floating chronologies. The computer program compares two sets of data and calculates the value of Student's t for each position of overlap; anything over 3.5 could be statistically significant (Baillie and Pilcher, 1973), although matches must always be checked visually. The first floating chronology, made up of timbers from the Portchester and Old Windsor excavations and dated to c.AD 500 - 800 (REF 8 in Fletcher, 1977), gave no significant results. The other, a c.800 year long curve from north-eastern Ireland (Hillam and Baillie, unpublished), falls somewhere within the period c.100 BC - AD 800. This gave a t-value of 5.03 with Mean 2 at the end of the sequence, but nothing with Mean 1. The visual match between Ireland and Mean 2 was also very good but since there is no other data to confirm it, the match must remain tentative for the



moment, especially as Mean 1 does not appear to match. The ring widths of both means are given for future reference in Tables 2 and 3.

The oak timber used was of high quality, being slow-grown and straight-grained. This would be necessary to prevent the boards from warping or splitting on drying, after they had been radially split from the trunk. It is obviously not possible to determine the origin of the timber. For such an important function, it is likely that the best quality wood was used even if it meant obtaining it from outside the area.

The tree must have been at least 300-400 years old when felled. The exact age cannot be calculated since the pith is absent and it is not possible to distinguish any sapwood. The latter could be present at the outer edge but the inclusion of wax makes definite identification impossible. Similarly the size of the tree cannot be estimated because of all the breaks and general wear of the last thousand years, but it must have been a fairly large oak.

In conclusion, tree-ring analysis of St. Cuthbert's coffin has produced two mean curves which should eventually extend English tree-ring chronologies back in time and may help in establishing a date for the Irish sequence. When the coffin is firmly dated, more information should be available about the length of the timber's seasoning time before the coffin's construction in AD 698.

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References:

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

Fletcher J.M. 1977, Tree-ring chronologies for the 6th to 16th centuries of Southern and Eastern England. Journal of Archaeological Science 4 335-352.

| Board | Piece | Rings |
|---|---|---|
| 5 Archangels | 2 | 101 |
| | 3 | 33 |
| | 13 | 34 |
| | 18 | 28 |
| | 22 | 44 |
| | 28 | 99 |
| | 30 | 65 |
| | 32 | 84 |
| | 56 | 52 |
| | 69 | 49 |
| 2 Apostles | 8 | 53 |
| | 16 | 49 |
| 12 Apostles | 14 | 67 |
| | 16 | 91+ |
| | 18 | 81 |
| | 20 | 61 |

| Board | Piece | Rings |
|---|---|---|
| Top | 4 | 83 |
| | 5 | 69 |
| | 6 | 47 |
| | 7 | 80? |
| | 8 | 55+ |
| | 12 | 65 |
| | 19 | 88 |
| | 20 | 36 |
| Virgin/Child | 6 | 36 |
| | 12 | 45 |
| | 13 | 114 |

Table 1: List of pieces measured from each board. The number of rings measured is given; this is not always the complete section.

