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Comparative Ecomorphology of *Lemna Minor* L. and *Spirodela Polyrrhiza* (L.) Schleid Collected from Municipality Areas of Malda District

***Abstract*: Duckweeds prefer stagnant aquatic or semi aquatic habitat with influx of organonitrates and organophosphates. The various ecophysiological responses of the two prominent duckweed species were studied in relation to the physico-chemical parameters of the habitats in the Malda district of West Bengal. The study laid down a fundamental relationship among the morphometry of the plant species and the ecological indices in a significant correlation to the aquatic habitat.**

Keywords: Abundance, Frequency, Duckweeds, Root length, Frond area, *L. minor* L., *S. polyrrhiza* (L.) Schleid

Luxuriant growth and maximum productivity of plants is an indicator of environmental optimality. Exquisite plant growth is always correlated with morphological structure with ecological functionality under prevailing environmental conditions. A change in environmental conditions like nutrient availability results in alteration of morphological features. According to Varghese (1993)[1], the variation between ecological and morphological parameters forms the basis of ecomorphological features. Human activities such as input of domestic sewage, industrial effluents and agricultural wastes can change the limnological conditions of the water bodies along with the abundance and cover of aquatic species.[2]

Duckweeds belong to the aquatic macrophyte class of plants which are restricted to the surface water of stagnant water bodies in tropical and subtropical countries. They belong to the monocot order Alismatales, family Lemnaceae and are represented by 5 genera - (*Lemna, Spirodela, Landoltia, Wollfia, & Wollfiella*) with 37 species[3]. Duckweeds are known to form thick mats on the surface of nutrient rich water and can uptake dissolved substances from water resulting in accumulation of their biomass[4]. They are used for the treatment of wastewater[5]. Due to their ability to store nutrients above their metabolic needs showing fast growth, they are suitable for testing the different mathematical models. Species of *Lemna* and *Spirodela*are known to produce transgenic proteins having wide application in veterinary science.[6]

Lemna minor L. commonly known as lesser duckweeds, is cosmopolitan in occurrence. It bears symmetrical or suborbicular fronds with a single long root. Reproduction takes place mainly by vegetative means, flowers rare, if produced, are covered by spathe[7]. *Spirodela polyrrhiza* (L.)Schleid, also known as greater duckweeds, are quite common in the nutrient rich water bodies of subtropical and tropical water bodies[8]. It bears a flattened frond surface on both sides bearing 2-18 roots on the dorsal side[9]. Plants are known to produce turions under unfavourable conditions, which sink to the bottom and produce daughter fronds when favourable condition returns[10]. Flowers are rarely produced, generally unisexual, produced inside the covered lateral pouches[11].

Malda district is located on the North west bank of Ganges River. About 28.77 % of the total area of the Malda District is occupied by water bodies[12]. According to Ghosh(2005)[13], these water bodies are habitat for a lot of aquatic macrophytes including duckweed species like *Lemnaperpesuella* (L) & *Spirodela polyrrhiza* (L.) Schleid. The current paper aims to compare the ecomorphological features of *Lemna minor* L. & *Spirodela polyrrhiza* (L.) Schleid in different aquatic habitats of Malda and Old Malda municipalities.

Materials and Methods: The duckweed species namely *L. minor* L. and *S. polyrrhiza* (L.) Schleid were collected from six different stagnant water bodies marked as Duckweed Collection point (DCP1-DCP6); three within the English Bazar municipality (between $25^{0}01'$ (N) to $25^{0}14''$ (N) latitude and 88^{0} $07''$ (E) to $88^{0}85''$ (E) longitude) and three within Old Malda Municipality ($25^{0}04'$ (N) to $25^{0}14''$ (N) latitude and $88^{0}08''$ (E) to 88^{0} $90''$ (E) longitude). The collected species were identified as from Central National Herbarium, Botanical Survey of India, Shalimar, Howrah and then were subjected to calculation in root length, frond length and frond area were calculated. For calculating the root length of *L. minor* L., excised roots were placed on

