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TITLE Tree-ring analysis of timbers from Winterton, Lincs

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The well at Winterton, associated probably with the aisled building and dated archaeologically to about AD 250-350, was lined at the base with oak timbers, which raised the possibility on discovery of absolute dating by means of dendrochronology, by comparing the growth pattern in the annual rings of the wood with that of known date based on a continuous series of linked archaeological timbers, a record which exists as yet only in Germany. However, on removal and examination, the timbers were found to be complete trunks of young trees about 30 years in age which would provide too short a growth pattern to be certain of the accuracy of cross-dating.

Despite the impracticability of absolute dating, analysis of the annual growth rings could provide other information. For example, were the three packing timbers contemporary to the well lining? In what season were the timbers felled and why? How many trees must have been felled? Such details may be of economic and environmental interest, and are rarely available from Roman contexts, where timbers often have much outer wood removed and wide uniform growth rings.

The well lining consisted of two layers of four timbers each laid in a square, jointed at the corners, and held in place by packing timbers on the north, east and south sides, as well as stone packing. The 11 available timbers were sampled by sawing out a cross-section about 5cm thick from around the centre of each timber, avoiding any knots and branches which would distort the ring-width pattern. Each section was then split into two across the pith, to provide a radius along which to measure the ring-widths. Because the wood was completely waterlogged and the outer sapwood very soft, prior deep-freezing allowed consolidation for long enough to prepare the surface and show the structure of the wood clearly. The width of each annual ring was then measured to 0.1mm and the values plotted as a graph showing the variations in ring-width from year to year (as in Fig. 2).

All the timbers were of oak (Quercus sp.), a wood in which the annual ring is formed of two parts; in the spring a line of large vessels are formed to carry sap and are known as the earlywood, while over the summer dense layers of wood called the latewood are laid down. These zones are clearly visible in Fig. 1, the annual increment extending from the left of one earlywood zone to the left of the next. Because of this so-called ring-porous structure, the rings are very clear and in complete trunks allow a determination of the season of felling (see below).

The timbers were very uniform in size with diameters of up to 20cm and very little taper. Bark had been present on all the trunks but had become loose and disappeared in most cases; the bark edge can be determined by the presence of a complete annual ring around the entire circumference of the trunk, representing the year in which the tree was felled. The age of the trees - number of annual rings from pith to bark - varied between 28 and 35 years, some of this variation no doubt due to position of the sample in the trunk, the number of rings becoming less with increased height above ground. The annual rings were wide, falling from about 5mm near the pith to about 2mm near the bark, and evidently the trees had grown under very favourable conditions; forestry tables give diameters of 8-12cm for 30 year old oaks today.

The inner wood of an oak is dark and hard and known as heartwood, while the outer zone is pale and soft and active in carrying sap to the leaves; this is known as the sapwood and can be clearly seen in Fig. 1. Sapwood is very important in dendrochronology since it maintains a uniform width related to the age of the tree, 25 years in a mature tree and proportionately less in an immature tree, and thus allows an estimate of the year of felling even if most of the sapwood has been removed during conversion. In these timbers the sapwood maintains a width of 11-15 rings.

Having produced a growth curve for each of the 11 timbers, the next step was to compare the fluctuations in ring-width between timbers to determine whether they were contemporary. Computer programs are used for matching growth curves over 40 years in length; visual matching sufficed in this case to show immediately that the patterns of growth were almost identical in each timber, that each had been felled in the same year and that the boundary between heartwood and sapwood occurred at almost the same time. Fig. 2 shows the corresponding ring-width curves of 7 timbers, and the block diagram, Fig. 3, shows the years spanned by each timber and their relationships.

The uniform felling year indicates that the 3 packing timbers were contemporary to the well lining timbers and they may all have been cut from the same trees, the packing timbers originating in the more branched and curving parts of the trees whose straight sections were used for the lining. Oaks of this size and age might give 6m of clear bole, which could provide at least 4 of these timbers 1.50m long, or conversely a minimum of three trees must have been felled to provide the almost 15m of timber represented in the well. This might be further suggested by the presence of only three packing timbers, and by the grouping of ring-width patterns related to position in the well, similar groups being the east, west and north top timbers (2-3-4), the east, west and north lower timbers (6-7-8), and the east, north and south packing timbers (9-10-11). All the growth patterns are however sufficiently similar to have originated in adjacent trees.

