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Ancient Monuments Laboratory
Report 114/88

TREE-RING STUDIES IN THE SOMERSET LEVELS: THE MEARE HEATH TRACK 1984-85.

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Summary

This report describes the examination of almost 200 oak tree-ring samples from an important series of transverse and longitudinal planks and stakes, as well as a small study of roundwood of various species. The value of the wood lay in the fact that it was still *in situ*, whereas the majority of previous samples were found after disturbance by peat-cutting or excavation long ago. Thus conclusions could be reached about the relationships of tree-ring patterns and functions.

The usually thick and narrow planks were split in a variety of ways, from trees probably under 500mm in diameter and 150 years old. 101 tree-ring curves were cross-matched, bringing the total to 241; the existing data was also reworked to suggest the presence of a number of characteristic growth patterns, perhaps related to areas of woodland. They also indicated some severe disturbance to tree growth in the decades before the track was built.

The presence of sapwood on at least 10 timbers did not resolve the question of felling date for the trees, which is now quoted as arbitrary years 150-155. Absolute dating has not yet proved possible but Hillam's work has revealed a correlation with another Somerset chronology from the Tinney's tracks.

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TREE-RING STUDIES IN THE SOMERSET LEVELS: THE MEARE HEATH TRACK 1984-1985.

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INTRODUCTION

Since the publication of full dendrochronological results on the oak timbers of the Meare Heath track (Morgan 1982), further field collection and excavation along the line of the track have revealed much more information about the track's construction. The study of this large assemblage of tree-ring samples probably represents the last major project on the trackway, which is now virtually removed by peat-cutting operations.

In 1984, 44 wood samples from in situ stakes, brushwood and planks were collected during peat-cutting in Home Ground (see map, fig.000) in the same general area as previous excavations. During the same year, excavations began prior to peat-cutting over probably one of the last remaining stretches of the track. Completion of the 20m excavation in 1985 and the salvaging of planks shortly to be destroyed along the head(fig.000), many of which were already in a very dry and friable condition, resulted in an extensive collection of 148 tree-ring samples.

The value of the 1984/5 material for tree-ring studies was immense. Until this stretch of track was examined, only about 30% of the wood for tree-rings came from controlled excavation. The remainder came from field collection, often thrown out after peat-cutting, when only the stake bases were still *in situ*. While this salvaged wood contributed to the general tree-ring record, nothing could be determined about the original function of the planks, or their layout and associations. The material excavated in 1985 has almost doubled the numbers of planks known to have been used as transverses or longitudinals, and, through examination of their tree-ring record, has added considerably to our knowledge of the relationships of timbers and their parent trees. The new samples have also doubled the examples of timbers with sapwood, with 10 (+2?) new samples to add to the existing 8 (Morgan 1982). These have modified the evidence for the interpretation of felling dates for the trees used to build the track.

In addition, the first study of any quantity of roundwood, of oak and several other species, was undertaken to assess the general character of the brushwood surrounding the track timbers.

SAMPLING AND PROCESSING

Subsequent to the archaeological recording, sampling was carried out by sawing a thin cross-section from almost every piece of wood from both the excavation and the rapid survey up the head. Some of the planks now lying near the peat surface had possibly already been exposed and recorded by Bulleid in the 1930's (Bulleid 1933), and by Godwin in the 1940's (Godwin 1960; Clapham & Godwin 1948) where he also took a pollen profile. The wood was therefore quite dry on its upper surfaces and tended to crumble on sawing, despite being very hard inside. Sapwood would probably not have survived if present on the upper surfaces. Bandaging of the required section prior to sawing usually prevented any loss of continuity in the tree-ring pattern caused by splitting of the section.

In the dendrochronology laboratory, the driest samples were soaked in water in the hope some would be re-absorbed. The slices were then deep-frozen and their transverse surface planed with a Stanley Surform to expose the growth rings. The drier pieces tended to be too fibrous to plane and were cleaned with a sharp knife.

The processes of recording and comparing tree-ring data have been updated from those described in Morgan (1984), so a brief explanation will be given here. The ring-widths were recorded on a Bannister incremental measuring machine linked to an Apple IIe microcomputer. As the long travelling stage moves the width of each ring, a button is depressed and the distance is automatically recorded in the Apple's memory. Storage on floppy disk then enables a number of processes to be carried out on the raw ring-width data, using software written and supplied by Dr J.R. Pilcher of Belfast. The patterns can be compared with other individual or average curves. Any possible matches are suggested by correlation coefficients, the significance of which is tested by Student's _t_. These values may be significant when higher than 3.5 (at 95% confidence limits) (Baillie & Pilcher 1973), and can be checked visually by overlaying the curves. The data can be edited to make any changes and master curves can be calculated; more extensive and rapid comparisons require data transfer to a mainframe computer.

Each potential match must be carefully checked back on the plotted graphs, as the correlation values cannot be relied on alone. Matches must also be replicated; each curve must match consistently in the correct position with every other.

ROUNDWOOD OF VARIOUS SPECIES

The 18 roundwood samples from the excavation were identified by A.E. Caseldine of Exeter University: the species are listed in Table 1. The wide range of wood species listed in Table 000 of the archaeology report in these Papers suggest a variety of origins for the track wood, both in the woodland on higher ground (oak, ash, field maple, hazel, blackthorn), in the woodland margins (alder, birch) and in the bog itself (willow and bog myrtle).

Layers of brushwood material had been noted on previous excavations of the Meare Heath track. Bulleid (1933, 21) noted only 'some pieces of birch and possibly alder'. Clapham & Godwin (1948, 252) show a layer of brushwood beneath the timbers, described as being of alder and birch 25-38cm thick. The range of species was not appreciated until the 1974/75 excavations (Coles & Orme 1976) revealed a predominance of hazel(*Corylus avellana*) and alder (*Alnus glutinosa*), with some willow (*Salix* spp.) and birch (*Betula*spp.) and a little elm (*Ulmus* spp.), rowan (*Sorbus aucuparia*), alder buckthorn (*Frangula alnus*) and blackthorn (*Prunus spinosa*). At the 1977 sites, the range was again dominated by alder, with some hazel and birch, and a little blackthorn, willow, elm, rowan, ash (*Fraxinus* spp.) and guelder rose (*Viburnum opulus*) (Coles & Orme 1978, 32). There was thus little indication of any deliberate species selection, and the wide range suggested the richness and diversity of the woodland cover in the area in the late Bronze Age.

Hardly any tree-ring samples were collected from brushwood layers until the 1985 excavation, so little was known about the age and size range of the material used. Even now, the very few samples examined give only a limited view. Fig. 1 shows the relationship between age and size of the stems, and reveals the very rapid and variable growth rate of the alder - the stems cluster between about 5 and 15 years in age but may be 20-110mm in diameter. By contrast, the oak growth was much slower. There was no suggestion of stems of a certain diameter being preferred.

Ten of the stems examined were almost certainly cut in winter (determined by the stage of growth of the outermost ring beneath the bark), but two young oak stems suggested summer cutting by the absence of the latewood in their outer rings. A varied cutting season is consistent with the probable collection of brushwood when needed, to consolidate a particularly wet or low area of the bog to support the track timbers.

RESULTS OF THE TREE-RING STUDIES ON OAK

Full details of all the oak material from the Meare Heath track examined since 1974 are given in Table 2. From the 1984/5 sampling, a total of 114 oak planks and stakes were suitable for ring-width measurement. These included 5 samples with more than 100 rings (Table 3) - short in tree-ring terms but here vital in linking the many shorter curves, and a further 10 (+27) samples with sapwood up to 28 rings wide.

A second example of a partially formed ring was noted among the 1985 wood. The first had been found in stake TA6 (Morgan 1988, fig.III.33) excavated in 1977, in the ring equivalent to year 52; the second occurred in timber 186 from the 20m excavation, in the ring equivalent to year 102. Over several centimetres, the earlywood vessel zone was marked only by a very faint line of thicker-walled cells and tiny vessels. Measurement along this radius led to the complete loss of the ring, and inconsistencies in the subsequent cross-matching. The absence of large earlywood vessels may be due to some damage to the cambium over a small area during the previous winter. While such locally present rings have been noted before in Irish bog oaks and archaeological timber from London (Hillam, pers.comm.), they are not common, and could lead to difficulties of cross-matching if only a thin radial plank was available for measurement.

