SUMMARY

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Botanists often make a distinction between vascular and non vascular plants. This distinction implies that the vascular system performs a major role in the life of higher plants. And, indeed it does. The main body of the most higher plants consists of an elaborate vascular system that permeates almost every organ and tissue of the plant. Although researches have been carried out to reveal the translocation mechanisms, there is not much data available to know how the structural system develops and how it is organized to perform the complex functions. To perform its varied functions the vascular system must develop in stages with each advancement in structural complexity leading to greater diversity. This information is rather in short supply for the leaves of tropical evergreen and deciduous trees. The leaf of an angiosperm is an elegantly integrated structure associated with a number of complex physiological processes. As the organ specialized for photosynthesis it is the principal source of assimilates in the plant. Prerequisite to an understanding of the complex physiological processes enumerated above is a thorough knowledge of the structure of the leaf. An adult plant is structurally more complex and functionally more demanding than a seedling of the same species. None the less each must progress through a given series of ontogenetic stages before it matures, and its vasculature must be developmentally coordinated and functionally integrated with that of the other leaves and essential parts. This vascular continuum between internode and leaf, its structure and its development is the subject of this treatise. The thesis is actually in three parts. The parts are concerned with three related aspects of plant anatomy but their shared goal is the elucidation of the integrative nature of internode, node, petiole and lamina. The internode-node-leaf continuum (Sections I and IV) is followed by the structure and development of procambium and its transformation to cambium (Sections II and V) and phloem (Sections III and VI) in the leaves of *Crataeva nurvala* and *Salvadora persica*.

Crataeva and *Salvadora* were selected for this investigation mainly because they show two contrasting growth rhythms i.e., *Crataeva* is a deciduous tree in which leaves remain only about 4-5 months and *Salvadora* is considered as an evergreen tree in which leaves remain for about 11 months and there is no simultaneous leaf-fall. Chiefly petiole was chosen for the study since it is the organ not only concerned with the translocation of food materials but also functions as an intermediate transport vehicle between the stem and lamina.

5.1 Internode-node-petiole continuum

Crataeva nurvala exhibits a unilacunar multitrace node. The many traces depart the internodal vasculature and traverse the basal region of the petiole. But they never terminate there. Instead, they traverse into the petiole, with many bifurcations and anastomoses and further extend into the lamina. At the distal region the petiolar strands trifurcate into the three petiolules and later as veins and their divergencies. In *Salvadora* each leaf is served by two traces which arise from a single gap. Petiole vascular strands originate from two original median strands as centifugal divergencies on both sides. Compared to *Crataeva*, petiolar strands in *Salvadora* show less anastomoses of strands and the number of vascular strands remains more or less unchanged throughout the length of the petiole.

The petiole with its upward and downward vascular extension, respectively in the leaf and node is the point for a significant interjunction of vascular continuum. This continuum of cells and tissues has been exemplified in both plants.

Vascular system in the petiole of *Crataeva* is a closed one whereas in *Salvadora* it is open. In both the plants, median strand has greater individuality and is established earlier in the leaf than the laterals. Despite the nodal diversity exhibited by both these plants, their vascular system originates and develops in remarkably similar ways.

5.2 Procambium and cambium

Because of its structural, functional and developmental importance, differentiation of the procambial template in roots and shoots has been considered to be an important research topic. Persuasive evidence has been presented herein that leaf trace system develops acropetally and continuously in both Crataeva and Salvadora. As the leaf primordium develops into a recongnizable leaf form, the vascular system differentiates in stages, first as procambial and subsequently as phloem and xylem. Procambium is the precursor of the primary vascular system. Vascularization proceeds developmentally from a primary to a secondary vascular system with the primary serving as both a structural and organizational template for the secondary. The procambium in the petiole of Crataeva and Salvadora originates from the vascular meristem; a region designated as an advancing front of the acropetally developing procambial strands. Procambium is distinguished by dense narrow cells, elongated parallel with the longitudinal axis of the petiole. The procambium develops acropetally in the petiole and it elongates passively along with the petiole. The procambium is distinguished developmentally into procambium and metacambium in Crataeva. However, no distinct metacambial stage is observed in Salvadora.

Transition from procambium to cambium is gradual in both the plants. The procambial cells gradually acquire the characteristics of vascular cambium during the later stages of petiole elongation and transform into fusiform initials during transition. Birefringent properties of the secondary walls of primary phloem fibres, xylem fibres and xylem parenchyma are taken as a supporting index to determine the transition from a primary to a secondary state. Cambium is non-storied in the petiole of Crataeva and storied in Salvadora and this bears no relation with the cell arrangement of procambium since it is homogeneous and non-storied in both the plants. A noteworthy feature of the cambium in both the plants is the absence of rays. However, on wounding rays are observed among the population of fusiform initials in the petioles of Crataeva. The production of rays in the wounded petiole is presuemd to be under the influence of wound hormones.

5.3 Phloem

Differentiation of the procambial strands in the vascular meristem is followed by the differentiation of some of its cells into phloem and xylem. Both in Crataeva and Salvadora the maturation of first vascular elements in the procambial strand occurs while the procambium is actively dividing and it clearly shows the outline and the internal pattern of the future vascular elements. The first phloem elements are easily discernible in the strands by their somewhat thickened cell walls which readily absorb cellulose stains, and by the scarcity of stainable contents in their lumina. The differentiation of phloem precedes that of the xylem and it also develops acropetally in the petiole.

No distinct separation has been made between protophloem and metaphloem as its separation is only arbitrary. Identification of metacambium in Crataeva made it easy to categorize metaphloem elements from protophloem elements whereas in Salvadora only early protophloem and late metaphloem elements were clearly recognized. The primary phloem includes sieve elements, companion cells and phloem parenchyma. Development of the protophloem fibres is more pronounced in the middle region of the petiole and they are all procambial in origin.

Cessation of elongation of the petiole is considered as a primary criterion for judging the initiation of secondary growth in the petiole. The anatomical features which accompany the initiation of secondary growth are taken as complementary criteria.

Salvadora shows anomaly during secondary growth and produces included phloem in addition to the normal secondary phloem. Petioles during the post elongation period produce secondary phloem and secondary xylem. Both in *Crataeva* and *Salvadora* production of secondary xylem is more than the secondary phloem. Protophloem elements are found to be short lived which are soon replaced by metaphloem elements and then by secondary phloem elements. No dormancy callose was noticed in the phloem elements during the study period. A comparison between wound phloem and regular phloem sieve elements is also made.

Use of thiazolyl blue staining helped to locate the metabolically active cells in the phloem and contiguous cells. Companion cells in the phloem and vessel associated contact parenchyma cells in the xylem are uniformly stained indicating their metabolic status.