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CURRENT TREE-RING RESEARCH IN THE SOMERSET LEVELS

Ruth A. Morgan

SUMMARY

The paper considers the need for extensive sampling of wood from the Somerset Levels trackways, as well as various aspects of practical analysis and data study. The evidence for either coppicing or random collection of young stems of hazel, alder, birch and other species is discussed. Mention is made of the need for modern comparative analysis of growth patterns in these species.

The second part considers results from more substantial oak timbers in three trackways of Neolithic and late Bronze Age date. The relationships between ring-width curves of the boards, linked into floating tree-ring chronologies, help to determine how the trackways were built, and the type of woodland exploited. The floating chronologies are invaluable for relative dating; they have also been subjected to thorough radiocarbon dating and statistical calibration.

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Heading summary

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Current sampling strategy

Excavation and research on the archaeology of the Somerset Levels are becoming more and more urgent. For the sake of peat extraction and modern farming techniques, the problems of drainage are being tackled continuously. They are resulting not only in the removal of parts of the prehistoric trackways and artefacts from the banks of the drains and edges of the cuts, but also in such a severe lowering of the water table that even the deepest lying wood is threatened with drying out and rapid decay. Even where the peat is not being cut, the root systems of trees growing above are penetrating and weakening the wood,

For example, the Iron Age Meare Village West excavated in 1979 (Orme, Coles, Caseldine & Bailey, 1981) produced only hard and very dry fragments of wood after prolonged drying out of the clay deposits, but their very hardness enabled them to survive analysis. In this they are unusual. On earlier sites, such as the Neolithic Sweet track (Coles & Orme, 1981), the wood in some parts has been found to have deteriorated rapidly even in the last few years between excavations; either it cannot be lifted at all and take its own weight, or the processes of examination (such as deep-freezing) cause its disintegration. The threat to sections of trackway still in the ground is very real.

Peat extraction is causing the rapid removal, section by section, of entire trackways, although the companies are extremely helpful in giving information and delaying their activities until excavation is completed. The complex in a field called Tinney's Ground (Coles & Orme, 1980) was only discovered in 1973; the tracks have now been completely removed. With such imminent and total losses in view, sampling for tree-ring analysis has become more and more extensive; it now involves the examination of virtually every piece from a heavy timber-built trackway, and a wide selection from specified parts of a hurdle or brushwood structure.

In the early stages of this work, sampling extended only to the oak boards on which to build classic tree-ring chronologies. The potential of other classes of wood was not appreciated until gradually the excavation of varied types of site began to expose the variety of information which might be forthcoming, given thorough sampling of both timbers and the young stems of many species. Now experience of working on wood of all sizes and species since tree-ring studies began on the tracks in 1973 has enabled a format of details and queries to be produced, so that sampling on each type of structure is as efficient as possible and no vital evidence is lost.

Examination of the wood and data analysis

The first piece of information required is of course the wood species itself, which indicates the range of trees and shrubs available in the locality and the particular use they were being put to by the trackway builders. Wood identification is not generally carried out by the DoE dendrochronology laboratory at Sheffield University, but by the Somerset Levels Project's environmental staff at Exeter University; the reasons for the two studies not being combined are threefold:

1. Identification requires high magnification in trans-

mitted light, whereas tree-ring studies involve magnification of only up to x30 and usually x10 in reflected light.

2. Identification makes use of thin sections cut in all three directions while tree-ring studies make use of the cleaned up transverse surface only.

3. Identification can be very time-consuming, particularly when more obscure wood species occur.

4. A very comprehensive reference collection of thin sections and blocks of all wood species must be built up if identification is to be undertaken in quantity.

Short cross-sections of the trackway wood, each one bagged and labelled with Dymo tape, arrive in the laboratory to be cut, washed and deep-frozen. The transverse surface is then easily cleaned with a plane (Stanley Surform) to reveal the wood structure clearly. Woods involved include oak (*Quercus*), ash (*Fraxinus*), hazel (*Corylus*), alder (*Alnus*) and birch (*Betula*), with occasional lime (*Tilia*), elm (*Ulmus*), holly (*Ilex*) and willow (*Salix*). For each piece, the diameter of the stem is recorded, followed by the number of growth rings (to say 'annual' would be inappropriate, since many of these species' growth patterns have never been recorded and some suggest anomalous features), and details are noted of the growth rate from the widths of the rings, particularly the innermost and outermost rings. A very narrow inner (Rackham, 1977 67) or outer ring may suggest cutting in summer, while completed growth indicates the more usual practice of winter cutting when the sap is not rising. If there are more than about 20 growth rings, the width of each one will be measured under the microscope, using a travelling stage and electronic measuring device (Fig. 1). For further details of the method, see Morgan, 1975 and forthcoming; Hillam, 1979.

In order to produce statistically reliable results, brushwood bundle, that is, a sample of each stem across the hurdle. In this way, the age structure of the entire length of trackway can be determined. One difficulty in the case of very long stems or rods is where to collect the samples - the top end of the stem will of course be younger than the base. Where possible, duplicate samples are taken from top and base; the age and diameter of each indicate the speed and evenness of growth, and the use of the age value for the stem base avoids including misleadingly low figures in the final analysis(Fig. 2).

The data from the stems within each track can then be plotted and compared by function and species. After calculating the average age and diameter, and their range, the distribution can be illustrated in a scatter diagram (Fig. 3 right). Regression analysis enables a line to be plotted on the scatter, the slope of which indicates the rate of growth - the steeper the line, the faster the growth. Two contrasting sites are shown in Fig. 3 right - the concentration of alder stems from a brushwood bundle track (TIN A 77) compared to the wide scatter from the Baker platform (for the interpretation,see below).