Conversion methods.

Methods of converting the trees into planks and stakes, demonstrated by the material studied since 1974, are summarised in Table 4 and illustrated in figs. 2 and 3. A slightly higher proportion of tangential and 'intermediate' planks were found in the recent excavations than hitherto.

The great diversity in size and cross-section of the planks and stakes is shown in fig. 2, which illustrates the two different methods of splitting a tree into planks. The upper tree-trunk was split tangentially (today known as 'plain-sawn'), a useful means of obtaining a wide plank from a relatively small trunk. Some of the 'intermediate' planks could have originally been one wide plank which has since split lengthwise along the rays into two planks. The lower trunk in fig. 2 shows the more straightforward method of radial aplitting, which gives a plank width limited to less than the radius of the tree. The sketches also show the tendency for planks from the 20m excavation to be radially split and those from farther north up the head (numbers over 300) to be tangential.

There seems to have been no consistent rule or preference in the track about plank width, thickness, length or method of conversion. This could suggest a slightly haphazard community effort rather than the well planned construction of several experienced craftsmen; nonetheless much planning must have gone into general construction methods, the quantities of timber needed and the route to be taken. There is no evidence of re-used wood (see below) to help explain the diversity.

Plank widths of over 80mm are summarised in fig.3. The majority were under 200mm wide, with only 25 planks (out of 163) exceeding this. The widest plank, 315, at 400mm, was split tangentially right across the tree, almost at the pith, supporting the evidence of original tree diameters of around 500mm (allowing for absent sapwood and outer rings). Other such wide planks may now have split into two - longitudinals 010 and 012 were both about 130mm wide and 40mm thick, with almost 70 growth rings, both series ending in a mass of extremely narrow rings. Their almost identical ring patterns spanned the same years. They could thus easily be part of the same plank or same tree.

The histogram of plank widths in fig. 3 also indicates the reason for adopting the less easy tangential method of splitting. Few radial planks exceed 140mm in width, whereas wider tangential planks were available from the same size of tree. Original tree size probably did not exceed 500mm. It cannot now be determined whether larger trees were not available in the already cleared woodland, or whether they were avoided as less easy to fell and work.

Comparison of conversion method with numbers of rings, illustrated in fig.4, demonstrates the short ring series generally available from tangential planks, and the longer series from radial and especially 'intermediate' planks. Ring numbers peaked in all three at 50-80 years. Thus the conversion method seriously affects the potential value of planks for tree-ring studies.

Cross-matching the curves.

The ring patterns of the 114 measured samples were compared to the existing track chronology, 149 years in length and representing 115 timbers (Morgan 1982). While comparison with the track chronology gave a guide as to the time span of some of the individual curves, especially the longer ones, the chronology proved too general to allow the cross-matching of many others. Reference back to other individuals or groups of curves was the only means of resolving the relative time spans; this process of replication was particularly important with the shorter curves lying at either end of the time scale.

A total of 101 curves from the recently excavated material were cross-matched, leaving only 13 short series not fitted into the chronology. This brings the total of correlated curves to 241 (see Table 2). The time scale has also been extended slightly. Three samples extended the start of the chronology by up to 9 years (007, 034 and 306); however, the relative dates have not been altered to allow for this extension, and they have minus values for their start years. The end of the chronology is less certain than hitherto, since the examination of further timbers with sapwood, and is further discussed below.

The bar diagram, fig.5, showing the time span of all the 1984/5 cross-matched individuals, presents the same format as that for the Sweet track (Morgan 1984) and is likewise interpreted as resulting from the origins of many pieces of wood in the same trees.

Sapwood and the time of felling.

The end year of the chronology was previously set in arbitrary year 152 on the basis of suspected bark surface on two timbers found in 1977. The further evidence from 10 (+27) examples of sapwood found in 1985 indicates that the felling year cannot be defined as precisely. The problem lay in the difficulties of recording the ring patterns over the last 50 years of the trees' lives, due to extremely variable ring-widths. Many timbers showed irregularities, with groups of extremely narrow and inseparable rings alternating with very wide rings. Often the ring patterns matched well at the start and then clearly went out of phase over the last few decades.

It was thus difficult to be confident of precisely recording the ring-width patterns of the sapwood zone where it survived, and therefore of defining the exact felling date. Table 5 and fig. 6 give full details of the time span and year of transition of the timbers with sapwood. The presence of sapwood was evidently of no significance - it was left on transverses and stakes without concern. Indeed one stake, 017, was made almost entirely of sapwood, possibly in haste; it lay next to another stake 022 whose ring-pattern cross-matched between years 107 and 151, yet it had no sapwood. It is likely to have come from a tree felled at a later date, and pushed through the same probable hole in transverse 003 to supplement the sapwood stake 017.

The bark surface was suspected on timbers 77 1.139, 77 2.33 and 85.300; however, at least 5 other ring series were found to extend beyond year 152 by a variable amount. Uncertainty over narrow rings is felt to be the cause of these discrepancies, rather than any variation in felling year (i.e. it is not suggested that the trees from which these five timbers came were felled slightly later).

In view of the uncertainty over measuring the sapwood rings and defining the outer edge, the felling year is now given as between arbitrary years 150 and 155. The transition to sapwood lay uniformly within the decade 120-130, with the exception of 005 and 271 - they changed to sapwood in around year 143. The range in transition years is generally quite wide, as is shown in fig. 6, and all the samples fall within the 10-55 year sapwood boundaries (at 95% confidence limits) recently proposed (Hillam, Morgan & Tyers 1987).

Many of the timbers with sapwood appeared to belong to tree groups 2 and 7 (see below), which may be from the same area of woodland; many may indeed be from the same tree. One group of timbers with sapwood was found in the 20m excavation, around 11-12.5m (fig.000). Transverse 002 lay close to stakes 022 and 017, as well as possible packing pieces 005 and 271. Farther north, transverses 319 and 320 lay about 2m apart (fig.000); both had similar cross-sections, dimensions and number of sapwood rings, suggesting an origin in the same length of tree trunk. However, timber 320 was too decayed to measure the rings with confidence, removing the only certain source of evidence of a common origin.

Transverses 300, 319 and 320 also showed that some split planks were placed bark surface down on the peat, as described by Clapham & Godwin (1948, 252) in the trackway farther to the south. Their sections are shown in the upper trunk in fig.2. However, these are the first examples found, and they consisted of much less in section than the previously described 'halved logs'.

Grouping of curves.

The original Meare Heath material from 1974-77 had been grouped into so-called 'tree groups', not so much representing single trees, but perhaps from several trees in the same area of woodland. These were labelled A -G (Morgan in Coles & Orme 1976). The groups were based on ring-width series showing very similar and diagnostic patterns, with generally high correlation values. With the addition of more data, these groups became inappropriate and two needed linking together. It was thus decided to rework all the data to examine the reality and interpretation of the grouping system. It became clear then that distinct groups of patterns could be defined, based largely on the last 50 years of the trees' lives; prior to this, the patterns were all relatively similar.

The new tree groups were labelled 1-7, and each curve was allocated to the group or groups of curves it resembled most. Due to time constraints, this was done by visual assessment, but would definitely merit a more intensive study of the degree of similarity within and between groups, using statistical means. Useful comparisons could be made with similar within and between tree studies on modern material (e.g. Milsom 1979). The distinct tree growth patterns in the Meare Heath wood contrast with other assemblages such as the Sweet track, where most growth patterns were relatively similar (Morgan 1984).

Some of the curves in each group were averaged to create group master curves, against which further comparisons could be made. The relative time span of each group master is shown in fig.7, the approximate number of individuals resembling each group appearing to the right of each bar. Many other curves matched several groups equally well and are not included. Groups 2 and 6 represented the largest number of samples, group 5 the least. The variation in start year shown by the bars is probably a combined result of conversion method (removing the inner wood) and varying tree age.