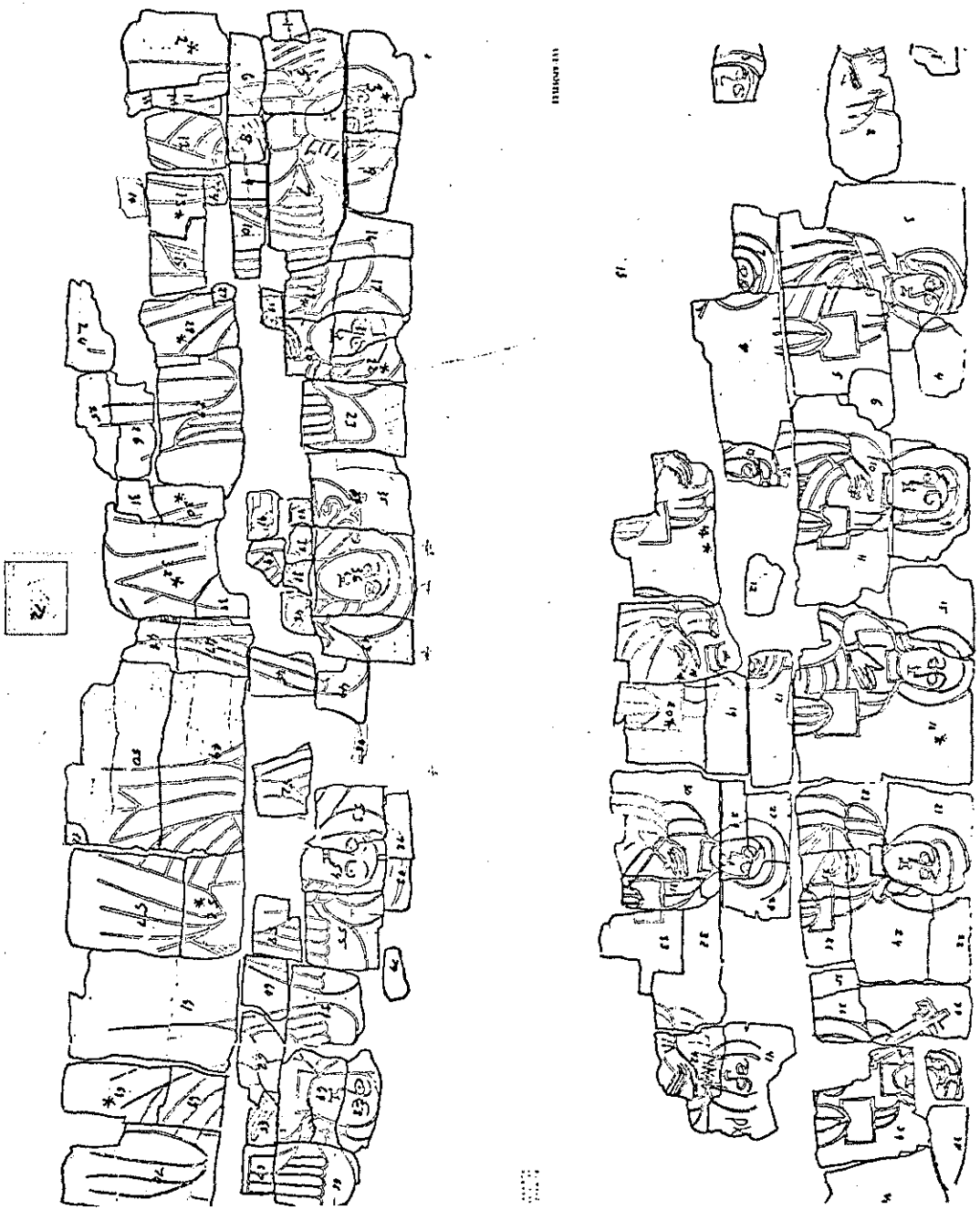

Figure 1: Plan of the pieces of oak timber making up the coffin sides. Left - 5 Archangels. Right - 12 Apostles. Samples measured are indicated by asterisks.

