AML Report 3544 79. October 1981
For: Somerset Levels Papers 8 1982

TREE-RING STUDIES IN THE SOMERSET LEVELS: THE MEARE HEATH TRACK, 1974 - 1980

Ruth A. Morgan

The Meare Heath track has now been excavated at many sites particularly along the northern half of its known 1.6km and probable 2.5km length across the Levels (Coles & Orme, 1976; 1978). This intensive examination has been necessitated by the resumption of peat-cutting in the area and the drying out of the peats, which affects the quality of the wood for studies of all aspects of prehistoric wood-working including tree-ring analysis.

Tree-ring results have been published for the 1974-75 excavations on Meare Heath (Morgan in Coles & Orme, 1976 . 312-316) and for the 1977 excavations in Meare Heath Field (Morgan, 1978). This report represents a summing up of all the data from excavated timbers and those collected from the area during field walking, between 1974 and 1980. The sites or areas which have contributed samples, and their quantities, are listed in Table 1. Also shown are the numerous small finds, of timbers from disturbed contexts probably thrown into nearby ditches during previous peat-cutting. As such, their origin in the track has often been proved by the tree-ring analysis, but one disadvantage is the lack of any evidence regarding their function.

The report discusses the compilation of a final tree-ring chronology of 149 years, which represents 115 boards and stakes from the track. The main archaeological questions which might be answered to some extent by tree-ring analysis are:

1. does the growth rate and quality of cross-matching between the

ring patterns of the timbers suggest an origin in the same trees and from the same woodland, or from a more widespread environment?

2. some of the timbers in the track were split radially and some tangentially. Are the different methods of conversion related to woodworking traditions, available size of trees or to their function within the track?

3. how many trees would have been felled to build the track (cf. Coles & Orme, 1976, 311; 1978, 39)?

The amount of data now available makes it more feasible to consider these questions with some degree pf reliability.

The tree-ring chronology

The final form of the master chronology for the trackway timbers has been established by the cross-matching of 115 curves. In view of the number of components, they give a relatively short chronology of 149 years, indicating the absence of any aged trees. The board with the most rings (MHF 1977 2.33) at 126 can be contrasted with the shortest curve of 22 years (1975 2.42) from a tangential board used as a peg. Almost half the samples have less than 40 growth rings (Table 2) and only 6 exceed 100 rings.

Table 3 lists details of all the cross-matched samples. Only 11 further timbers were measured but not cross-matched, because of too few or very erratic growth rings. There is therefore no suggestion of reuse among the trackway timbers - virtually all the wood used was cut down deliberately to build the track. One or two of the timbers appear however to postdate the majority and may be later repairs (see below).

n.p. The form of the bar diagram (Fig. 1), showing the time span of each curve within the 149 year framwork, suggests that many of the timbers came from the same trees, and is partly created by the inclusion of many stakes with only 30-40 rings which could be split from the same board. Hence some timbers come from the inner parts, some from the middle and some from the outer rings of the same tree, and their rings form the pattern of gradual fall-off back in time. The same pattern occurs in the Sweet Railway curves (Morgan, 1976), although there the much wider boards came from trees over 350 years old.

About 20 samples have the pith present, or the curvature of the rings indicates its proximity. Two of these also have very high average ring-widths (1975 1.175;1977 1.152) and start the chronology. The presence of both pith and sapwood enables the tree age to be estimated at a maximum of 150 years, and possibly rather less. Radii range between 7 and 26cm with an average of 16cm; the trees were probably around 30-50cm in diameter. However the presence of so much thoroughly split wood, such as the stakes, makes it difficult to give reliable estimates.

Sapwood was preserved on 8 timbers, in widths of between 4 and 33 growth rings, the latter being the full complement and extending to the bark surface (1977 2.33). The outer ring of this sample thus represents the year of felling of the tree - arbitrary year 149. The extremely narrow outer rings make the season impossible to determine. Fig. 2 shows the chronological relationship of the samples with sapwood in more detail. The variation in the year of transition from heartwood to sapwood is quite normal; 1977 2.33 has an unusually wide zone for a tree of this age since the rings are narrow. About 20 sapwood rings would be about average; it is also feasible for 79.68 5 to have been felled at the same time with a possible 14 sapwood rings. These samples then suggest a common felling date, at least within a year or two. Reference back to Fig. 1 however shows at least 3 timbers which may be later than the majority, since their heartwood extends well beyond the sapwood transition zone. They are 77C, 77TA10 E and 77.5. They may represent later repairs to the track.

Godwin (1960) noted the presence of bark on the under surface of many transverses made from split trunks in the southern area of the track. This may be a sporadic feature, as no timbers with sapwood were found in the 1974-75 excavations - all occurred in the northern length of Meare Heath Field areas 1, 2 and TA (1977) and in Vestey's South (1979).