Correspondence between the groups is shown by a matrix of Student's t values in Table 6. Generally, all groups correlated well up to around arbitrary year 100, after which each behaved differently. Three of the curves are partially illustrated in fig.8. The group 2 patterns showed a sudden sharp decline in ring-width around arbitrary year 100; in group 3 this occurred in year 93, and in group 7 the decline took place in year 117. The other groups maintained a steadier growth rate throughout, and in group 6 it even increased. The causes of these differences are not known, but it is clear that the trees from which the patterns in groups 2, 3 and 7 were derived suffered several severe checks to their growth during the decades before they were felled. alternating with periods of recovery and rapid growth. Growth retardation can have a number of causes, both natural and anthropogenic, such as waterlogging, severe defoliation (by insects, animals or man), or damage to the bark. It could even, in this case, be caused by cultivation techniques, such as periodic slash and burn, which may have damaged and disturbed the roots. Recent cross-matching with the Tinney's chronology, from trackways some distance away heading east-west, revealed that the extreme variation in ring-width in some of the Tinney's timbers was contemporary. Either the same sources of wood were being used, or the effect was quite widespread.

The grouping of the curves, and speculation over the causes of the severe setbacks to tree growth occurring in the local late Bronze Age woodland, leads on to the question of how to interpret the differing growth patterns. Taking into consideration the very small proportion of the 2.5km long trackway represented by the tree-ring samples, and the quantities of timber in some of the groups, an origin in individual trees is not being suggested. It is more probable that the groups represent several trees in scattered areas of woodland, perhaps each affected by different stress factors.

The structure and significance of tree group 7.

In order to gain a clearer understanding of the composition of the groups, group 7 will be considered in more detail. It was first recognised among the 1985 material, but was subsequently added to by material from earlier studies. The series of transverses, chips and stakes showed a very diagnostic growth pattern extending over the last century of the time scale; the pattern related to that of group 2, except that the severe decline in growth occurred 17 years later in group 7. The last 20-30 rings are uncertain owing to the difficulty of recording very narrow bands.

Figs.9 and 10 illustrate the relationship of the timbers in group 7, and demonstrate the refinements of tree-ring studies if sampling is sufficiently extensive. The group includes timbers performing several functions - transverses, stakes (two of which, 022 and 243, passed through holes in transverses) and stray chips. The sketch section of a tree trunk in fig.9 shows the feasibility in this case of all the planks and stakes being split from the same tree.

The bar diagram in fig.10 reveals a uniform end year for most of the ring series, in the decade 130-140; this suggests proximity to the sapwood transition and the surface to which many timbers were trimmed. The relatively late transition to sapwood in 005 and 271, and the possibility of 022 being a later repair, have already been discussed.

The bar diagram suggests that both planks and stakes were formed from the same length of tree trunk, probably producing the latter by splitting down planks. The common end years and the large number of stray pieces or chips in this group suggests that some of this material was produced on site, by woodworkers trimming the planks and splitting stakes as required. No clear concentrations of this associated wood occurred in the trackway; the inclusion of two stakes from farther south, found some 10 years ago, indicate the widespread distribution of group 7 wood. This tends to confirm the idea of initial conversion within the woodland, and subsequent mixing of the planks.

Tree-Rings and Track construction.

One of the major aims of the tree-ring study of material from known contexts was to examine relationships and constructional details of the track timbers. The tree-ring patterns of adjacent pairs or groups of transverses and longitudinals were compared, to identify those which were possibly from the same length of tree trunk and those which definitely were not. The planks involved are listed in Table 7.

Similar ring patterns in two pairs of longitudinals, 010/012 (fig.000) and 331/332 (fig.000), suggested they either came from the same tree or were even once part of the same plank which split lengthwise. The transverses with corresponding rings generally lay next to each other, such as 301 and 302 (fig.000, at c50m). Timbers 316, 319 and 320 (fig.000) formed an interesting group. They were all tangential planks with traces of sapwood. The form of their cross-sections (fig.2 upper) and the time span of their rings suggested that 316 came from the heartwood area of the tree, 319 from the heartwood with some sapwood, and 320 from the outermost area of the tree with full sapwood. All three adjacent planks were held in place by two stakes and had a third hole or notch at one end - no other planks in the same area had the same features.

Conversely, the tree-ring patterns of other adjacent timbers almost certainly showed that they were not split from the same tree (though it is possible they came from a non-overlapping part). Table 7 shows that they include all the transverses from the 20m excavation; plank 004 had a very erratic growth pattern which could not be cross-matched at all. Longitudinals 317/318 and 339/340 did not form pairs.

Further studies aimed to examine the relationship of transverses with two holes and the stakes which held them in place; however the short ring series of the stakes resulted in too few being cross-matched to pursue this aspect. The functions of each correlated timber were also compared to relative time span; no detectable difference in position within the chronology emphasised the common origin of planks and stakes, and showed no preference of certain parts of the tree for particular functions.

Absolute dating.

Radiocarbon dates for the trackway wood vary quite widely in the late 2nd millennium bc (Orme 1982 23-5; these Papers), making it difficult to predict the likely time span of the tree-ring chronology with any certainty. In addition, the Meare Heath chronology is reduced to about a century by the problems encountered in recording the rings over the last few decades on most samples. However, the refinements to the site chronology described above have led to further efforts to cross-match the tree-ring pattern with others. Impetus has also come from the recent establishment of other chronologies from the Fens and north-east England and the reworking of all the late Bronze Age material (Hillam pers.comm.), which might enable any possible matches with the long Irish reference chronology (back to 5289 BC - Brown, Munro, Baillie & Pilcher 1986) to be checked.

As this report goes to press, some progress has been made in linking the available chronologies. It has been greatly assisted by a new computer program which produces the best position of match between each of a large number of curves, thus enabling the more rapid processing of large quantities of data (Crone pers.comm.; Okasha 1987). Reworking of the data from the Tinney's tracks currently in progress (they were recorded about 10 years ago, when much less sophisticated recording and cross-matching facilities were available) has enabled some of the Meare Heath and Tinney's individual curves to be cross-matched (Hillam pers.comm.). This shows that the Meare Heath track was constructed some 70 or 80 years before the Tinney's trees were felled; further precision is not possible as the Tinney's wood lacks sapwood.

Further attempts tp correlate floating chronologies and the Irish sequence are now in progress, and it is hoped that absolute dating will soon be achieved. Further details of the progress in cross-matching will be published elsewhere.

CONCLUSIONS

This report describes material collected from what is probably the final stretch of the Meare Heath track. The timbers have revealed the approximate size and relationship of the trees originally felled. The cross-matching of 101 further curves and the reworking of earlier tree-ring data have resulted in refinements of the final chronology and a grouping system probably related to the original sources of the timber. However, the precision of the felling date has been reduced to a 5 year span, in arbitrary years 150-155.

Work is in progress on correlating the first century of the chronology with other floating and dated chronologies; so far, this has led to cross-matching with the Tinney's chronology, showing the Meare Heath track to be some 70-80 years earlier.

ACKNOWLEDGEMENTS - this work has been funded by HBMC. I am grateful to Jennifer Hillam for her work on linking the late Bronze Age chronologies and to the Belfast Dendrochronology Lab. for their assistance in dating attempts.

REFERENCES

BAILLIE, M.G.L. & PILCHER,J.R. 1973. A simple cross-dating program for tree-ring research. Tree-Ring Bulletin 33, 7-14.

BROWN,D.M., MUNRO,M.A.R., BAILLIE, M.G.L. & PILCHER, J.R. 1986. Dendrochronology - the absolute Irish standard. Radiocarbon 28, 279-283.

BULLEID, A. 1933. Ancient trackway in Meare Heath, Somerset. Proc. Somerset Arch. Soc. 79, 19-29.

CLAPHAM,A.R. & GODWIN, H. 1948. Studies of the postglacial history of British vegetation. Phil. Trans. Roy. Soc. B 233, 233-273.

COLES, J.M. & ORME, B.J. 1976. The Meare Heath trackway. Proc.Prehistoric Soc. 42, 293-318.

COLES, J.M. & ORME, B.J. 1978. The Meare Heath track. Somerset Levels Papers 4, 11-39.

GODWIN, H. 1960. Prehistoric wooden trackways of the Somerset Levels. Proc. Prehistoric Soc. 26, 1-36.

HILLAM,J. 1985. Dendrochronology of the North Ferriby boats. In S.McGrail & E.Kentley (eds) Sewn Plank Boats B.A.R. S276/NMM 10, 145-162.

HILLAM, J. 1985a. Theoretical and applied dendrochronology: how to make a date with a tree. In P.Phillips (ed) The Archaeologist and the Laboratory CBA Research Report 58, 17-23.

HILLAM,J. 1987. Dendrochronology - 20 years on. Current Archaeology IX, 358-363.

