EFFECT OF RADIAL GROWTH RATE ON RAY NUMBER AND DIMENSION OF SOME OF THE RING POROUS HARD WOODS.

by

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Summary *Radial growth rate as indicated by ring width influenced ray frequency and dimensions in samples of wood having wide and narrow growth rings of ash (Fraxinus excelsior), bakain (Melia azedarach), elm (Ulmas laevigata) and mulberry (Morus alba.). Ash, elm and mulberry had singificantly more rays per unit area in the samples with wider growth rings than in the samples with narrower growth rings. The rays in bakain samples with wider rings had more cells and cell size was larger, both along their height and width; in elm, cell size was significantly higher but not cell number. No significant relationship was found between rate of growth and either cell number or cell size along the width or height of rays in ash and mulberry.*

Material and methods The material for this study was obtained from laboratory hand samples of $1.5 \times 7.5 \times 15.0$ cm size of ash, bakain, elm and mulberry which showed both narrow and wide growth rings. Samples measuring 10 x 10 x 15 mm were taken from each of the narrow as well as wide ringed portions and boiled in water till they were fully water-logged and sank in water. From the tangential faces of these blocks 20 microns thick sections were cut on a sliding microtome. These were stained in safranin and dehydrated in alcohol and mounted in canada balsam. Ray height at their heighest point and ray width at their widest point were recorded from the tangential sections with the aid of an eye-piece micrometer. One hundred readings for ray height and ray width in microns were recorded and also the number of cells in the height and width of each ray. Number of rays was counted per eye-piece field in fifty fields for both fast and slow grown materials of all the four species. Area of the field was calculated and from there ray frequency taken as number of rays per square mm was determined. The mean value for these measurements was calculated together with their standard deviation.

Results All the four species studied are ring-porous and the rate of growth in the radial direction is indicated by the width of growth rings. Table 1, below shows the differences in ray frequency and dimensions with different rates of growth.

The following conclusions can be drawn from this table:

(1) Number of rays per unit area is significantly larger (0.01 % level) in fast growing samples of ash, elm and mulberry as compared to slow growing samples, the difference is not significant for bakain.

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TABLE 1

Differences in ray frequency and dimensions in ash, bakain, elm and mulberry.

	ash		bakain		elm		mulberry	
	slow-grown	fast-grown	slow-grown	fast-grown	slow-grown	fast-grown	slow-grown	fast-grown
Mean growth ring width mm.	2.4	6.5	6.2	23.0	4.3	12.5	7.0	23.0
Number of rays/ sq. mm	24.6	28.6**	11.6	12.1	14.2	19.7**	6.4	8.4**
Mean ray height (u)	242±75	254±86	291±82	347±102*	289±156	318±170	539±205	560±230
Mean cell number along ray height	11.2±3.8	12.8±4.7	15.7±4.4	18.2±5.2*	18.9±10	19.5±10	43.0±17.7	44.4±20.1
Mean cell height (u)	21.6	19.8	18.5	19.1	15.2	16.3	12.5	12.6
Mean ray width (u)	46±8	43±10	49±10	68±18**	43±18	58±27**	68±14	65±15
Mean cell number along ray width	2.7±0.5	2.8±0.5	4.4±0.8	5.3±1.3**	4.2±1.6	4.0±2.0	6.8±1.5	7.0±1.7
Mean cell width (u)	17.0	15.4	11.1	12.8**	10.2	14.5**	10.0	9.3

*Significant at 0.05 % level.

**Significant at 0.01 % level.

(2) Mean ray height is significantly larger (0.05% level) in fast growing samples of bakain as compared to slow growing. Difference is not significant for the other species tested. Mean cell number along ray height in bakain is significantly higher. (0.05% level) for fast growing samples as compared to slow growing ones. Mean cell height is not significantly diffeient.

(3) Mean ray width is significantly higher (0.01% level) for bakain and elm, but not for ash and mulberry. In bakain both cell number and cell width along ray width are significantly higher (0.01% level) in fast growing samples as compared to slow growing; in elm, only mean cell width is significantly larger (0.01% level).

In Fig. 1 (A, B and C) graphs are given which show changes in ray frequency and ray dimensions with the change in radial growth rate for all the four species. In these graphs, number of rays per eye-piece field (A) and the number of cells at the highest (B) and widest point (C) of rays is plotted against the percentage number of time that each measurement was taken. These graphs are self explanatory and convey the same idea as in Table 1, but in such a way so as to give the range of variation of data also. Right sidewards displacement of graphs show positive changes in the ray frequency and dimensions as affected by the faster rate of radial growth.