Initial cross-matching on the early material revealed a number of different types of growth pattern, ie those with higher or lower degrees of sensitivity, which were interpreted as belonging to individual trees or trees growing adjacent to each other. The groups consisted of A-G; A and E were quite similar except that A became much more variable in its latter half with zones of very wide and narrow rings. B represented material later in the framework with a slightly different and more sensitive growth pattern. C and F included short curves of lower sensitivity, while D was the least sensitive. Group G consisted of zones of very narrow and wide rings (mean sensitivity 0.40 compared to 0.16 for D). This pattern is reminiscent of the almost cyclic variations in the latter half of Tree 2 from the Tinney's Ground tracks (Morgan, 1978a, Table 2b). The C14 dating (see below) suggests they could be contemporary, but no cross-matching has yet been found between the two chronologies. It is possible that such a growth pattern could be related to some form of management in the area, which was obviously being intensively exploited in the last few centuries of the second millennium. The periodic release from competition caused by coppicing may produce this type of pattern. Lambert and Orcel (1977) interpret bursts of rapid growth as the effects of forest clearance on the prehistoric Swiss lake shores. Periodic flooding may also cause stress of this nature.

As more material was examined and compared, it became clear that the dividing line between the different tree groups was more and more difficult to draw. Many could still be designated E or B, but some of the shorter curves resembled all the tree groups.

It was also found that group G was equivalent to the latter half of group A. In the final analysis, 15 samples each resembled groups A/G and B, while E was represented by 24 samples. A further 31 curves resembled all the groups. There was no concentration of timbers from any particular group along the trackway. All the curves are sufficiently similar to suggest an origin in the same woodland, the differences perhaps being explained by variations in soil, density of forest cover and altitude. The E and B groups maintain reasonable growth rates of 1-2mm per year for oak; the A/G group may have originated in trees growing lower down near the Levels, where they would be more readily affected by both human interference and flooding. The trees felled for the track may not have come from such poor woodland as may have been suggested in previous reports, but they were certainly secondary and quite young, following previous clearances.

It would appear that some change took place which caused the relatively sudden decline in growth rate found in the A/G group and also 7 samples which showed a sudden fall to very narrow growth rings, almost a diffuse-porous structure. These trees did not recover their growth rates. The decline in all these cases took place between arbitrary years 90 to 115, that is, about 50 years before the trackway was built.

The raw ring-width values for each corresponding year of each of the 115 samples are in the process of being converted to indices and meaned to give a standard reference chronology, using the INDXA program (Fritts, Mosimann & Bottorff, 1969). This will be available for use in the future. Meanwhile, a working reference chronology has been calculated, using 20 random curves with a simple arithmetic mean. The mean values are given in Table 4 .

The C14 dating and calibration

Three C14 dates, resulting from wood samples taken from 30 year intervals of the tree-ring chronology (Morgan, 1978), were calibrated statistically by Dr R.M. Clark of Monash University, Australia. The calibration data consisted of 99 paired observations of C14 date and corresponding tree-ring date between 1850 and 1000 BC. He produced a 95% confidence interval for α, the date of the most recent ring of the chronology, between 1445 and 1270 BC. There is thus only a 5% chance that the date lies outside this span. Correspondingly the earliest ring of the chronology must lie within the range 1595-1420 BC. For further discussion, see Clark & Morgan (forthcoming).

Conversion of the timbers

Examination of the Meare Heath boards used as longitudinals and transverses quickly revealed differing methods of conversion from the tree - some had been split out radially, but from a tree of relatively small diameter this of course produces a board only as wide as the radius (II in Fig. 3). In order to produce a wider board, some were split out tangentially (III in Fig. 3) with the rings running parallel to the width of the board instead of across it. By this means, a board almost as wide as the tree diameter could be produced but with more effort. This type of board also splits readily in use along the rays, so it would not be ideal for walking on. The lengthwise splitting into two or more boards may have been noted on the track surface where two boards lay parallel (Coles & Orme, 1978, p.30; Bulleid, 1933). This feature was exploited in the production of stakes, which the cross-matching showed came from the same trees as the boards; they were probably made by splitting tangential boards lengthwise into two or three pieces which could then be trimmed to shape. They usually had a rectangular or pentagonal shape in cross-section (I in Fig. 3). There were a small group of timbers which simply represented the split half of the trunk with sapwood removed. Finally, there was a group of boards which were split at an angle between radial and tangential, often with the pith present or nearby and here labelled 'intermediate' (IV in Fig. 3). This too enabled a wider board to be split from a small tree.

The five types of timber were analysed by comparing different variables, such as average ring-width, age and average board width, function within the trackway (where known) and time span of the growth rings within the 149 year chronology. The results are summarised in Tables 5 and 6 , and Fig. 4 .

1. Average ring-width

The average ring-width calculated for each timber was compared to function within the track and age, to see if trees of differing growth rate and thus size were converted into different types of board. Table 5 and Fig. 4 show that split halves, stakes and tangential boards came from narrower-ringed (slower-grown) trees than radial boards and particularly intermediate boards. The last type had much wider rings and the widest average board width, so they also produced the longest ring-width curves. It seems that some of the largest and well grown trees were selected for conversion in this way, while the smaller narrow-ringed trees could be equally useful for tangential boards. The intermediate boards are unusual in showing an increase in average ring-width with increasing age, illustrated in Fig. 4 .

