SUMMARY

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The subject theme presented throughout the thesis is to view the leaf in its entirety, in its developmental and structural aspects throughout its survival. The thesis has been described in three parts, the internode-node-petiole continuum and petiole vasculature (Section I and IV), the structure and development of procambium and its transformation into the secondary vascular meristem (Section II and V) and the structure and development of the phloem in the leaves during their life span, until senescence (Section III and VI).

The two species selected for the present work were Gmelina arborea Roxb., a deciduous tree and Tabebuia rosea DC., an evergreen tree. They were selected because of their contrasting growth rhythms. The petiole was mainly selected for the study because it is integrated between stem and the lamina and it is this organ which is mainly concerned with the translocation of food materials between the stem and lamina, i.e., it serves as an intermediate transport vehicle.

5.1 Internode-node-petiole continuum

1. Gmelina arborea exhibits a unilacunar single trace node. The single trace is a composite strand made up of five vascular strands. Tabebuia rosea exhibits unilacunar multi-trace condition with five strands of the leaf trace, associated with the organization of the petiole vasculature.

2. The single leaf trace in *Gmelina* trifurcates into a median and two laterals. The lateral strands mainly bifurcate and anastomose involving in the primary organization of the petiole vasculature. In *Tabebuia* the five strands divide equally and traverse without much bifurcation or anastomosing and at the distal region they divide and diverge into the five petiolules.

3. Cortical strands located on either side of the adaxial groove of the petiole in *Gmelina* originate from the lateral strands. They are absent in *Tabebuia*.

4. In both the species the median strand shows greater individuality and is established earlier in the leaf than the laterals.

5. The identity of the median strand is retained in the mature petiole of *Gmelina*, but in *Tabebuia* due to the excessive secondary growth and development of interfascicular cambium the identity becomes almost obscured.

5.2 Procambium and cambium

1. The term 'vascular meristem' represents an advancing front of the acropetally developing procambial strands.

2. Persuasive evidences are presented in the thesis to confirm the continuous and acropetal development of the leaf trace system both in *Gmelina* and *Tabebuia*.

3. Few strands are observed in _Gmelina arborea_ which originate independently in the interfascicular region and develop both acropetally and basipetally. Such strands have been termed as the subsidiary strands.

4. Vascularization in both the plants proceed developmentally from a primary to a secondary vascular system with the primary serving as both a structural and organizational template for the secondary.

5. The primary vascular meristem in _Tabebuia_ has been categorized into procambium and metacambium, while metacambium is not distinctly identifiable in _Gmelina_.

6. The procambium is a homogeneous tissue in both the species and is easily distinguished by its dense narrow cells, elongated parallel with the longitudinal axis of the petiole.

7. The late procambial stage in _Gmelina_ shows micromorphologically two types of cells, polygonal and rectangular, when viewed transversely. Tangentially no distinct ccntrasting features are noted. In _Tabebuia_ metacambium consists of two distinct systems of cells, the long and short cells, which become more conspicuous at the late metacambial stage.

8. The secondary vascular meristem cells in the petiole of _Gmelina_ though give rise to the secondary derivatives micromorphologically do not show any similarity to the typical

cambial cells and hence are termed as 'transit cells'. In Tabebuia the two distinct systems of cells in metacambium assume the true characteristics of cambium once the petiole ceases elongation. Both fusiform and ray cells are present.

9. Birefringent properties of the walls of primary phloem fibers, xylem fibers and xylem parenchyma are taken as additional criteria signalling the transition from primary to secondary stage in both the species.

10. Interfascicular cambium is absent in Gmelina but present in Tabebuia. The ontogeny of the interfascicular cambium resembles to that of the fascicular cambium. It is derived by dedifferentiation and redifferentiation of the parenchyma cells interspersed between the young vascular strands.

11. Both in Gmelina and Tabebuia procambial cells gradually acquire the characteristics of secondary vascular meristem (transit cells/ cambial cells) during the late stages of petiole elongation.

5.3 Phloem

1. Both in Gmelina and Tabebuia development of protophloem precedes that of protoxylem.

2. Differentiation and maturation of the first vascular elements in the procambial strand occur while the procambium is still dividing actively. Persuasive evidences are

presented herein also to show the acropetal development of phloem elements.

3. In _Gmelina_ the two tissues namely protophloem and metaphloem, usually merge gradually and hence no distinct delimitation between the two is evident.

4. The primary phloem of both the plants include sieve tube elements, companion cells and phloem parenchyma.

5. Primary phloem elements are organized in the form of complexes interspersed with parenchyma in _Gmelina_. In _Tabebuia_ no such complexes were discernible.

6. In _Gmelina_ the secondary phloem elements were also organized in the form of complexes. The primary and secondary phloem complexes were demarcated by one or two layers of parenchyma, which served as an additional criteria to judge the secondary growth. In _Tabebuia_ the presence of fusiform and the ray cells was an additional criteria to judge the secondary growth.

7. The secondary phloem in _Gmelina_ consists of sieve tube elements companion cells and phloem parenchyma. In _Tabebuia_ the secondary phloem includes the sieve tube elements, companion cells and axial and ray parenchyma.

8. The protophloem sieve elements are short lived in both the plants. Metaphloem is more persistent which is then gradually replaced by the secondary phloem elements.

9. The different morphological types of slime accumulation in the mature sieve tube element reflects the varying degrees of condensation of contents, resulting from severing of the sieve tube elements. Considering the various micromorphological forms of aggregation of sieve tube element contents including P-protein, observed in this investigation, their peripheral position was also indicated in a normal functioning sieve tube element.

While looking at the various aspects of investigations undertaken in the present thesis, my projections on them are as follows:-

(a) The establishment of the primary vascular system in the petiole is controlled by different sets of factors, other than those subjected by stem-leaf relationship. The bifurcation and amalgamation of the vascular strands in the shoot axis are integrated with node-internode morphology and its phyllotactic pattern. No such integration is present in the petiole. The nature of the leaf trace does not solely determine the pattern of primary vascular system in the petiole. The leaf trace strands in their strategic arrangement undergo infrequent anastomoses and mostly the laterals are instrumental in establishing the primary vascular pattern. The identity of the median strand is frequently sustained.

(b) The procambium-cambium system is visualized as a continuum but varying micromorphological cell features associated with this continuum tissue system in its phasic development indicate how this transition is achieved and the continuum is maintained. It has stage-wise developmental and histological features like procambium-cambium-transit cells-axial cambial system and finally axial and radial cambial system. This is very well revealed in the study of the petioles of the deciduous and evergreen trees, investigated in the present treatise.

(c) That the interfascicular parenchyma in its dedifferentiation and redifferentiation also passes through a primary-secondary tissue continuum as the procambial differentiation of a discrete vascular strand passes through this phase, in an earlier time sequence. These two phasic developments reflect an uniform pattern of tissue continuum associated with primary and secondary growth.

(d) The phloem in the petiole also passes through various developmental phases from the initiation of a leaf to its senescence and final fall. The longevity of the sieve elements is short and subject to physical forces and developmental sequences the petiole (leaf) undergoes through its life span. This is reflected in sequential obliteration and continuous but limited production of the phloem.