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Stem-node-leaf continuum in *Bauhinia purpurea* Linn.

R. K. Dubey, K. C. Sharma[1] and A. Pillai
Department of Botany, University of Rajasthan, Jaipur-302 004, India

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Abstract. Vasculature of the axis, node and petiole was studied in *Bauhinia purpurea* Linn. The distal, middle and proximal foliar nodes show a trilacunar three-trace condition. The subopposite stipules and the pair of microscopic nectaries at the base of the petiole are vascularized from the lateral traces. The petiolar anatomy of the simple bilobed leaves resembles Howard's (1963) *Bauhinia* type. The vascularized spinule terminating the midrib is supposed to be the rudimentary terminal leaflet. This and the laminar vascularization suggest the possible derivation of simple bilobed leaf from an original imparipinnate compound leaf.

Key words: *Bauhinia purpurea* Linn.; Nectary; Stem-node-leaf continuum; Trilacunar node.

Introduction

Importance of the study of stem-node-leaf continuum has been emphasized by recent investigators (Howard, 1974; Pillai and Sharma, 1982; Larson, 1984; Sharma and Pillai, 1985). Vascularizations of inter-node, foliar node and petiole in *Bauhinia purpurea* Linn. are described here.

Materials and Methods

10-12 samples each of internodes, nodes and leaves from basal, middle and distal parts of branches of *Bauhinia purpurea* Linn. were collected, fixed in FAA, processed through TBA series and embedded in paraffin. Serial transverse sections cut at 8-10 μm were stained with safranin and light green SF (C.I. no. 42095) combination. Measurements are averages of 5-8 readings. These refer to the leaf at the third node as considered from apex of a mature branch.

[1] Mailing address: B-88, Surya Marg, Tilak Nagar, Jaipur-302 004, India.

Observations

Bauhinia purpurea Linn. is a small profusely branched ornamental tree bearing simple alternate, stipulate and bilobed leaves. The two subopposite stipules are vascularised. At the base of the petiole two subopposite, adaxially located microscopic nectaries (approximately at 2.06 mm) are present (Figs. 6, 15). The lamina is distally bilobed due to the formation of a deep groove (Fig. 1). The midrib and four pairs of lateral veins arising distally from the petiole form the laminar vasculature. The midrib terminates in a spinule at its tip.

The Internodes

The quadrangular stem shows four unequal ridges alternating with furrows. A ring of about 16 conjoint, collateral and open bundles forms the internodal vasculature (Figs. 2, 11). The four bundles inner to the ridges are larger. A single layered endodermis surrounds the stele. 5-6 layered primary phloem fibre patches are present between the endodermis and the secondary phoem.

Uniseriate multicellular epidermal hairs with a

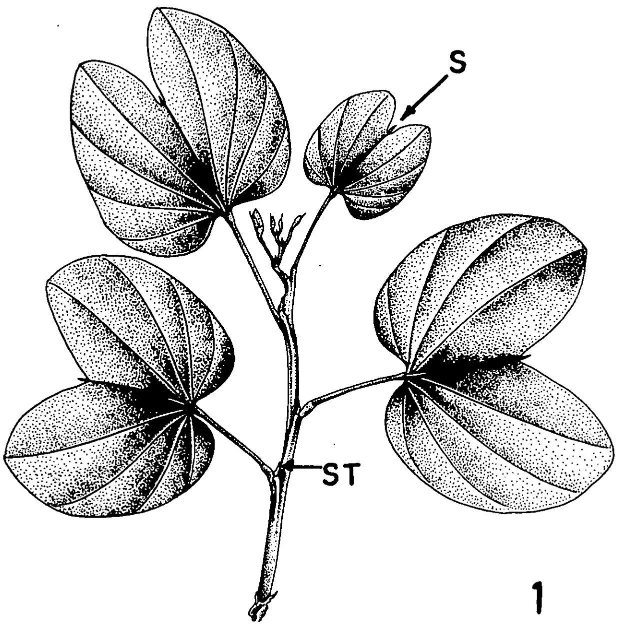


Fig. 1. A twig showing phyllotaxy and positions of stipules and spinules. (S-Spinule, ST-Stipule).

small basal and a long pointed apical cell are present on the internode, node and petiole (Figs. 2, 3). Vascular patterns of distal, middle and proximal nodes examined from 5-8 branches are identical.

