NUCLEAR AREA AND SLENDERNESS RATIO IN TENSION WOOD OF SOME ANGIOSPERMS

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Abstract

Nuclear morphology in ray cells in the upper and the lower sides of leaning branches and vertical branches has been studied. The frequency of spherical, oval or fusiform nuclei in ray cells differs considerably in different zones of tilt and vertical woods. The nuclear area gets reduced with an increase in the slenderness ratio in the upper tiltwood (tension wood).

Introduction

Tension wood is formed on the upper side of the inclined axes of angiosperms. It is considered as a modification of the normal cellular structure of woody plants altering its physical, chemical and anatomical properties. Despite numerous investigations on structural and biochemical aspects of tension wood (Jaccard, 1938; Jayme, 1951; Wardrop, 1964; Timell, 1969; Scurfield, 1972; Cote, 1977), the nuclear behaviour in it has never been studied. The present investigation is an attempt to investigate the variation in the nuclear morphology in ray cells of the upper and the lower parts of inclined and vertical branches of three tropical hardwood trees.

Material and methods

Inclined and vertical branches of identical girth were collected from the trees of *Azadirachta indica* A. Juss (Meliaceae), *Mangifera indica* L. (Anacardiaceae) and *Polyalthia longifolia* (Sonn.) Thw. (Annonaceae) growing under the natural conditions in the Botanical Garden of this University. The upper side of inclined branches was marked and discs cut from such branches fixed in FAA. Cubic blocks of wood samples with intact cambium were cut out of such discs from the region between the pith and the upper periphery and designated as upper tiltwood (UTW), and from that between the pith and the lower periphery and named as lower tiltwood (LTW) as shown in figure. Similar wood blocks from vertical branches were prepared from the region between the pith and the periphery and designated as vertical wood (VW). Fifteen μm thick transverse sections of UTW, LTW and VW were stained with toluidine blue 'O' (O' Brien, Feder & McCully 1964). For convenience of description and comparison, the radial distance from the cambial zone inwards up to 200 ray cells was divided into three zones: (1) outer zone—the first five ray cells from the cambial zone, (2) middle zone—ten cells from the 10th to 100th cells, i.e. 10th, 20th, 30th,........100th cell, and (3) inner zone—ten cells at the intervals of 10 cells from 110th to 200th cell, i.e. 110th, 120th, 130th,........200th cell. Thirty samples each of UTW, LTW and VW were analysed for cross sectional area, width and length of nuclei. In all, 2250 nuclei were analysed