Examination of the outermost annual ring of each timber allowed the determination of the season of felling. In 9 of the trunks, the outermost ring consisted of the earlywood and about half the average latewood zone or less - the sudden fall in ring-width can be seen in Fig. 2. Although this could conceivably be caused by a particularly severe year climatically, it would have needed to be very severe indeed to cause such a drop in growth rate. It is more likely that the trees were felled in midsummer, perhaps July or August, when the latewood had only been half formed. The other two timbers (6 - the north lower, and 7 - the west lower) showed only sporadic sections of earlywood around the circumference (see Fig. 1 in which the photo of timber 6 shows no ring 52 at all), and while this might be due to surface damage, it is more feasibly the result of felling near the start of the growing season in May. There is no obvious explanation for the felling of some timbers a month or two earlier than the rest unless they were perhaps intended for another purpose.

Summer felling is unusual. Even in prehistoric contexts, trees were felled in winter while the sap was down. It could be the result of haste or ignorance, but the most obvious reason may have been to take advantage of the low water-table to dig and line the lower part of the well. The trees were evidently felled as and when required regardless of season, which suggests that timber was not stored but that ample supplies of suitable trees were growing in the vicinity. After felling, the trunks were simply cross-cut to length and the branches trimmed off.

Two posts or stakes were also discovered on the site associated with field enclosures and of unknown date. Both were of oak. The stake (sample 12) consisting of a halved and trimmed trunk showed only 17 annual rings, but the post (sample 13) had 44 rings and traces of sapwood remaining at one corner. It represented one quarter of a trunk of similar diameter to the well lining timbers but with narrower rings. The growth pattern was compared to that of the well timbers and suggests that the post is contemporary; its curve is shown at the base of Fig. 2 and illustrates the same features although the overlap of up to 26 years is rather short to be absolutely certain. In this position the boundary between heartwood and sapwood is also aligned (Fig. 3). It thus appears that the post was split from a tree felled at the same time as the trees for well timbers, but that trimming has removed the outer edges.

Since the date of the well's construction could not be fixed closely by archeeological association or by dendrochronology, a sample of wood was cut and submitted to Harwell for radiocarbon analysis. The advantage of prior examination of the growth rings means that selected areas of the trunk can be cut and that these have a known relationship with the time of felling and of use, so that large errors through the analysis of already old wood are not introduced. The wood selected came from the outermost 15 sapwood rings of the south and east top timbers (1 and 2), intended to give a radiocarbon date as close as possible to the year of felling.

The result of AD 240 $\pm$ 60 (HAR 1605) falls within the early part of the expected archaeological date, and suggests that the trees were felled and the well was dug around the mid third century.

Legends:

Table — Details of the 13 timbers examined from Winterton; they include 11 lining and packing timbers from the well and two posts from enclosures.

Fig. 1 — Segment of well lining timber no. 6 from the pith to the bark edge (radius 8cm). The dark inner wood is called heartwood and the soft pale outer wood is sapwood; this area particularly shows the structure of the annual rings with lines of spring vessels and dense zones of summer wood. Ring 52 is barely present on this timber perhaps due to felling early in the growing season or to damage, so the outermost ring shown is ring 51; the ring-width curve is illustrated in Fig. 2. (Photo: H.A.Jones)

Fig. 2 — Ring-width curves for 7 of the well timbers showing the variations which occur in the patterns of each and prove their contemporaneity. The vertical line around arbitrary year 40 represents the boundary between heart-wood and sapwood. The very narrow outermost ring, 52, of each timber indicates felling in summer before the ring had been completely formed. At the base is part of the curve for post 13 in its tentative position.

Fig. 3 — The block diagram shows the arbitrary years spanned by the annual rings of each timber, open areas representing the heartwood and hatching the sapwood. Post 13 is probably contemporary to the well lining timbers but has lost some outer wood during conversion.

Winterton, Lincs.

Sample no.	Context	No. of rings	No. of sapwood rings	Radius cm
1	Well, S. top	35	13	9
2	Well, E. top	31	12	10
3	Well, N. top	33	15	7.5
4	Well, W. top	30	11	9
5	Well, S. lower	35	11	9.5
6	Well, N. lower	28	13	8
7	Well, W. lower	31	12	9
8	Well, E. lower	31	13	10
9	Well, E. packing	31	11	8
10	Well, N. packing	28	12	9
11	Well, S. packing	29	12	11.5
12	Stake in enclosure, DW/LH	17	-	6
13	Post in enclosure, DW/EE	44	6	11