HILLAM,J., MORGAN,R.A. & TYERS, I.G. 1987. Sapwood estimates and the dating of short ring sequences. In R.G. Ward (ed) Applications of Tree-Ring Studies B.A.R. S333, 165-185.

MILSOM, S.J. 1979. Within and between tree variation in certain properties of annual rings of sessile oaks. PhD thesis, Liverpool Polytechnic.

MORGAN, R.A. 1980. Tinney's Ground. Somerset Levels Papers 6, 69-72.

MORGAN, R.A. 1982. The Meare Heath track. Somerset Levels Papers 8, 39-45.

MORGAN, R.A. 1984. The Sweet track 1979-1982. Somerset Levels Papers 10, 46-64.

MORGAN, R.A. 1988. Tree-Ring Studies of Wood used in Neolithic and Bronze Age Trackways from the Somerset Levels. B.A.R. in prep.

MORGAN, R.A., LITTON, C.D. & SALISBURY, C.R. 1988. Trackways and tree trunks - dating Neolithic oaks in the British Isles. Tree-Ring Bulletin 47, in press.

MUNRO, M.A.R. 1984. An improved alogarithm for cross-dating tree-ring series. Tree-Ring Bulletin 44, 17-27.

OKASHA, M.K.M. 1987. Statistical methods in Dendrochronology. Unpub. PhD. thesis, University of Sheffield.

ORME, B.J. 1982. The use of radiocarbon dates from the Somerset Levels. Somerset Levels Papers 8, 9-25.

TABLE 1. Tree-ring samples from the Meare Heath track, 1984-85.

SPECIES	NUMBER OF SAMPLES
Oak *QUERCUS*	167
Alder *ALNUS*	9
Ash *FRAXINUS*	1
Hazel *CORYLUS*	2
POMOIDEAE	1
Field maple *ACER*	1
Unidentified	11
Total	192

TABLE 2. Summary of oak tree-ring material from the Meare Heath track, 1974-1985.

	Year of collection							
	1974/5	1976	1977	1978	1979	1980	1984/5	Total
Total number of samples	99	17	78	4	31	3	192	424
Number of oak samples	96	13	71	4	30	3	167	384
Number of measured samples	61	7	52	4	17	3	114	258
Number of cross-matched samples	61	7	49	3	17	3	101	241
Number of samples with sapwood	0	0	7	0	2	1	10(+2?)	20(22?)

TABLE 3. Numbers of growth rings in oak samples from the Meare Heath track, 1974-1985.

NUMBER OF RINGS	YEARS EXCAVATED 1974-1980	1984-1985
0 - 40	75	76
41 - 60	44	37
61 - 100	47	44
101+	6	5
Uncertain	7	5
Total	179	167

TABLE 4. Details of conversion method used in the Meare Heath wood, 1974-1985.

CONVERSION METHOD	YEAR COLLECTED 1974-1980	1984-1985	TOTAL	%
RADIAL	67	40	107	29
TANGENTIAL	18	16	34	9
'INTERMEDIATE'	17	21	38	10
STAKE TYPE	73	61	134	37
ROUNDWOOD	4	28	32	8
CHIPS/OTHER	0	26	26	7
Totals	179	192	371	

TABLE 5. Details of oak samples with sapwood from the Meare Heath track.

SAMPLE NUMBER	NO.OF RINGS	NO.OF SAPWOOD RINGS	CONVERSION METHOD*	FUNCTION+	SPAN IN CHRON.	YEAR TRANS. TO SAP	NO.OF SAP RINGS TO 150-155
77 1.103	48	33?		S	?98-c145	?113	?37-42
77 1.139	116	23	R	T	37-152	130	20-25
77 2.33	129	34	R	L	24-152	118/9	32-37
77 2.34	+88	24	R	T	59-146	122	28-33
77 TA10F	61	22	T		86-146	124	26-31
77C	67	19	T		c87-153	c134	c16-21
79 68.2	44	7	T		91-134	127	23-28
79 68.5	112	4	R	T	28-139	135	15-20
80 2B	65	11	R		70-134	123	27-32
85.002	103	5?	R	T	31-133	129	21-26
85.005	49	12	R		106-c154	c143	c7-12
85.017	48	26	R	S	105-c152	127	23-28
85.037	95	14	R		49-143	129	21-26
85.211	63	13	R		c80-142	c129	c21-26
85.271	c37	14	T		120-c154	c142	c8-13
85.297	39	24	T		c115-153	c129	c21-26
85.300	128	28	I	T	25-152	124	26-31
85.319	74	17	T	T	71-144	127	23-28
85.320	+48	17	T	T	c103/6-150/3	133/6	c16-21

* R = Radial
T = Tangential
I = Intermediate

\+ S = Stake
T = Transverse
L = Longitudinal

TABLE 6. Degree of similarity between the 7 'tree groups' derived from the varying ring patterns of the Meare Heath timbers. The figures are Student's t values calculated by the CROS program (Baillie & Pilcher 1973).

TREE GROUP	1	2	3	4	5	6	7
1	–						
2	3.3	–					
3	11.8	9.2	–				
4	6.4	5.8	7.0	–			
5	2.3	3.3	5.3	4.4	–		
6	4.4	3.8	5.8	7.4	3.9	–	
7	2.1	2.1	4.3	5.0	1.7	5.0	–

TABLE 7. Adjacent transverses or longitudinal planks which probably originated in the same tree, or were definitely not from the same tree, as determined by their tree-ring patterns.

	PROBABLY SAME TREE:	NOT SAME TREE:
Longitudinals:	010 and 012	317 and 318
	331 and 332	339 and 340
Transverses:	301 and 302	002, 003 and 004
	304 and 305A	007 and 008
	306 and 307	
	338 and 341(?)	
	316,319 and 320	
Stray planks		103 and 104

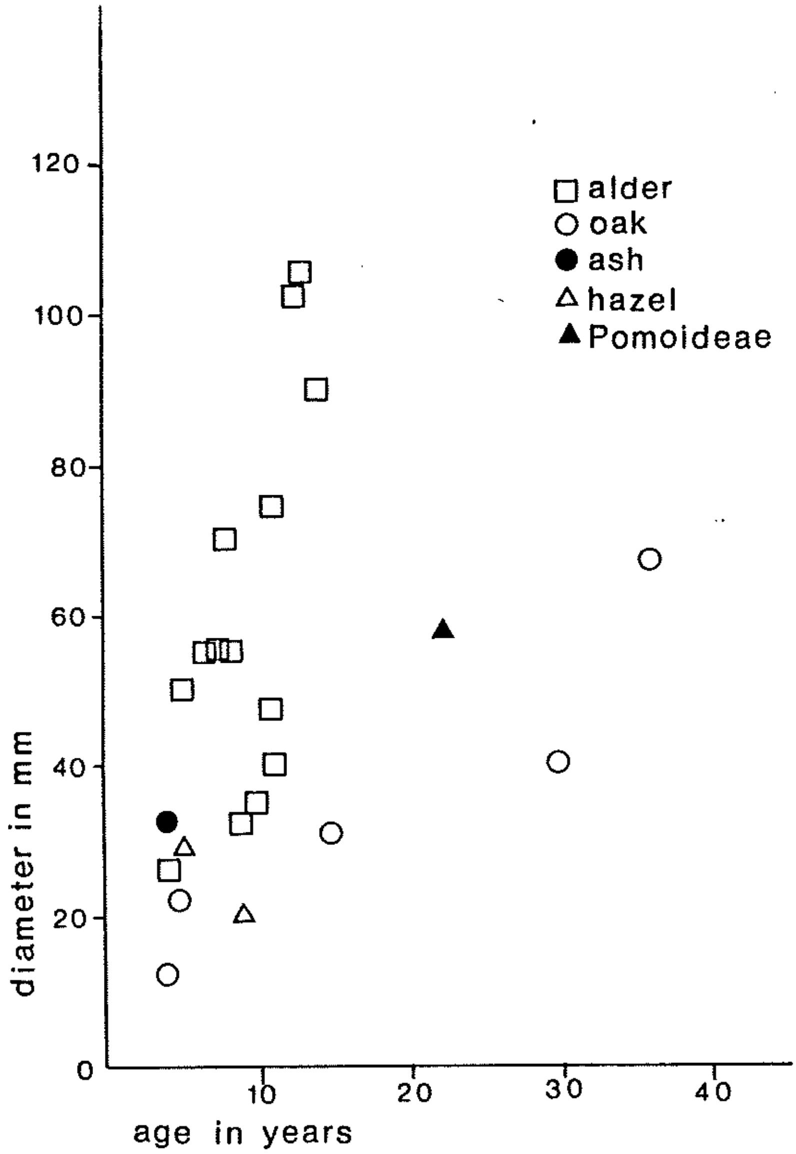

FIG. 1. Scatter diagram showing the range in age and size of the roundwood of various species.

