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AN ANATOMICAL STUDY OF ANGSANA (*PTEROCARPUS INDICUS*) STEM CUTTINGS

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Pterocarpus indicus Willd., belonging to subfamily Papilionatae of the Leguminosae, is a well-known timber tree species which produces classic furniture wood and is found throughout the Indo-Malesian and Pacific region (Corner 1988). It is usually cultivated through vegetative propagation as the shoot and root are capable of being reproduced vegetatively owing to the presence of undifferentiated cells with unrestricted developmental potential (Wareing & Graham 1976). The inability of some plants to root owing to their size and structural complexity can be overcome by using young parts of the plants, coppices or rejuvenated shoots. However, the capacity for vegetative propagation in trees varies greatly between species and genotype. This is influenced by both environmental and physiological states (Komissarov 1969, Hartmann & Kester 1983). One of the disadvantages of using angsana cuttings is that the major branches shear easily when fully grown. This occurrence is commonly faced by local councils and urban planners where the trees are planted in the open and along roadsides. Branch breakage can possibly be caused by changes in external environmental factors or weak mechanical properties of the wood.

The purpose of this study was to ascertain (a) the nature of the meristematic tissues in the stem, and (b) to investigate if there is an anatomical explanation for subsequent mechanical failure of mature branches. Young woody seedlings of angsana were initially raised in polythene bags. The stems were then pruned to initiate the formation of buds and shoots. Samples were harvested at intervals of 1, 7 and 10 weeks of growth with six replications each. Each sample of the cuttings comprised the smooth surfaces at both ends of the stems and measured about 1 cm long. They were fixed in 50% formalin-alcohol-acetic acid (FAA) for at least 48 h. The samples were then washed with 50% ethanol and placed in a vacuum oven for about 15 min for complete penetration of the woody tissues. The samples were subjected to the standard technique of dehydration using a tertiary butly alcohol (TBA) series and embedded in paraffin wax (Johansen 1940). With a rotary microtome, longitudinal sections (L.S.) were cut to a thickness of 12 μm. The sections were then stained using the safranin and fast green method (Sass 1958) and mounted in Permount.

The common features in woody plants are well described by Stover (1951), Esau (1965), Fahn (1972), Metcalfe and Chalk (1972) and Cutler (1978). Angsana stems are of no exception as they develop meristematic tissues with the parenchyma cells abundantly available in the stem which act as ground forming tissues. Parenchyma tissue is involved in the wound healing and regeneration process (Fahn 1972). Sclereids are occassionally present in the supporting tissues while secretory elements are common and they secrete a reddish gum-like resin. When stained, this resin is yellowish in colour (Figures 1 and 2). These sclereids and secretory elements are found in the cortex and pith regions. Meristematic tissues were observed to be present throughout the stem cuttings during the first week (Figures 1 and 2). However, only cell division as opposed to cell differentiation was observed to take place. Further to this, high accumulation of starch was seen in the parenchyma cells.

Cell differentiation was evident after the third week with radial formation of new xylem and phloem. This was followed by an increase in the circumference of the stem where the parenchyma cells became larger in diameter accomplished by continued meristematic activities. The meristematic cell was seen to have a smaller diameter, was more elongated and had more dense cytoplasm throughout the shoot development period up to the seventh week (Figure 3). By the tenth week, the new bud had produced a branch which was complete with differentiated tissues such as the sclerenchyma, primary xylem and phloem, secondary xylem and phloem (Figure 4). In angsana these smaller branches and so-called twigs are seen to persist for a few years while other dead twigs and branches cling to the larger branches or trunks until they are mechanically broken off or decay (Khairul, personal communication). For a healthy growing branch, normally large bundles of fibre can be seen in the inner side of the wood (Figure 4). Although this supporting tissue is present, there is a weak point near

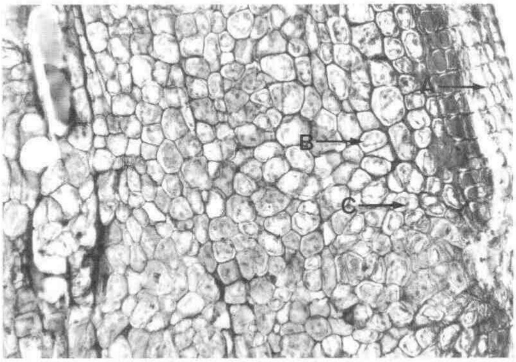

Figure 1. Longitudinal section of one-week-old cutting with dense parenchyma tissues and nucleus
A : bark, B : parenchyma, C : nucleus (× 20)

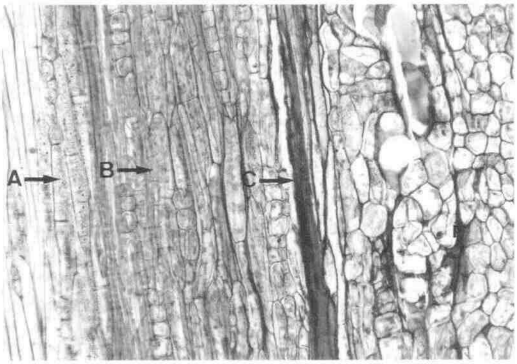

Figure 2. Cell division occuring in the primary xylem and phloem tissues of one-week-old cutting
A : xylem, B : phloem, C : fibre (× 20)

Figure 3. Longitudinal section of seven-week-old cutting with developing shoot, D
A : secretory tissues, B : nucleus, C : parenchyma (× 10)

Figure 4. Longitudinal section of the stem, I, and developed branch, II, at ten weeks
A : continuous fibres, B : resin/ lignified cell, C : discontinuous fibres (× 10)

the tension wood region where the fibre tissue is not continuous. Although this study does not clearly show it, the vessels, fibres and other cells may be less lignified with their walls consisting apparently mostly of cellulose. Furthermore, the parenchyma cells of the stem are more abundant than elsewhere in the xylem. In some species, a definite abscission zone may be present in which the hard tissues are greatly reduced and modified. This phenomenon is commonly found in some temperate trees which can be easily propagated such as *Populus* and *Salix* in the family Salicaceae and *Ulmus* in the family Ulmaceae (Eames & MacDaniels 1953, FAO 1979). Such weakly lignified vessels and fibres rupture easily because of less deposition of lignin, weak compression wood and the presence of transverse scalariform pitting. Further studies and sectionings are suggested to examine the differences in the mature tree stem/branch and to compare with materials obtained from other local species where their branches are not known to break easily.

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