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

VIII. The Stem of *Hygrophila polysperma* T. Anders.

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**INTRODUCTION**

*Hygrophila polysperma* T. Anders. is a slender herbaceous species. It has creeping stems that root at the nodes and send vertical shoots which terminate into spikes of small pale blue flowers. It usually occurs side by side with the very much allied species, *H. serpyllum* (Nees) T. Anders. The plants form dense mats on the margins of ponds and lakes. The species is also capable of growing almost submerged, only the upper portions of the vertical shoots and the spikes projecting out of water. Such forms show a certain, though definite, degree of heterophylly which has not been emphasised by earlier workers. The aerial leaves are much smaller in size, thicker and somewhat hairy. The bracts of the inflorescence are more pubescent. The submerged leaves are longer, glabrous and filmy. Ream (1953) has worked out the ontogeny of the hydathodes on the submerged and aerial leaves of this species.

**MATERIAL AND METHOD**

The material was collected mostly from the lakes and ponds of Umred and Ramtek. Both the submerged and wetland forms have been studied. The material was fixed in formalin acetic alcohol. The anatomical studies presented here are based mostly on free-hand sections of the stem. The diagrams represent camera lucida sketches made by the author.

**DESCRIPTION**

1. **Epidermis.**—Outer walls thickened; cuticle thin, though recognizable (Fig. 1). Stomata caryophyllaceous, raised above the level of ordinary epidermal cells, restricted to certain areas of the epidermis, below which occur the chlorenchymatous patches of the outer cortex (Fig. 3). Cystoliths solitary, elongated, abundant. Hairs uniseriate, multicellular, with knob-studded walls (Fig. 4). Peltate multicellular glands frequent (Figs. 5 and 6).
**Text-Figs. 1-13.** *Hygrophila polysperma* T. Anders. Fig. 1. Part of the T.S. of the stem of the wetland form showing the epidermis and the collenchymatous outer cortex. Fig. 2. Part of the T.S. of the stem of the submerged form showing the poorly developed collenchyma of the outer cortex. Fig. 3. Part of the T.S. of the stem of the wetland form showing the raised stoma and the patch of chlorenchymatous cells of the outer cortex situated below it. Fig. 4. Part of the T.S. of the stem of the wetland form showing the epidermal hair. Fig. 5. Part of the T.S. of the stem showing the multicellular peltate gland in section. Fig. 6. The gland in surface view. Fig. 7. Part of the T.S. of the stem of the wetland form showing the lacunar middle cortex. Fig. 8. Part of the T.S. of the submerged form showing the profusely lacunar middle cortex. Fig. 9. Part of the T.S. of the stem showing the endodermis, pericycle containing some sclerenchymatous fibres and the phloem. Fig. 10. Part of the T.S. of the stem of the wetland form showing the well-developed wood. Fig. 11. Part of the T.S. of the stem showing the thin-walled parenchymatous pith. Fig. 12. T.S. of the stem of the wetland form (semi-diagrammatic). Fig. 13. T.S. of the stem of the submerged form (semi-diagrammatic).
2. **Cortex.**—Outer cortex mostly collenchymatous; collenchyma well developed in the wetland form as well as in the aerial portions of the stems of the submerged form (Fig. 1); interrupted by chlorenchymatous radial sectors which are situated below the stomatal openings (Fig. 3). The submerged stems show a comparatively much poorer development of this tissue (Fig. 2).

Middle cortex chlorenchymatous, lacunar; air-spaces schizogenous, prominent and radially elongated in the submerged stem, smaller and roundish in the stems of wetland forms (Figs. 7 and 8); the cortical region consequently much broader in the submerged stem than in the wetland form (cf. Figs. 12 and 13).

Endodermis distinct; cells containing starch-grains.

3. **Pericycle.**—Not easily distinguishable from the phloem below; includes some sclerenchymatous fibres at places (Fig. 9).

4. **Vascular system.**—The phloem and xylem form continuous zones. Xylem vessels arranged in radial rows. There is a comparatively uniform development of the vascular system round the pith in the stem of the wetland form. In the submerged form the development of the vascular system is more pronounced in the four corners of the stem. Secondary growth poor or absent in the submerged stem. Wood is well developed in the stem of the wetland form (Figs. 9 and 10).

5. **Pith.**—Thin-walled and parenchymatous (Fig. 11); cells containing bundles of raphides and small-sized druses of calcium oxalate. The pith narrows down considerably in the submerged stem and occupies a much smaller volume in comparison to the cortex. In the wetland form it occupies one-sixth of the entire cross-sectional area of the stem, while in the submerged form this proportion may be reduced to a mere one-twentieth (cf. Figs. 12 and 13).

**Discussion**

1. As has been pointed out earlier, *Hygrophila R. Br.* is a typical hydrophytic genus. The anatomical adaptations met with in the robust erect march species of the genus, *viz.*, *Hygrophila quadrivalvis* Nees, have been reported earlier by the author (1957). The present species is a slender herbaceous plant. Its capacity to live as a submerged form as well as the phenomenon of heterophylly exhibited by it indicate a higher degree of morphological adaptation.
2. The foregoing account of the physiological anatomy of the stem of *Hygrophila polysperma* T. Anders. further brings out the hydrophytic nature of the species and serves to indicate the degree of its adaptation to water. The cuticle is thin, the stomata are raised, the primary cortex is lacunar and the aerial and submerged parts of the stem show differences which are quite characteristic of amphibious plants. The poorer development of collenchyma and wood, the relegation of the mechanical and conducting elements of wood towards the centre, the very elaborate development of lacunae in the aerating tissue and, finally, the consequent broadening of the cortex and narrowing of the pith in the submerged stem are all in accordance with our earlier observations on the anatomy of the stems of helophytes belonging to families of diverse origin like the *Compositae*, *Scrophulariaceae* and *Lobeliaceae*. This provides us with a clear instance of parallel evolution of similar characters in response to similar conditions of environment and also indicates the nature of anatomical adaptation of plants to water at different phyletic levels.

3. The family Acanthaceae, to which the present species belongs, as well as the other three families, mentioned in the above paragraph, belong to the group of sympetalous dicotyledons and represent the culminations of certain evolutionary progressions. The occurrence of typical hydrophytic genera, like *Hygrophila* R. Br. and *Lindernia* All., in this group of advanced angiosperms is certainly significant in view of the ecological evolution of the angiosperms. Members of the Sympetalae, which have attained a high degree of specialisation to terrestrial life, have an inherent handicap in adapting themselves to an aquatic environment. The capacity of *Hygrophila polysperma* T. Anders. to grow as a submerged aquatic, the phenomenon of heterophylly exhibited by it, and the anatomical responses to the watery environment, enumerated above, indicate the success achieved by such essentially terrestrial plants in their attempt to embark upon an aquatic career. And, this success is quite significant. For, as Arber (1920) points out, “it is always possible that those individual genera and species among the Sympetalae, which are hydrophytic at the present day, may each, in some future age, be represented by an entire aquatic family”.

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LITERATURE CITED

