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AUTHOR Jennifer Hillam May 1982

TITLE Tree-ring analysis of three Roman
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TREE-RING ANALYSIS OF THREE ROMAN TIMBERS FROM GLOUCESTER (Eastgate)

by Jennifer Hillam, May 1982.

Sample 308 (46/74)

Sample 308 was examined in 1982 following work in 1975 by Ruth Morgan on timbers from Roman Gloucester (Morgan, 1975). The 1975 samples were cross-sections of oak piles from the Period 5 city wall (wall 12, trench IV). Morgan crossdated the ring sequences from three of these timbers (W103, W104, W106 - see Table 1) to produce a floating tree-ring chronology of 85 years. The outer rings (years 60-85 - see Fig.2) were dated by C14 to ad 350 \pm 80 (HAR-1339) but absolute dating was prohibited because of the lack of dated reference chronologies for that period.

Sample 308 was a section from an oak pile under one of the late Roman external artillery towers. Absolute dating is still a remote possibility since dated British chronologies extend back only as far as AD 404 (Hillam, 1981). Earlier Roman sequences have been dated by comparison with dated German chronologies but these cover the period 252BC - AD209 (Hillam & Morgan, 1981a). Fourth century timbers such as Morgan's Gloucester samples or those from the late 4th century riverside wall in London (Hillam & Morgan, 1979) are still undated. The aim of the 1982 study therefore was to determine the temporal relationship between the 1982

and the 1975 ring sequences since this would reveal whether the late Roman towers are contemporary with or later than the latest city wall.

Method

The sample was deep-frozen for 48 hours. The cross-section was then prepared by surfacing it, whilst still frozen, with a Surform plane. The annual growth rings, now clearly visible, were measured using the Sheffield tree-ring measuring apparatus. This consists of a travelling stage which is connected by a linear transducer to a display panel. The sample on the stage is observed through a low-power binocular microscope and, as each ring is traversed, the width in 0.1mm is displayed on the panel. The widths are recorded manually and then represented graphically by plotting them against time, in years, on transparent semi-logarithmic recorder paper. The transparent paper allows the graphs, known as tree-ring curves, to be compared visually by sliding one over and past another. A tree-ring match occurs when two curves are found to be synchronous. The use of the logarithmic scale for the ring widths aids the process of visual matching by exaggerating the narrower rings, although the ring widths of master chronologies are sometimes converted to index values (as in Fig.3). (Further details of tree-ring dating are given in Baillie, 1982, or Hillam, 1979.)

Results

. 308 had 46 heartwood rings (the widths are listed in the Appendix) but none of the outer sapwood rings were preserved. The presence of sapwood is important

when interpreting tree-ring results since it indicates that very little wood was removed during the timber's conversion to a post or plank etc.. It also enables fairly accurate felling dates to be estimated as the number of sapwood rings in oak is relatively constant at 20-40 rings (for further discussion see Baillie, 1982, pp53-60; Hillam, 1979; Hughes et al, 1981). It is possible that the sapwood on 308 was lost after excavation. Several piles were sampled, although only 308 was kept for tree-ring analysis, and all appeared to be untrimmed trunks or quarter-trunks driven into the ground (C. Heighway, pers.comm.). This compares with the city wall samples (Table 1), all of which retained some, if not all, of their sapwood rings.

The 308 ring sequence was compared visually with those from the city wall timbers and was found to be almost identical to W103, W104 and W106. The match is shown in Fig.1 where 308 is compared with Morgan's Gloucester mean curve (made up from those three sequences). 308 covers years 5-50 on the arbitrary scale.

The 1975 and 1982 data were compared together statistically using the Belfast computer program (Baillie & Pilcher, 1973). This provides an objective measure of correlation between two tree-ring sequences by calculating the value of Student's t for each position of overlap. Any value greater than 3.5 indicates a match, provided that it is accompanied by an acceptable visual match. The agreement between 308 and the Gloucester mean curve is $t = 7.62$ whilst the results for comparisons between the individual sequences vary from 4.52 to 6.91 (Table 2). The agreement values between 308 and the city wall sequences are as high as those

within the city wall sequences. Morgan suggested that W103, W104 and W106 were timbers cut from the one tree. The 1982 results therefore indicate that 308 must have come, if not from the same tree, at least from the same woodland source.