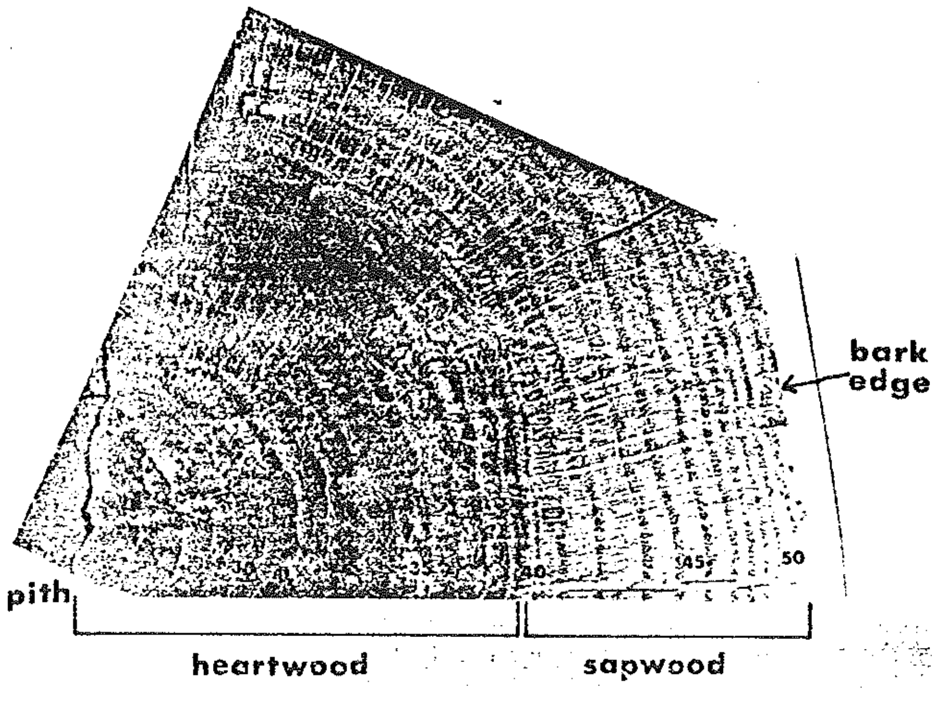


Fig. 1

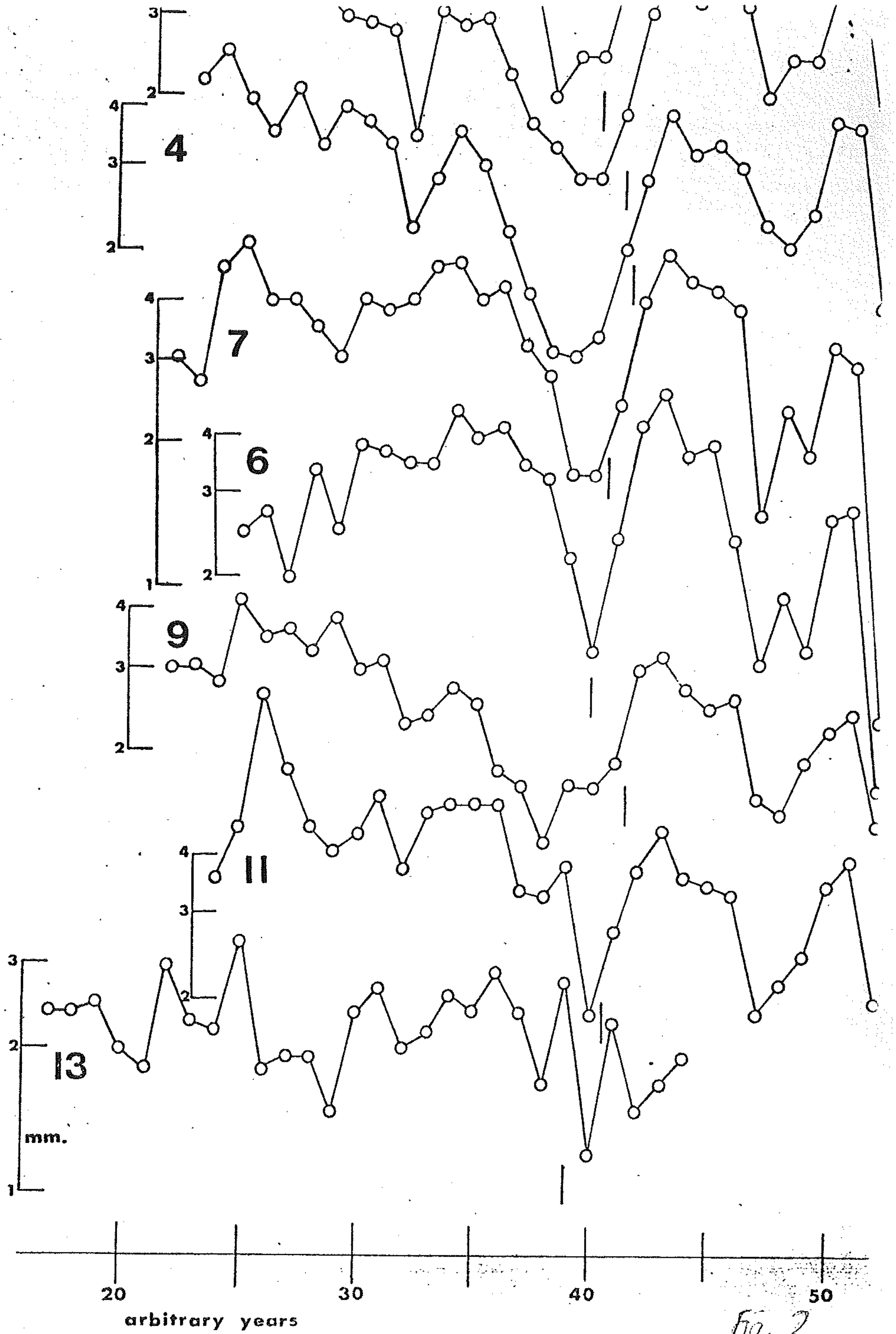