The data can be further represented by histograms showing the number of stems in each age group; again Fig. 3 left compares the alder brushwood concentration of TIN A 77 with the Baker alder samples.

Stems of various species in hurdle/brushwood tracks

The evidence for coppicing

As the results of stem analyses accumulate and the various distribution diagrams can be compared, it is possible to search for reasons for the different patterns. It is clear now that the trackway builders were not only well aware of the advantages of using wood of certain species for particular purposes, but also of how to produce wood of the size they needed. If the correct size of stems was not naturally available, they deliberately cut back the main stem to produce a crop of long straight rods from the stool. This would happen readily by accident; on a regular rotation of cutting, it becomes coppice management. Hazel is the tree which is most usually associated with coppicing, but many species regenerate in this way (Rackham, 1976 34-5).

Coppice management is evident from physical features of the wood itself - the swollen torn heels and straightness of the stems(Rackham, 1977); it is also determined by the concentrations of stems of a certain age found by ring counts. Fig. 3 shows the type of pattern produced from alder coppice at TIN A 77 (Morgan, 1980) - the peak in the histogram and dense concentration in the distribution of age compared to diameter. The age concentrations vary; they are 7-8 years in TIN A 77, 2-6 years in TIN D (contemporary parallel structures both of which were of alder brushwood), or 3-6 years in the hazel rods at Rowland's (Morgan, 1977).

The reasons for the choice of different aged stems might be considered, particularly in the case of contemporary structures such as in Tinney's Ground - perhaps different areas of coppice were being exploited, or perhaps two different groups of builders preferred to work with certain sizes of wood according to tradition. For the hurdles, the wood is generally of the order of 7-8 years old, the same age as it is cut today on the standard hazel coppice cycle for the manufacture of hurdles. However, of course this depends more on growth rate and thus diameter. As Rackham (1977 67) suggests, the practice of drawing might better explain the often quite wide variation in age - here the stems of the correct size were selected from the stool irrespective of age, so that some would have few wide rings and others many narrow ones. The importance of examining the age and diameter together cannot be overemphasised.

Pollarding, the cutting back of the main stem above grazing level, also produces a crop of poles which could be used; the effect of the practice on the growth rings of the main stem, if this were to be used for timber, has never been examined.

Random collection

For the less formal structures, such as the Baker platform, a late Neolithic deposit of heavy roundwood and brushwood to consolidate the wet terminal to the Bell track (Coles, Fleming & Orme, 1980), the data suggests the lack of any clustering in age or size in any of the five species plotted, except perhaps in the case of willow (Morgan, 1980a). This structure was probably built of any available stems collected in the woodland, or left over from other woodworking activities, and thrown down on the wet surface. This is attested not only by the range in size and age, but also by the range of species. It is of interest that alder seems to have been favoured for boards at this time; both on the platform and the broadly contemporary Abbot's Way (Coles & Orme, 1976), it was split from relatively mature trees which must have been widely available nearby.

Growth rate

The widths of the annual rings, or the growth rate, can give some information on the type of environment in which the trees grew, whether wet or dry, sloping or flat, in competition or open. Very wet conditions result in rapid uniform growth often seen in alder and willow; drier conditions on a hill slope result in rings which are narrower and vary in width from year to year (sensitive) according to the climate and other factors. Different species also have different preferences. Such comments can of course only be of a very general nature, but patterns begin to emerge as the evidence is accumulated and compared. Data from each species within each track is currently being collated to analyse any changes which may have taken place through time and between trackways and areas. Such studies are only possible within the framework of continuous projects as in the Levels.

Where sufficient rings exist for measurement, about 20 or more, the growth patterns of stems of one species within a trackway are usually very similar, as might be expected from a common source. Sometimes too the pattern resembles those from other species, as in hazel and alder from the Baker platform (Morgan, 1980a 26) or the Abbot's Way (Morgan, 1976a). Alternatively the pattern may resemble that from other nearby trackways as is the case of the hazel at Rowlands and Walton (Fig.4)(Morgan, 1977). The problem with attempting to assume their contemporaneity from this correspondence in growth pattern is that little is known about growth rates and patterns among many of these species, nor about the effect of coppicing on the growth pattern. It may be that the very cycle of cutting and regrowth produces a characteristic pattern in the stems which is unconnected to climatic or other factors. The narrow rings in years 18 and 26 (Fig. 4) may be caused by topping (Rackham, 1977 71).

Modern hazel

A study of modern hazel coppice is now being initiated using material from the counties of Lincolnshire and Avon (thanks to Mr Lewis and Mr Cram respectively); these are ash and oak/lime woodlands with hazel understorey, which are being converted back to their original coppice-with-standards condition. Small samples will be cut from all the stems in adjacent and separate stools, accompanied by records of age, cutting cycles, evidence of topping, etc. which can be compared to the growth patterns. This should make clearer the effect of coppicing on the growth rate and age distribution.

Sections of hazel stems from a Midlands hedgerow (thanks to Dr C. Salisbury of Nottingham) revealed some features also noted in the Somerset hazel. In particular there was often a series of very narrow or even only locally present growth rings around the outside. It is not clear whether these are annual or inter-annual, but in view of the apparent dieback of the hedgerow in question, they may represent a rapid fall in growth rate. If inter-annual, they must represent some particular growth feature of hazel in its current year of growth, since they are not apparent in earlier rings. The study of such details in modern wood will help to formulate ideas about the situation in prehistoric times.

Oak in the timber tracks

The approach to studying the oak material must be rather different since it rarely occurs as young roundwood. The plotted ring-width curves from each timber can be compared both visually and by computer one with another, until they are linked into a relative chronological framework. Unlike a complex urban archaeological site where timbers date to different periods and may have different origins, here the timbers might be expected to be contemporary and to have come from the same source, except perhaps for the odd repair. However, the situation ~~is~~ not always as straightforward as this.

