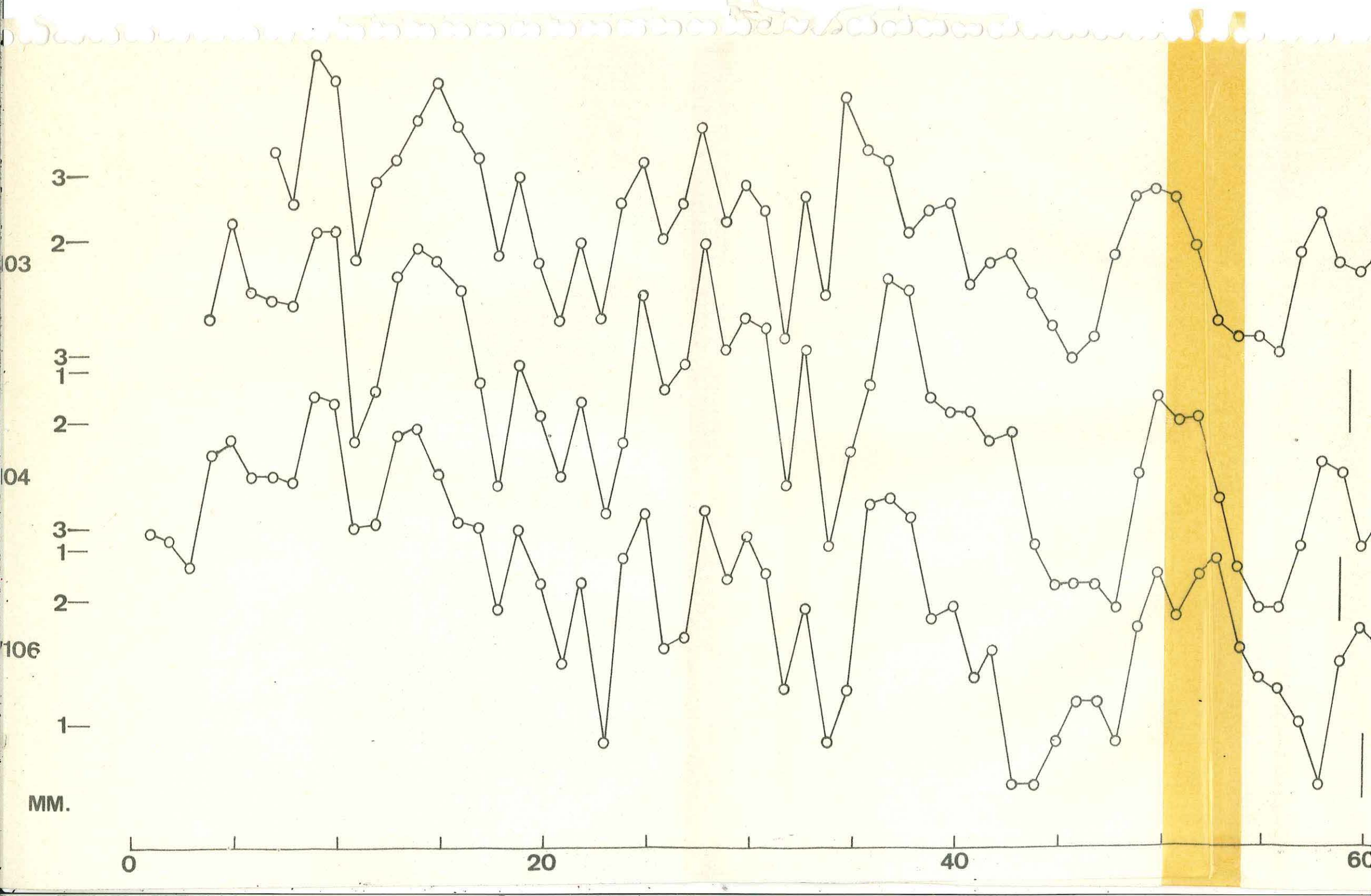

3
2
03
3
1
2
04
3
1
2
106
1
MM.
0
20
40
60

Tree-ring analysis of Roman wood samples from Gloucester.