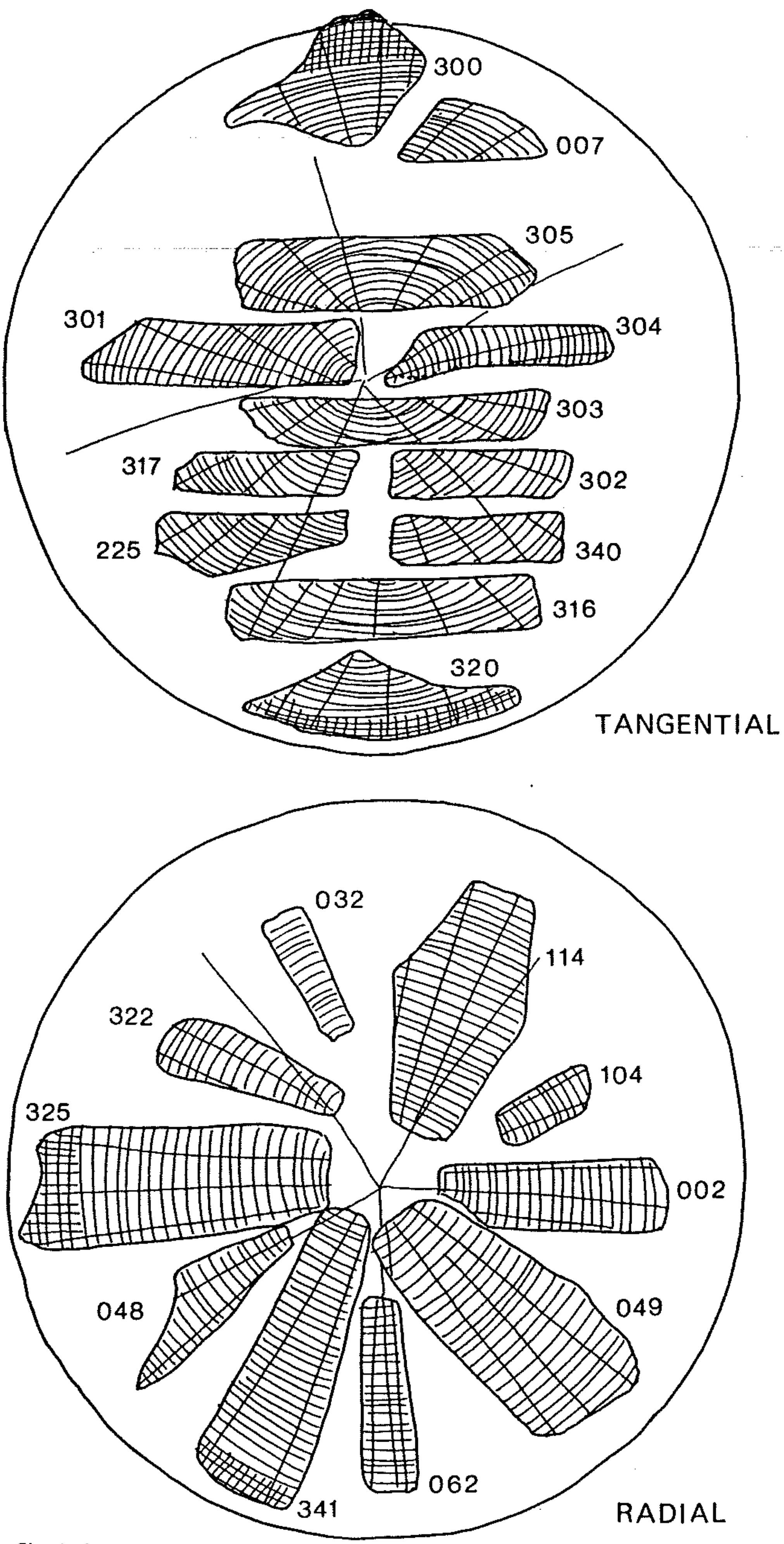

FIG.2. Sketch sections of two tree trunks (not to scale). The upper trunk shows the tangential method of splitting, with sections of planks from the trackway; the lower trunk shows radial splitting, with sections of planks and stakes. Hatching represents sapwood and bark is also present on 300.

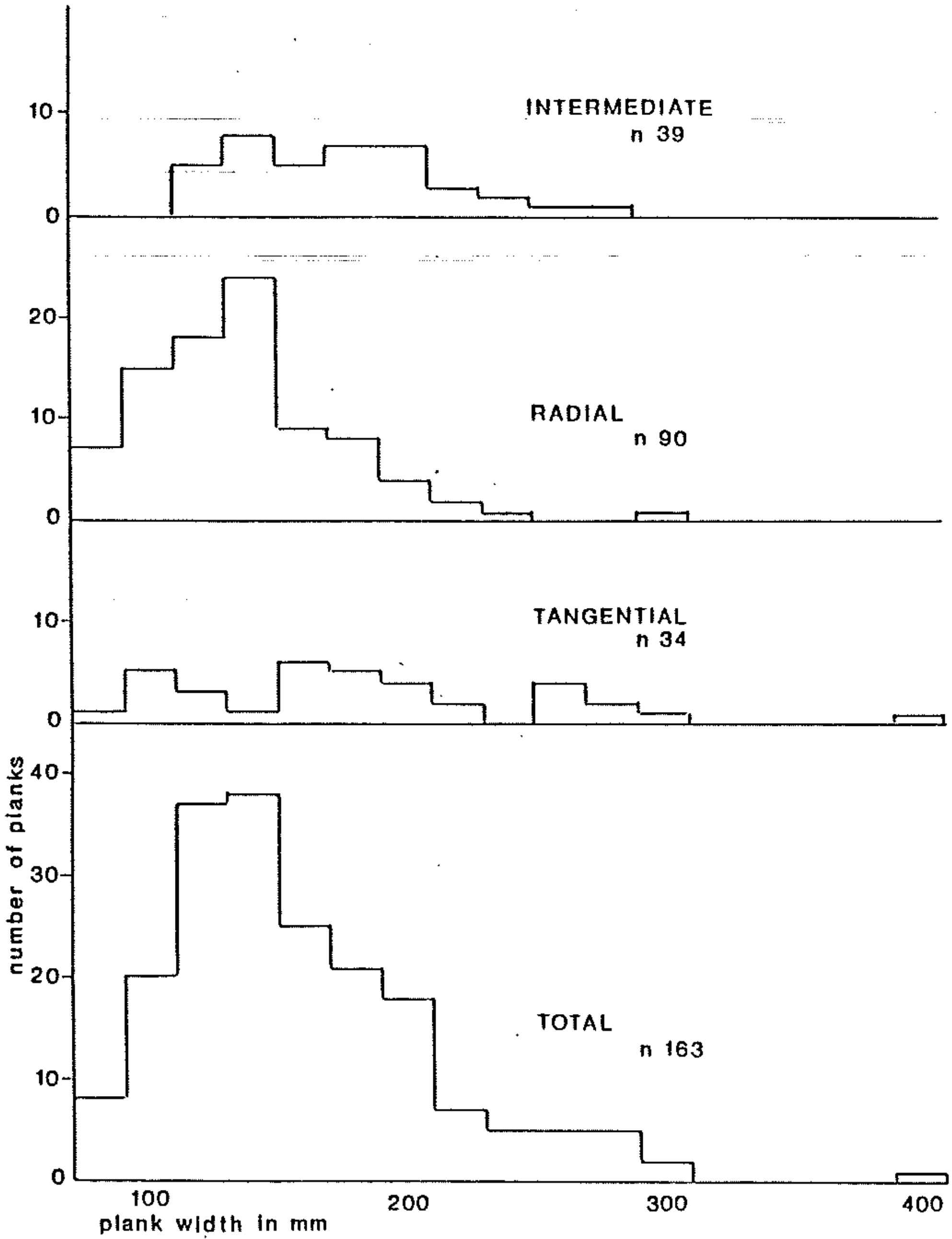

FIG. 3. Histograms showing the range in plank width among planks converted by the different methods. Data includes all planks examined since 1974.

