International Journal of Innovative Research and Review ISSN: 2347 – 4424 (Online)
An Online International Journal Available at http://www.cibtech.org/jirr.htm
2017 Vol. 5 (4) October-December, pp.53-58/Bhati et al.
Research Article

STEM-NODE –LEAF CONTINUUM IN *HELIOTROPIUM SUBULATUM* LINN

ItiShri Bhati[1], Rajendra Saini[1], *Shiv Kumar Singh[2], Raaz.K.Maheshwari[3] & Manju Sharma[4]
[1]S.S. Jain Subodh P.G. Autonomous College, Jaipur
[2]Kedia Institute of Science and Technology College, Rajawas, Jaipur
[3]Department of Chemistry, SBRM Govt College, Nagaur, Rajasthan
[4]Department of Botany, U.O.R. Jaipur
**Author for Correspondence*

ABSTRACT
The study of Stem- Node-Leaf Continuum in *Heliotropium subulatum* of family Boragenaceae has been made to describe the vascular pattern in the internode, the node and the petiole. The internode is hexagonal stem showing six equal ridges alternating with furrows. The Node is unilacunarunitrace type. The Petiolar vasculature has been classified. It is crescent shape throughout the petiole and midrib. The results are discussed with respect to the evolutionary conception of the node.

Keywords: *Stem, Node, Leaf, Petiole, Vasculature*

INTRODUCTION
The study of nodal organization has an important bearing in understanding the main course of vasculature and its subsequent supply to various plant organs, both vegetative and reproductive and their accessories. The information so derived could be helpful in inculcating structural and developmental sequences, of these organs, and also a criterion for systematic studies (Chacko, 1976).
The Node is defined as either a joint or a place where a leaf, two opposite leaves or a whorl of leaves may be borne. The word node has also been associated with internal structure of the stem, where the term indicates the relationship of the vascular supply of the leaf base or the petiole with that of the stem. The stem and the leaf may be said to have a continuous vascular supply. The unit of conducting tissue which enter the stem from the leaf or conversely depart from the stem and enter the leaf have been termed traces and their association with the total vascular supply of the stem in such that a lacuna or gap generally filled with parenchymatous tissue is present.
Although, each lacuna normally has one trace, two trace, three trace or more groups of vascular strands have also been associated with a lacuna (Esau, 1953). The type of node for a family or the genus is generally constant but the deviations from the main type do exist thus making this character to be family genus specific (Fahn, 1974).
There are some species of Boragenaceae family which have been worked out to understand the nodal vasculature. *Heliotropium subulatum* also belongs to the some family whose vasculature has been studied with the some orientation (Chacko, 1976).
The present paper deals with the detail of nodal organization in *Heliotropium subulatum* and its implications.

MATERIALS AND METHODS
The nodal material was collected from mature plant. The material was fixed in Formalin-Acetic Acid – Alcohol (FAA) consisting of formalin, acetic acid and 70% ethanol in a proportion of 1: 1: 18. For about 48 hours and preserved in 70% ethyl alcohol till required for further processing. Specimens were washed thoroughly in 70% alcohol, dehydrated through tertiary butyl alcohol (TBA) series and embedded in paraffin.
Serial transverse section of internode, nodes, and leaves were taken at 10-10 m. Houpt s adhesive was used for affixing the paraffin ribbons to slides. The dried slides were then stained with Tannic Acid-Ferric Chloride, saffranin and light green combinations (Johansen, 1940).

Research Article

Morphological Observations

Heliotropium subulatum (Boraginaceae)

Plants are wildly grown as erect annual herbs and measure about 1-3ft in height. They are scabrous and hispid with stiff bulbous, based hairs (Figures 1, 2, 3).

The stem is aerial, erect or tapered, herbaceous, dichotomously branched, green, hairy and rough.

Leaf measuring about 3-5 x 2-3 cm in (length x breadth) is subentire, acute, sessile or nearly narrowly lanceolate and tapering towards the base. Leaves are exstipulate, alternate and hairy. They have narrow lamina with nerves indistinct above.