The relative positions of the matching ring sequences are shown in Fig.2. W103 appeared to have its full complement of sapwood rings so the felling date of the city wall timbers is winter or early spring of year 85/86 on the arbitrary scale (Morgan, 1975). The season of felling is indicated by the outermost ring: in this case it was fully formed, whereas if the tree had been felled in summer it would have been incomplete. The high agreement between the ring sequences and the possibility that the 308 sapwood was lost after excavation point to the likelihood of a contemporary felling date for 308 and the city wall timbers. As the seasoning of timber seems to be a fairly recent introduction, except for wood intended for panelling or furniture (see, for example, Hollstein, 1965), construction would probably follow almost immediately after felling. Thus tree-ring analysis indicates that the Period 5 city wall and the external artillery tower are probably contemporary, and that they were constructed in c. year 86 on the arbitrary scale.

The Gloucester ring sequences were compared with the 4th century curves from London (see above), but no reliable crossdating could be found. Nor did the Gloucester curves appear to match with dated German chronologies (Becker, 1981; Hollstein, 1980). As more late Roman timbers are examined, absolute dating should become possible. In the meantime the present study illustrates the use of tree-

ring analysis to provide valuable relative dating.

Sample 305 (46/74)

The sample, which was removed from the end of an oak timber in a watch-tower of the Gloucester fortress, was thought to date to some time in the late 60's AD. The purpose of the tree-ring analysis in this case was twofold: first, to attempt to give a more accurate date and second, to add more data to the Roman chronologies which are being constructed at Sheffield (Hillam & Morgan, 1981a). At present almost all the Roman timbers dated dendrochronologically have come from excavations in the City of London, particularly from the Thames waterfront sites (Hillam & Morgan, 1981b). 305 offered a chance to test the usefulness of the London chronologies for dating timbers from other areas of England.

The timber was prepared and measured as described above. It had 75 heartwood rings (see Appendix for list of ring widths) but again none of the sapwood rings were present (Table 1).

The 75-year ring sequence was compared visually with the Roman London master chronology (159BC - AD171: Hillam, unpubl.). There was a high correlation between the two curves when 305 was assigned the calendar years 32BC - AD43 (Fig.3). This agreement gave a t-value of 6.92. The dating was checked by comparing 305 with a second London chronology made up from timbers excavated by Gustav Milne at Peninsular House. 305 was again found

to match over the period 32BC - AD43.

305 contained no sapwood so the felling year can only be given as a terminus post quem. Although the number of sapwood rings in oak is relatively constant (Baillie's estimate of 32 ± 9 rings is used here), the amount of heartwood removed during conversion of the timber, if any, cannot be calculated. 305 must therefore have been felled some time after c. AD66.

The study shows that, although tree-ring dating cannot in this case improve on the accuracy of the archaeological dating, the Roman London reference chronologies currently being constructed at Sheffield can be used to date individual timbers from other parts of the country.

Sample 10 (1/74)

The archaeological dating of this sample was extremely vague. The timber was apparently included by accident in the foundations of the Roman stone North gate. The sample was examined in the hope that it might provide information about the dating of the North gate.

The timber had 65 annual rings (Table 1; widths are given in the Appendix). The ring pattern was compared, both visually and with the aid of the computer, with other Roman tree-ring sequences. No convincing match was found with any of the Gloucester sequences or with the London chronologies.