Three trackways are at present under consideration.

The Sweet track

This early Neolithic structure consists of a one board wide walkway of oak boards, supported on a rail and peg substructure of other wood species, which can be analysed as already described. The trackway has now been examined over several long stretches of its 1500m length across the Levels, at the Drove (Coles & Orme, 1979), Burtle and Factory sites (Coles, Hibbert & Orme, 1973) in the south, At the Railway (Coles & Orme, 1976a) and South Drain sites towards the centre, and currently (during 1981) in field T towards the north . The sites are shown in Fig. 5 . The repeated opportunity to examine the same structure is invaluable for all concerned, since it enables not only more thorough research projects to be formulated, but also comparisons to be made between different parts of the same track.

The first thoroughly sampled site was the Railway site of 1973, from which the growth patterns of 168 boards were correlated into a 314 year chronology (Morgan, 1976). Only one or two failed to conform to the same growth pattern, and it was evident that the fine wide radial boards had all been split from a few very old trees, probably almost 400 years old and 1m or more in diameter. This is a formidable undertaking with only stone tools. The age and growth rate were as we might expect today in scattered parkland oaks with short stocky boles.

The interpretation of the bar diagram forms an important part of tree-ring analysis. Each line represents the years spanned by an individual timber, within the relative framework of all the cross-matched timbers (Fig.6). The Railway curves show a regular fall-off back in time, indicating that some boards came from the inner trunk, some from the middle and some from the outer trunk of the same trees after the bark and sapwood had been removed. The position within the chronology can be compared to the board's location within the track; as no pattern or concentration was found, it can be assumed that the trees were converted to boards at the felling site and mixed randomly during construction.

The bar diagram contrasts with that from the Drove site boards, though this site produced only 19 cross-matching curves covering a span of 154 years (Morgan, 1979). The trees used were much younger and still growing vigorously, whereas the aged Railway trees were growing very slowly towards the latter part of the chronology. The smaller trees enabled only a few boards to be split from each, and thus most of their growth curves extend almost to the outside of the tree. There is as a result a concentration of curves ending at a similar time. This is the more usual pattern for the bar diagram from, for example, a timber building.

The contrast between the timber of the two sites, some 600m apart, is quite dramatic. It can be suggested that two different areas of woodland were being cut down, perhaps by two different teams of trackway builders. Possibly one group was cutting down young straight oaks from already exploited and regenerated woodland on the more accessible Poldens and building the track up from the south, while another group was laboriously cutting down primary ancient oaks on the Westhay/Meare 'island' and building down from the north.

The key area for resolving this differnce between the two sites lies under Shapwick Heath owned by the Nature Conservancy. For the purpose of drawing up a priority document on the entire trackway, which is fast drying out in places, test excavations are taking place to examine the character of the track and take samples to see if this change in the use of young or ancient trees is gradual or abrupt (Coles & Orme, 1981). The track to the north of the South Drain is also unknown, so it will be of interest to see if the current samples from field T conform to the Railway pattern.

The Meare Heath track

This late Bronze Age trackway was constructed of one or two longitudinal boards resting on transverse boards pegged down at either end (Coles & Orme, 1976b;1978). Cross-matching of 115 curves into a 149 year chronology revealed that all the timbers, including the stakes, had been split from trees 100-150 years old and 30-50cm in diameter. Different tree groups could be identified, one of which showed signs of severe stress in the last few decades, perhaps due to coppice management or periodic waterlogging. No variations comparable to those in the Sweet track were observed in the 500m of trackway examined (Morgan, in Coles & Orme, 1976b 312-316; 1978).

The oak boards used in the track proved to have been split in various directions, radial, tangential, at an angle between the two ('intermediate') and simple split halves. The stakes probably originated in lengthwise splitting of tangential boards. Various analyses have been carried out comparing the method of conversion to the average ring-width, to the position of the curve within the tree-ring chronology and to the function performed by the board in the track. There was little evidence that function influenced the method of conversion. The stakes generally seemed to come from the inner trees and the intermediate boards extended right across the trunk. Data related to average ring-width, conversion method and age is plotted in Fig. 7 , showing the greater age and growth rate of the intermediate boards. The tangential boards generally had narrower rings.

Tinney's Ground

The alder brushwood tracks already mentioned, crossing the field parallel to each other, were supported by scattered groups of oak boards (Coles,Orme, Hibbert & Jones, 1975; Coles & Orme, 1978a, 1980). Superfluous holes indicated their reuse from another structure. A total of 23 curves from the boards cross-matched into a 249 year chronology, showing that more mature trees were available locally in the late Bronze Age, perhaps farther to the east than would be suitable for the Meare Heath track. They also show a period of severe stress in the latter years, with groups of very narrow rings followed by groups of very wide rings on an almost regular cycle.

Three groups of curves could be determined, probably representing the same or adjacent trees. It was found that boards from the same tree occurred in at least two of the parallel tracks, TIN A and TIN D which lies some 60m to the north. So they were constructed using oak boards from the same structure, if not in the same year, at least very soon after one another.