The Node

The node is trilacunar three-trace. Of the four large bundles inner to the ridges, three adjacent ones form the three traces to the leaf (Fig. 12). The anodic lateral departs first from the central cylinder followed by the cathodic and the median large trace (Figs. 4, 12). The lateral gaps close immediately by differentiation of fresh procambium. Axial vasculature flanking the median gap separates in the form of two arcs to supply the axillary bud (Figs. 4, 13). The median gap closes after the departure of the axillary bud supply. The laterals move toward the median and also give off branches at 1.96 mm level to supply the nectary and stipule on the respective sides (Figs. 5, 6, 14). The three traces then fuse at the base of the petiole forming a semilunar group on the abaxial side representing the main vasculature of the petiole (Figs. 6, 15).

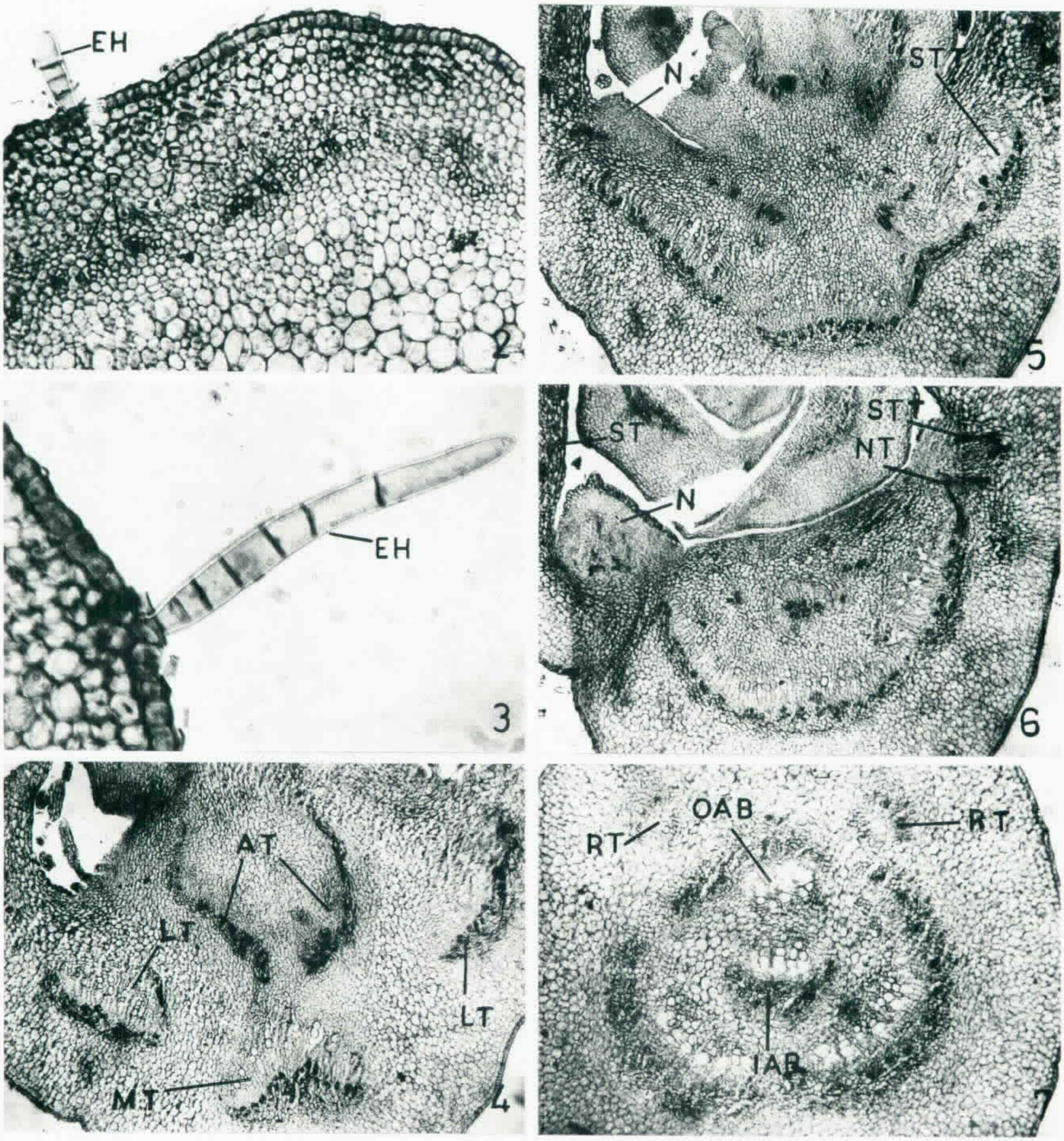
The Petiole

The freshly differentiating procambium and branches from the flanks of the laterals before their fusion with the median form a group of small concentric amphivasal bundles on the adaxial side (at 2.17 mm level) (Figs. 6, 15). By a gradual decrease and obliteration of abaxial xylem these bundles form a large, adaxial, collateral bundle (Fig. 16). The abaxial arc becomes deeper (at 2.32 mm level) and then forms a complete ring of collateral vasculature (at about 2.51 mm level). The adaxial bundle is inside this ring and inverted (inner adaxial bundle