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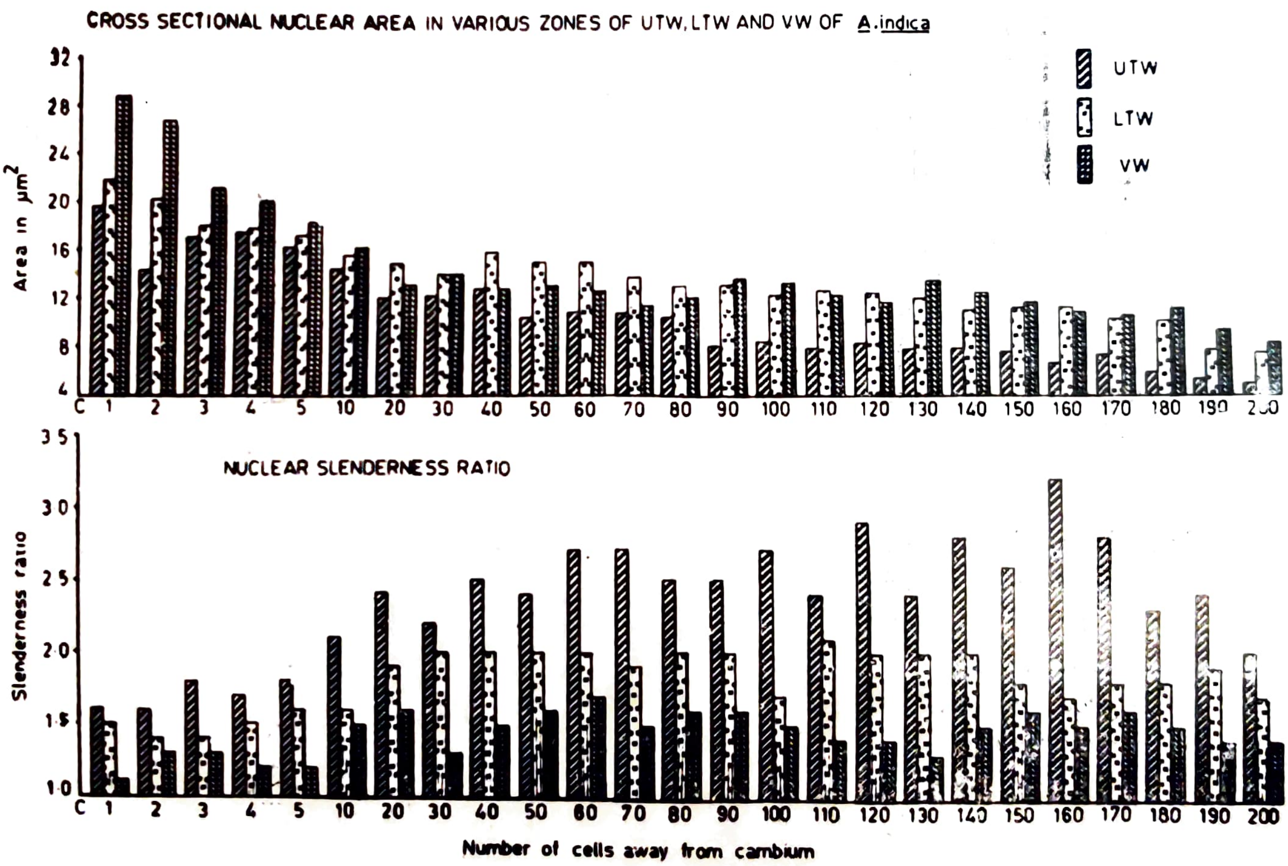
for each species. The standard deviation ranged from 0.05 to 0.2 in different cases. It is insignificant, hence not shown in the histograms. Slenderness ratio of nuclei was determined by dividing the average length by the average width of the nuclei.