No cross-matching has yet been found between the two late Bronze Age chronologies from Tinney's and Meare Heath, despite the likelihood of some overlap. The Tinney's chronology was rather uncertainly dated even by radiocarbon determinations; its relationship to the alder brushwood, which represents the actual construction date, and on which the radiocarbon dates were based, was unknown. The boards must be earlier, whether by years or decades. Radiocarbon samples were thus cut from groups of rings of known relative age (enabling the correct allowances for growth to be made) from all three chronologies, in an attempt to fix their calendar dates as closely as possible (Morgan, 1979a). The results have been statistically calibrated by Dr R.M. Clark (Clark & Morgan, forthcoming) to give the position of best fit with the bristlecone pine data, and they give the most accurate indication of the range of calendar dates between which the trees were growing. With a 95% confidence interval, the date ranges are:

Sweet	4095-3825 - 3695-3425 BC
Meare Heath	1595-1420 - 1445-1270 BC
Tinney's	1640-1310 - 1390-1060 BC

No correlations have yet been found with reference chronologies for Ireland (Pilcher et al, 1977) or Germany (Becker & Delorme, 1978) which span the prehistoric period.

Tree-ring studies on the trackways of the Somerset Levels will continue as long as the excavations go on, as each new section of each track produces new and exciting results and opens up some new aspect for research. The rapid removal and decay of these structures makes their intensive study even more vital.

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Legends to Figures:

Fig. 1 The tree-ring measuring machine used in the DoE dendrochronology laboratory at Sheffield University. The slice of planed wood lies on a long travelling stage and is viewed through a binocular microscope at x10. The stage is moved along to traverse each growth ring; the distance travelled is recorded electronically by the linear transducer (the rod in the centre of the photo) and displayed on the panelmeter on the left.

Fig. 2 Illustration of a late Neolithic hurdle (above) showing the various features which can be analysed. The longitudinals are named rods and they are woven around sails. Most of the wood is hazel, with a little birch, the bark of which can be recognised. The table below lists the typical age and diameter recorded for each group of stems, based on the Rowland's track (Morgan, 1977).

Fig. 3 Having recorded the age and diameter of each stem, the data is presented in two ways - the histogram (left) and the scatter diagram (right). Two sites are compared here; the alder stems from Tinney's Ground are clearly concentrated at an age of 7-8 years suggesting an origin in coppiced woodland, while those from the Baker platform show no concentrations and were probably collected at random.

Fig. 4 Ring-width patterns of hazel stems from Walton and Rowland's reproduced from (Morgan, 1977). The pattern is very similar in all; it is not yet clear whether this represents contemporaneity or is the result of coppice management.

Fig. 5 Map of the route followed by the Sweet track (reproduced from Coles & Orme, 1981). Mention is made, moving from north to south, of the current excavations in field T (1981), excavations at SA beside the South Drain (1979), the Railway site (1973), an unknown length below Shapwick Heath Nature Reserve, and the Factory (1972), Drove (1977) and Burtle (1972) sites at the southern extremity. The higher gound of Westhay 'island' lies to the north, the Poldens to the south.

Fig. 6 Bar diagrams comparing the layout of curves from the Sweet Drove site and the Sweet Railway site. Each curve is shown spanning certain years in the chronology where it is cross-matched. The contrast between the two sites is evident - the Drove curves all end at a similar time and were all cut from most of the radius of young trees, while the Railway curves show a gradual fall-off back in time, and came from both the inner and outer parts of very large trunks.

Fig. 7 Scatter diagram comparing the method of conversion, the age and the average ring-width of all the oak timbers from the Meare Heăth track. The distributions show the gradual decline in ring-width with age within each group. Certain trees however seem to have been converted into particular types of board - the tangential boards are narrow-ringed, while the 'intermediate' boards come from older faster-grown trees,