Acknowledgements

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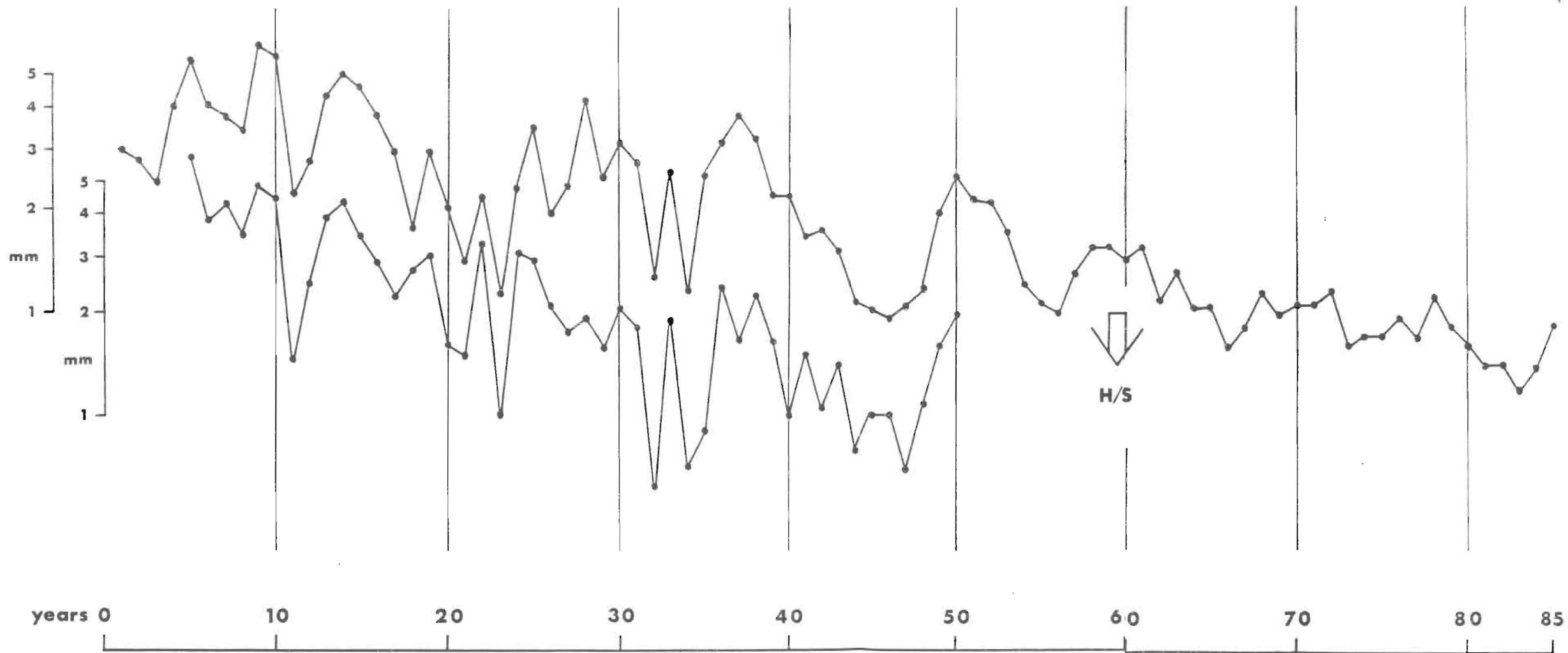
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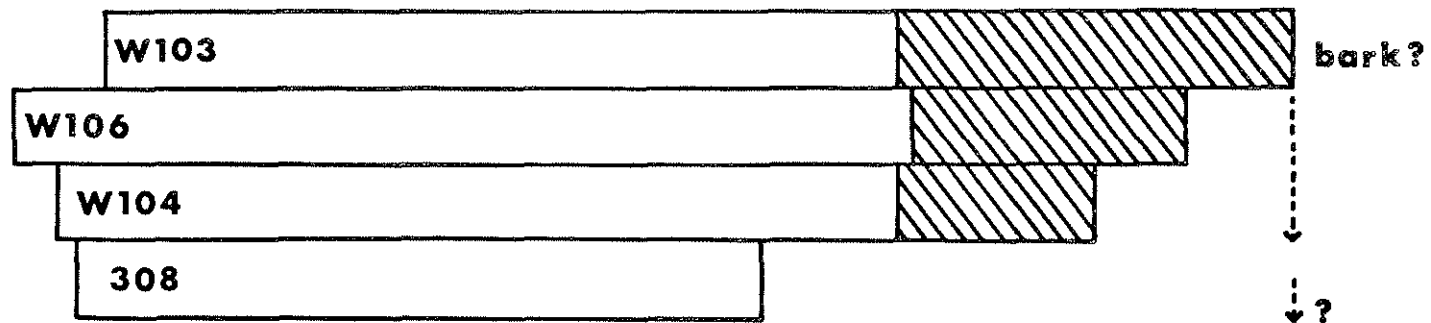
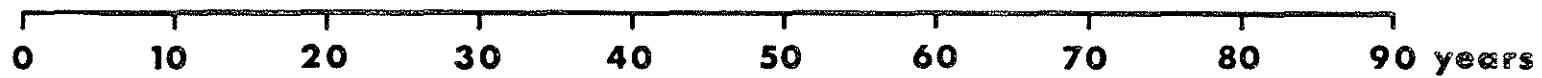
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CAPTIONS TO FIGURES AND TABLES