Inflorescence is a helicoid cyme. The flower is sessile, ebracteate, simple, white and borne in spikes, which are unilateral or sometimes 2-ranked, especially towards the apex. Flowers are pentamerous, hypogynous, zygomorphic and seem to be star shaped on observing from upside. The calyx is formed of five fused 0.3-0.5cm long green hairy sepals. The corolla tube is made up of five fused petals which are 0.2-0.3cm long wider upwards, setose outside and elongated. The corolla lobes are caudate-acuminate and spreading. It is yellowish white coloured. Five stamens are attached to the swollen portion of the corolla tube. The anthers are sessile, bifid at the apex, white and dorsifixed. The ovary is bicarpellary and syncarpous. The style is glabrous, 0.1-0.2mm long and emerging from depression found at the top of the ovary. Stigma is bilobed and the stigmatic ring supporting a long cone, is penicillate with white shining hairs. Ovary is superior, bilocular and have two ovules per locule.

The fruit is a drupe or dividing into four nutlets. It is about 0.1-0.2mm long, rounded and rugose or tuberculate on the back. Seeds are dark black oblique endospermic.

Figure 1: Plant Growing in Field

Figure 2: Showing a Hairy Twig of Stem and Leaves

Figure 3: Showing Inflorescence

Figure 1-3: Habit of *Heliotropium Subulatum* with Vegetative and Reproductive Stages

RESULTS AND DISCUSSION

Results

The Internode

The outline of internode is from oval to pentagonal. The epidermis is single layered having thick walled cells with cuticle. Internodal Cortex- is divided into three parts, (a) outer cortex- 3-4 layered with collenchymatous cells (b) middle cortex- 3-4 layered with chlorenchymatous cells and (c) inner cortex- 4-5 layered with parenchymatous cells having intercellular spaces.

The Internode is pentagonal stem shows 5 equal ridges altenating with furrows. A ring of about 13-14 conjoint collateral & open bundles forms the intermodal vasculature. All the bundles are generally of same size. The endodermis is not cleared. Epidermal hairs present on epidermis (figure 4-5).

The Node

A large, almost tri-lobed, group of vasculature separates from the axial ring leaving a single gap, thus, characterizing the node as unilacunarunitraced type. The gap made due to departure of the vascular group for the leaf is filled by differentiation of procambium tissue (Figure 6, 7).

The Petiole

The large vascular group after entering the petiole base becomes crescent shaped and maintains this shape throughout the petiole length and midrib region (Figure 8). Small bundles separate out from either sides of the bundle at higher levels and supply the lamina (Figures 9, 10).

Discussion

Our observation indicates the stem outline of *Heliotropium subulatum* is oval to slightly angular and the cortex is demarcated into outer middle and inner portion. The axis vasculature is represented by a continuous ring the data indicate that the species studied here, as also the previous ones by several authors, have specific combination of internodal histology. In *Heliotropium subulatum* unilacunar type of node is present and a single large vascular bundle originates as a leaf trace. The uniform condition of node in one family have been recorded by earlier workers also (Kavathekar *et al.*, 1979; Gupta and Murty, 1983; Jain *et al.*, 1984 and Bhati, 2015a). The species studied here shares the common features of unilacunar one trace nodal condition within the member of Solanaceae. Whereas, variations in the unilacunar condition within a family, the Solanaceae. Eames (1961) suggested a strong correlation between the simple leaf and unilacunar condition of node. Earlier Sinnott and Bailey (1914) put forward the view that majority of angioperms having unilacunar nodes did not possess stipules. Later Dickison, (1969); Gupta and Murty, (1983); Bhati, (2015b) also supported this view. But Kshetrapal and Tyagi (1981) in *Buddleia* and *Nicotiana* and Negi and Sharma (2001) in *Hamelia* found that the unilacunar node was also associated with stipular supply. The species studied here have various types of unilacunar nodes and exstipulate leaves. The data are in agreement with Sinnott and Bailey's (1914) observations. Metcalfe and Chalk (1950) suggested taxonomic importance of petiolar anatomy and proposed nine types of vascular systems in dicotyledonous petioles.

