Abstract

Podostemaceae is the largest family of fresh water aquatic angiosperms, represented by 50 genera and 280 species. It constitutes 11.8% (48) of the total 407 known aquatic plants. The Podostemaceae is characterized by a combination of several morphological, embryological and evolutionary features which are notionally atypical among the flowering plants. India harbours 10 genera and 28 species of Podostemaceae, of which 23 are endemic which are largely confined to Kerala and Karnataka. In spite of a sufficient number of species available in different parts of India, several aspects of the Indian species are poorly understood. Present work aims to understand aspects of reproduction and development and also assesses phylogenetic relationships in some Indian Podostemaceae. The reproductive ecology, female gametophyte development and seedling development was investigated in four species of Podostemaceae, namely Zeylanidium olivaceum (Gardn.), Engler, Podostemum subulatus Gardn., Willisia arekaliana Shivam. and Sadanand and Polypleurum munnarense (Nagendran and Arekal). The study was carried at the sites of natural occurrence of these plants in different districts of the state of Kerala. Observations were made while standing in the swiftly flowing water and were complemented with suitable methods in the laboratory wherever required. To elucidate the phylogenetic relationships, within the Indian Podostemaceae a combined analysis of molecular and morphological data was done for eight different genera and 14 species.

Based on the results of the study of reproductive ecology it was found that the all the investigated species are self-pollinated and are predominantly inbreeeders. They show completely different adaptations to achieve pollination and their high natural fecundity indicates an efficient and successful adaptation for self-pollination. Nevertheless they do not have wide distribution because of complete lack of vegetative propagation. Observations of female gametophyte development show that the megagametophyte of all the investigated species is 3-celled/3-nucleate before fertilization. Therefore, due to the absence of central cell before fertilization the second male gamete is left without a partner to fuse with. The observation indicates that the loss of double fertilization in
Podostemaceae is a result of lack of central cell. Investigation of seedling development in four species shows that there is lack of a conventional plumule and radicle in the seedlings of investigated species. There is limited growth both at plumular and radicular pole and therefore development of a dorsiventral plant body (thallus) occurs from the lateral side of the hypocotyl. The development of plant body (thallus) is variable among the four investigated species. Plant body develops endogenously in *P. munnarense*, *P. subulatum* and *Z. olivaceum* whereas in *W. arekaliana*, the thallus develops exogenously.

Present investigation also examined the role of PcG homologs of *Arabidopsis FIE* in two of the podostemads, namely *Zeylanidium olivaceum* and *Polypleurum stylosum var. stylosum* (Wight) Hall. Analysis of their expression patterns, and their evolutionary relationships were also deduced. It was established that there is conservation of protein structure of FIE between Podostemaceae and other plants suggesting that Podostemaceae FIE may interact with the other members of PRC2 in a manner similar to that in other plants. It was also found that FIE have many other functions in podostemads than the usual function of governing proper endosperm and seed development.

The assessment of phylogenetic relationships within the Indian Podostemaceae reveals that the family may be divided into two clades, Tristichoideae and a clade consisting of Podostemoideae and Weddellinoideae, and monophyly of each subfamily was supported robustly (>0.90 Posterior probability, PP). Subfamily Tristichoideae were divided into two clades, *Terniopsis* formed one of the clades and in the other clade *Tristicha trifaria* is sister to a clade of *Dalzellia* and *Indotristicha*. The Podostemoideae were divided into mainly two clades corresponding to the geographical region (American and Asian) of their occurrence except the New World species of the genus *Podostemum*. The molecular data resolved the two species of *Podostemum* as sister to the Asian clade. Analysis also concludes that the Indian Podostemaceae is a monophyletic group.