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

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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 spine 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 internode, 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.

**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 phloem.

Uniseriate multicellular epidermal hairs with a
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 (OA1 and OA2) facing each other and two inner (IA1 and IA2) 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 IA1 and OA1 on one side and IA2 and OA2 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 x 200. 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).
Discussion

Sinnott (1914) described three types of nodes in angiosperms viz., unilocular, trilocular and multilocular. The foliar nodes reported here show a trilocular 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 node 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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Literature Cited

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).

羊蹄甲茎-節-葉維管束之連續性

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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、中間及基部均為三隙三端的構造。其近於對生的托葉及葉柄基部—對極小的蜜腺皆由側面的東跡來供應維管束。二裂葉片的葉柄解剖構造與 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翼片；此態與葉片維管束的供應情形顯示羊蹄甲的二裂葉片可能是由奇數羽狀複葉衍生而來。