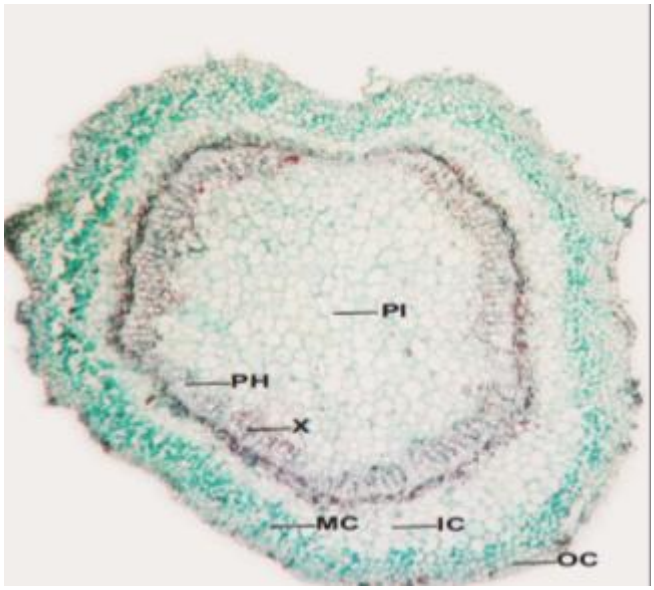

Figure 4: A Part of Internodal Vasculature X 100

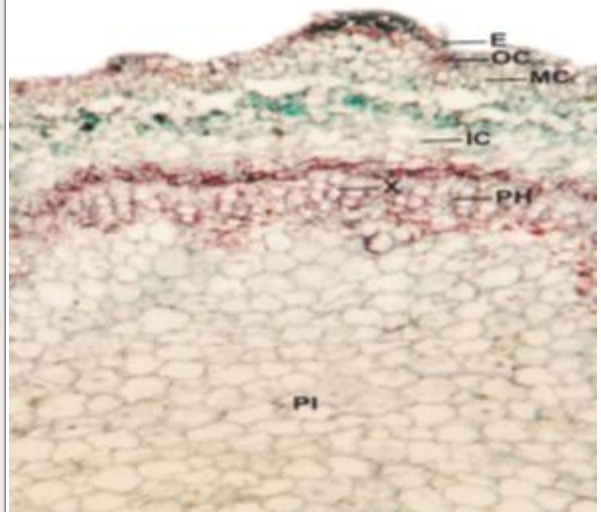

Figure 5: Magnified View of Internodal Vasculature X 400

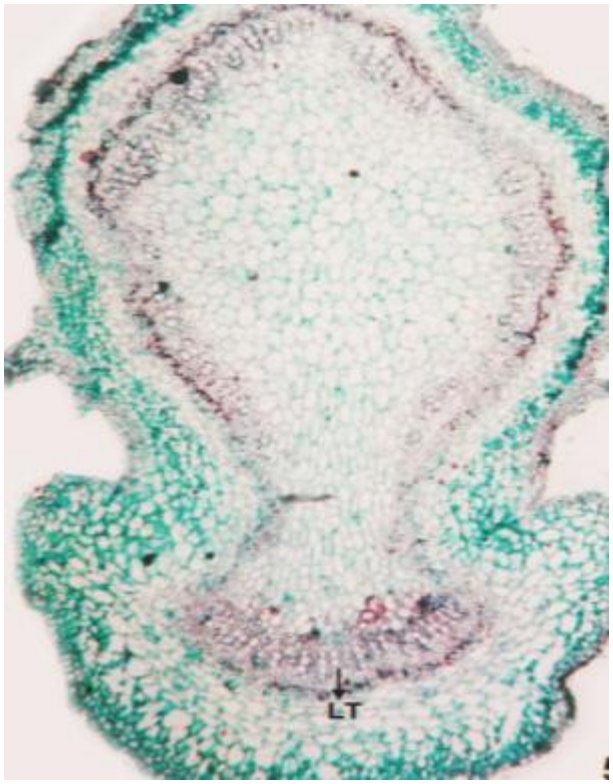

Figure 6: Vascular Groups Preparing as a Trace to a Leaf X 100

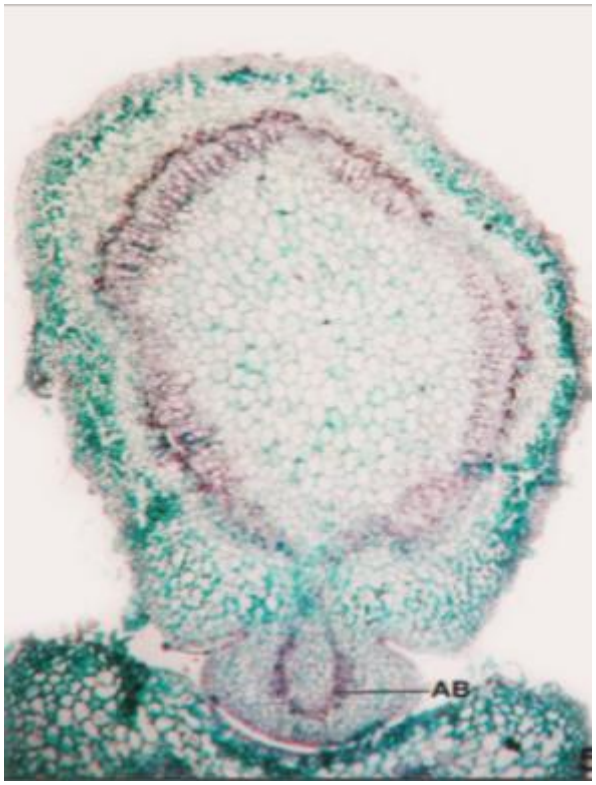

Figure 7: The Vascular Group Departuring from the Axis and Axial Vasculature Supplies the Axillary Bud before the Leaf Gap is Closed X 100

Figures 4 -7: Transverse Section of Main Stem Axis and Petiolar Region in *Heliotropium Subulatum* AB: Axillary Bud; E: Epidermis; IC: Inner Cortex; LT: Leaf Trace; MC: Middle Cortex; OC: Outer Cortex; PH: Phloem; PI: Pith; X: Xylem

Howard (1963) also gave a preliminary classification relating to the nodal structure at the level of the gap to the vascular pattern obtained in the petiole. Hara (1943) reported different shapes of petiolar vasculature viz., 'U' –Shaped, 