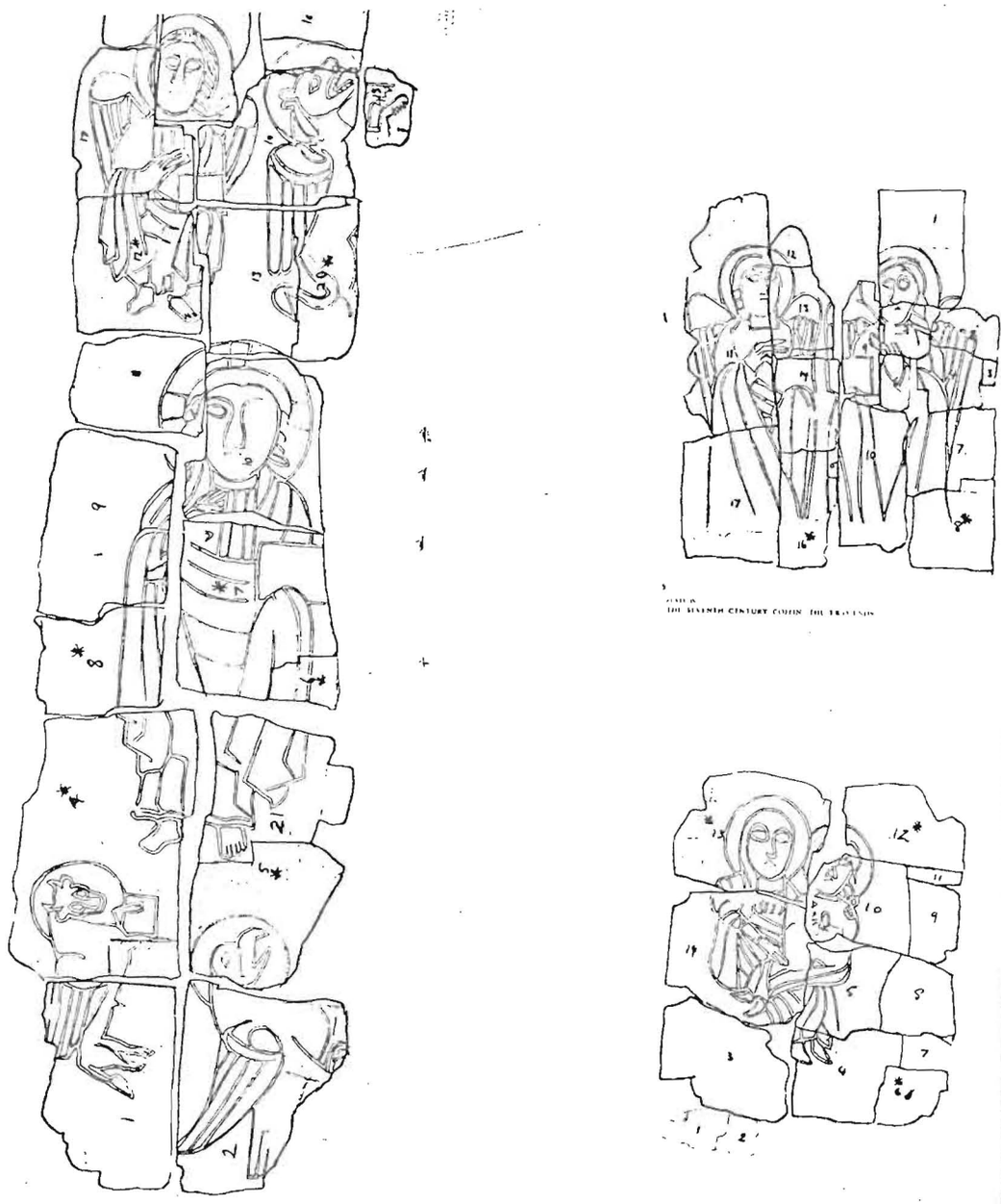

Figure 2: Plan of the coffin lid (Top) and the two ends: 2 Apostles (above) and Virgin and Child (below). Asterisks show the pieces measured.