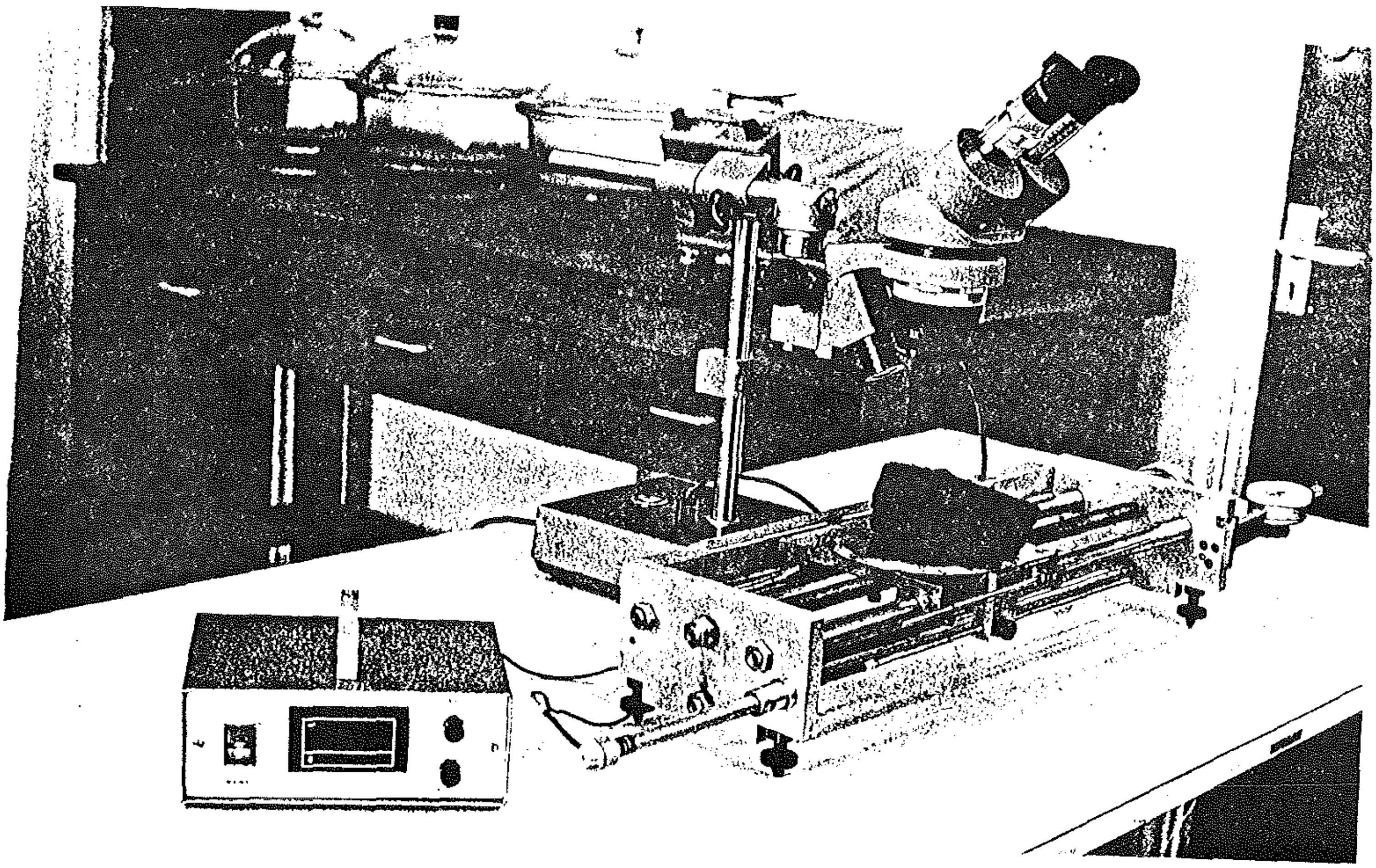
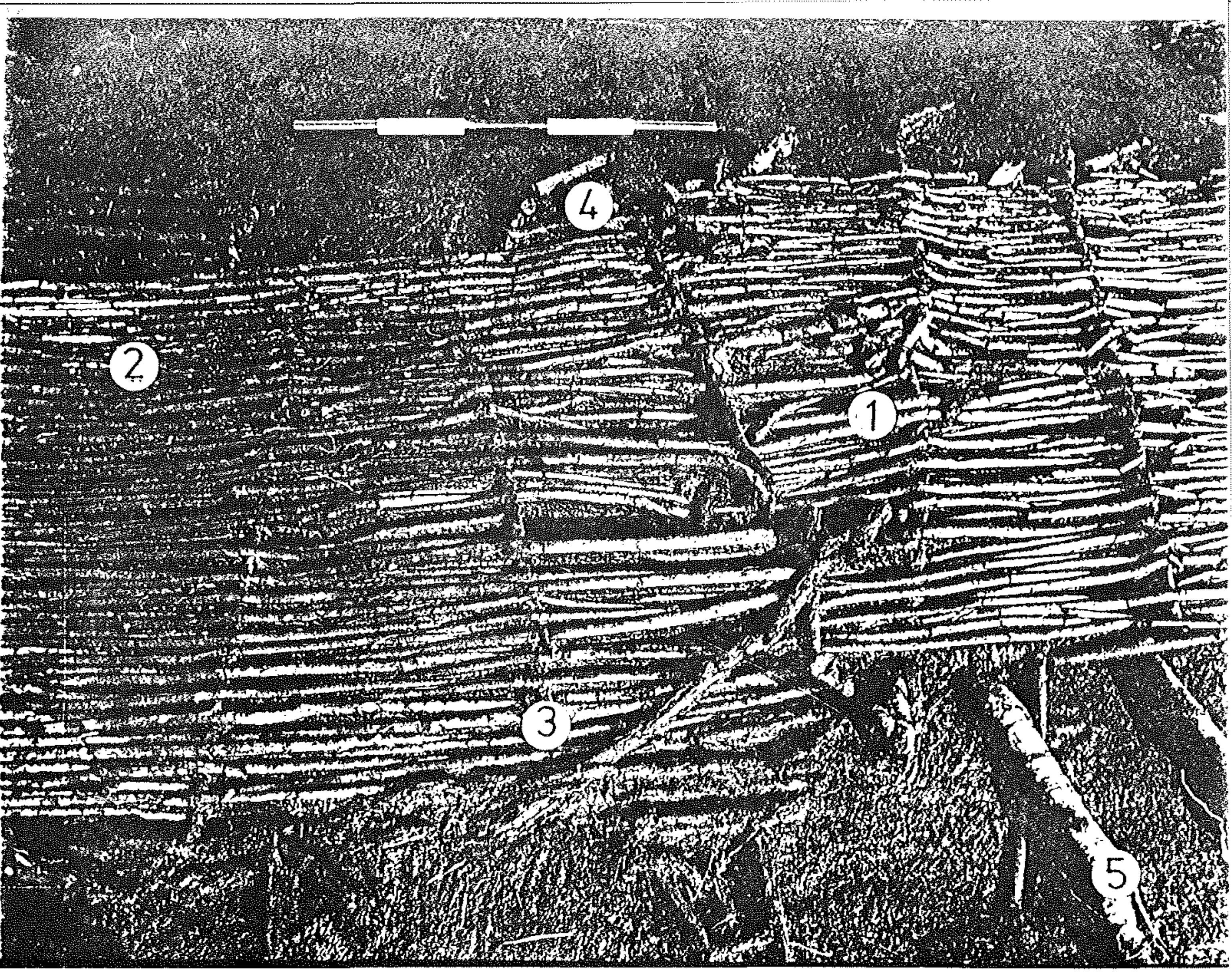
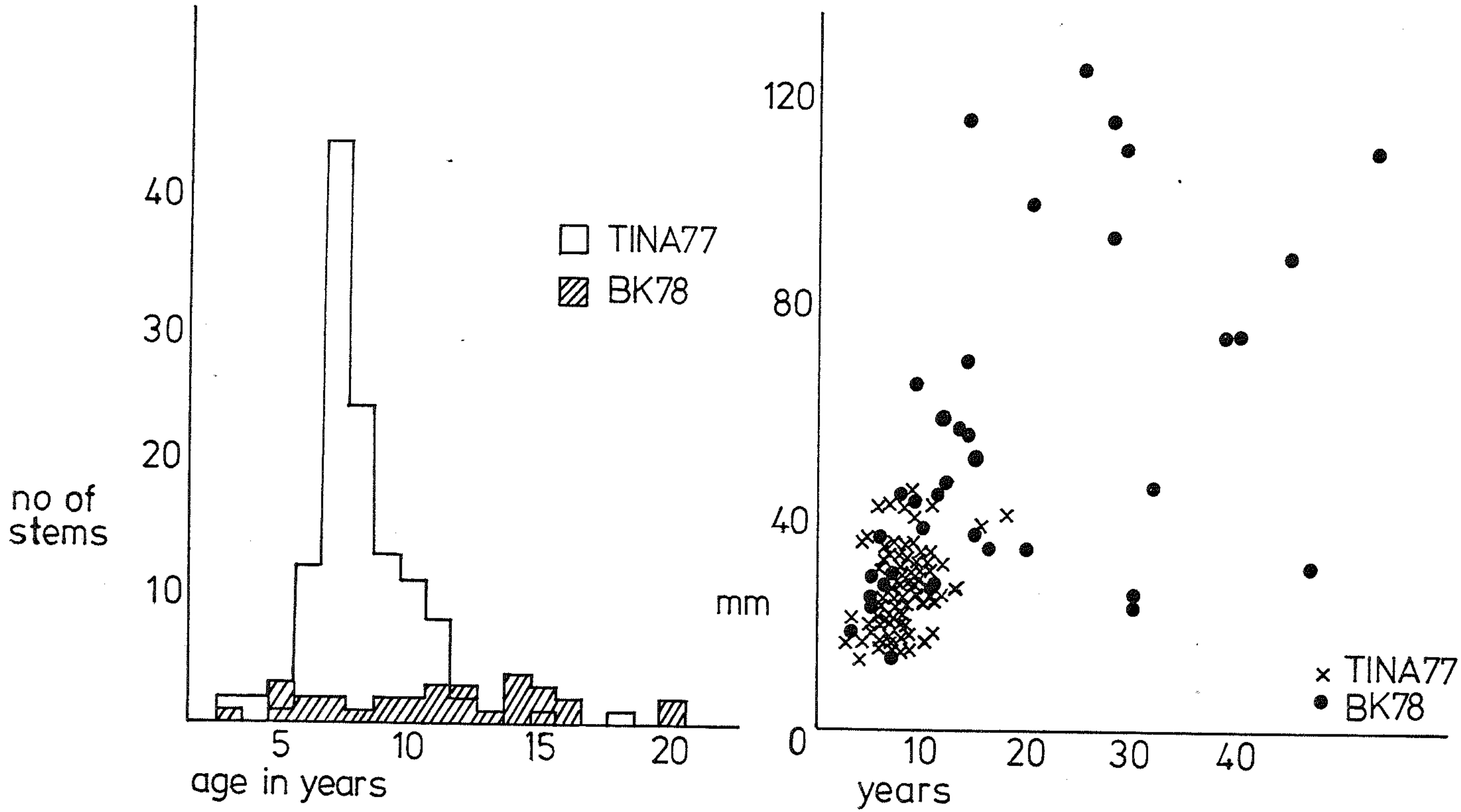