Observations

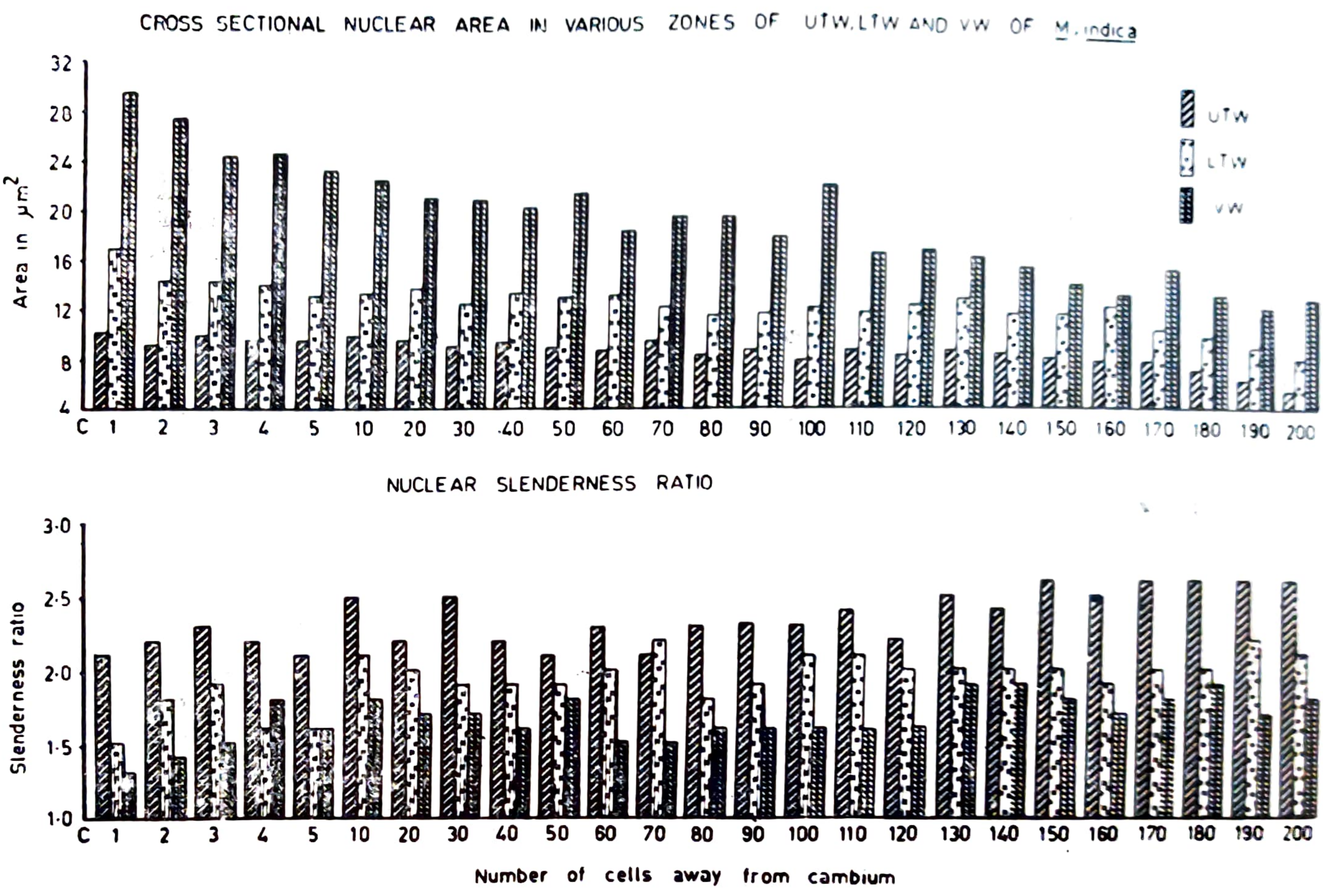
Nuclei are either spherical, oval or fusiform in *A. indica*, and *M. indica*, whereas in *P. longifolia* they are mostly spherical and rarely oval, and their frequency varies from zone to zone of tilt and vertical woods.

Nuclear area—The nuclear area (NA) in its cross section differs in each corresponding zone of UTW, LTW and VW, and in different zones within each kind of wood. In *A. indica*, the nuclear area decreases gradually from the inner zone in all types of wood. But in each of the three zones of UTW the value of NA is lower than in the corresponding zone of LTW and VW (Text-fig. 1). Text-fig. 2 depicts the difference in the nuclear area in



Text-fig. 1—Histograms showing the cross sectional area and slenderness ratio of nuclei in various zones of UTW (upper tiltwood), LTW (lower tiltwood) and vertical wood (VW) in *Azadirachta indica.*

UTW, LTW and VW of *M. indica*. NA in the outer and the middle zones of UTW and LTW does not show gross variation, but in the inner zone there is a little reduction in it. Nuclei in VW have very high NA (Text-fig. 2). However, even within the five cells of the outer zone, conspicuous reduction in NA can be noticed. After remaining more or less constant in the middle zone, NA shows very gradual declination in the inner zone (Text-fig. 2). In general, the values of NA are appreciably less in all the zones of UTW than those of LTW and VW.