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millimeter (mm) graph paper attached to a glass slide and the mean root length were calculated from 10 specimens of *L. minor* L. Using similar technique, the frond length and frond area were calculated for *L. minor* L. For *S. polyrrhiza* (L.) Schleid. having multiple roots, all the roots were excised from the dorsal surface of the thallus and average root length were determined for 5 specimens of *S. polyrrhiza* (L.) Schleid from each collection point. Frond length and frond area were calculated in the similar way as mentioned above. The fresh weights were determined by blotting the 20 specimens of each species after blotting them gently in a blotting paper. The frequency, abundance and percentage cover for both the duckweed species in each water body was calculated using a 1m x 1m quadrat[14]. Species prominence was calculated as mean cover multiplied by square root of frequency[15].

The water samples from six DCP were collected in small plastic containers of 50 ml volume and were subjected to chemical analysis. The power of hydrogen (pH) was determined by using a portable pH meter. Nitrate nitrogen (NO_3N-) was determined as per Trivedy and Goel[16] using sulphonic acid and phenol. Ammoniacal nitrogen (NH_4N^-) was calculated using standard protocol of APHA[17]. Total Soluble Phosphorus (TSP) in water was calculated as per Indian Standard[18].

***Results*:** The morphological parameters of two duckweeds species in the six DCP for *L. minor* L. & *S. polyrrhiza* (L.) Schleid are provided in Table 1. The mean root length was found to be lowest in DCP6 (10.25mm) and highest in DCP6 in case of *L. minor* L. and for *S. polyrrhiza* (L.) Schleid, the mean root length was highest in DCP3 and lowest in DCP5. The frond area was found to be highest in DCP1 for *S. polyrrhiza* (L.) Schleid as compared to that of *L. minor* L. found to be highest in DCP6. The frond length to root length ratio (F/R ratio) was found to be highest in DCP 2 and lowest in DCP 5 (0.191) for *L. minor* L. F/R ratio was considerably much higher in *S. polyrrhiza* (L.) Schleid. as compared to *L. minor* L. in all the six DCP. Fresh weight of the plant also followed the same trend where *S. polyrrhiza* (L.) Schleid had the highest mass in all the DCP as compared to that of *L. minor* L. Figure 1 gives a comparative account of the different morphological parameters of the two duckweed species in the six collection points.

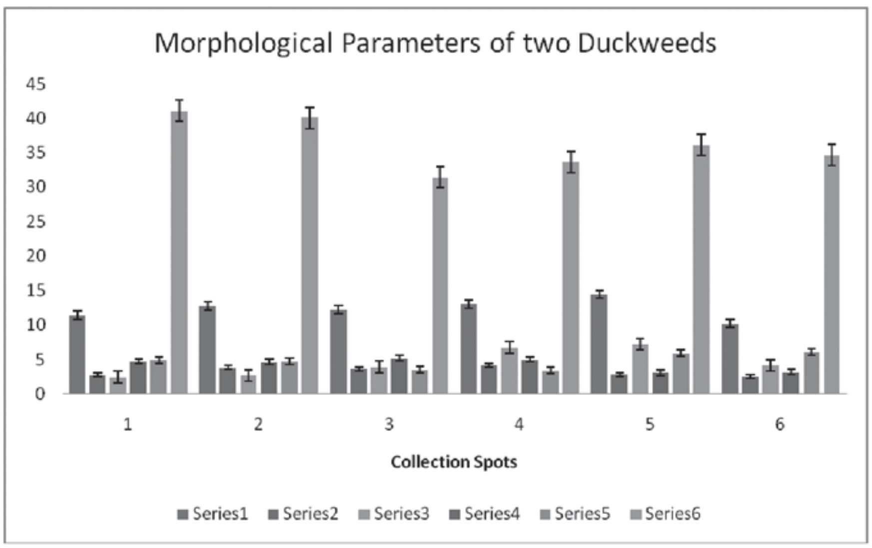
In Table 2, the different ecological parameters are given. In the six DCP, *L. minor* L. and *S. polyrrhiza* (L.) Schleid was found to co-exist. The abundance of *L. minor* L. was found highest in all the DCP as compared to *S. polyrrhiza* (L.) Schleid. The frequency of *S. polyrrhiza* (L.) Schleid was highest only in DCP6, but in other 5 DCP,