The similarity in average ring-width between the stakes and tangential boards (Table 5) lends support to the theory that stakes were split out from the boards,

2. Function compared to time span in the chronology

A second possibility was a connection between timbers serving similar functions in the track, and their time span within the 149 year chronology. This might suggest whether pieces intended for a particular purpose were uniformly cut from certain parts of the tree. Separate bar diagrams were prepared for the time spans of the tangential and intermediate boards, and the pegs, where their function was known. The curves for the pegs or stakes tend to lie quite early in the time scale, suggesting the use of the inner parts of the tree for this purpose. Most of the tangential boards lie between years 60 to 110, extending over the outer heartwood. The intermediate boards start much earlier in the chronology, and many extend to the 100-120 year area, probably the result of trimming of the sapwood.

3. Function compared to method of conversion

Table 6 gives the numbers of timbers serving different functions, where known, compared to the method of conversion. It was hoped that a neat pattern might emerge, such as all the transverses being tangentially cut, but in fact the opposite seemed true - either type was used for either function. Transverses were particularly random, but the majority of the longitudinals were radially split, as if the trackway builders recognised the problem of lengthwise splitting. It is unfortunate that the function of so many pieces is unknown. The figures however suggest that the method of conversion was of no importance to the ultimate purpose of each timber.

The extent of woodland exploitation

The figures given in previous reports (Coles & Orme, 1976, 311; 1978, 39) for the number of trees which must have been felled and split to build the trackway may have been underestimated to some extent. It is however difficult to extract facts and figures from forestry manuals on the average bole length of trees of this age and diameter on which to base calculations; top heights, which include the crown, are usually given. The Meare Heath boards are generally quite thick, often 5-10cm, which reduces the quantity per length of bole, and tangential boards are more wasteful. The number of trees estimated after the 1977 excavations (Coles & Orme, 1978, 39), about 60-65, could probably be doubled if not trebled.

Yield tables (Hamilton & Christie, 1971) revealed that in their lowest yield class 4, into which the Meare Heath trees appear to fall, 100 year old oaks have a diameter of 34.5cm and top height of 20.2m; the same figures for 150 year old trees are 47.4cm and 21.3m. Height growth is thus very small. Usable timber originates in approximately ½-2/3 of the top height, the remainder representing the crown. The bole might then be 10-12m long; cut into 2m lengths for conversion, which might produce 5 or 6 boards per length, of the thickness found in the track, the total of possibly 5000 boards for transverses and longitudinals might require the felling of almost 140 trees. The estimated 5000 stakes, at perhaps 20 per 2m length, would require about 40 trees. This gives a total of 180 trees to build the entire trackway.

A bog oak from Meare Heath field area 4

A section from a possible bog oak was collected from MHF area 4 in 1977 at the northern limit of the field (Coles & Orme, 1978 20). It was a tangentially split piece 35 x 21cm with 210 growth rings. Its chronological relationship to the track was unknown, though it lay about 20cm below a sickle flint and was presumed to be rather earlier. A radiocarbon sample cut from the outermost 30 growth rings gave a result of 3230 ± 70 bc (HAR 3195). The date falls within the range of those from the Sweet track, suggesting a slightly earlier felling date but every possibility of an overlap with the 382 year Sweet chronology. Computer comparison gave a possible match with the final ring of the bog oak at year 79 of the Sweet chronology (t=4.06), which would make the Meare Heath oak some 250 years earlier than the Sweet track. However, there is little possibility of finding further material with which to prove this correlation. No definite matches could be located with the Irish prehistoric chronology (Pilcher, et al, 1977).

Conclusion

Analyses of this type are only possible when suffi cient samples are available from many exposures of the same structure. The only information lacking here, which would have been valuable, is the function served by timbers found in disturbed contexts, a lack which has limited the value of the results.

The overall picture from the data as it stands (and little more of the track is expected to be found) is one of a track built from trees in local woodland which reached 100-150 years old and 30-50cm in diameter. There is no evidence of more mature trees being available. To compensate for this, other methods of converting the trees to timber were employed- tangential and intermediate boards could be wider. The method of conversion seems to be unrelated to function. Growth rates and sensitivity are consistent with conditions as they are today on the north slopes of the Poldens (from trees examined by coring), apart from the stress shown in the latter years of one group of timbers.

The 149 year tree-ring chronology which has resulted from the cross-matching of 115 curves is dated by calibrated radiocarbon determinations to 1595-1420 - 1445-1270 BC (at 95% confidence limits). Apart from providing valuable data for experience in handling large numbers of curves, the chronology is available for cross-matching and relative dating in a period when timber is appearing on other sites.

References:

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

Clark, R.M. & Morgan, R.A. forthcoming An alternative statistical approach to the calibration of floating tree-ring chronologies: two sequences from the Somerset Levels.