- Fig.1 Tree-ring match between 308 (bottom) and Morgan's Gloucester mean curve (top). H/S - heartwood/sapwood boundary; the scale in years is an arbitrary one.
- Fig.2 Bar diagram showing the years spanned by the city wall ring sequences (W103, W104, W106) and that from the external tower (308). Sapwood rings are represented by hatching, and the probable felling year by arrows.
- Fig.3 Tree-ring match between 305 (top) and the corresponding section of the Roman London chronology (bottom). The ring widths of the London mean curve are represented by indices which vary around a mean of 100 whereas the vertical scale of 305 is logarithmic. The horizontal scale is in calendar years.
- Table 1 Details of the Gloucester Roman timbers; sketches are not drawn to scale. Analysis of the 1975 samples was carried out by Ruth Morgan.
- Table 2 Summary of t -values; figures in brackets indicate the length of overlap, in years, between each pair of ring sequences.
- Appendix Tree-ring data from the 1982 samples: listing of the ring widths.

Fig. 1





HAR-1339
a.d. 350 ± 80

Fig. 2

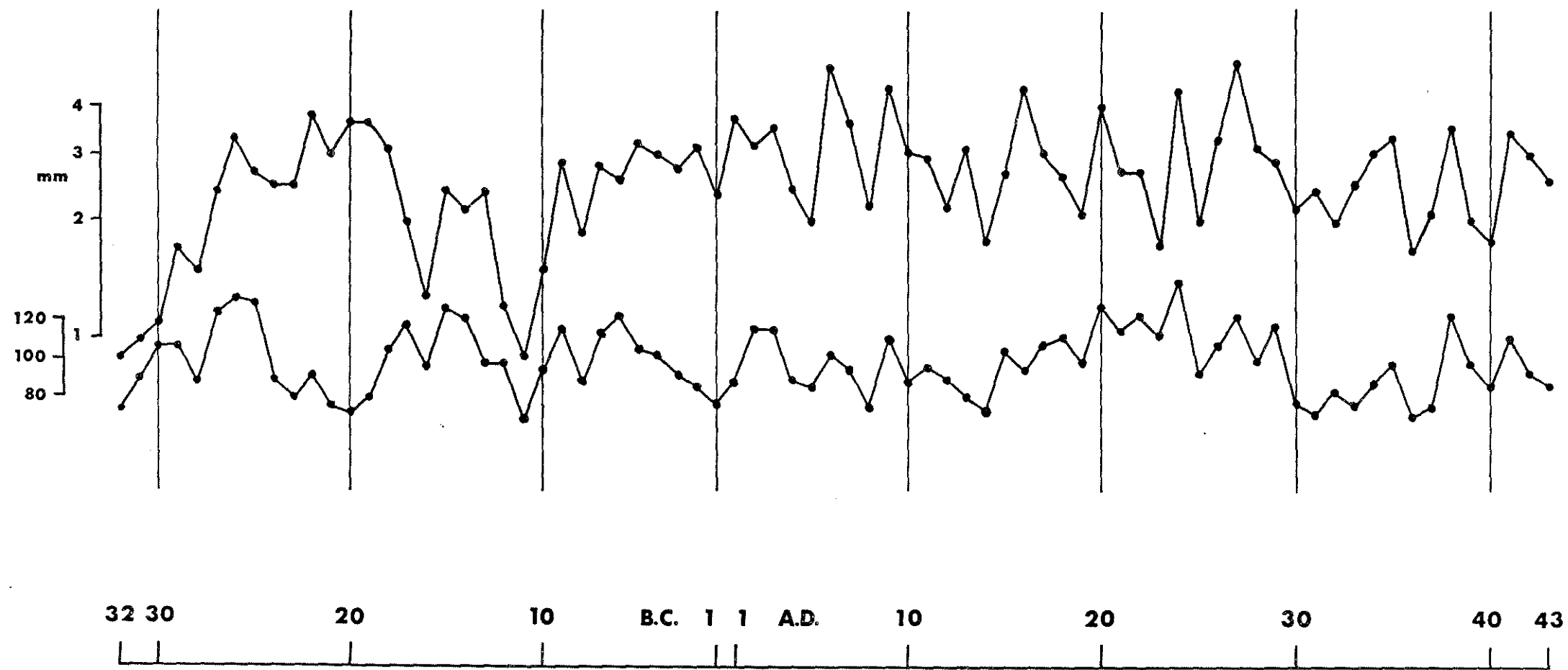


Fig. 3



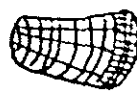





no.	no. of rings	sapwood rings	average width(mm)	sketch/dimensions (cm)