Table 1: Morphological parameters of *L. minor* L. and *S. polyrrhiza* (L.) Schleid. in the six DCP (Values are mean followed by standard deviation).

Collection Point	Duckweed Species	Root Length (mm)	Frond Length (mm)	Frond Surface Area(mm^2)	F/R Ratio	Fresh Weight (In mg)
DCP1	*Lemna minor* L.	11.457±1.67	2.75±0.87	2.45±0.43	0.213	100.75±5.80
	Spirodela polyrrhiza (L.) Schleid	4.71±1.1	4.91±0.86	41.1±2.20	1.04	288.41±20.79
DCP2	*Lemna minor* L.	12.81±1.37	3.8±0.63	2.63±0.48	0.296	115.15±6.91
	Spirodela polyrrhiza (L.) Schleid.	4.62±1.2	4.67±0.9 3	40.1±1.69	1.01	436±21.4
DCP3	*Lemna minor* L.	12.23±1.05	3.62±0.58	3.91±0.68	0.295	138.77±5.37
	Spirodela polyrrhiza (L.) Schleid	5.15±0.88	3.51±0.67	31.39±1.76	0.670	439.52±30.2
DCP4	*Lemna minor* L.	13.1±1.47	4.1±0.91	6.72±1.05	0.31	118.57±6.37
	Spirodela polyrrhiza(L.) Schleid	4.98±0.92	3.32±0.82	33.65±1.86	0.66	276.82±19.61
DCP5	*Lemna minor* L.	14.45±1.06	2.78±0.50	7.2±1.35	0.192	152.45±5.92
	Spirodela polyrrhiza(L.) Schleid	3.05±0.67	5.92±1.03	36.15±2.13	1.91	199.61±22.6
DCP6	*Lemna minor* L.	10.25±1.43	2.52±0.48	4.1±0.75	0.24	128.98±3.97
	Spirodela polyrrhiza (L.) Schleid.	3.15±0.71	6.03±1.09	34.71±1.97	1.91	382.91±21.37

Table 2: Ecological Parameters of *L. minor* L. and *S. polyrrhiza* (L.) Schleid in six DCP(Values are mean followed by standard deviation)

COLLECTION POINT	DUCKWEED SPECIES	Frequency	Abundance	Percentage cover	Species prominence
DCP1	*Lemna minor* L.	93.2±6.04	85.14±0.7	73.12±4.47	705.72
	Spirodela polyrrhiza (L.) Schleid	76.2±8.6	31.7±0.6	30.4±2.87	215.36
DCP2	*Lemna minor* L.	95.3±6.24	87.5±0.63	68.6±2.38	669.68
	Spirodela polyrrhiza (L.) Schleid	66.56±5.95	87.5±0.63	48.3±1.36	393.95
DCP3	*Lemna minor* L.	85.5±5.45	72.19±5.12	69.32±1.48	640.97
	Spirodela polyrrhiza (L.) Schleid	88.7±5.16	36.57±2.12	36.3±1.50	341.87
DCP4	*Lemna minor* L.	83.21±5.05	69.62±2.5	71.32±5.50	650.57
	Spirodela polyrrhiza (L.) Schleid	76.4±8.1	29.7±1.02	36.2±1.27	316.67
DCP5	*Lemna minor* L.	94.3±6.65	88.17±1.86	57.32±2.21	556.6
	Spirodela polyrrhiza (L.) Schleid	64.76±5.16	38.6±1.71	47.8±1.257	384.66
DCP6	*Lemna minor* L.	81.27±5.05	79.7±2.32	61.8±2.6	557.126
	Spirodela polyrrhiza (L.) Schleid	90.6±5.55	52.12±2.67	36.46±1.46	347.04