Coles, J.M. & Orme, B.J. 1976 The Meare Heath trackway Proc. Preh. Soc. 42 293-318

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

Fritts, H.C., Mosimann, J.E. & Bottorff, C.P. 1969 A revised computer program for standardizing tree-ring series Tree-Ring Bulletin 29 15-20

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

Hamilton, G.J. & Christie, J.M. 1971 Forestry management tables. Forestry Commission booklet no. 34

Lambert, J. & Orcel, C. 1977 L'état de la dendrochronologie en Europe occidentale et les rapports entre dendrochronologie et archéologie en Suisse Archives Suisses d'Anthropologie Générale 41 73-97

Morgan, R.A. 1976 Tree-ring studies in the Somerset Levels: the Sweet track Somerset Levels Papers 2 66-77

Morgan, R.A. 1978 Tree-ring studies in the Somerset Levels: the Meare Heath track Somerset Levels Papers 4 40-41

Morgan, R.A. 1978a Tree-ring studies in the Somerset Levels: Tinney's Ground Somerset Levels Papers 4 82-85

Pilcher, J.R., Hillam, J., Baillie, M.G.L. & Pearson, G.W. 1977 A long sub-fossil oak tree-ring chronology from the north of Ireland New Phytologist 79 713-729

Excavation year	Source	No. of samples examined (total)	No. of curves matched
1974 July/ 1975 April	Meare Heath area 1	35	23
1975 Sept	Meare Heath area 2	59	21
	Meare Heath area 3	2	2
	Meare Heath area 4	3	3
1976	Small finds in Ten Acres	17	5
1977 April	Small finds	12	7
August	Meare Heath Field area 1	23	8
	Meare Heath Field area 2	8	6
Dec	Meare Heath Drove and Ten Acres - small finds	34	20
1978	Small finds in Home Ground and Ten Acres	5	2
1979	Vestey's South	24	11
	Vestey's North	7	4
1980	Small finds in Ten Acres	3	3
	Total:	232	115

Table 1. Summary of all the tree-ring samples collected from the Meare Heath track between 1974 and 1980.

No. of rings in sample	Stakes	Inter-mediate boards	Tangential boards	Radial boards	Split halves	Total
0 - 40	55	2	8	10	-	75
40 - 60	14	3	5	19	3	44
60 - 100	4	10	3	29	1	47
100+	-	1	-	5	-	6
unknown	-	1	2	4	-	7
Total	73	17	18	67	4	179

Table 2. Summary of all the oak samples collected 1974-1980, grouped by number of growth rings and method of [illegible]

Excavation year	Sample no.	No. of rings	No. of sapwood rings	Average ring width mm	Years spanned of 149 year chronology	Conversion
1974	1.17	65		2.19	66-130	T/R
	1.22	39		1.55	86-124	R
	1.23	81		1.34	49-129	T
	1.24	69		1.64	65-133	T/R
	1.26	64		2.53	45-108	R
1974/5	1.45	63		1.89	13-75	R
	1.47	80		1.98	35-114	R
	1.56	44		1.22	64-107	T
	1.98	38		1.67	44-81	S
	1.126	47		1.26	66-112	S
	1.140	108		2.05	7-114	T/R
	1.147	28		1.64	50-77	T
	1.148	97		1.58	17-113	R
	1.151	40		2.34	72-111	T
	1.152	74		1.62	44-117	T
	1.154	47		1.4	64-110	T
	1.164	31		1.93	42-72	S
	1.165	37		1.42	70-106	S
	1.174	64+		1.94	32-95+	R
	1.175	30		3.88	7-36	R
	1.178	63		1.44	48-110	R
	1.184	75		1.35	37-111	R
	1.187	29		1.81	43-71	S
1975	2.2	57		1.15	46-102	S?
	2.8	36		1.24	50-85	S
	2.16	77		1.19	49-125	R
	2.23	46		2.04	35-80	R
	2.28	79		2.03	28-106	R
	2.29	46		1.05	48-93	S
	2.30	51		1.67	35-85	R
	2.32	51		1.65	52-102	split half
	2.35	30		1.49	41-70	S
	2.37	95		1.81	24-118	T/R
	2.42	22		1.9	38-59	T
	2.43	36		1.85	27-62	S
	2.52	69		1.79	53-121	R
	2.61	26		1.66	39-64	S

cont.