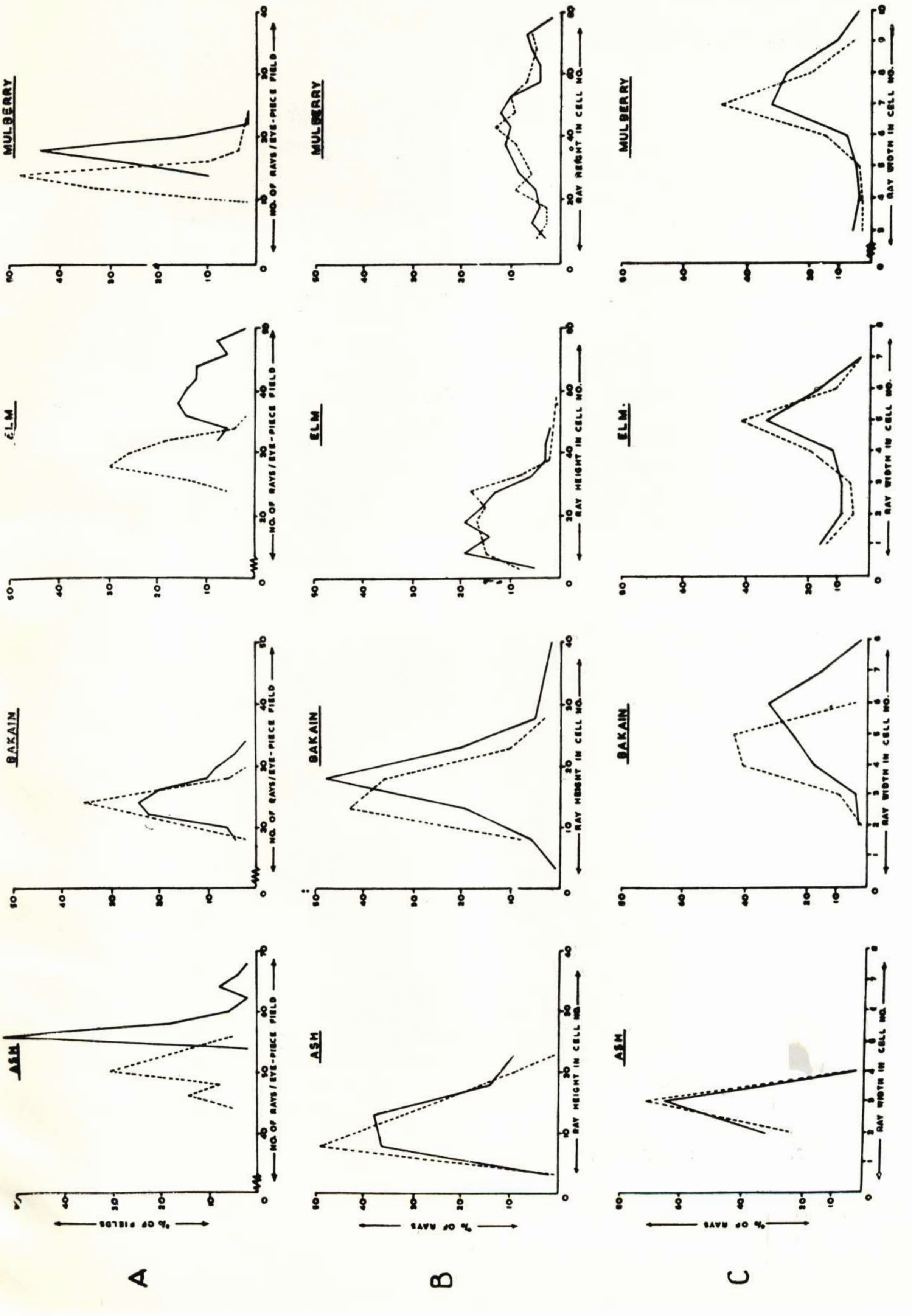
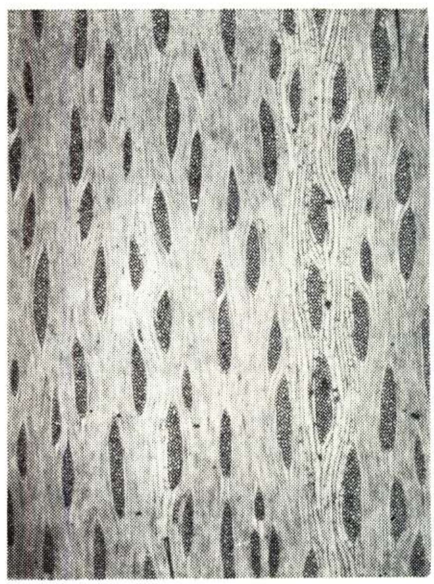


Fig. 1 Continuous lines in the graph represent data from fast growing samples and discontinuous lines from slow growing.

