APPLICATION OF NODAL CHARACTERS IN THE STUDIES OF SCROPHULARIACEAE

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The nodal structure in 15 genera has been studied. The leaves are mostly opposite, rarely alternate or whorled and exstipulate. The foliar nodes are uniformly unilacunar and one-traced or rarely three-traced. *Antirrhinum* has both, unilacunar three-traced and unilacunar one-traced node. The single trace shows variation in its branching pattern in different taxa. The origin of axillary bud trace is either independent or in association with leaf trace. The sclerenchyma occurs at four corners of node in certain taxa. It is inferred that unilacunar one-traced condition of the node in the family is a result of reduction. The variation in the nodal characters can be employed in the delineation of taxa.

Key Words: Scrophulariaceae, Node, Evolution.

The information obtained on the nodal organization is widely employed in the systematic and phylogenetic studies. Earlier Sinnott (1914) recorded unilacunar one-traced node in the Scrophulariaceae. Studies of Esau (1953), Varghese (1967), Kumar et al. (1980) and Cronquist (1981) also indicate a unilacunar node in this family. The present paper deals with further details of nodal structure in a few taxa and its morphological implications.

MATERIALS AND METHODS


OBSERVATIONS

In most of the investigated plants the leaves are borne in opposite phyllotaxy. In a few species, however, they are arranged in alternate, opposite or whorled manner. The flower or inflorescence is frequently axillary. Generally a single bud is developed in the axil of each leaf. In some cases two (*Stemodia verticellata* and *Lindernia crustacea*) or four buds are formed as in *Mecardonia* (Fig. 12).

In all the plants examined, the internodal region is with a ring of vascular bundles or a vascular cylinder. In *Lmophila*, a ring of air chambers encloses the vascular tissue.

At nodal region, an arc shaped vascular trace separates out leaving behind a prominent gap in a majority of the species. Thus a node becomes a unilacunar single traced structure (Fig. 1, 4, 7, 13). In *Lindenbergia indica*, three traces are derived from the axial tissue leaving a single gap (Fig. 10). These three traces then extend into the petiole.

Three traces that emerge from the axial vascular tissue in *Antirrhinum majus* (Fig. 5), fuse with one other to form an arc shaped vascular trace (Fig. 6) and enter into the petiole. However in some nodes of these plants, a solitary arc shaped vascular trace is given out leaving a gap (Fig. 7).

A solitary trace exhibits variation in its shape, nature, place and extent of branching. It is three-lobed in many a taxa as in *Verbascum* (Fig. 1), horse-
Figures 1-18. Transverse sections of nodal region. Fig. 1-3 Verbascum chinense, Fig. 4. Kickxia ramosissima, Figs. 5, 6, 7. Antirrhinum majus, Figs. 8, 9. Sutera dissecta, Fig. 10. Lindenbergia indica, Fig. 11. Stemodia viscosa, Fig. 12. Mecardonia procumbens, Fig. 13. Lindernia antipoda, Figs. 14, 15. Veronica anagallis-aquatica. Figs. 16-18. Limnophila indica.

ABT - Axillary bud trace, AC - Air chamber, LT - Leaf trace, Scl - Sclerenchyma.
Application of nodal characters in Scrophulariaceae

shoe shaped in *Sutera* and *Veronica* (Figs. 8, 14) and five lobed in *Stemodia viscosa* (Fig. 11).

A single trace remains unbranched in its upward course and enters into the petiole or leaf in *Russelia, Sutera, Bacopa, Microcarpaea* and *Kickxia* (Fig. 4). In other plants it shows branching at various levels in the node or at the base of petiole or after traversing into the petiole.

In the nodal region, a single trace usually give off two lateral branches in the species of *Stemodia, Lindernia, Alectra, Buchnera, Verbascum, Mecardonia, Lindenbergia* (Figs. 2, 12) and *Lindernia grandiflora*, while it divides at the base of petiole in *Veronica* (Fig. 15). Further, each of the lateral traces divides during their upward course in some species, so that five traces are observed in *Verbascum, Stemodia viscosa, Lindernia parviflora, L. ciliata* and *L. antipoda*, whereas in *Limnophila* more than five traces are noticed (Figs. 17, 18).

The sclerenchymatous patches are seen at four corners of the nodes in some plants like *Lindenbergia indica, Lindernia ciliata, L. crustacea, L. parviflora* and *L. antipoda* (Figs. 10, 13). The well developed air chambers of internode also extend up to the node in *Limnophila indica* (Figs. 16-18).

The vascular supply to axillary bud and the leaf may arise simultaneously or successively in the different taxa investigated. In *Verbascum*, the origin of the leaf trace is followed by the bud trace (Figs. 1 to 3). In *Bacopa, Sutera and Veronica*, The broad arc or horse-shoe shaped trace emerges out from the stellar structure, which first cuts the traces for axillary bud towards inner side and then behaves as a leaf trace (Figs. 8, 9, 14, 15).

**DISCUSSION**

While exhibiting a greater degree of uniformity in the plants studied, the anatomy of node presents certain interesting variations. The node is unilacunar single-traced in all the plants except *Lindenbergia indica*, where it is unilacunar three-traced. However, in *Antirrhinum*, both unilacunar three-traced and unilacunar one-traced nodes occur. Varghese (1967) reported unilacunar three-traced node in *Nemesia*.

The single trace reveals variation in its shape, place and branching. In most of the species, there are three lobes, while it remains undivided in *Kickxia, Russelia, Sutera, Bacopa* and *Microcarpaea* or sends two lateral branches in the nodal region in *Verbascum, Stemodia, Limnophila, Mecardonia, Lindernia, Alectra, Buchnera* and *Lindernia grandiflora*, and at the base of petiole in *Veronica*. Each lateral trace splits further into five or more traces in different members.

In some nodes of *Antirrhinum*, the three traces derived from axial vascular tissue show fusion among themselves in their upward course forming an arc shaped solitary trace.

It is interesting to note that four sclerenchymatous patches in *Lindenbergia indica, Lindernia antipoda, L. ciliata, L. crustacea* and *L. parviflora*, serve a mechanical function. The well developed air chambers in *Limnophila* give buoyancy to the organs.

The present study reveals that the majority of the taxa show unilacunar single-traced nodal structure. It is in *Lindenbergia indica*, the node has unilacunar three-traced organization; while in *Antirrhinum*, both nodal structures-unilacunar three-traced and unilacunar singled-traced occur.

If the trilacunar 3-traced node in the Tubiflorae is considered as to be primitive as suggested by Sinnott (1914), a unilacunar 3-traced condition as seen in *Lindenbergia indica* and *Antirrhinum* can be derived by the amalgamation of three distinct gaps into one.

On the basis of the present study, it may be presumed that the arc is the result of fusion of three to five or more traces into one or it gets amplified to give many branches. According to Canright (1955) and Philipson and Philipson (1968) the arc is derived as a result of ontogenetic and phylogenetic fusion of several traces, and the present work reinforces to the same. It is held that the nodal evolution might have involved a reductional process in Scrophulariaceae as evidenced by *Antirrhinum*, wherein three traces show fusion leading to the formation of a solitary broad arc.

The vascular supply to each axillary bud is derived from axial vascular tissues either directly or in association with a leaf trace. In *Sutera, Bacopa* and *Veronica* it emerges jointly with a leaf trace.

The nodal characters namely, the variation in the branching pattern of the solitary trace, vascular sup-
ply to each axillary bud either directly or in association with leaf trace, the occurrence of sclerenchymatous patches and the development of air chambers can thus be used as adjuncts in the segregation of the taxa studied.

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REFERENCES