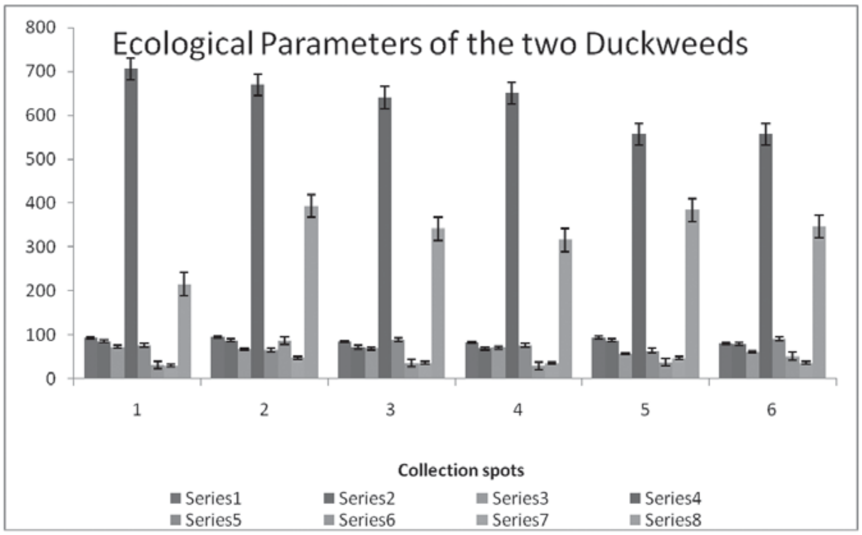


series1	Root length of *L.minor L.*	series4	Root length of *S.polyrrhiza*
series2	Frond length of *L. minor L.*	series5	Frond length of *S.polyrrhiza*
series3	Frond area of *L. minor L.*	series6	Frond area of *S.polyrrhiza*

Figure 1: Comparison between the morphological parameters of two duckweed species.

the frequency of *S. polyrrhiza* (Schleid) was low as compared to *L. minor* L. which had the highest frequency in DCP2. In all the DCP, the percentage cover of *L. minor* L. was greater as compared to *S. polyrrhiza* (L.) Schleid the highest being in DCP1 for *L. minor* L. The species prominence value of *L. minor* L. was greater in all the DCP as compared to *S. polyrrhiza* (L.) Schleid. All the values are mean followed by SD. Figure 2 depicts a comparison between the ecological parameters of the two duckweed species in the six collection points. In Table 3, the physic-chemical parameters of the six water bodies are given. The pH was found to vary between 6.95 to 7.85. Nitrate nitrogen (NO_3N^-) was lower as compared to NH_4N^- in all the six water bodies under study. TSP was found highest in DCP3 and lowest in DCP5.

Discussion: Plants show high phenotypic plasticity in growth with respect to local environmental conditions[19]. There is a high variation among the mean root length of *L. minor* L. and *S. polyrrhiza* (L.) Schleid frond length and frond area in the six DCP under study. In Spite of low mean root length, the fresh weight of *S. polyrrhiza* (L.) Schleid, is greater as compared to *L. minor* L. indicating higher rate of biomass accumulation. Accumulation of biomass is an indication of plants capacity to assimilate carbon (C) resulting in overall growth of the plants[20]. For aquatic macrophytes nutrients are absorbed by submerged roots as well as by stem /fronds, although these two ways of absorption in plants have different relative importance depending on surrounding ecological parameters[21]. *L. minor* L. prefers to uptake TSP, nitrate and ammonia nitrogen maximally from the surrounding water as compared to *S. polyrrhiza* (L.) Schleid[22]. According to Ice and Couch (1987)[23], roots of *L. minor* L. play minimal role in uptake



series1	Frequency of *L.minor L.*	series5	Frequency of *S.polyrrhiza*
series2	Abundance of *L.minor L.*	series6	Abundance of *S.polyrrhiza*
series3	% cover of *L.minor L.*	series7	% cover of *S.polyrrhiza*
series4	Species prominance of *L.minor L.*	series8	Species prominanve of *S.polyrrhiza*