1975 cont	2.66	54		0.99	59-112	S
	2,78	26		1.55	94-119	S
	2.81	63		1.28	58-120	R
	2.87	44		1.7	36-79	R/S?
	2.99	24		1.62	48-71	S
	2.102	45		1.65	87-131	R
	2.108	61		1.42	38-98	R
	3.1	36		1.26	89-124	S
	3.2	38		1.1	57-94	S
	4.3	81		2.4	32-112	T/R
	4.5	113		1.34	17-129	R
	4.6	90		1.48	36-125	R
1976	7.1	68+		0.98	32-99+	split half
	22	44 +c10		1.63	57-100	R
	03.2	44		1.86	40-83	R
	05.8	58		1.57	66-123	R
	05.9	32		1.55	74-105	T
1977	4	53		1.44	13-65	R
	5	62		1.04	74-135	R/S?
	9	49		2.28	59-107	R
	11	79		1.54	30-108	R
	13	38		1.42	63-100	S
	15	64 +c30		1.91	24-87+	R
	17	64	20	1.2	85-148	T
	1.23	30		1.52	35-64	R
	1.50	58		1.02	59-116	split half
	1.70	c50+43		0.95	+63-105	S
	1.88	81		1.15	27-107	T/R
	1.90	59		0.78	44-102	T
	1.119	35		2.06	76-110	R
	1.139	111+c8	19	1.37	37-147+	R
	1.152	34		3.21	1-34	R
	2.32	48		2.08	42-89	R
	2.33	126	33	0.97	24-149	R
	2.50	89		1.31	23-111	R
	2.56	28		2.03	38-65	R
	2.74	88	24	1.0	59-146	R
	2.78	93		2.68	15-107	T/R
	D1	58		2.05	46-103	T/R
	D10c	77		1.62	20-96	R
	D13	91		2.2	34-124	T/R

cont.

1977 cont	D15	43		1.19	82-124	S
	D21	74		2.23	9-82	T/R
	TA1	66		1.9	50-115	T/R
	TA5	30		1.44	60-89	T
	TA6	36		1.58	97-132	S
	TA10A	59		1.38	68-126	S
	B	66		1.6	56-121	R
	C	39		2.42	54-92	R
	D	45		2.26	21-65	R
	E	111		1.16	33-143	R
	F	61	22	1.11	83-143	R
	G	59		1.94	20-78	T/R
	TA10H	46		1.48	87-132	S
	A	37		3.64	90-126	R
	B	71		1.7	28-98	R
	C	65		1.49	85-148	R
	D	49		1.26	21-69	R
1978	9.1	80		2.05	47-126	R
	9.2	80+		1.89	50-129+	R
1979	68.2	44	7	1.17	91-134	T
	68.4	45		1.42	59-103	R
	68.5	112	4	1.56	28-139	R
	68.7	66		1.83	24-89	R
	68.9	32		2.18	60-91	R
	68.10	60		2.03	35-94	R
	68.12	66		1.04	55-120	S
	68.17	84		1.42	39-122	R
	68.18	32		1.83	78-109	S
	68.19	88		1.45	35-122	R
	68.20	30		1.27	53-82	S
	91A	47		1.63	33-79	R
	91B	50		1.98	20-69	R
	91C	30		2.01	35-64	S
	91F	32		1.59	43-74	S
1980	2A	45		1.34	16-60	S
	2B	65	11	1.32	70-134	S?
	2C	75		2.17	37-111	R

Table 3. Details of the 115 cross-matched oak curves. In the conversion column, R denotes radial, T tangential, T/R intermediate, and S stake.

	0	1	2	3	4	5	6	7	8	9	T
0		49.0	47.0	38.0	26.0	28.0	19.0	50.0	41.0	43.5	2
10	21.5	35.0	38.0	51.0	36.5	26.3	37.7	31.7	29.2	34.3	4
20	40.2	39.2	34.8	34.2	32.7	31.3	21.7	25.0	32.7	30.1	10
30	20.8	16.0	16.6	22.5	21.2	30.7	33.0	33.3	33.1	31.1	12
40	43.3	39.7	43.7	39.9	39.9	32.5	43.1	48.2	44.4	30.7	15
50	24.9	38.6	28.9	26.4	27.1	19.2	24.1	30.8	24.5	19.8	17
60	25.6	24.6	35.2	21.7	26.8	14.0	16.5	15.4	13.0	11.9	17
70	9.8	10.8	12.6	11.8	11.4	15.2	16.9	15.4	14.9	14.0	16
80	10.2	9.9	12.7	15.3	15.4	18.2	20.8	15.9	16.7	19.2	16
90	15.5	14.9	15.9	15.8	16.1	19.5	17.0	17.7	18.7	14.9	15
100	15.5	11.1	9.2	11.4	11.9	12.7	15.3	17.6	11.6	11.7	12
110	11.7	11.2	9.5	12.0	9.4	6.9	8.1	9.6	9.3	9.3	7
120	8.7	8.3	6.9	9.3	9.3	8.2	5.0	6.0	9.0	12.2	4
130	12.0	5.3	6.7	8.3	5.3	9.7	7.0	8.0	10.7	9.7	3
140	3.5	6.0	6.5	4.5	5.0	6.0	7.5	4.0	5.0	5.0	1

Table 4. Mean ring-width values (0.1mm) for a working reference chronology spanning 149 years. It is represented by 20 curves picked at random. A chronology in indices representing all 115

Type of board	Average ring width mm	Average board width mm	No. of samples
Stakes	1.41		
Radial boards	1.79	122	60
Tangential boards	1.45	148	16
Intermediate boards	2.00	174	14
Split halves	1.22		
Final average	1.654		

Table 5. Comparison of the average ring-widths and board widths with the method of conversion.

