Asian J. Exp. Sci., Vol. 22, No. 2, 2008; 189-191

Marsileaceae : An Amphibious Heterosporous Group of Ferns The Persisting Enigma

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Abstract : Marsileaceae, the heterosporous aquatic/amphibious fern family forms a central, pivotal position in botanical compendium and thought in terms of botanical conundrums and riddles like the Land ---Water Form Conversions, heterospo ry and the emergence of Seed Habit, Reproductive Biology features like micro- and Mega-spore differentiation, sporal aberrations in shape, size and number/sporangium, parthenogenetic/apogamous expressions, heterophylly juvenile adult leaf sequencing, leaf margin serrations-crenations, phototropic-photonastic leaf movements including nyctinasty, heliotropism and sleep-seista movements, Biological Clocks and chronobiological regulation, phytogeographic parameters like geographic Continental speciation and distribution of Marsileaceae (Cosmopolitan *Marsilea*, Restricted *Pilularia*, Endemic *Regnellidium*), plant nutrition to include biological regulation of LAND-FORM → WATER → FORM conversions in response to carbohydrate nutriton/CO_2 concentration/Infra-red treatment, Gametophytic regulation of sexual fertilization & genetic expression Vs Sporophytic governance.

Keywords : Fern, Heterosponj, Biological clocks, Chronobiological regulations, Marsileaceae

Introduction

This perplexing group of aquatic/ amphibious ferns has received unabated attention and occupies a central and pivotal position inbotanical compendium and thought in terms of such theoretical conundrums as Land water Form conversions, Heterospory and emergence of Seed Habit, Reproductive Biology - microspore megaspore differentiation , Sporal aberrations in shape, size and number per sporangium, Parthenogenesis and apogamous expressions, Heterophylly including juvenile-adult leaf sequencing and leaf margin serrations-crenations , floating aquatic land leaf, phototropic-photonastic leaf movements including nyctinasty, heliotropism and sleep - siesta positions, Biological Clocks and chronobiological regulation, Phytogeographic dimensions, specifically biogeography and Continental Speciation and distribution of the three genera comprising this family (cosmopolitan Marsilea, constrained Pilularia, endemic Regnellidium), plant nutrition and biological regulation of Land-Form & Water-Form conversions in response to carbohydrate nutrition/CO_2 concentration/infra-red treatment, Gametophytic regulation of sexual fertilization and genetic expression versus sporophytic governance. All these aspects have received considerable attention from specialised laboratories in England (Allsopp 1952-64), Belgium (Martens & Feller 1958-70), USA (Wallace *et al*., 1984). Investigations concerning these aspects were reviewed comprehensively by Bhardwaja (1980) .

Systematics and monographic treatment of this fern group was initiated and extensively carried out in Germany with the first monograph being published by Braun (1839-1873) at the Botanisher Garten u. Museum, Berlin followed by Baker in England (1886) and Launert (1968 - 1984) on African and European species of Marsilea at Natural History Museum, London in last quarter of twentieth century. Braun`s monograph was published in 1871-1873, while regional monographic surveys were published by Gupta (1962) for India and South-east Asia based on doctoral dissertation of Bhardwaja (1958), African Marsilea species by Kornas (1983-1993), Australian Marsileaceae by Tindale (1981) and the new world species of Marsilea by Johnson (1986).

Bhardwaja (1997, 2000), in the course of his researches extending over almost half a century with the systematics and speciation aspects to include evolutional specifics in Marsilea specially and the allied Pilularia and Regnellidium in general on the basis of access to the world material of Marsileacea in Botanischer Garten u. Museum, Berlin, Heidelberg Munich in Germany; Uppasala Botanic Garden, Sweden; Natural History Museum, London & Royal Botanic Gardens , Kew, Surrey, England; Botanic Gardens, Sydney, Australia; New York Botanical Gardens, Bronx & Western Carolina University, USA, has recognized a total of 62 species and six sub-species of Marsilea, one species of Regnellidium and 6 species of Pilularia. Bhardwaja has concluded on the basis of his exhaustive studies that speciation in this family reflects geographic dichotomy as evident from sporocarp features, vegetative morphology and reproductive biology manifest in the immense variability of microspores. This is also confirmed by the cytological behaviour of Marsilea, the largest genus where aneuploidy seems confined to Afro-Asian and African species while polyploidy is exclusive to Australian species. Low magnitude of hybridization in Marsileaceae is stipulated to be consequential to spore dispersal mechanism which inhibits intersporocarpic fertilalization. Sporocarp (spore) dispersal in desert species of Marsilea (1997) collates mimesis and polychory, being aptly suited for telochory in majority species while atelochory is the dominant theme in African species. Vegetative characters like leaf margin also indicate this pattern of geographic speciation (2000). Simulated morphometric and anatomical features of cultivated taxa with irrigation regimes not found in nature has added to systematic difficulties apropos morphometric criteria in Marsilea apart from adding to perplexities of resolving sporocarp homologies based on teratological expressions in leaf sporocarp as these may be reflecting metabolic alterations at the morphologic plane only. Future txanomic work in the family has to be based on garden cultivation of the taxa apart from field conditions which would provide biosystematic criteria for species delimitation including parthenogenates/polyploids/hybrids. Speciation pattern in Marcileacea is shown in figure 1.

Recent work in the this family relates to phylogeny of the group with reference to the fossil record (Pryer, 1999) and structure and function of spores (Schneider and Pryer, 2000). It must be emphasized that Marsilea is an ideal material for investigation of biorhythms in plants so spectacularly

displayed by the non-pariel sleep movement of this genus. Magnetic field effect on plant growth and reproductive processes provides another research topic for which Marsilea is certainly a material of choice.

References

Bhardwja T. N. (1980): Recent advances in our knowledge of the water fern Marsilea. *Asp. Plant sci*., **3**, 39-42

Bhardwja T. N. (1997): Spore dispersal in the desert species of Marsilea.: *J. Indian Bot. Soc*. **76**, 111-114.

Bhardwja T. N. (1997): Systematics, Speciation and Evolutionary Trends in Maraileaceae. D.Sc. Theasis, Unpublished, Rajasthan University, Jaipur 1- 114.

Bhardwja T. N. (2000): The continuing Marsilea Trail : In retrospect. *Indian Fern J.*, **17**, 50-60.

Bhardwja T. N. (2007) : Investigations of the amphibious heterosporous fern family Marsileaceae; systematics, phytogeography, speciation and evolutionary biology, Western Regional Humboldt Kolleg & Humboldt Club -Jaipur.

Haig D. and Westoby M. (1989): Selective forces in the emergence of the seed habit. *Biol. J. Linn. Soc. London*., **38**, 215-238.

Pryer K.M. (1999): Phylogeny of Marsileaceous ferns and relationships of the fossil Hydropteris pinnata reconsidered. *Int. J. Plant Sci*., **160(5)**, 954.

Schneider H. and Pryer K. M. (2002): Structure and function of spores in the aquatic heterosporous fern family Marsileaceae. *Int. J. Plant Sci*., **163(4)**, 485-505.