Analysis of five cross-sections of wooden piles from below the city wall of Gloucester (wall 12, trench IV) provided interesting results on Roman timber-working techniques which have been noted from other sites, as well as an 85 year tree-ring sequence to be used for relative and absolute dating.

Each wood section was deep-frozen still in its waterlogged condition for about 24 hours, and, while still frozen, one or two edges (radii) were cut with a sharp knife to give a clean surface showing each annual ring boundary. The ring-widths were then measured to the nearest 0.1mm. and plotted on semi-logarithmic paper; correlation was carried out both visually and using the Hamburg computer program.

All five piles were of oak (Quercus sp.), a ring-porous species in which lines of large vessels visible to the naked eye are formed each spring and are separated by dense cells formed in summer. All had some sapwood remaining; sapwood is the outermost 5cm. or 25 rings of the tree which is paler in colour and softer than the heartwood. One sample (W102) also had bark preserved at one point, which indicates that the outermost annual ring represents the year of felling. The stage of growth also shows that the timber was felled in winter or early spring.

Four of the samples had been cut to represent somewhat less than one quarter of the trunk - probably the trunk was split into quarters along the rays and then hewn down to shape, removing some of the sapwood at the same time, leaving a timber with a rectangular or triangular cross-section. The fifth (W101) represented the entire stem of a small oak with one edge hewn away.

The condition of the wood was not good; ring-widths varied

considerably and narrow rings were occasionally difficult to define owing to cracks and distortions of the surface; scattering of the vessels in the very narrow rings made identification and measurement difficult. Also the sapwood, being softer than the heartwood, had become crushed to some extent. However, after repeated measurements and correlations, the timbers provided ring sequences of between 32 and 79 years with from 8 to 25 sapwood rings (Table 1). Radii varied from 7 to 19cm. All except the stem (W101) were extremely sensitive (i.e. the ring-widths varied considerably from year to year), with ring-widths varying from 0.5 to 3mm. and above (Fig.1).

Visual and computer correlation showed that samples W103, W104 and W106 originated in the same tree, as the patterns of their ring widths proved to be almost identical, as did the position of the heartwood-sapwood boundaries (Fig. 1). Computer values for the three curves gave levels of similarity of between 68.4% and 70.8% (Table 3). Each annual value for the three sequences could thus be averaged into a mean curve of 85 years with 25 sapwood rings, the values for which are listed in Table 2. Sample W103, whose final ring forms the last of the mean curve, probably has the bark edge remaining, shown by the complete preservation of the outermost annual ring, and since 25 years is the average sapwood width of oak, ring 85 of the mean curve probably represents the year of felling of the tree.

The ring sequences of 32 and 59 years of samples W101 and W102 respectively could not be fitted satisfactorily into the same growth pattern.

Thus the results show that trees aged perhaps between 100 and 150 years and probably 50 to 60cm. in diameter had been felled and split into four or more to provide piles to support

the city wall. No concern was apparently felt over leaving the less durable sapwood on the timbers. Such a technique has been demonstrated before for the Roman period; for example, it was proved on well timbers from Scole in Norfolk that the four uprights of the well had originated in the same tree and also had sapwood remaining.

The sensitivity of the growth pattern of the Gloucester timbers seems to indicate that the oaks had grown in a situation in which one factor of the climate or environment was limiting to growth; such wide fluctuations in increment are due to equally variable changes in perhaps rainfall or temperature, or to the effects of management, defoliation or seed production. The timber would be less durable than that usually selected by the Romans with consistently wide rings, since the recurring bands of very narrow rings would form points of weakness in the absence of dense summerwood.

A radiocarbon sample was removed from two of the timbers, W103 and W104; it consisted of the entire sapwood of the two samples and thus covers annual rings 60 to 85. The date should therefore fall shortly before the actual felling date of the timber.