hereinafter referred as IAB) (Fig. 17). At about 3.37 mm level the ring separates into two lateral arcs. Branches from the adaxial flanks of each arc separate and fuse to form a large adaxial bundle (outer adaxial bundle hereinafter referred as OAB) opposite to the IAB (Fig. 18). From the adaxial flanks of each arc at about 3.74 mm, two bundles separate, move to the cortex and get housed in the two adaxial ridges of the petiole (Figs. 7, 19, 20).

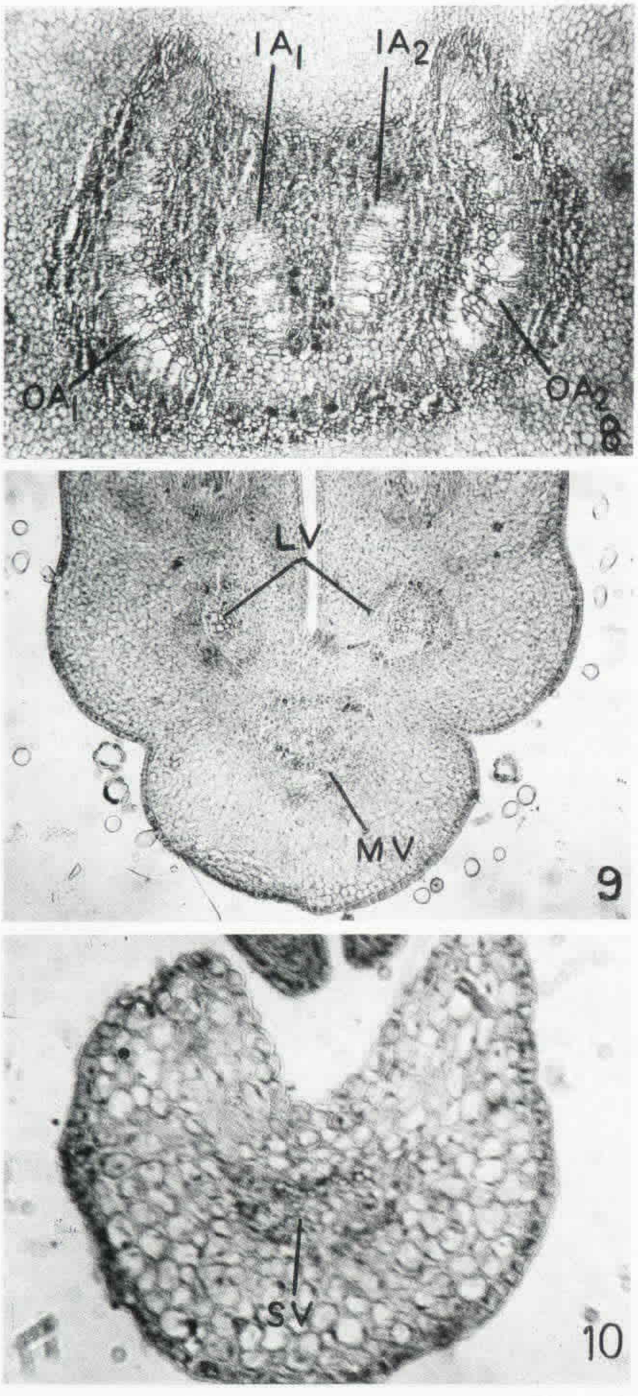
At about 4.93 mm level the petiole vasculature consists of two abaxial bundles and a few smaller bundles in addition to the inner (IAB) and outer adaxial (OAB) bundles (Figs. 7, 20). The xylem groups of IAB and OAB bifurcate gradually at higher levels by differentiation of parenchyma between them (Figs. 20, 21). The lateral arms of xylem of these bundles facing each other fuse on the corresponding sides to form two lateral xylem groups with common phloem (at 6.14 mm level) (Fig. 21). The abaxial larger bundles and the adjacent smaller vascular bundles regain the former shape as two lateral arcs facing each other at 6.26 mm level (Figs. 21, 22). The petiole vasculature at 6.50 mm level is composed of four lateral arcs, two outer (OA_1 and OA_2) facing each other and two inner (IA_1 and IA_2) facing the outer ones (Fig. 22). The ridge bundles fuse with the adaxial ends of the outer arcs on the respective sides resulting in two large outer and two small inner arcs (Figs. 8, 23).