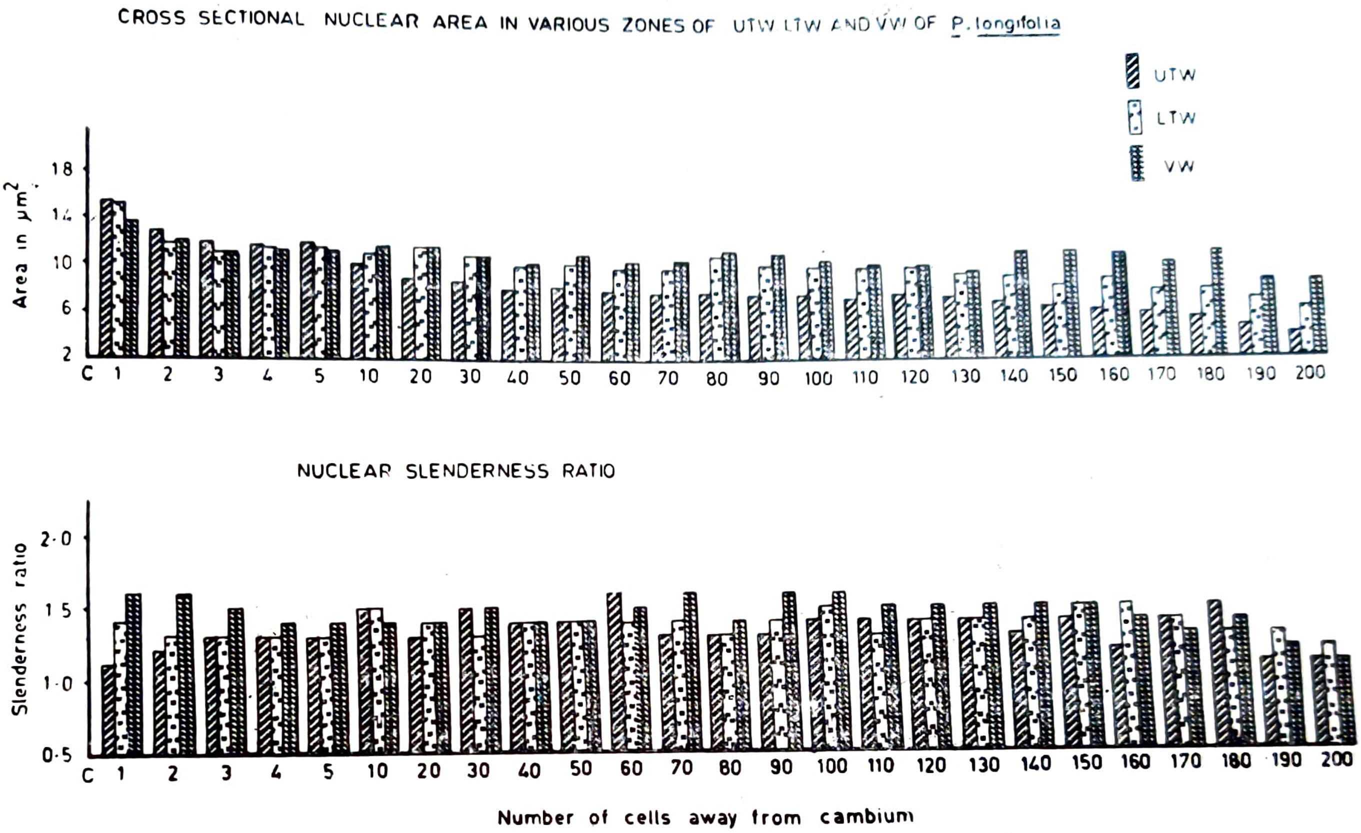


Text-fig. 2—Histograms showing the cross sectional area and slenderness ratio of nuclei in various zones of UTW, LTW and VW in *Mangifera indica*.

In *P. longifolia* (Text-fig. 3) NA is the highest in the outer zone of tiltwood and vertical wood of all the zones, and it does not vary much from each other in UTW, LTW and VW. The middle and inner zones of UTW show appreciable reduction in NA as compared to that of LTW and VW. Though the NA varies only a little in the middle zone of LTW and VW, it is greater in the inner zone of VW than that of LTW.