Function in trackway	Radial boards	Tangential boards	Inter-mediate boards	Split halves	Stakes/ slats
Transverses	17	9	7	2	1
Longitudinals	9	2	4	-	1
Pegs	5	1	-	-	29
Unknown	33	6	5	1	23

Table 6. Comparison of method of conversion with function in the trackway.

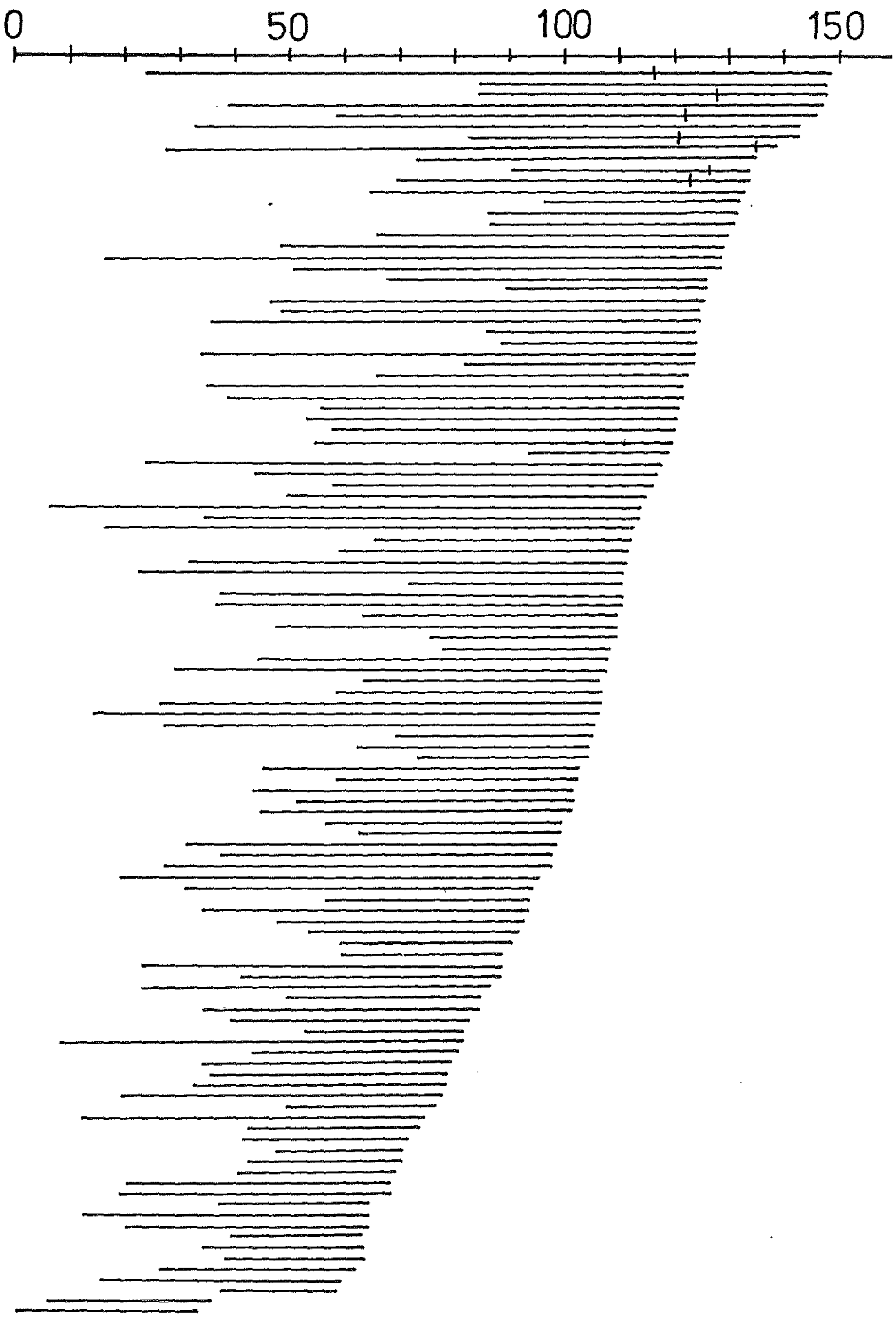
Legends to figures:

Fig. 1 Bar diagram illustrating the years spanned by each curve within the framework of the 149 year chronology. The regular fall-off back in time results from the conversion of trees into many boards and stakes. Vertical . on the upper bars denote the transition from heartwood to sapwood. The timber with the outermost ring dating to arbitrary year 149 extends to the bark surface; this year represents the year of felling for most of the trees.