The piles are thought to date by their context to the fourth century A.D. Two other more or less contemporary sets of material were available to which the mean curve was compared by computer and visually. One is a mean curve of 94 years (with 15 sapwood rings) from Lynch Farm near Peterborough, dating to about 300 A.D. and the other a 258 year individual curve (i.e. one sample only) from a well at Portchester (work still in progress by J.M. Fletcher) dating to the fifth century A.D. A certain amount of agreement was found between the three curves,

which must be treated with caution in view of the wide geographical distribution and the lack of a large quantity of corroborative material.

Lynch Farm and Gloucester gave a similarity value of 65.5% with Gloucester ending some 20 years after Lynch Farm, thus giving it a possible date of about 320 A.D., and the comparison of Lynch Farm with Portchester gave a value of 64.5%, the former ending some 170 years before the latter (with no sapwood) which fits quite well with the archaeological dating. The corresponding position for Gloucester was also listed in the print-out at 61.3%. Assuming the Lynch Farm curve to date to 300 A.D., therefore, the Gloucester timbers would have been felled in about 320 A.D. and Portchester just prior to 500 A.D. (with sapwood addition). Such dating must, however, await the results of the radiocarbon analysis and also tree-ring analyses still in progress for this period.

Ruth A. Morgan

University of Sheffield

May, 1975

Legends to tables and figures.

Table 1 Summary of the data relevant to the timbers from Gloucester.

Table 2 The mean annual values for the 85 year curve from samples W103, W104 and W106.

Table 3 Levels of similarity and overlap lengths for the correlation of the three curves involved in the mean curve. All are at 99.9% levels of probability.

Fig. 1 The growth curves of the three matched samples, W103, W104 and W106; each circle represents the ring width value, and the vertical lines around year 60 indicate the heartwood-sapwood boundary. The ordinate is a logarithmic scale in millimetres, the abscissa years. The close correspondance between the three curves is very clear.

Gloucester Roman timbers - description.

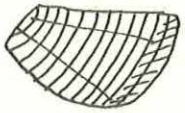
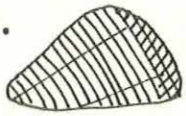
No.	No. of rings	No. of sapwood rings	Dimensions	Sketch	Description
W101	32	8	14x9cm. rad. 7cm.		Not very sensitive, rings 1-3mm. wide.
W102	59	19	12.5x12.5cm		Very sensitive, rings 0.5 -3mm. Bark.
W103	79	25	15x15cm.		Very sensitive, rings 1-3mm. Bark edge?
W104	69	13	17.5x13cm.		Sensitive, rings 1-3mm., not as clear, sap crushed.
W106	78	18	19x18cm.		Very sensitive, rings 1-3cm. wide.

Table 1

Gloucester Roman timbers - mean annual values for the tree-ring curve involving three samples, 0.1mm.

	1	2	3	4	5	6	7	8	9	10
1	29.0	28.0	24.0	40.0	54.5	40.5	37.3	34.0	59.0	55.6
11	22.0	27.6	42.3	48.3	46.3	37.0	29.3	17.3	29.0	20.3
21	14.0	21.6	11.3	22.6	34.6	19.6	23.0	41.6	24.6	30.6
31	27.0	12.6	25.0	11.3	24.6	31.0	37.0	31.6	21.6	21.6
41	16.6	17.0	15.0	10.6	10.0	9.6	10.3	11.6	19.3	24.3
51	21.3	21.0	17.0	12.0	10.6	10.0	13.0	15.6	15.6	14.6
61	15.3	11.0	13.0	10.3	10.3	8.0	9.0	11.3	10.0	10.6
71	10.6	11.6	8.0	8.5	8.5	9.5	8.5	11.0	9.0	8.0
81	7.0	7.0	6.0	7.0	9.0					

Table 2

Computer values of the levels of similarity between the three correlated samples, with overlap length below.

	W103	W104	W106
W103	-		
W104	70.8% 65	-	
W106	69.7% 71	68.4% 68	-

Table 3