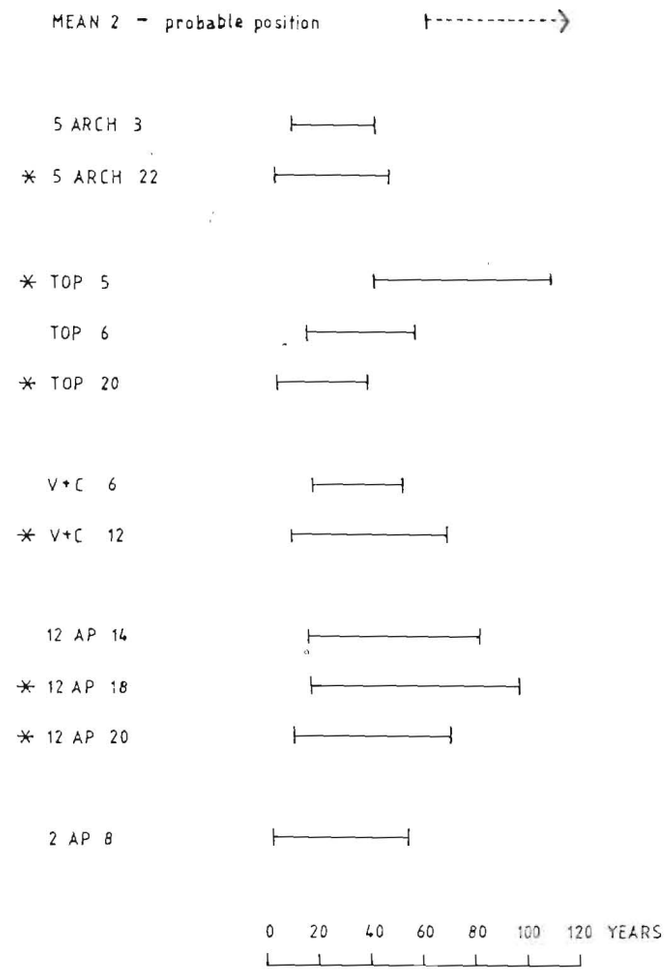


Figure 3: Block diagram showing the relative positions of the Mean 1 group. Samples actually included in the mean are marked by asterisks. The position of Mean 2 is indicated by the dotted line.

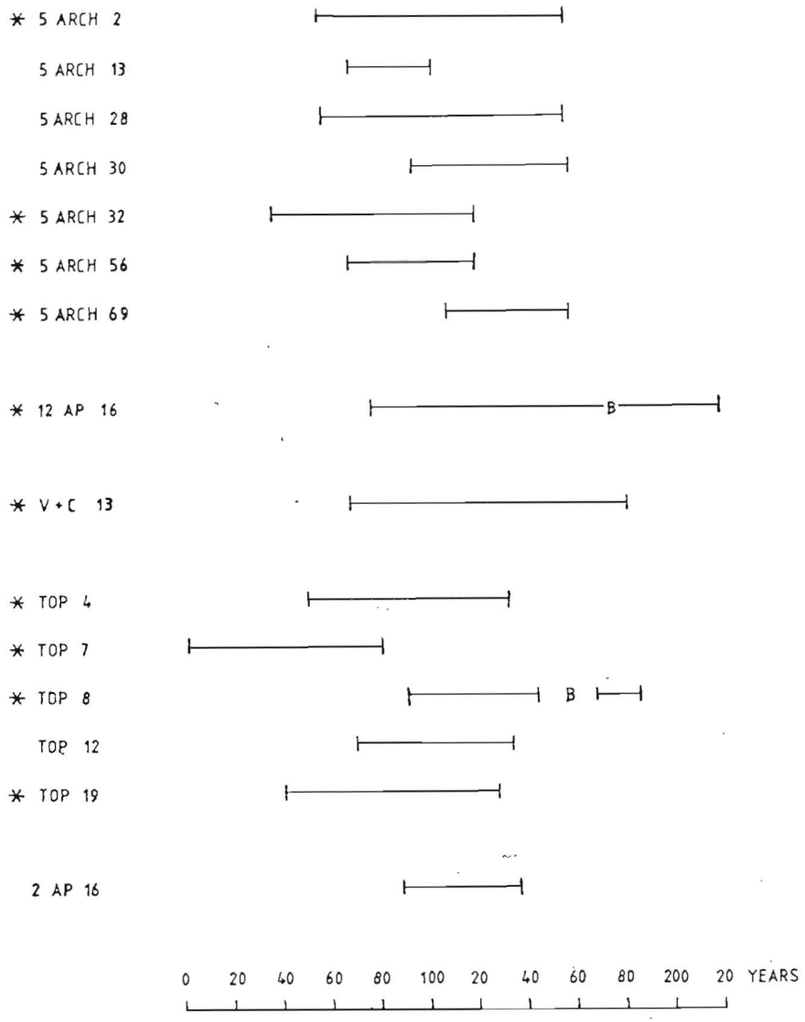


Figure 4: Block diagram of the Mean 2 group; those included in the mean are shown by asterisks. 'B' - breaks in the ring record due to indistinct rings.

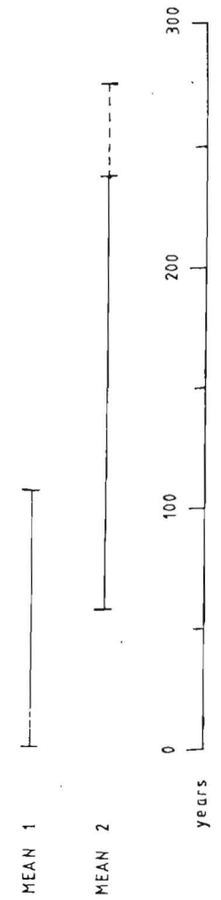


Figure 5: Relative positions of the two mean cuves. t-value is only 2.87, due to possible errors in the measurements of Top 5 and Top 7. Broken line represents the extension of 12 Apostles 16, which is not included in the mean because of the incomplete ring record of that sample (see Figure 4).