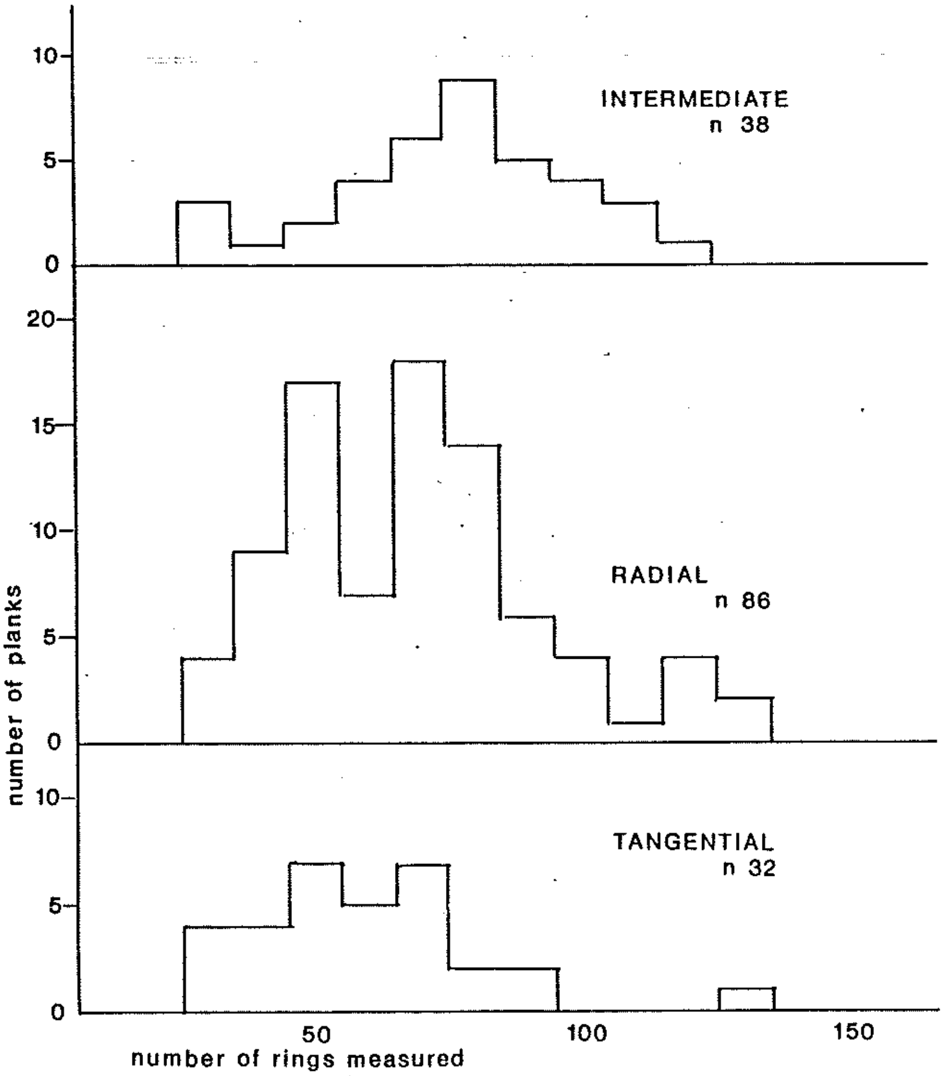

FIG. 4. Histograms showing the range in number of rings measured compared to the method of conversion of oak planks examined since 1974.

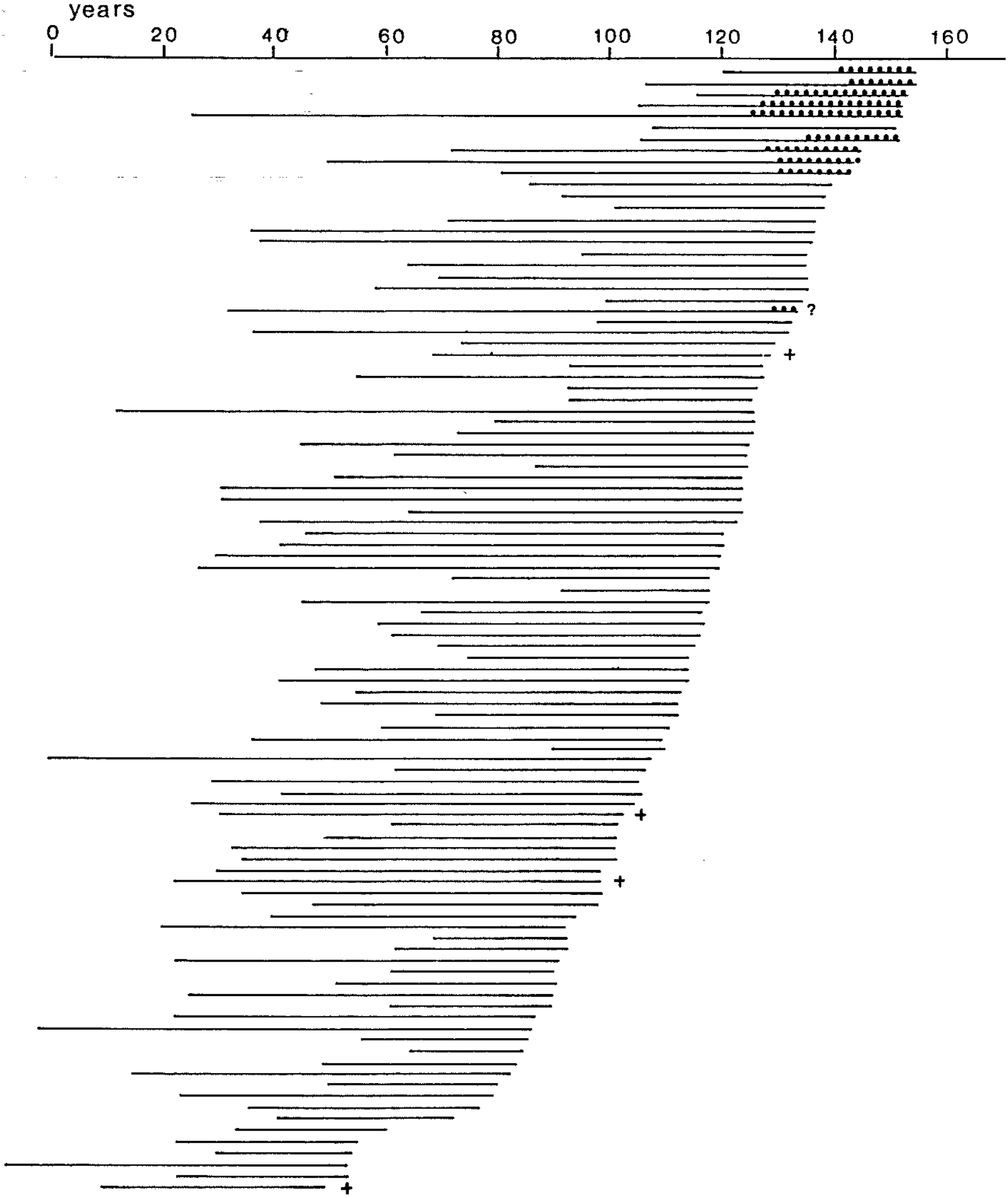

FIG. 5. Bar diagram showing the relative time span of each individual curve from wood found in 1984/85. The scale represents 'floating ' years, as yet undated. Dots represent sapwood, + indicates additional unmeasured rings.