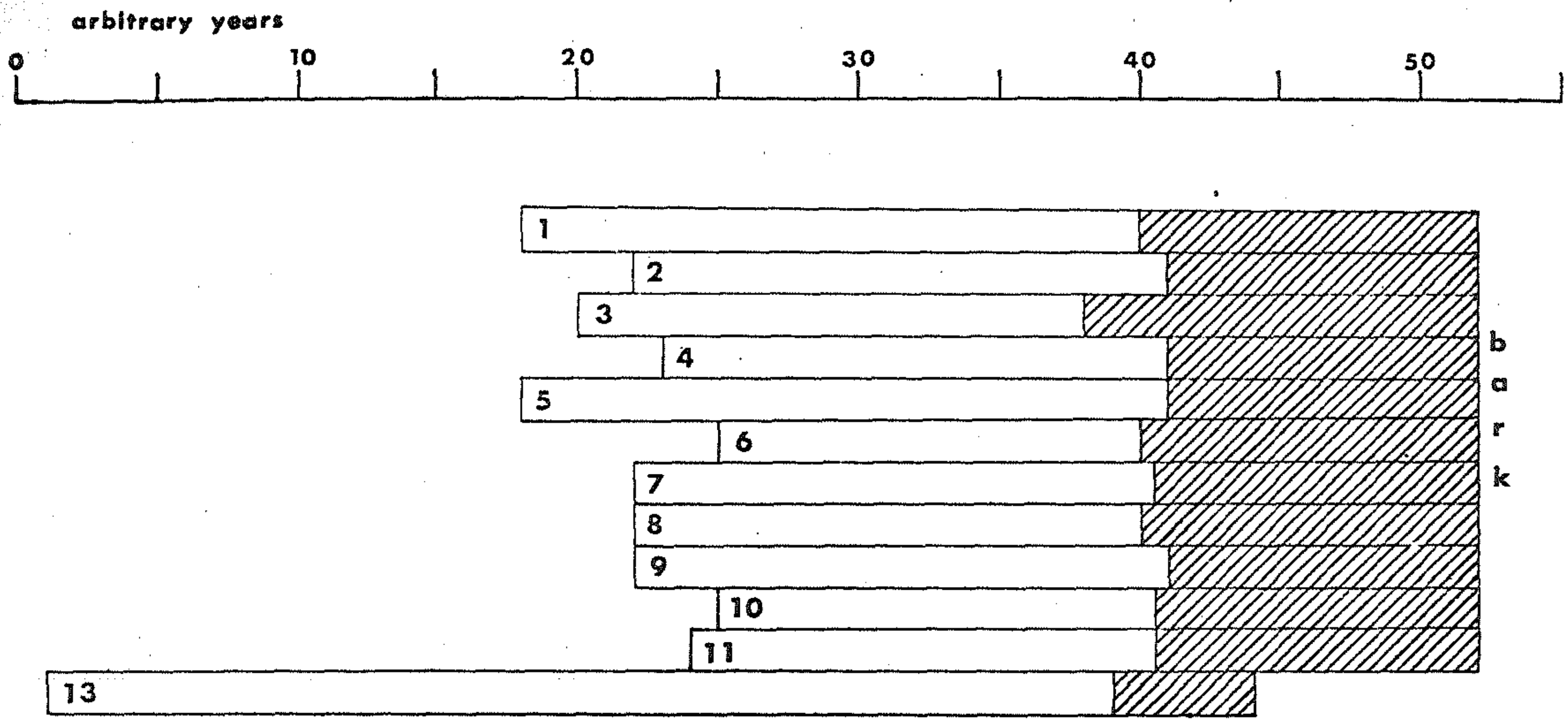


Fig. 2


arbitrary years
0
10
20
30
40
50
1
2
3
4
5
6
7
8
9
10
11
13
b
a
r
k