'I'-Shaped or 'O'-Shaped. The traces to a leaf fuse and form an arc at the base of petiole which is broadly 'U'-Shaped in this species reported here. Lavania and Govil (1991) also reported the same. Earlier Canright (1955); Philipson and Philipson (1968) stated that the petiolar vascular arc was derived through ontogenetic and phylogenetic fusion of several traces. The data reported here broadly agree with these suggestions. The ridges bundles observed in all the five species of Solanaceae may be considered as laminar traces because they become a part of laminar vasculature at higher levels. Metcalfe and Chalk (1950) have also reported similar results.

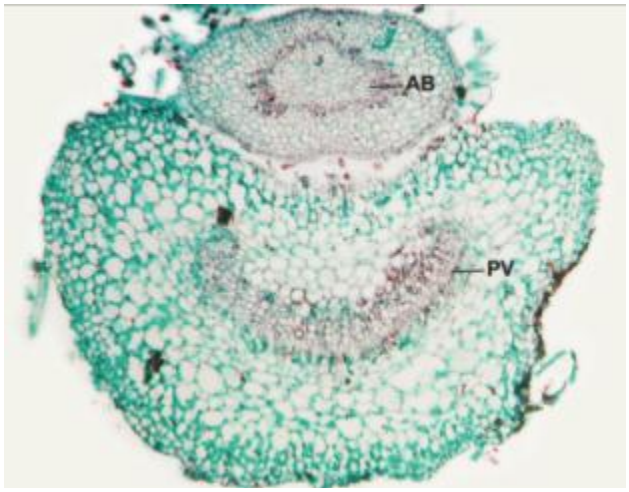

Figure 8: Separation of Petiole Bud from the Main Axis X 400

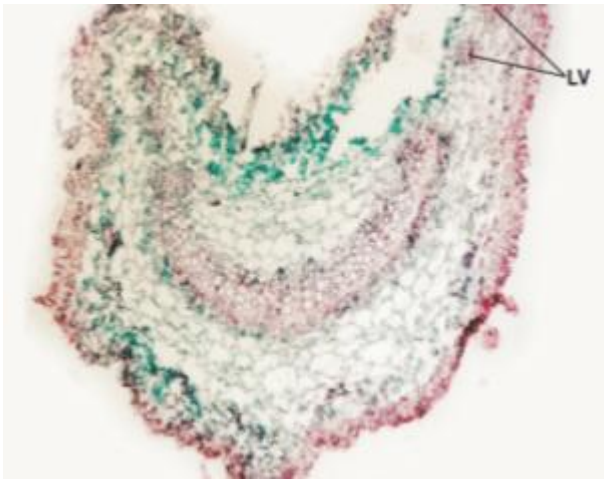

Figure 9: Separation of Marginal Bundles from the both Ends of the Crescent Shaped Large Arc of the Petiole and Move towards the Lamina X 400