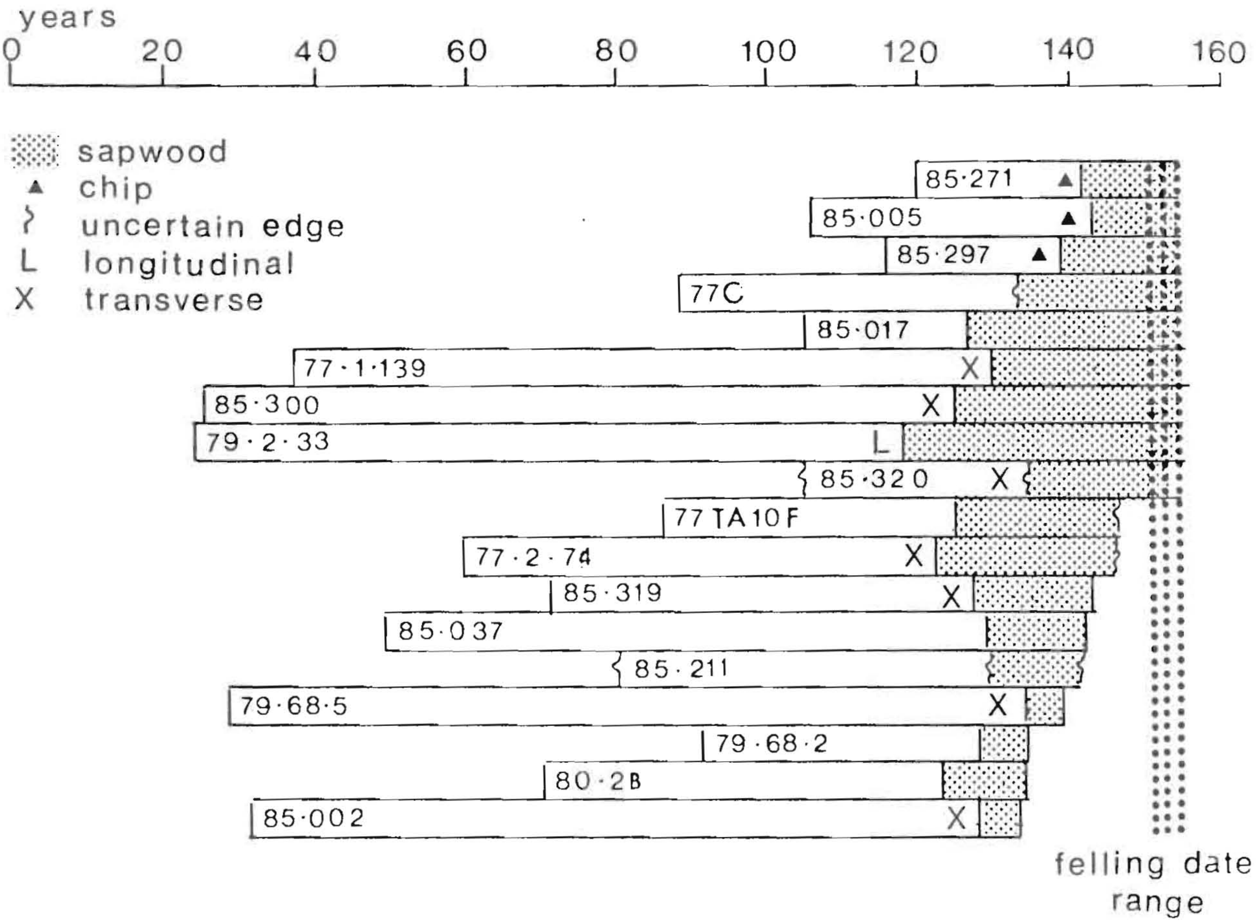

FIG. 6. Detailed bar diagram of the time span ('floating' years) of track timbers with sapwood; note the variation in year of transition to sapwood. The felling date range is now given as arbitrary years 150-155, in view of uncertainties in measuring the outer sapwood rings.

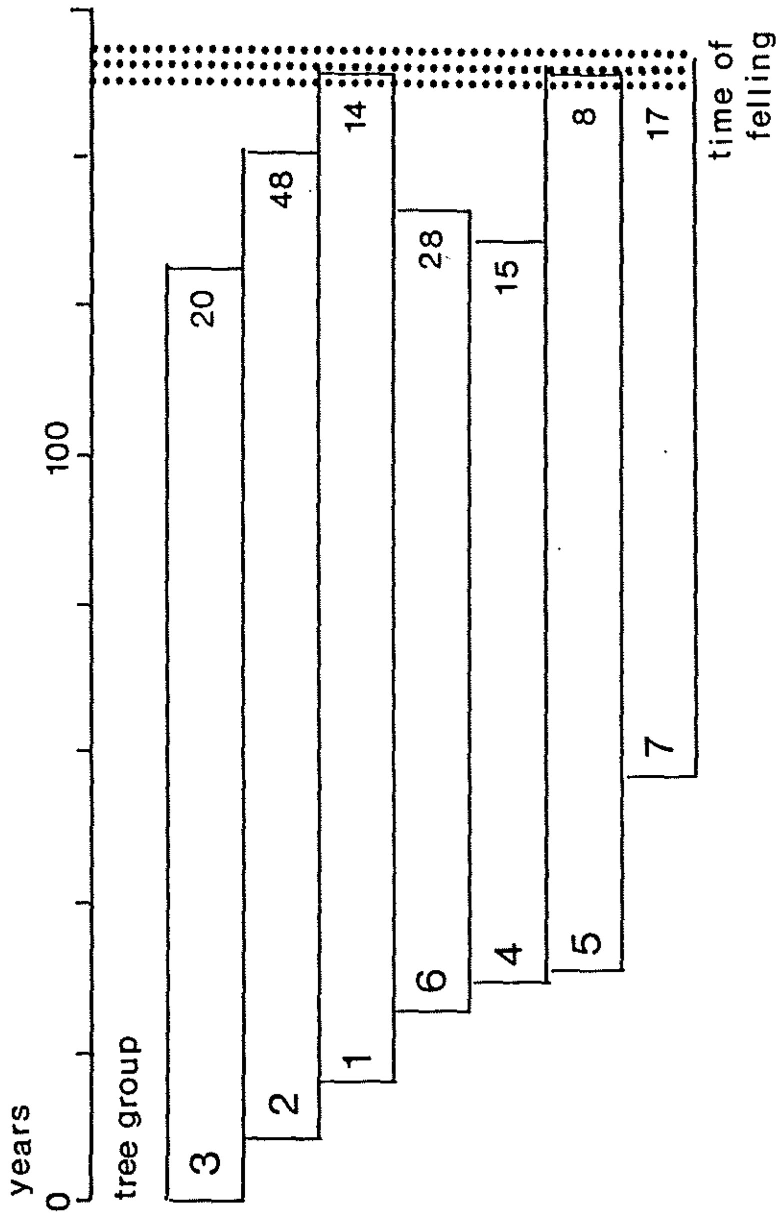

FIG. 7. Bar diagram showing the relative time span ('floating' years) of the 7 tree group chronologies. To the right of the bars are the numbers of samples belonging to each group.