Branches from IA_1 and OA_1 on one side and IA_2 and OA_2 on the opposite side form the first pair of lateral veins (Fig. 24). The next three pairs of lateral veins are also formed in a similar manner (Fig. 9).

The major part of the vasculature forms the four pairs of lateral veins. The remaining vasculature is retained in the midrib and the last remnants of the vasculature enter the spinule at the bottom of the lobes (Figs. 10, 25).



Figs. 2-7. Transverse sections through internode, node and petiole. Fig. 2. A part showing internode vasculature x200. Fig. 3. A multicellular epidermal hair enlarged x 750. Fig. 4. Trilacunar three trace node and axillary bud supply x 75. Figs. 5-6. Formation of adaxial concentric vascular bundles and supply to the stipules and nectary at their base x 75. Fig. 7. Petiole vasculature x 100. (AT-Axillary bud trace, E-Endodermis, EH-Epidermal hair, IAB-Inner adaxial bundle, LT-Lateral trace, MT-Median trace, N-Nectary, NT-Nectary supply, OAB-Outer adaxial bundle, P-Primary phloem fibres, RT -Ridge trace, ST-Stipule, STT-Stipular supply).



Figs. 8-10. Transverse sections through petiole, midrib and spinule terminating the latter. Fig. 8. Petiole vasculature x 100. Fig. 9. Midrib and lateral veins vasculatures x 100. Fig. 10. Spinule vasculature x 100. (IA_1 and IA_2-Inner arcs of vasculature, LV-Lateral vein vasculature, MV-Midrib vasculature, OA_1 and OA_2-Outer arcs of vasculature, SV-Spinule vasculature).

Discussion

Sinnott (1914) described three types of nodes in angiosperms viz., unilacunar, trilacunar and multilacunar. The foliar nodes reported here show a trilacunar three-trace condition. The data presented agree with the previous reports by Wateri (1934) and Pillai and Sharma (1982) where all the leaf traces form the petiole vasculature and the laterals also supply the stipules.

Howard (1963) classified petiolar vasculature relating the nodel structure at the level of the leaf gaps to the vascular patterns obtained in the petiole. The petiolar vasculature reported here is Howard's *Bauhinia* type: " Node 3-3, bundles fuse to form a siphonostele, accessory bundles in medullary position. " The petiole vasculature gives off four pairs of veins and the lamina is distally bilobed due to the formation of a deep apical groove. The spinule terminating the midrib is vascularised. This may be an indication of its derivation from an original imparipinnate compound leaf with four pairs of leaflets. The vascularised spinule terminating the midrib may represent the rudiments of the terminal leaflet.

Vascularized microscopic nectaries in the axil of stipules are present. Pillai and Sharma (1982) and Sharma and Pillai (1985) reported foliar nectaries in *Pithecolobium* and *Acacia*. Based on some anatomical details Schnell, *et al*. (1963) classified foliar glands and gave some suggestions on phylogenetic origin of glands. The present report agrees with Elias's (1972) and Pillai and Sharma's (1982) suggestion that the presence or absence of specialized or unspecialized foliar nectaries or glands in the three subfamilies of leguminosae may be useful in considerations of taxonomy.