Slenderness ratio (*SR*)—The slenderness ratio (SR) of nucleus in various zones of UTW, LTW and VW is presented histographically in Text-figs. 1, 2, 3 and in *A. indica* (Text-fig. 2) SR differs from zone to zone of UTW and LTW; in VW it does not change appreciably from the outer to the inner zone. As majority of the nuclei are spherical and oval in the outer zone of UTW and LTW, their SR remains fairly low around 1.5. But in the outer zone of VW SR is as low as 1.0, as most of its nuclei are spherical. The outer zone of UTW, however, shows high SR value. The SR value in the middle and the inner zones of UTW is much higher than that of LTW and VW. The mean SR value in any zone of LTW and VW is below 1.7, whereas in UTW it is higher than 2.0 (Text-fig. 1). In *M. indica* due to the predominance of fusiform nuclei in all the three zones of UTW, the SR is appreciably high in it (Text-fig. 2). The minimum nuclear slenderness is observed in VW since the spherical nuclei are abundant, except in the inner zone where majority of them are oval.

As the nuclei in the tiltwood and vertical wood of *P. longifolia* are spherical or oval, their slenderness ratio is conspicuously low, and does not exceed 1.6 (Text-fig. 3). Never-



Text-fig. 3—Histograms showing the cross sectional area and slenderness ratio of nuclei in various zones of UTW, LTW and VW in *Polyalthia longifolia*.

theless, in the outer zone nuclear SR is greater in VW than in UTW and LTW. UTW and LTW do not show appreciable variation in SR in their outer zone. The SR fluctuates marginally in the middle and the inner zones of UTW, LTW and VW. However, it is greater in vertical wood than in tiltwood at any radial point from the cambial zone.

Discussion

The actively dividing cambial cells have spherical nuclei and the cells in close vicinity of cambial zone which are undergoing differentiation, are equipped with slightly oval nuclei (Bosshard, 1966). In *A. indica* and *M. indica* the ray cells in the wood adjacent to the cambial zone have coval nuclei. The nuclei in the first five ray cells of the outer sapwood are the largest of all the regions of sapwood in the presently investigated species, as in *Ougeinia oo'einensis* and *Garuga pinnata* (Bhat & Patel, 1980). The cross sectional area of the nucleus decreases gradually from the outer to the inner zone of sapwood as observed in *Acacia auriculiformis* by Bhat and Patel (1982).

In *A. indica* and *M. indica* nuclear area is higher in ray cells of the vertical wood than those of the tiltwoods, and it is lower in the upper tiltwood (where the maximum tension wood formation is noticed) than in the lower tiltood. Nonetheless, in the upper tiltwood of *P. longifolia*, the ray cells in the wood very close to the cambial zone have slightly larger nuclei than the corresponding zone of the vertical wood. Bosshard, (1966) considered that the cells with high activity and vitality possess large nuclei and nucleoli. However, in *A. indica* and *M. indica* the nuclei have low NA value in the ray cells of tiltwood. These cells have reduced starch and lipid contents, and increased total protein content and succinate dehydrogenase activity (Reghu, 1983) which are the signs of high metabolism of reserve foods.

The reduced cross sectional area and increased slenderness of nuclei in the regions of high reaction wood formation, in the present study at least, do not appear to be the signs of low metabolic activities.

Slenderness ratio is yet another measure used to understand the metabolic status of a cell. The surface area of nucleus and its slenderness ratio in the storage cells of wood are closely related with the distance of the cell from the cambial zone (Frey-Wyssling & Bosshard, 1959, 1966). In *A. indica* and *M. indica* the nuclear slenderness ratio is higher in the upper tiltwood (with high tension wood formation) than in the lower tiltocd and the vertical wood. In *P. longifolia* the slenderness ratio is around 1.6 in all the wood types. As the nuclear studies in reaction wood are not available in the earlier reports, any generalization on this vital aspect of reaction wood is not possible. However, it is reasonable to think that the storage cells in leaning branches undergo a lot of changes in the metabolic activity as reflected by the changes in the nuclear size and slenderness. The part of the leaning branches undergoing reaction changes in its constituent cells shows the highest changes in the nuclear shape and slenderness in its ray cells.

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Explanation of Plate

Text-fiig. 1—Dried and polished disc of tilt branch showing the placement of samples. The region between the wedge and the pith is upper tiltwood, and the one opposite it is the lower tiltwood.