CONTRIBUTION TO OUR KNOWLEDGE OF THE
PHYSIOLOGICAL ANATOMY OF SOME INDIAN
HYDROPHYTES

V. The Stem of Lindernia Allioni

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INTRODUCTION

The genus Lindernia Allioni of the Scrophulariaceae was reconstituted by Pennell (1935) after merging with it the genera Vandellia Brown ex. Linn., Ilysanthes Raf. and Bonnaya Link. & Otto. The total number of species under Lindernia Allioni, in its new and amplified form, would be about seventy. Mukerjee (1945) enumerates twenty-five species of this genus occurring in India.

Lindernia Allioni is a typical hydrophytic genus whose species are mostly annual herbs that thrive usually in marshy areas, rice fields and damp places. In the present contribution it is proposed to give an account of the physiological anatomy of the stem in four species occurring at Nagpur, viz., L. crustacea (Linn.) F. Muell., L. hirsuta (Bth.) Wettst., L. ciliata (Colsm.) Pennell, and L. parviflora (Roxb.) Haines.

The stem in all the species is erect or sub-erect and often diffusely branched. In Lindernia parviflora (Roxb.) Haines the stem is particularly slender and glabrous. L. crustacea (Linn.) F. Muell. and L. ciliata (Colsm.) Pennell have sparsely hairy stems. In L. hirsuta (Bth.) Wettst. the stem is succulent and clothed with many spreading hairs.

ANATOMY

1. Epidermis.—Outer walls thicker than the undulated lateral walls; cuticle very thin, though recognizable, in all the four species (Fig. 1); anthocyanin present characteristically in the epidermal cells of the stem of L. hirsuta (Bth.) Wettst. Unicellular or uniseriate bicalicular, thick-walled, papillose trichomes present in the hairy stems (Fig. 2). Multicellular peltate glands in all the species (Fig. 3). Stomata raised; guard-cells smaller than the epidermal cells (Fig. 1).
TEXT-FIGS. 1-5. Lindernia hirsuta (Bth.) Wettst. Fig. 1. Part of the T.S. of the stem showing the raised stoma, the small-sized guard-cells, the thin cuticle and thick outer walls of the epidermal cells. Lindernia crustacea (Linn.) F. Muell. Fig. 2. Part of the T.S. of the stem showing the uniseriate, bicellular thick-walled trichome. Fig. 3. Part of the T.S. of the stem showing the peltate gland in section. Fig. 4. Part of the T.S. of the stem showing the lacunar cortex. Fig. 5. Part of the T.S. of the stem showing the thin-walled parenchymatous pith cells with small intercellular spaces.

2. Cortex.—Collenchyma almost entirely wanting, only the outermost layer of the cortex showing collenchymatous differentiation (Fig. 6). Strands of sclerenchymatous fibres present in the sub-epidermal region of the ridges in the quadrangular outline of the stems (Figs. 6 & 7). Chlorenchyma usually confined to the cortical region of the ridge (Fig. 6), but in L. parviflora (Roxb.) Haines the entire cortex is chlorenchymatous. Intercellular lacunæ present in the cortex of all the species (Fig. 4). The cortical cells are generally spherical, thin-walled and the intercellular spaces roundish. The cortex of L. parviflora (Roxb.) Haines shows thin-
walled, elongated, chlorophyllose cells and prominently developed elongated lacunae (Fig. 7). Endodermis is conspicuous.

**Text-Figs. 6–8.** *Lindernia hirsuta* (Bth.) Wettst. Fig. 6. Part of the T.S. of the stem showing the chlorenchymatous cortex and the sub-epidermal sclerenchymatous rib in the ridge. Fig. 8. Part of the T.S. of the stem showing the endodermis, pericycle and the vascular bundle. *Lindernia parviflora* (Roxb.) Haines. Fig. 7. Part of the T.S. of the stem showing the profusely lacunar and entirely chlorenchymatous cortex and the more superficially situated sclerenchymatous rib.
3. **Pericycle.**—1–2 layered, walls slightly thickened (Fig. 8).

4. **Vascular system.**—Vascular bundles separated by prosenchymatous cells, typical parenchymatous medullary rays absent. Xylem and phloem well developed (Fig. 8).

5. **Pith.**—Thin-walled parenchymatous, intercellular spaces small (Fig. 5).