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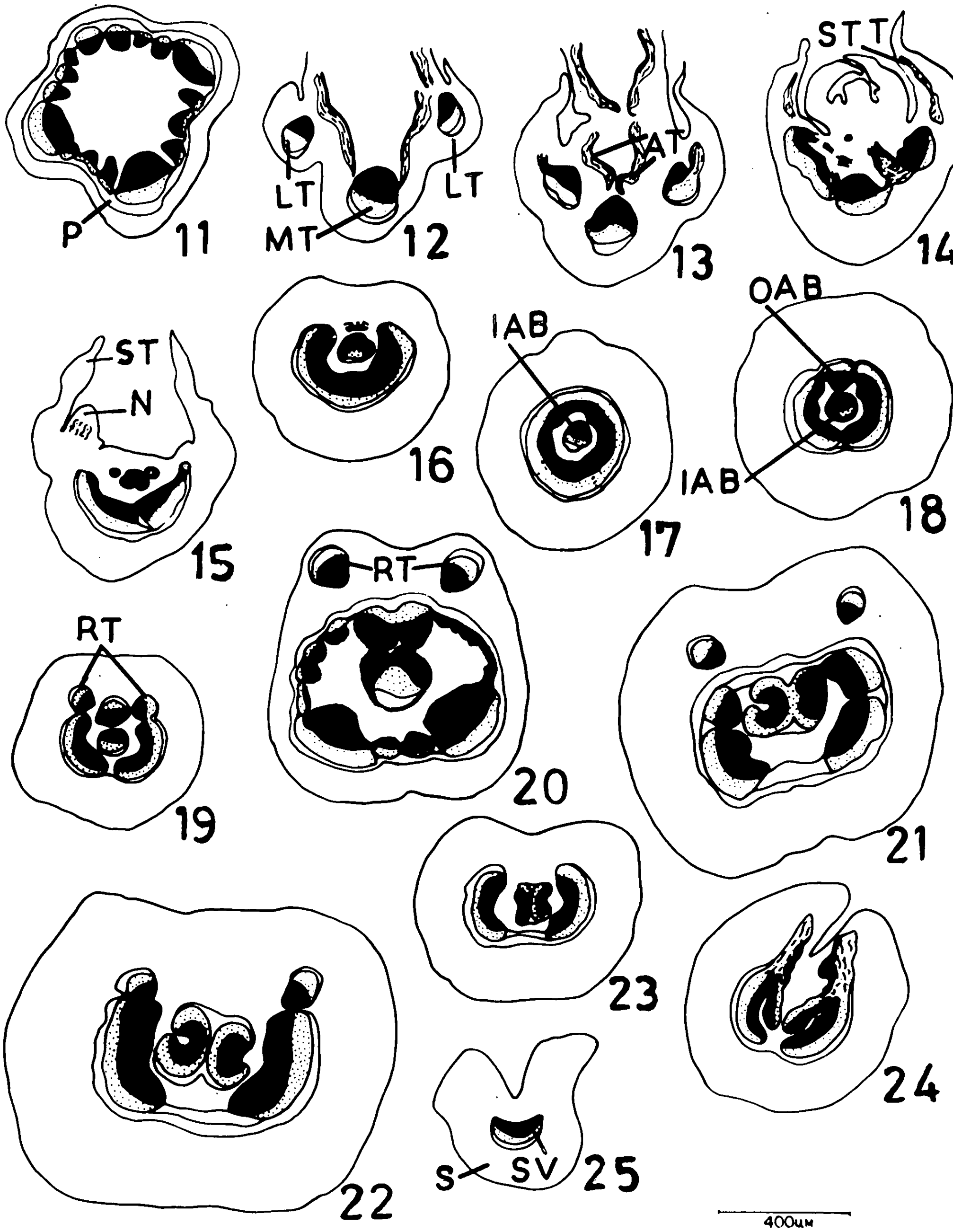

Figs. 11-25. Camera lucida diagrams of the transverse sections through internode, node, petiole, midrib and spinule. Fig. 11. The internode vasculature. Figs. 12-13. Trilacunar three-trace node and axillary bud supply. Fig. 14. Fusion of the traces and supply to the stipules and the nectary. Fig. 15. Nectary at the stipule base and concentric small bundles on the other side. Figs. 16-17. Formation of Inner adaxial bundle (IAB). Figs. 18-23. Sections showing petiole vasculature at different levels. Fig. 24. Departure of lateral viens vasculature. Fig. 25. Vasculature to the spinule. (AT-Axillary bud trace, IAB-Inner adaxial bundle, LT-Lateral trace, MT-Median trace, N-Nectary, OAB-Outer adaxial bundle, P-Primary phloem fibres, RT-Ridge trace, S-Spinule, ST-Stipule, STT-Stipular supply, SV-Spinule vasculature).

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羊蹄甲莖-節-葉維管束之連續性

R. K. Dubey, K. C. Sharma and A. Pillai

Department of Botany, University of Rajasthan
Jaipur-302 004, India

本文研究羊蹄甲(*Bauhinia purpurea* Linn.)的軸、節和葉柄的維管束系統。該種的葉節末端、中間及基部均爲三隙三束跡的構造。其近於對生的托葉及葉柄基部一對極小的蜜腺皆由側面的束跡來供應維管束。二裂單葉的葉柄解剖構造與Howard(1963)的 *Bauhinia* 型類似。葉片之中肋末端具維管束的小刺可能是退化的頂羽片；此點與葉片維管束的供應情形顯示羊蹄甲的二裂單葉可能是由奇數羽狀複葉衍生而來。