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NOTES ON DISTRIBUTION AND BIOLOGY OF *CERATOPTERIS THALICTROIDES* (L.) BRONGN. (PARKERIACEAE) WITH SPECIAL REFERENCE TO SPORE PRODUCTION AND FERTILITY UNDER POLLUTION STRESS

BHASWATI PANCHANAN AND M.S. MONDAL
Botanical Survey of India, Howrah

ABSTRACT

Present paper deals with 8 samples of water fern-*Ceratopteris thalictroides* (L.) Brongn. growing in the fresh water lakes of Indian Botanic Garden, Shibpur, Howrah and in nearby areas inundated by different factory wastes containing hydrocarbons, saponins, mercury residues and various heavy metals in addition to acidic and alkaline residues.

Biology of the water fern including spore production, fertility, germination etc. have been studied under control (IBG lakes) and field stress conditions. It is observed that environmental and pollution stress cause severe alteration in the life cycle of this aquatic fern affecting spore production rate, fertility percentage and germination. It is also observed that presence of humus in the soil, salinity and pH of the water also affect the biology and phenotypic plasticity of this water fern. Present observation will be very much helpful in further studies on the biology of the aquatic plants.

INTRODUCTION

The genus CERATOPTERIS (L.) Brongn. is circumtropical in distribution and is restricted to aquatic in habit and low marshes. Number of species in the genus have long been confused due to the polymorphism present in size, shape and dissection of the sterile fronds. According to Diels, 1900 ; Campbell, 1905 and Bower, 1928, the genus has 12 species. Benedict (1909) recognised 4 species in his comprehensive treatment of the genus. Many pteridologists consider the genus to be composed of a single variable species-*Ceratopteris thalictroides* (L.) Brongn.

Benedict (1909) recognised *C. thalictroides* (L.) Brongn. as a pantropical, old world species distributed in warmer regions throughout the world.

In India it is distributed in aquatic/marshy habitats, fresh water ponds, stream sides, rice fields, swamp ditches, taro patches, water logged rocky crevices, water edges of road side swamps, brackish waters, waste marshy places, submersible areas except the temperate, subalpine and alpine high altitude areas. The species grows at sea level to ± 1200 m. above m.s.l.

C. thalictroides (L.) Brongn. is unique because of its rapid gametophyte growth, production of a sporophyte with fertile fronds in about 3, 5 months (Klekowski, 1970), an annual life cycle of about 12 months duration, profuse vegetative reproduction by buds found on the blades of both sterile and fertile fronds,

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32 very large spores per sporangium, a sporangial annulus which has lost much of its function in spore dissemination and production of antheridogen (Schedlbauer and Klekowski, 1972).

OBSERVATION

Life cycle of *C. thalictroides* (L.) Brongn. have been studied in the fresh water lakes and pools of the Indian Botanic Garden and surrounding areas of IBG particularly the polluted canal and ditches submerged with different factory wastes.

C. thalictroides (L.) Brongn. is a highly polymorphic species. It is a rooted aquatic. But semiaquatic to free floating forms of this species have also been observed. This herb grows in sandy alluvial wet soil, blackish loamy clay soil, rooting in coarse, grainy sandy soil cover or marshy places. Vegetative leaves deeply submerged but top of the fertile leaves emerge above the level of water.

In fresh water conditions the young populations are characterised by large areas of bare soil. Young plants are always rooted, but later many of them become partially free floating with the mass of humus embedded in the roots during the monsoon, when the field is submerged and flooded over particularly in ditches and canals with wastes. The plants growing near embankments are rooted. Comparatively smaller plants in which only sterile leaves are developed, are found growing submerged but the fertile leaves of well developed plants are always above water.

Gametophyte establishment takes place in open areas, particularly when the water level lowers to the point where the ground is emergent. But the gametophyte establishment is restricted with the increase of coverage of open soil by plant population. In the oldest population, it is noticed that gametophyte establishment is completely eliminated by profuse plant growth and rapid increase of vegetative reproduction from frond buds. When both sterile and fertile fronds fall due to senscence, bud development is initiated from the numerous initials located in the sinuses of the primae.