Figure 2: Comparison between the ecological parameters of two duckweed species

of nutrients, where fronds play a vital role. But under nutrient limiting conditions, roots of *L. minor* L. play a major role in mineral uptake[6]. All the six DCP were shady places, so it may be concluded that the two species were growing in low light intensity regions. According to Givinishet al (1988)[24], the leaf root ratio (L/A) tends to be higher in plants growing in low photon density so that they can maximize their rate of photosynthesis. It is quite evident from the high L/A ratio; the six water bodies have high nitrogen and phosphorus content making them nutrient rich. Previous literatures clearly suggest that high phosphate and nitrogen (both ammonia and nitrate) are required for the growth of *Lemna* and other duckweed species. Duckweeds prefer to grow in such waters and are known to accumulate them within their biomass[15]. Plants growing in dry and open environments tend to have low shoot: root ratio, whereas in nutrient rich moist habitat the shoot: root ratio becomes higher[25]. The high frequency and abundance of the two duckweed species indicate that they have well equipped morphological adaptations in these nutrient rich aquatic habitats. Niklas (2000)[26] suggested that a wide range of unicellular auto trophs and various multi cellular plants thrive in aquatic ecosystems without showing extensive morphological adaptations. This is evident from the minimal morphological specialization found in *S. polyrrhiza* (L.) Schleid & *L. minor* L. in the six DCP. The percentage cover and prominence value for *L. minor* L. were higher than *S. polyrrhiza* (L.) Schleid, in the six duckweed collection points. It indicates that *L. minor* L. is better equipped to survive with adequate adaptability. Prominence value is an important quantitative measure to determine the prominence of a species in a community[27].

Conclusion: The study correlated the morphometric plasticity in response to ecochemical parameters and variability of inherent potential of the plant to cope with the ambient