Fig. 1



	Function	Species	No. of stems	Average age years	Average diameter mm
1	Central pole	Hazel	9	14.7	45
2	Rod	Hazel	67	5.0	16
3	Sail	Hazel	28	8.7	24
4	Peg	Hazel	35	14.0	36
		Birch	16	20.0	43
5	Stray	Birch	6	19.0	45

fig. 2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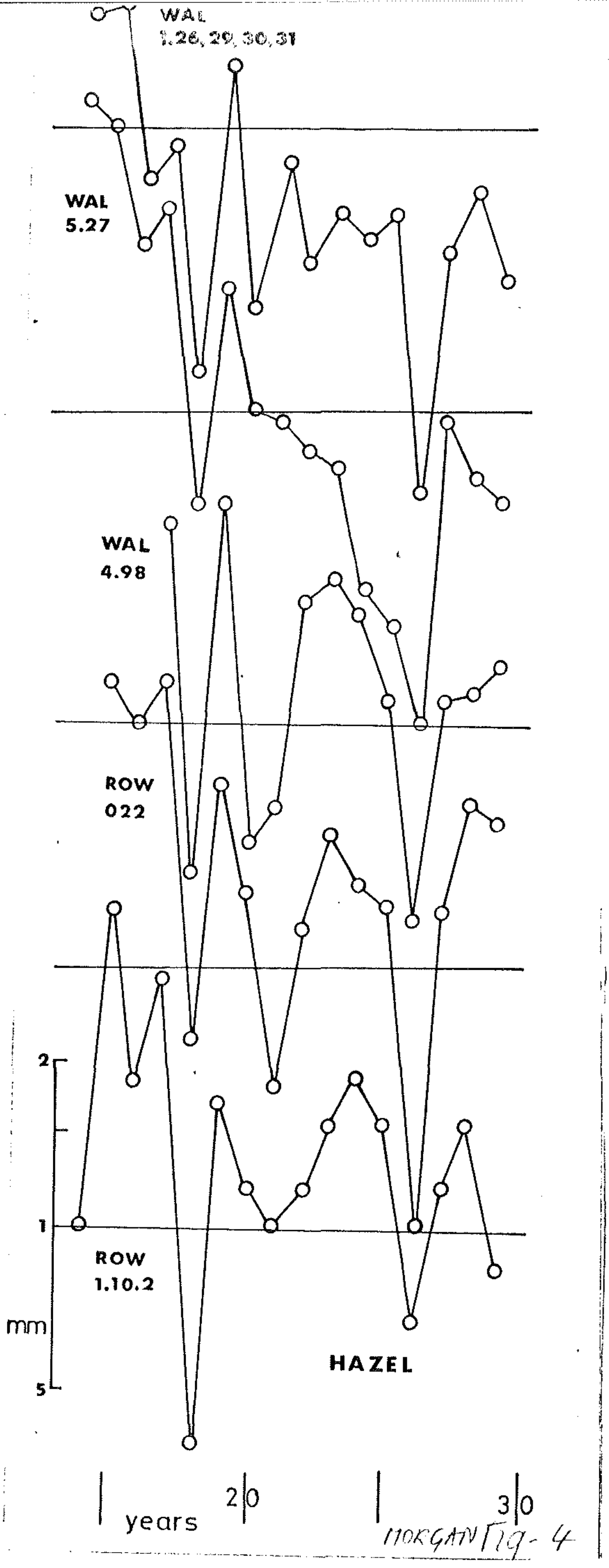
MORGAN FIG.