Other distinct features of the biology of *C. thalictroides* (L.) Brongn. which may be coinsidered with its aquatic habitat include a sporangial annulus which functions only in opening the sporangium, but without the characteristic features which has been interpreted as a mechanism for spore dissemination. Mondal (1989) studied the spores of the species collected from Indian Botanic Garden. Spores are rounded, triangular, trilete, 2-4 costae arise from near the end of the trilete mark and pass on to distal surface, diameter 69 μm (range 63-79 μm). Exine ± 8 μm thick, striate, homogeneous. The large spores of this species may float, becoming suspended in the water, or sink immediately. These features can be interpreted as restricting the spore dissemination. With this, the rapid gametophyte growth and sporophyte production must also be considered to interpret the increase of number of plants which remain in a favourable environment for survival.

Klekowski (1970) observed that the cultures of *C. thalictroides* (L.) Brongn. become sexual in less than 20 days following sowing and the fertile sporophylls are produced in 105 days. This rapidity in growth may be related to varying or seasonal water supply.

Mondal (*l.c.*) observed that different water ferns and aquatic angiosperms show spore/pollen morphological variability, dimorphism and abnormalities with infertile abortive forms due to environmental stress. Rate of pollen/spore production and % of fertility also varies with the environmental stress, presence of

humus in the soil, salinity and pH of the water.

The authors collected the plant specimens from the surrounding areas adjacent to Indian Botanic Garden polluted with factory wastes and affluents. Water and subsoil analysis shows that it is very rich in hydrocarbons, alkalis, mercury residues, detergents, solid and heavy metals like cadmium, lead etc. It is observed that plants growing in the fresh water lakes and pools of the IBG show 65-70% fertile spore production and premonsoon production of sporophytes is higher than in other seasons of the year.

Samples collected from the waste polluted water areas show lower fertile spore production ranging from 37-48% only and abortive spore production including dimorphic spores is increased. Production of sporophytes also become very much lower in the waste fed areas. It is also observed that young sporophytes are seen only during post monsoon period. Laboratory tests from the waste water and subsoil analysis reveal that the pollutant content goes up to 2.8 ppm in the summer time, little lower during monsoon up to 1 ppm. Table I shows percentage of spore production and heavy metal (cadmium) deposits in the plants and total pollutants present in areas in terms of ppm.

Table - I

Sample	Date of collection	Locality	% of fertile spore production	Presence & absence of abnormal/ dimorphic spores	Pollutants in ppm	Presence of cadmium in μ /gm
1.	15.5.95	IBG (PL)	63%	2%	NIL	NIL
2.	21.5.95	Nimtala IOC	39%	17%	2.2	0.1
3.	28.7.95	,,	47%	13.5%	1.7	0.08
4.	23.10.95	,,	42%	11%	2.8	0.001
5.	11.5.96	Hanskhali (HOW)	46%	3%	1.2	0.03
6.	2.8.96	,,	48.5%	6%	0.9	0.01
7.	22.10.96	,,	51%	4.8%	0.5	0.02
8.	22.10.96	IBG (JL)	65%	NIL	NIL	NIL

Note : * Pollutants include - Hydrocarbon, detergents, mercury residue.

(PL) - Prain Lake. (JL) - Janardan Lake.

True hydrophytic habit is very much sensitive to temperature and water supply. Phenotypic plasticity is very common due to environmental stress. The range of variation in habitat, sensitivity, physical and chemical properties of water must be reflected on reproductive factors. Observations on *Ceratopteris* (L.) Brongn. by Devol (1956), Ninan (1956), Nishida (1962a, 1962b), Pal & Pal (1962, 63, 69) and Lloyd (1972, 73) are noteworthy in this direction. *C. thalictroides* (L.) Brongn. is a highly polymorphic species. The extreme variation found throughout the distributional range of this species probably

reflects on its mode of spore dissemination and reproductive biology. Klekoski (1970) performed genetical study on Howaiian *Ceratopteris* and indicated that none of the sporophytes tested are heterozygous and these homozygous populations have an intragametophytic mating system. Chromosome number reported also vary from 40-130. The distinct features ralating to spore dissemination and vegetative reproduction determine the distribution pattern and the ability of a species to undergo long distance dispersal. The reproductive biology and evolutionary pattern of different populations of *C. thalictroides* (L.) Brongn. found both on Island and continental areas conclude that a small number of propagules were isolated geographically and then followed by genetical drift and environmental stress, speciation began and continued inbreeding and vegetative reproduction. (Lloyd, 1973).

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