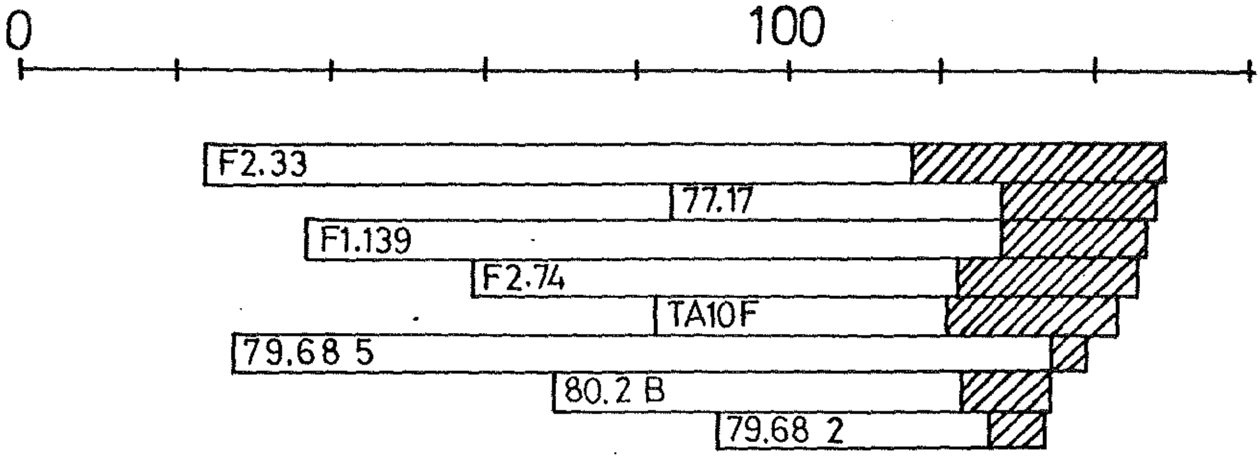
Fig. 2 Curves from the timbers with sapwood (hatched) shown in greater detail; the variation in the year of transition to sapwood is quite normal.

Fig. 3 Sketch diagram showing four of the groups into which the timbers have been divided according to their method of conversion. I - stakes, II radial boards, III tangential boards (here with some sapwood) and IV intermediate boards split at an angle to the rays.

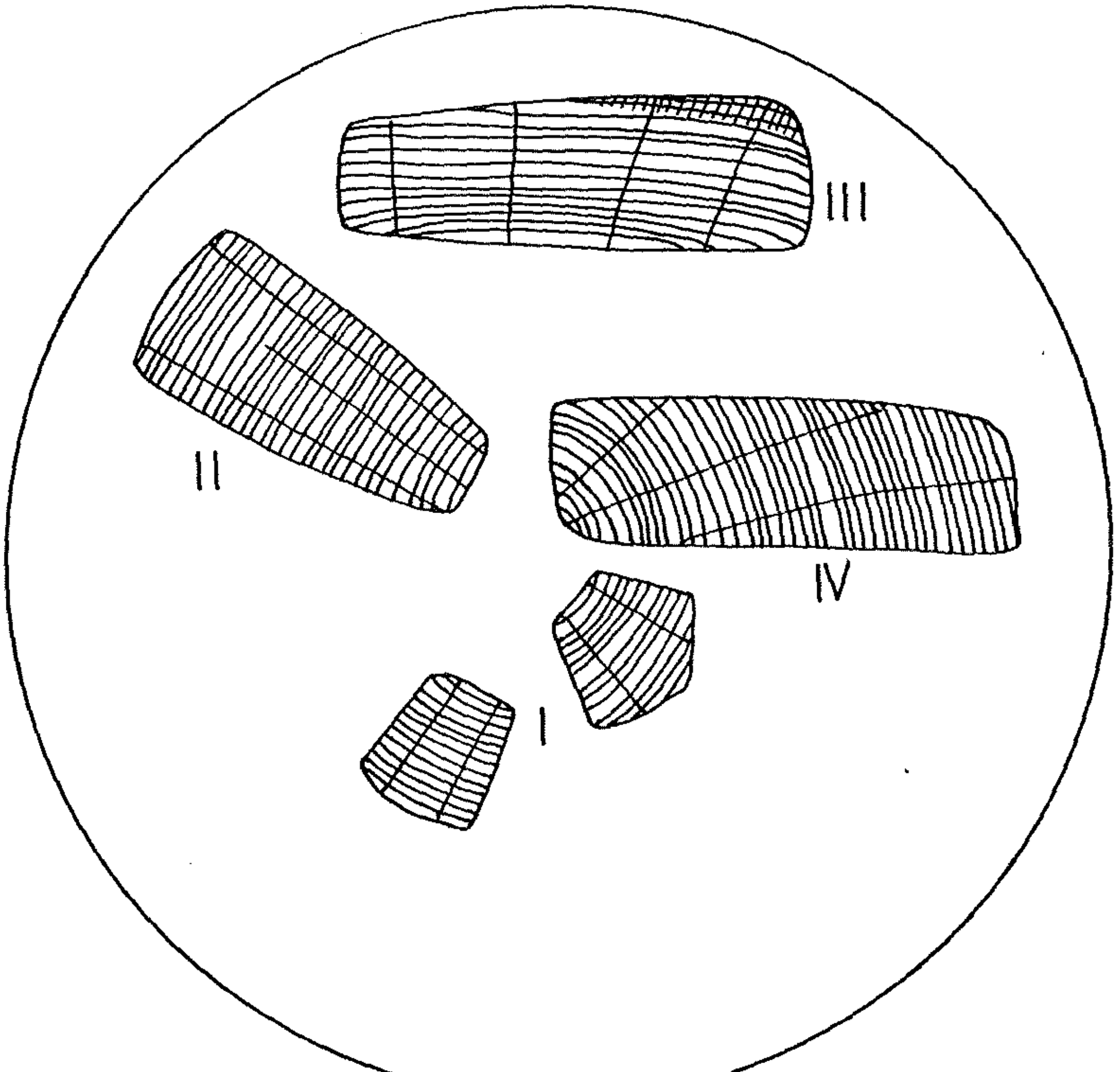
Fig. 4 Distribution of the timbers according to function, average ring-width and age. The scatter clearly shows the decline in average ring-width with age, except in the case of the intermediate boards. The narrow rings of the tangential boards are also apparent. Two of the three very wide-ringed samples lie close to the pith; the third is unique since its growth pattern matches nearer the outside of the tree.