<u>1975 samples</u>				
W101	32	8	1-3	 14 x 9
W102	59	19+bark	0.5-3	 12.5 x 12.5
W103	79	25+bark?	1.73	 15 x 15
W104	69	13	2.30	 17.5 x 13
W106	78	18	2.04	 19 x 18
<u>1982 samples</u>				
10	65	-	1.95	 32 x 5-8
305	75	-	2.67	 28 x 25
308	46	-	2.25	 12 x 13

TABLE 1

	W104	W106	308
W103	5.87(66)	4.52(72)	4.63(44)
W104		6.88(69)	6.70(46)
W106			6.91(46)

TABLE 2

APPENDIX

Sample 10 (65 rings)

year	ring width(0.1mm)									
	0	1	2	3	4	5	6	7	8	9
0		46	46	33	45	52	45	48	42	42
10	49	36	33	32	31	18	9	13	19	17
20	14	17	15	14	13	11	15	8	18	14
30	10	8	14	11	9	16	19	16	13	11
40	18	12	11	21	18	22	19	18	15	9
50	11	14	9	12	8	12	11	11	13	11
60	16	16	10	5	12	9				

Sample 305 (75 rings)

year	ring width(0.1mm)									
	0	1	2	3	4	5	6	7	8	9
0		9	10	11	17	15	24	33	27	25
10	25	38	30	36	36	31	20	13	24	22
20	24	12	9	15	29	19	28	26	32	30
30	28	31	24	37	32	35	24	20	51	36
40	22	45	30	29	22	31	18	27	44	30
50	26	21	40	27	27	17	44	20	33	52
60	31	29	22	24	20	25	30	33	17	21
70	35	20	18	34	30	26				

cont.....

Appendix/cont

Sample 308 (46 rings)

year	ring width(0.1mm)									
	0	1	2	3	4	5	6	7	8	9
0		59	39	43	35	48	45	15	25	39
10	43	32	28	23	27	30	16	15	33	10
20	30	29	21	18	19	16	21	18	6	19
30	7	9	24	17	23	17	10	15	11	14
40	8	10	10	7	11	16	20			