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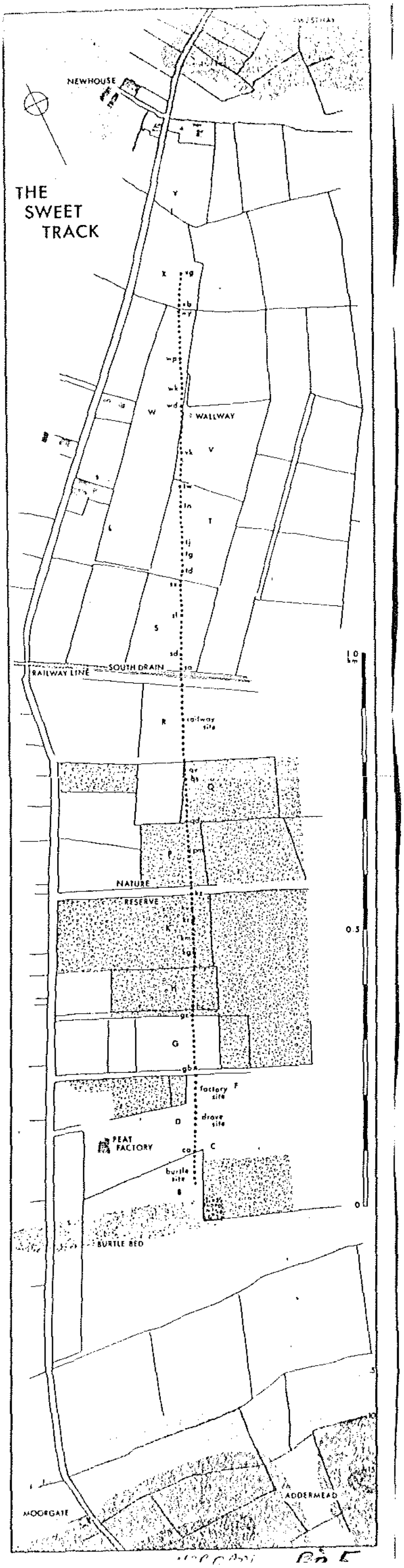
MORGAN Fig - 4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RAILWAY LINE
railway site
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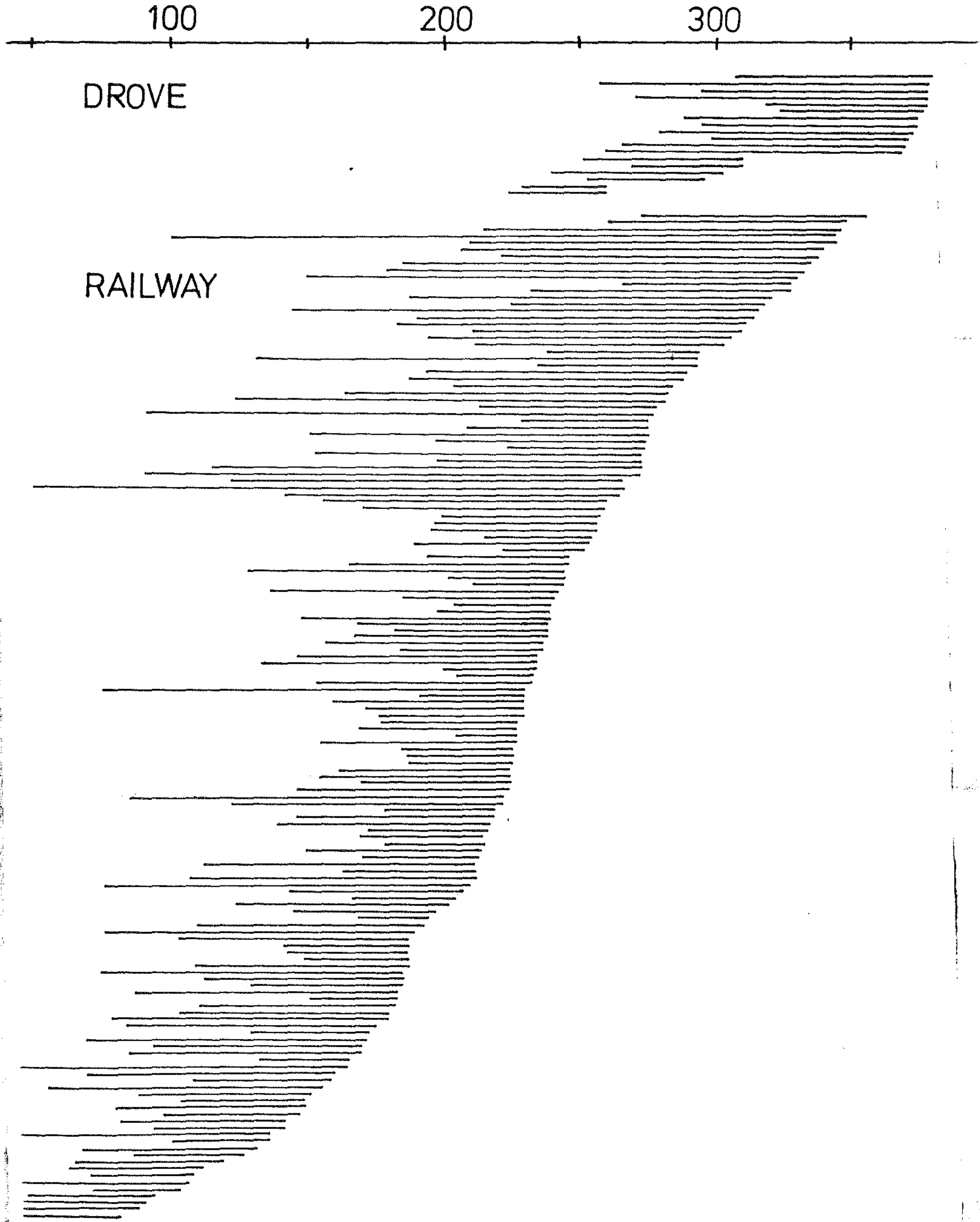