**DISCUSSION**

1. Scrophulariaceae is one of those advanced families of Angiosperms which, although thriving mainly on land, include a number of hydrophytic forms. The genera *Hydrothorpe Zucc.*, *Limnophila R. Br.*, *Dopatium Buch-Ham. ex. Benth.*, *Veronica Linn.*, *Bacopa Aubl.* and *Lindernia Allioni* exhibit various degrees of adaptation to the aquatic conditions in their morphological as well as anatomical characters.

2. The foregoing account of the physiological anatomy of the stem of the four species of *Lindernia Allioni*, that thrive in damp places or swampy areas, brings out clearly the anatomical adaptations of these species to their habitat. The various features enumerated above may be briefly reviewed as follows:

   (i) **Aerating system.**—As in the case of most hydrophytes, the stems of the species investigated above also show a characteristic development of aerating tissue in the form of the lacunar cortex. Solereder (1908) has mentioned the occurrence of a lacunar cortex in the stem of another species, *Lindernia pyxidaria* All. Syeedud-din (1940) describes the lacunar cortex in the stem of another hydrophytic member of the Scrophulariaceae growing in India, *Bacopa monnieri* (Linn.) Pennell (*Herpestop monniera* H. B. & K.). Of the four species investigated here, *Lindernia parviflora* (Roxb.) Haines exhibits a greater degree of adaptation in the form of a more fully developed cortical aerating system which consists of radially elongated, thin-walled, chlorophylllose cells separated by prominent schizogenous air-passage.

   (ii) **Assimilatory system.**—The assimilatory tissue comprises the chlorenchymatous cortex which is generally confined to the ridges. Here, again, *L. parviflora* (Roxb.) Haines shows an advance inasmuch as the entire cortex is here collenchymatous and thus constitutes a prominent assimilatory region of the stem.

   (iii) **Mechanical system.**—The disposition of the mechanical tissues in the stem of *Lindernia Allioni* deserves some special consideration. The thick-walled epidermis and the conspicuous endodermis provide concentric hollow cylinders of mechanical tissue for the stem. The sub-epidermal
sclerenchymatous ribs, situated in the projecting portions of the stem, recalling the pattern of their distribution in the stems of the Labiatae, confer further rigidity on the organ. These are more superficially situated in the stem of *Lindernia parviflora* (Roxb.) Haines (Fig. 7) than in the stems of the other three species (Fig. 6) in which they have been reported earlier by Solereder (1908). The wood fibres associated with xylem vessels are well developed and they form the innermost ring of mechanical elements.

In the stems of most hydrophytes, the cortex is penetrated by lacunae and is consequently weakened. One of the features, usually met with in the arrangement of the cortical cells of such stems, that seem in some measure to obviate the dangers of this fragility is that the outer cortex forms a firmer peripheral shell of collenchyma. Enough proof of this has been obtained in the stems of the composites investigated earlier by the author (Mirashi, 1954, 1955, 1956). It was only in the stem of *Cleome chelidonii* Linn. (Mirashi, 1956), which develops a lacunar pith in place of the usual lacunar cortex, that the characteristic collenchymatous hypodermis was not met with.

It is noteworthy, therefore, that in all the stems investigated here, and especially in the stem of *L. parviflora* (Roxb.) Haines, the collenchymatous outer cortex is conspicuous by its absence despite the fragile texture of the middle cortex which is lacunar. Now, the absence of a well-developed collenchymatous outer cortex in the stem is characteristic of the entire family Scrophulariaceae. Here is an instance, then, of how the adaptive responses of plants to their environment are primarily conditioned by their inheritance. The mechanical requirements of the stem could be satisfied only within the limitations of its inherent characters. The role played by inherent ancestral tendencies needs proper emphasis while interpreting the adaptations of plants in general and the hydrophytes in particular. It is possible that the different phylogenetic histories of the hydrophytes may have been responsible for the wide variety of adaptations exhibited by them in spite of their relatively uniform environment as compared with that of the terrestrial plants.

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**Literature Cited**

Mirashi, M. V.  

.. "Contribution to Our Knowledge of the Physiological Anatomy of Some Indian Hydrophytes. III. The Stem of Cleome chelidonii Linn.," Ibid., 1956, 43 (4), 233-36.

.. "Contribution to Our Knowledge of the Physiological Anatomy of Some Indian Hydrophytes. IV. The Stem of Spheranthus indicus Linn.," Ibid., 1956, 44 (3), 177-83.


.. "Some Common Indian Herbs with Notes on their Anatomical Characters. II. Herpestis monniera H.B. & K. JBNHS, 1940, 41 (2), 321-23.