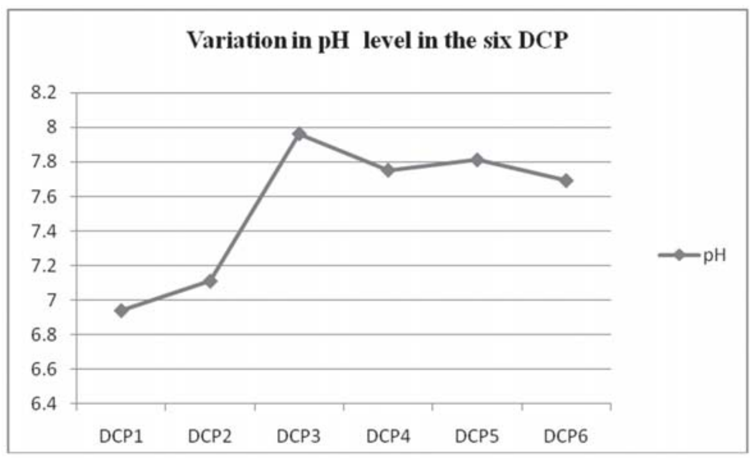


Figure 3- Variation in pHlevel in the six DCP water bodies

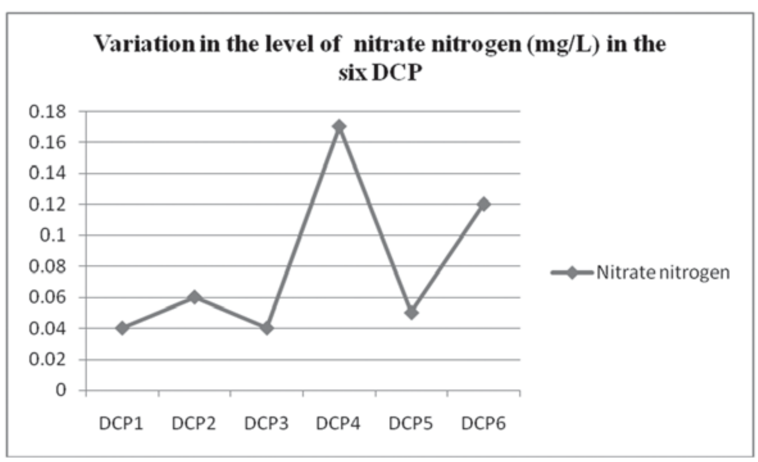


Figure 4. Variation in amount nitrate nitrogen (mg/L) in the six DCP water bodies

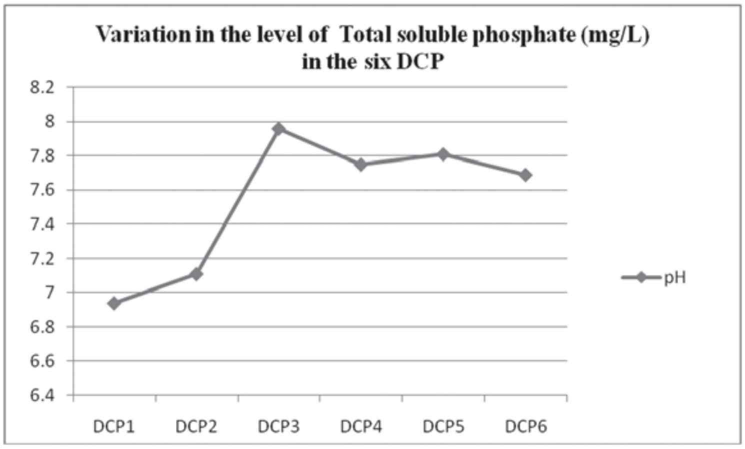


Figure 5. Variation in level of Total Soluble phosphate (mg/L) in the six DCP water bodies.

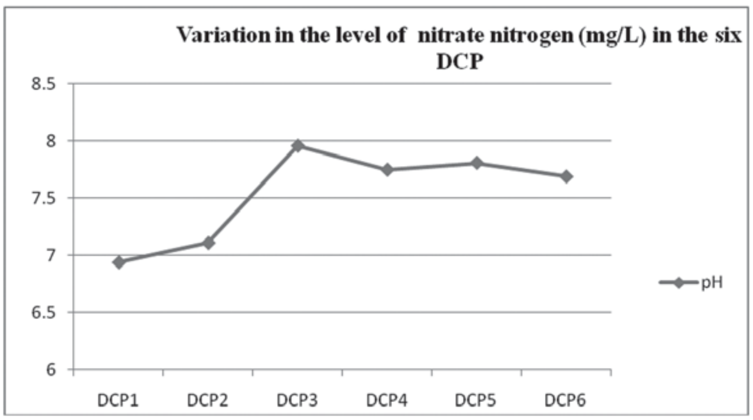


Figure 6. Variation in amount nitrate nitrogen (mg/L) in the six DCP water bodies.

Table 3: Limnological Parameters of 6 DCP (Values are mean followed by standard deviation)

Collection Point	pH	NO_3N^-(mg/L)	NH_4N^-(mg/L)	TSPmg/L
DCP1	6.94±0.40	0.04±0.02	0.465±0.12	4.05±1.12
DCP2	7.11±0.35	0.06±0.03	0.345±0.10	3.75±1.05
DCP3	7.96±0.50	0.04±0.02	0.156±0.13	3.45±0.75
DCP4	7.75±0.40	0.17±0.05	0.467±0.12	3.76±0.78
DCP5	7.81±0.30	0.05±0.03	0.134±0.13	2.35±0.82
DCP6	7.69 ±0.45	0.12±0.07	0.185±0.13	3.42±1.10

ecosystem.