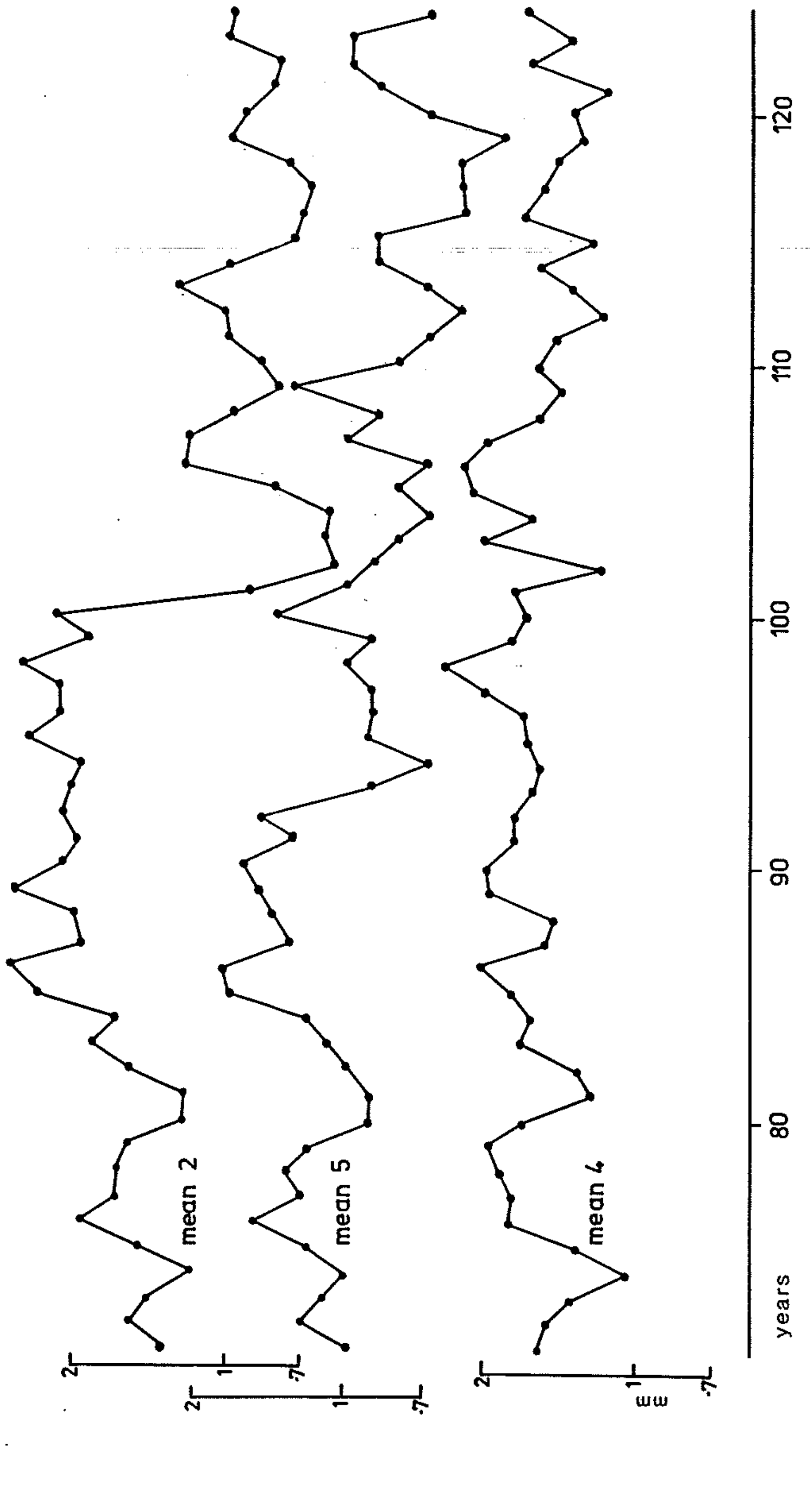

FIG. 8. Ring-width curves for three group chronologies, between arbitrary years 71 and 124. Note the sudden fall in ring-width after year 100 in group 2.

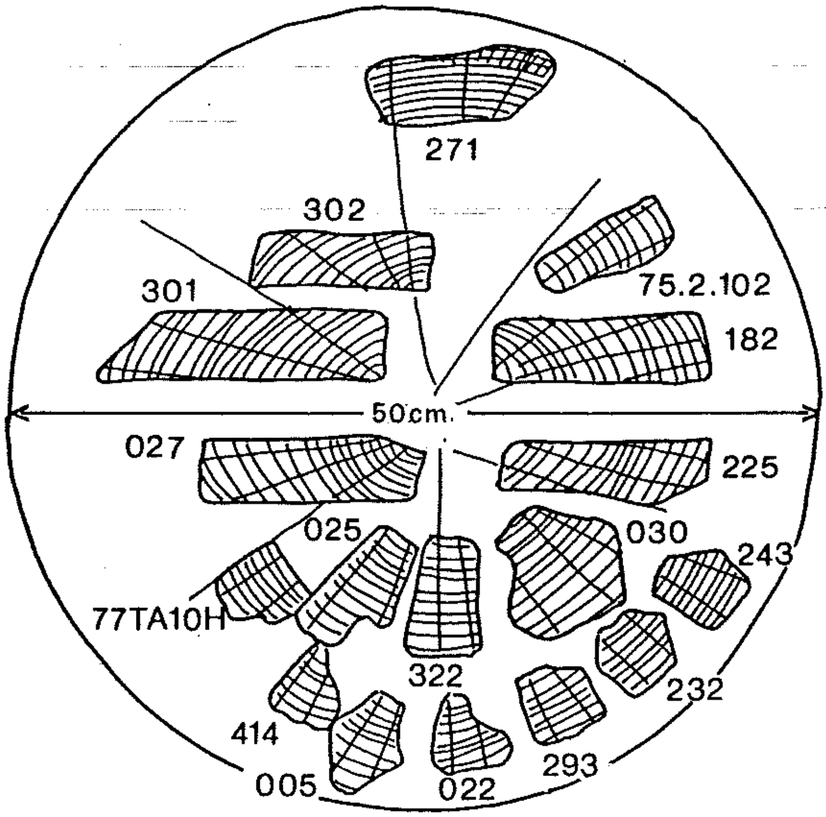

FIG. 9. Sketch section of the hypothetical tree (not to scale) producing the planks and stakes with similar growth patterns in group 7. Hatching indicates sapwood.

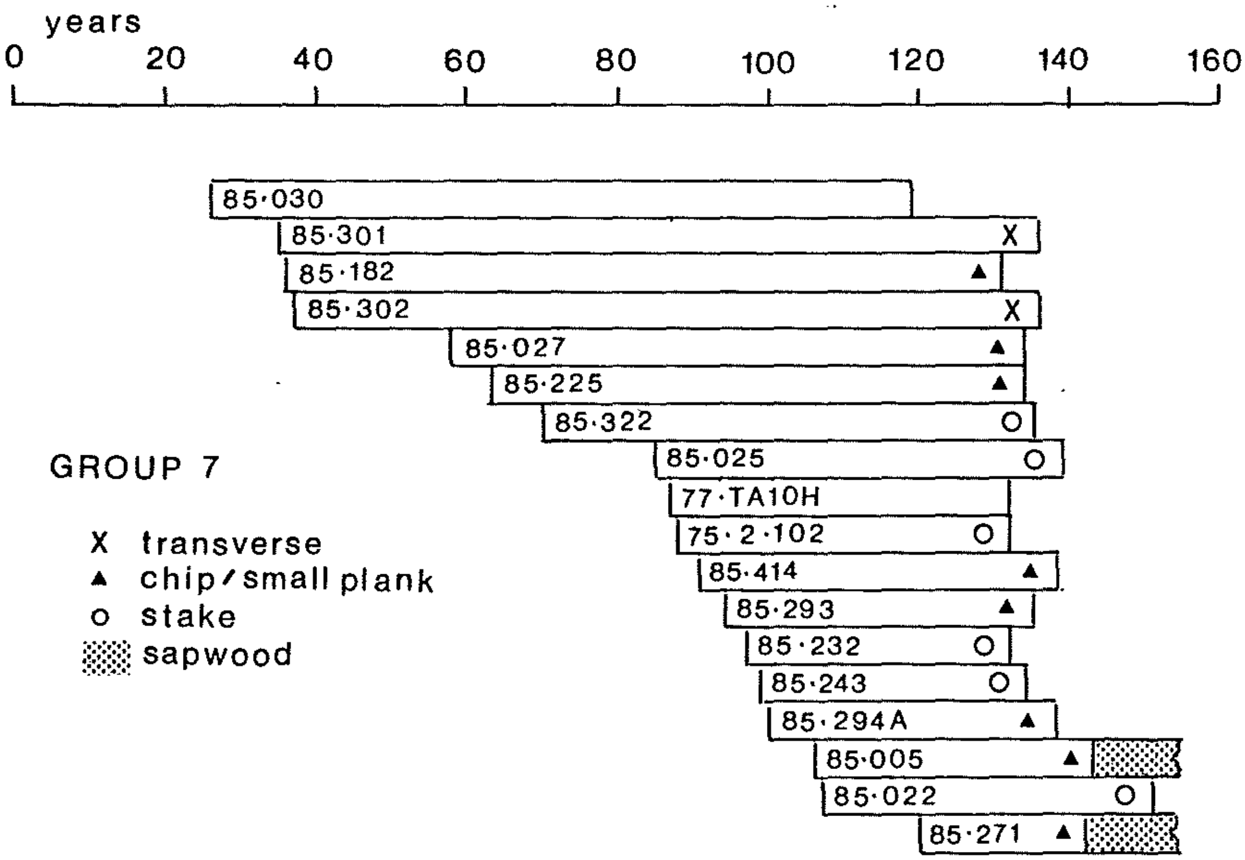

FIG. 10. Bar diagram showing the time span ('floating' years) of the components of group 7.