St. Cuthbert - Mean 1 — 107 years; 6 samples; 1 tree.

| years | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 15 | 20 | 16 | 34 | 26 | 18 | 18 | 21 | 18 |
| 10 | 24 | 16 | 7 | 12 | 16 | 18 | 17 | 19 | 20 | 22 |
| 20 | 17 | 16 | 9 | 11 | 15 | 15 | 12 | 19 | 18 | 19 |
| 30 | 17 | 22 | 17 | 16 | 17 | 14 | 14 | 15 | 15 | 8 |
| 40 | 7 | 13 | 14 | 18 | 20 | 25 | 20 | 16 | 13 | 16 |
| 50 | 12 | 14 | 17 | 15 | 22 | 18 | 20 | 19 | 21 | 29 |
| 60 | 22 | 23 | 19 | 21 | 17 | 17 | 16 | 18 | 21 | 15 |
| 70 | 22 | 16 | 16 | 16 | 20 | 17 | 20 | 17 | 19 | 22 |
| 80 | 21 | 23 | 17 | 19 | 15 | 14 | 20 | 20 | 19 | 14 |
| 90 | 17 | 12 | 15 | 13 | 12 | 11 | 13 | 14 | 13 | 15 |
| 100 | 12 | 14 | 6? | 8? | 13 | 11 | 14 | 16 | | |

Table 2: Ring widths of Mean 1. Values are approximately 0.1mm, due to estimation, rather than measurement, of some samples. ? - possible error in Top 5.

St. Cuthbert - Mean 2 — 180 years; 10 samples; 1 tree.

| years | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | 27 | 23 | 18 | 21 | 24 | 25 | 24 | 22 | 22 |
| 10 | 15 | 14 | 16 | 14 | 16 | 17 | 19 | 15 | 15 | 16 |
| 20 | 19 | 20 | 13 | 15 | 14 | 16 | 12 | 13 | 14 | 18 |
| 30 | 13 | 11 | 13 | 11 | 12 | 11 | 10 | 11 | 15 | 18 |
| 40 | 13 | 14 | 14 | 12 | 11 | 8 | 10 | 7 | 10 | 9 |
| 50 | 11 | 13 | 11 | 12 | 15 | 20 | 23 | 11 | 13 | 19 |
| 60 | 16 | 8 | 7 | 9 | 7 | 8 | 11 | 9 | 12 | 10 |
| 70 | 13 | 11 | 11 | 9 | 12 | 13 | 13 | 13 | 14 | 15 |
| 80 | 14 | 6 | 8 | 8 | 9 | 10 | 9 | 11 | 10 | 11 |
| 90 | 13 | 13 | 12 | 12 | 18 | 14 | 12 | 14 | 14 | 15 |
| 100 | 17 | 14 | 10 | 13 | 14 | 8 | 9 | 7 | 7 | 8 |
| 110 | 8 | 8 | 11 | 9 | 6 | 8 | 9 | 9 | 11 | 12 |
| 120 | 13 | 12 | 10 | 13 | 13 | 13 | 12 | 11 | 10 | 8 |
| 130 | 10 | 13 | 13 | 11 | 12 | 13 | 10 | 13 | 13 | 11 |
| 140 | 14 | 15 | 13 | 14 | 13 | 13 | 11 | 12 | 11 | 13 |
| 150 | 12 | 12 | 11 | 12 | 12 | 11 | 10 | 7 | 8 | 11 |
| 160 | 12 | 12 | 10 | 12 | 16 | 11 | 14 | 12 | 8 | 12 |
| 170 | 15 | 16 | 11? | 9 | 13 | 16 | 13 | 11 | 14 | 16 |
| 180 | 15 | | | | | | | | | |

Table 3: Ring widths of Mean 2. Values are approximately 0.1mm, due to estimation, rather than measurement, of some samples. ? - possible error. The first few years (Top 7) could also contain errors.