The basic morphometric features like root-shoot ratio, frond expansion, total root length etc. may be the important parameters for the ecophysiological markers of a plant species in relation to a specific climatic zone for a particular species. Ecovar specific differential morphometry may be used as aquick marker for the physic-chemical parameters of the habitat.

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1. M. Varghese, *Pollution Res*, **12**, 179–182. (1993).
2. G.H.P Arts, V.G. Vander, J.G.H Roelof, *Fresh water biology*, **24**, 287-294 (1990).
3. M.D. Ansal, A. Dhawan and V.I. Kaur, *Journal of Livestock research for rural development*, **22 (7)**, 119-124 (2010).
4. N.P. Tippery, D.H. Les and D.J. Crawford, *Plant Biol* , **17 (Suppl 1)**, 50–58, (2015).
5. S, Chaiprapat, J.J. Cheng, J.J Classen, and S.K. Lieh, *Trans. ASAE*, **48**, 2247–2258 (2005).
6. S. Rival, J.P. Wisniewski, A. Langlais, H. Kaplan, G. Freyssinet, G. Vancanneyt, R. Vunsh, A. Perl and M. Edelman, *Transgenic Res*, **17**, 503–513 (2008).
7. E. Landolt, Anatomy of the Lemnaceae (duckweeds). In Extreme Adaptations in Angiospermous Hydrophytes, Borntraeger, Berlin (1998).
8. E. Landolt and R. Kandeler, Biosystematic investigations in the family of duckweeds (Lemnaceae), the family of Lemnaceae-a monographic study, Vol. 2 (1987).
9. H.D. Edward: A Monograph on Lemnaceae. University of Illinois Press, Urbana, Illinois (1965).
10. M. Khondker, A.K.M. Nurul Islam and A. Dur-E-Makhnun, *Bangladesh J Bot*, **23(1)**, 99–106 (1994).
11. R. L. Bieleski, *Plant Physiol.*, **43**, 1309–1316, (1968).
12. R.S. Manas and D.S. Dilip, *Biology of useful plants and microbes*, **24 (1),** 235-243, (2014).
13. S. K. Ghosh, Illustrated aquatic and wetland plants in harmony with mankind. – Standard Literature, India (2005).
14. D.S. Srivastava, A, Cynthia and B.F Staicer, *Aquat Bot*, **51**, 181–196 (1995).

15. E. Beals, *Wilson Bull*., **72,** 156-181 (1960).
16. R.K. Trivedy and P.K. Goel, Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad, India, (1986)
17. APHA, Standard methods for the examination of water and wastewater, 20th edition, American Public Health Association, New York (1998).
18. Indian Standard –Methods of Sampling and test (Physical & Chemical) for water and waste water.3025 (part 32) (1988).
19. Y. Iwasa and J. Roughgarden, *Theoretical Population Biology*, **25,** 78–105(1984).
20. G.C. Evans, The quantitative analysis of plant growth. Oxford, UK: Blackwell Scientific Publications, (1972).
21. N. Cedergreen and T.V. Madsen, *New Phytol*, **155**, 285–290 (2002).
22. V. N Jonge, M. Elliott and E. Orive, *Hydrobiologia*, **23**, 475–476, (2002).
23. J. Ice and R. Couch, *J Aquat Plant Manage***, 25**, 30–31, (1987).
24. T.J. Givnish, *Australian Journal of Plant Physiology*, **15**, 63–92 (1988).
25. R.S. Russell, Plant Root Systems: Their Function and Interaction with Soil. London: McGraw-Hill (1977).
26. K.J. Niklas, *Annals of Botany*. **85**, 411–438 (2000).
27. M. Bog, *Planta*, **232**, 609–615 (2010).