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TREE-RING ANALYSIS OF ROMAN WOOD SAMPLES FROM GLOUCESTER (Eastgate)

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Dendrochronological analysis of five cross-sections of wooden piles from below the Period 5 city wall of Gloucester (wall 12, trench IV) was undertaken in 1975. It provided an 85 year tree-ring chronology for use in absolute and relative dating, as well as details of Roman woodworking techniques.

All five piles were of oak (Quercus sp.), a ring-porous wood species in which lines of very large vessels are formed each spring separated by a summer zone of dense cells. They also had sapwood still identifiable along part of their outer surface (see Table 1); this is the outermost zone of the tree which is paler in colour and shows unblocked vessels. It is usually between 20 and 40 rings wide depending on the tree's age. One sample (W102) also had bark preserved at one point, indicating that the outermost annual ring represents the year of felling of the tree. The stage of growth of this ring also shows that the tree was cut down in winter.

The wood sections had been kept wet and were deep-frozen for 24 hours, which consolidated the soft wood sufficiently to cut the transverse surface with a sharp knife. This process revealed the method by which the piles had been converted from the tree trunk. W102-6 were split to represent somewhat less than one quarter of the trunk, and used with little further working. W101 consisted of the entire oak stem with one edge hewn away.

The ring-widths were then measured to the nearest 0.1mm, using a x10 lens containing a scale. The timbers showed a high degree of sensitivity with ring-widths varying from 0.5 to 3mm and above (evident in mean curve, Fig. 1). The very narrow rings often proved difficult to determine, owing to the condition of the wood and wide scattering of the spring vessels. However, after several radii had been measured and cross-checked, ring-sequences of 32-79 years were obtained, which included 8-25 sapwood rings. Radii varied from 7 to 19cm. The figures suggest an origin in trees around 80-100 years old and about 50cm in diameter.

Each ring-width value was then plotted on special semi-logarithmic recorder paper; the curves can be overlaid and moved along for visual comparison. An additional aid was the Hamburg computer program (see Morgan, 1975 for more details) which gives a % correlation value for the positions of good match between two curves. (This program has now largely been replaced in Britain by one written in Belfast - see Hillam below.)

Comparisons showed that piles W103, W104 and W106 probably originated in the same tree, as their growth patterns were almost identical. Also the year of transition from heartwood to sapwood corresponded closely in each sample (Fig. 2). Computer values for the three curves lay between 68.4% and 70.8% (at confidence limits of 99.9%). Ring-width values for the individual curves are given in the Appendix. The annual values were averaged to give an 85 year mean curve, which can then be used for absolute dating. Since W103 has the average of 25 sapwood rings and probably extends to the bark edge, relative year 85 of the mean curve probably represents the year of felling; very shortly after this, the piles would have been put to use.

The ring sequences from samples W101 and W102 could not

be fitted satisfactorily into the same pattern.

Thus one or more trees had been split into four or even six to provide the piles which supported the city wall at this point. There was no need to remove the less durable sapwood or even bark for this purpose. Similar techniques have also been noted in tree-ring analysis of well timbers from Scole in Norfolk which dated to the 2nd century; the four uprights of the well had originated in the same tree and also had sapwood remaining (Morgan in Rogerson, 1977 p.216).

The sensitivity of the growth pattern of the Gloucester timbers seems to indicate that the oaks had grown in a situation of stress, where one factor or another of the climate or environment was limiting to growth. The recurring zones of narrow rings would lead to a reduction of strength compared to the often selected wide-ringed timber.

The 4th century AD is proving one of the most difficult periods to span by accurate records of tree growth, and forms the only weak link in the reference curve extending back to 724 BC for the Rhine area of Germany (Hollstein, 1980). It may be some time before exact dating of late Roman timbers is possible in Britain; if the Gloucester timbers can be dated in the future, the actual year in which they were felled can be ascertained because of the presence of the entire sapwood.

Meanwhile, the archaeological and tree-ring evidence is supported by a C14 date, based on selected annual rings; as a result, the date has a known relationship with the actual felling date of the timber. The wood for the C14 sample was cut from rings 60 to 85 of piles W103 and W104, and thus covers the entire sapwood zone. The result is a date of AD 350 $\pm$ 80 (HAR 1339), which should lie close to the date of insertion of the piles.

References:

Hollstein, E. 1980 Mitteleuropäische Eichenchronologie

Morgan, R.A. 1975 The selection and sampling of timber from archaeological sites for identification and tree-ring analysis Journal of Archaeological Science 2 221-230

Rogerson, A. 1977 Excavations at Scole, 1973 East Anglian Archaeology report 5 97-224

GLOUCESTER 46/74
W102
50
35 16 20 30 13 24 20 25 12 20 34 37 15 18 13 14 19 18 17 8 5 6 17 22 16
17 34 24 24 27 14 23 34 32 15 32 20 20 12 9 25 13 26 17 16 17 15 13 21 15
20 13 11 14 13 7 9 15 25
GLOUCESTER
W103
79
34 25 58 50 18 28 32 40 49 33 33 19 29 18 13 20 13 25 32 20 25 38 22 28 24
12 26 15 45 34 32 21 24 25 16 18 19 15 13 10 12 19 26 27 26 20 13 12 12 11
19 24 18 17 19 12 15 11 9 7 6 13 8 10 11 14 9 11 9 11 8 11 9 8 7
7 6 7 9
GLOUCESTER
W104
69
35 60 41 39 38 57 57 18 24 45 53 49 42 25 14 28 21 15 23 12 18 40 24 28 34
30 36 34 14 30 10 17 25 44 42 23 21 21 18 19 10 8 8 8 7 15 23 20 20 13
9 7 7 10 16 15 10 12 10 6 11 12 9 14 10 15 13 14 11
GLOUCESTER
W106
78
29 28 24 45 49 40 40 39 62 60 30 31 50 52 41 31 30 19 30 22 14 22 9 25 32
15 16 33 22 28 23 18 19 9 12 34 35 32 18 19 13 15 7 7 9 11 11 9 17 23
18 23 25 15 13 12 10 7 14 17 15 11 15 9 10 8 7 11 7 9 7 10 7 6 8
8 9 11