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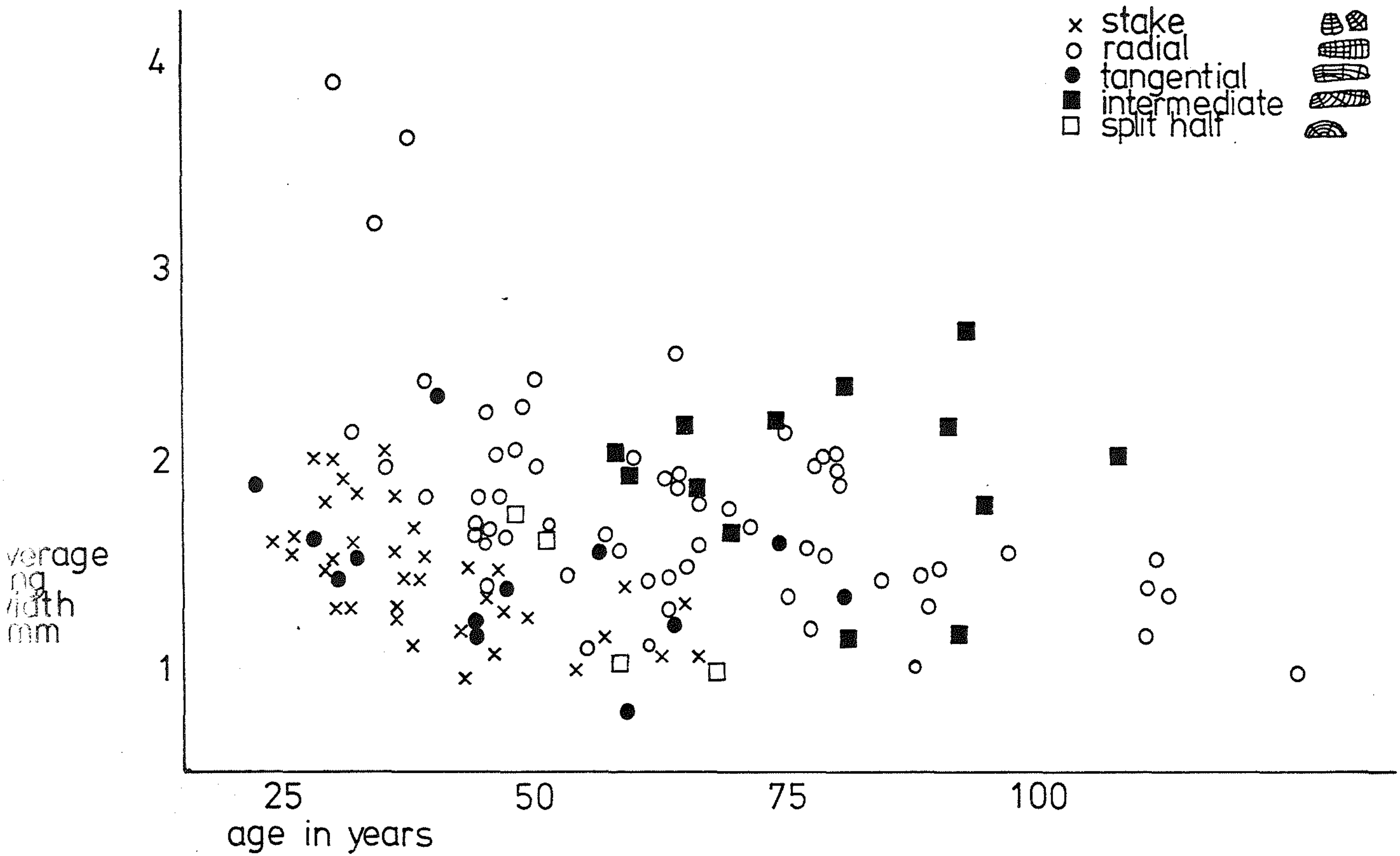

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MORGAN FIG. 7