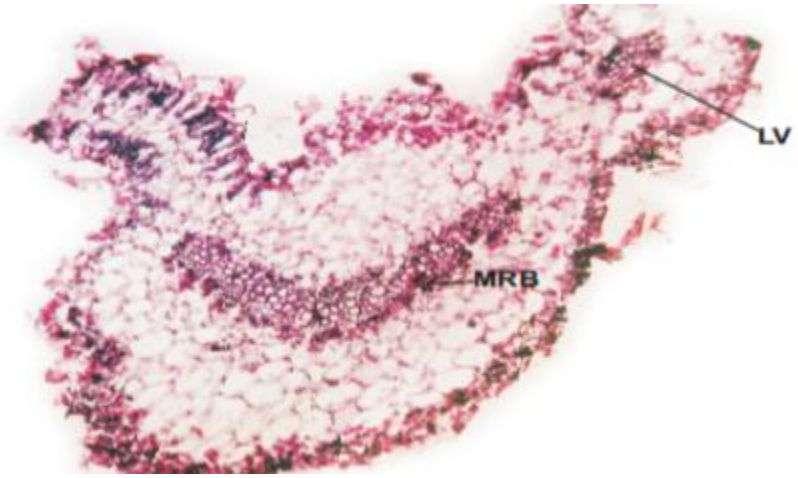

Figure 10: Showing Midrib Vasculature near the Leaf Tip X 400

Figures 9- 10: Transverse Section of Petiole and Lamina in *Heliotropium Subulatum*
AB: Axillary Bud; LV: Laminar Vasculature; MRB: Mid Rib Bundle; PV: Petiole Vasculature

REFERENCES

Bhati IS (2015a). Stem -Node-Leaf Continuum in Solanaceae. *Indian Journal of Fundamental and Applied Life Sciences* **5**(3) 71-80.

Bhati IS (2015b). Primary vasculature differentiation in *Ipomoea sp. Indian Journal of Plant Sciences* **4**(3) 6-12.
Canright JE (1955). The comparative morphology and relationships of the Magnoliaceae. IV. Wood and nodal anatomy. *Journal of the Arnold Arboretum* **36** 119-140.
Chacko B (1976). Development Anatomy and Histochemistry of certain Gymnosperm. Ph.D. Thesis, University of Rajasthan, Jaipur.
Dickison WC (1969). Comparative morphological studies in Dilleniaceae IV.Anatomy of node and vascularization of the leaf. *Journal of the Arnold Arboretum Harvard University* **50** 384-410.
Eames AJ (1961). *Morphology of the Angiosperms*, (McGraw Hill, New York, USA).
Esau K (1953). *Plant Anatomy*, Ist edition, (John Wiley and Sons, New York, USA).
Fahn A (1974). *Plant Anatomy*, 2nd edition, (UK, Oxford: Pergamon Press).
Gupta AK and Murty YS (1983). Nodal anatomy in some members of Tamaricaceae. *The Journal of the Indian Botanical Society* **62** 399-401.
Hara CL (1943). The anatomy of the petiole and its taxonomic value. *Proceedings of the Linnean Society of London* **155** 223-229.
Howard RA (1963). The vascular structure of the petiole as a taxonomic character. *Advances in Horticultural Science* **3** 7-13.
Jain S, Bansal S and Pillai A (1984). Stem-node-leaf continuum in Apocynaceae. *Feddes-Repertorium* **95**(3) 183-188.
Johansen DA (1940). *Plant Microtechnique*. (McGraw Hill Co., New York, USA).
Kavathekar KY, Goyal SC, Satija S, Jain S and Pillai A (1979). Nodal anatomy in some dicotyledons. In: *All India Symposium on Histochemistry, Developmental and Structural Anatomy of Angiosperm*, edition, (K. Periasamy, Tiruchirapally, India) 31-39.
Kshetrapal S and Tyagi YD (1981). A contribution to the vascular anatomy of the node in certain species of the Gentianales. *Journal of Indian Botanical Society* **60** 241-246.
Lavania S and Govil CM (1991). Nodal organization in *Solanum* L. *Journal of Indian Botanical Society* **70** 87-90.
Metcalfe CR and Chalk L (1950). Anatomy of the Dicotyledons I. (Clarendon Press, Oxford, UK).
Negi RS and Sharma KC (2001). Stem-node-leaf continuum in *Cassia glauca*. *Journal of Phytological Research* **14** 7-12.
Philipson WR and Philipson MN (1968). Diverse nodal types in *Rhododendron. Journal of the Arnold Arboretum* **49** 193-217.
Sinnott EW and Bailey IW (1914). Investigations on the phylogeny of the angiosperms. III. Nodal anatomy and the morphology of stipules. *American Journal of Botany* **1** 441-453.