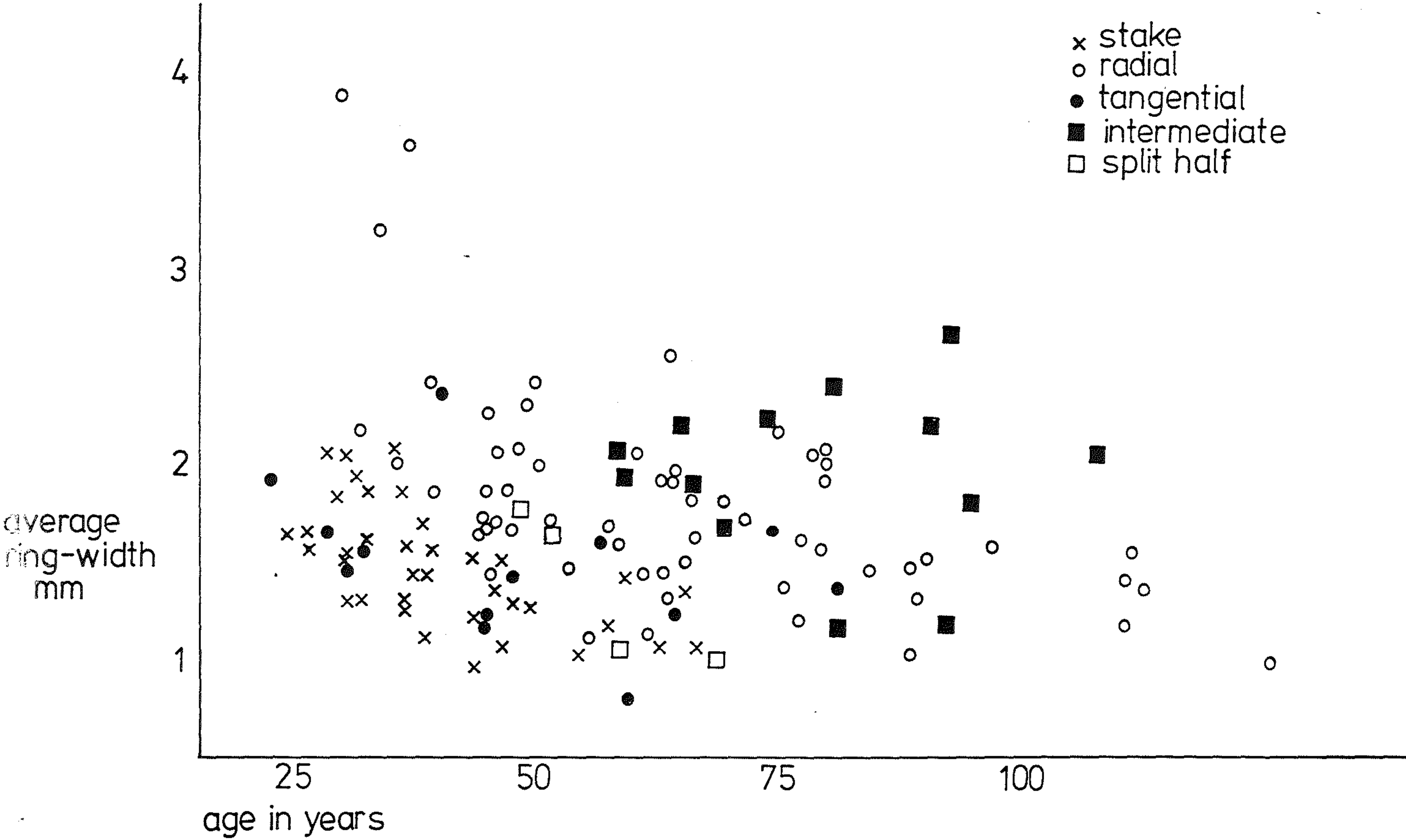
Morgan MH
Fig. 1



Morgan MH fig.



Morgan MH fig 3



Morgan MH fig.