Ash, slow-grown

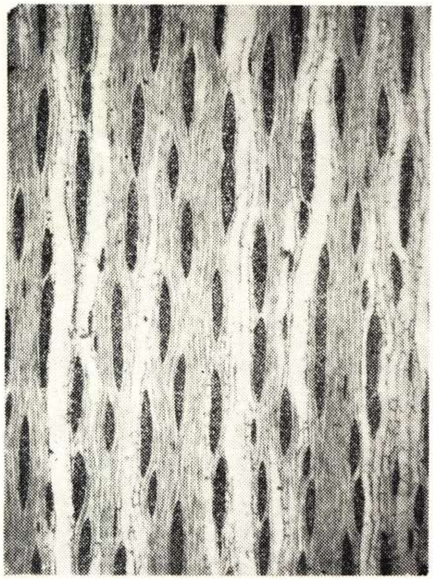
Ash, fast-grown

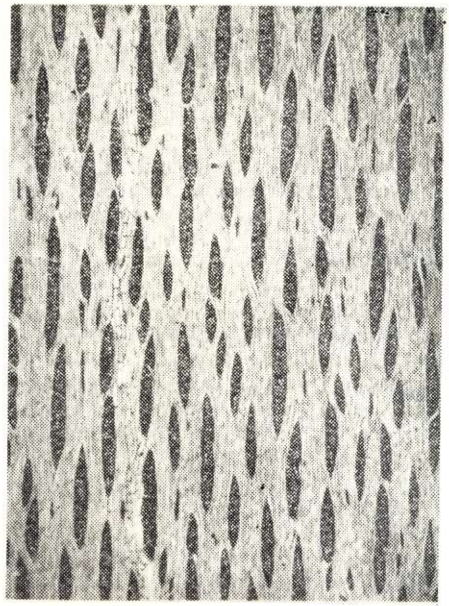
Bakain, slow-grown

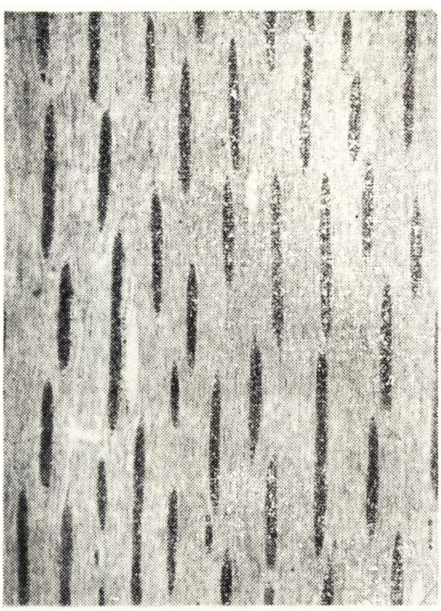


Bakain, fast-grown

Fig. **2.** (Magnification 25×, tangential section)


Elm, slow-grown


Elm, fast-grown


Mulberry, slow-grown


Mulberry, fast-grown

Fig. 2. (Contd.)

In Fig. 1 (A) it is clear that in all the four species, there are more number of rays per eye-piece field in fast grown samples than in the slow ones. This difference in ray frequency is maximum in case of elm, while it is least in case of bakain evidenced by greater and least shifting of continuous line graphs towards the righthand side.

In Fig. 1 (B and C), number of cells along ray height and ray width is higher in the fast growing sample of bakain as compared to slow growing. In rest of the three species the graphs for slow and fast growing samples more or less follow each other showing insignificant changes.

These conclusions are also depicted in Fig. 2.

Discussion. Several workers have found a relationship between radial growth rate and different anatomical features in certain tree species:

Ahmad (1970) ring-width and tracheid dimensions negatively correlated in *Abies pindrow*, Spach.

Bannan (1937) mean ray height in xylem ray tissue of certain conifers, at similar distances from the pith, greatest in sepcimens with widest growth rings.

Bannan (1954) ray volume and width of growth rings positively correlated in *Thuja occidentalis*, L.

Myer (1922) low land trees of *Fraxinus* (as well as other sepecies), had greater ray volume than upland trees.

White and Rombards (1966) ray dimensions and frequency influenced by faster radial growth in ash, sweet chestnut and sassafras.

It has long been known that growth brings about an increase in the circumference of secondary xylem with regular increase in the number of rays. Beside producing xylem initials, the cambium is stimulated to produce more-ray initials with increased growth rate. But this production of ray initials surpasses the increase in the tangential face of the tree and brings about an increase in the number of rays per unit area in the samples with fast radial growth rate than in the samples with slow radial growth.

Bannan (1937) in the study of xylem ray tissue of some of the conifers found that mean ray height at similar distances from the pith were greatest in the specimen with widest growth rings. The forces which are responsible for the increase in cell number along the height of the ray with faster growth rate are yet to be understood. But as regards cell height it is probable that in fast growing specimens the cambium is actively producing xylem initials by periclinal divisions of its fusiform initials and a number of xylem initials are found in varying stages of differentiation and maturation and therefore the cells of a young ray find a large number of immature cells around them which are flexible enough to give sufficient room to the developing and maturing ray cells for their sideways adjustments. This results in the production of mature ray cells which are higher and wider.

According to White and Rombards (1966) ray width expressed as number of cells showed a striking increase in all the fast grown samples of ash, sweet chestnut and sassafras. Faster radial growth rate is affected greatly by increase in the number of periclinal divisions of the initials of vascular cambium. This increase in the formation of more xylem initials in the radial direction also brings about an increase in circumference of secondary xylem. Due to this increase in circumference the developing xylem cells (including those of rays), are under a stretching force in the tangential direction. This results in the lateral enlargement of mature cells, and the cells tend to divide at right angles to the direction of this force. So the rays produced under these circumstances will be wider, with greater cell number and cell size.

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