



---

## Influence of hydrological parameters on phytoplankton diversity in puthukulam pond in Tuticorin district, Tamilnadu

J Selvi<sup>1</sup>, L Jeyapraba<sup>2</sup>

<sup>1</sup> Research Scholar, Department of Zoology and Research Centre, Sarah Tucker College, (Affiliated to Manonmanium Sundaranar University), Tirunelveli, Tamil Nadu, India

<sup>2</sup> Associate Professor and Head, Department of Zoology and Research Centre, Sarah Tucker College, (Affiliated to Manonmanium Sundaranar University), Tirunelveli, Tamil Nadu, India

---

### Abstract

Water is the most abundant and wonderful natural resource especially, the fresh water becomes a precious commodity. Today its quality is threatened by numerous source of pollution. The current study deals with the water quality variations influence the phytoplankton diversity in the selected pond of the study area. Several water quality parameters were analysed during the period from January – December 2018 from sampling station sited from Nazareth Puthukulam pond. The water quality parameters like water turbidity, Temperature, pH, Dissolved oxygen, Electrical conductivity, Total Dissolved solids, Hardness, Alkalinity, Calcium, magnesium, sodium, potassium, Chloride, Sulphate, Phosphate and Nitrate were analysed. 37 species of phytoplankton were observed during the study period of which 10 species from the class cyanophyceae, 9 species from the class Chlorophyceae, 9 species from the class Bacillariophyceae, 6 species from the class Euglenophyceae, and 3 species from the class Dinophyceae. The maximum number of species of the class Cyanophyceae were observed during study period. The water quality parameters such as temperature, Alkalinity, phosphate and Nitrates are favourable for the growth of phytoplankton. Correlation study shows positive and Negative correlation with water quality parameters with Phytoplankton.

**Keywords:** water quality parameters, phytoplankton, cyanophyceae, chlorophyceae, bacillariophyceae, euglenophyceae and dinophyceae

---

### Introduction

Water is a necessary obligation for human beings and industrial development. It is one of the most delicate parts of the environment (Das and Acharya 2003) [8]. Freshwater ecosystems provide the vital resources for humans and are the sole habitat for an extraordinary rich endemic and sensitive biota (Jasmine *et al.*, 2013) [19]. Ponds have been used since time centuries old as a traditional source of water supply in India. However, the water of the ponds, lakes and river are polluted mainly due to discharged waste water from residential areas, sewage outlets, solid wastes, detergents, automobile oil wastes, fishing facilities and agricultural pesticides from farmlands (Hasan *et al.*, 2007; Elayaraj and Selvaraju 2014a) [15, 4].

The Quality of the aquatic ecosystems are detected by phytoplankton. Phytoplankton also serves as an indicators of water quality and 'natural regions' which are characterized by typical species or species groups (Sampathkumar and Ananthan 2007) [33]. Planktons are the autotrophic constituent of the plankton community they at the base of aquatic food web and is the most significant factor for production of organic matter in aquatic ecosystem. Most reservoirs will need significant amount of Phytoplankton is the bioindicator of water pollution its disappearance, density, appearance, and pattern of distribution be determined by on abiotic and biotic factors. (Komala *et al.*, 2013, Panigrahi and Putra 2013) [20].

Phytoplankton diversity is influenced by most important aquatic environmental factors like light, temperature and the physico chemical properties such as Dissolved oxygen, Electrical Conductivity, Total hardness, Total Dissolved solids, pH, Total alkalinity, nutrients and particularly Sulphate, Nitrate and Phosphate. (Fonge *et al.*, 2013) [13]. The interactions of human being with the aquatic ecosystem impacts the physical and chemical conditions of the ecosystem of aquatic organisms. (Hermann, 1999, Ngodhe *et al.*, 2013) [27].

The present study is an attempt to analyse the impact of hydrological parameters on the diversity of phytoplanktons in Puthukulam pond situated in Nazareth.

### Materials and Methods

Water samples were collected from the pond monthly from January to December 2018 and taken to the laboratory for the analysis of physico-chemical factors such as Turbidity, Temperature, pH, Dissolved oxygen, Electrical conductivity, total Dissolved solids, Total Hardness, Total Alkalinity, Calcium, magnesium, sodium, potassium, Chloride, Sulphate, Phosphate and Nitrate by using the standard methods of (BIS 2012).

Collection of phytoplanktons were done by using plankton net (No. 25) with 30 cm mouth diameter and length of 1 m. For further analysis, the volume of the collected surface water concentrate was adjusted to 25 ml and it was preserved immediately with 4 % formalin or Lugol's solution. Standard literatures were used to identify the collected phytoplankton. (Anand, 1980, Desikachary 1959, Desikachary 1987, Fritsch, F.E. 1971) <sup>[1, 10, 11, 14]</sup>.

## Result

In the present analysis, the result of physico-chemical parameters seasonal variation was given in Table 1. 37 Species of phytoplanktons belongs to 5 orders Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae, Dinophyceae were recorded in the study area. The seasonal variation of such orders were given in Fig:1. Monthly occurrence of identified phytoplankton were represented in Table 2. Correlation between the phytoplankton and the water quality parameters were given in the table 3. Diversity indices of Puthukulam pond were given in the table 4.

## Discussion

A total number of 37 species of phytoplanktons were recorded in puthukulam during the study period in which 10 species belongs to cyanophyceae, chlorophyceae and bacillariophyceae 9 species each, Euglenophyceae 6 species, and Dinophyceae 3 species.

The highest distribution of Cyanophyceae was recorded during the post monsoon season. The Cyanophyceae members are *Phormidium corium*, *Oscillatoria princeps*, *Microcystis*, *oscillatoria curviceps*, *Scytonema*, *tolypothrix*, *Anabaena sp.* *Planktothrix rubescens*, *Planktothrix agardhi*, and *Oscillatoria limosa* were observed. Physico chemical factors like Dissolved oxygen, Nitrate, phosphate, pH, and nutrients have favoured and influenced the growth of cyanophyceae (Elayaraj and Selvaraj, 2014) <sup>[4]</sup>. Higher Dissolved oxygen and Nitrogen during post monsoon season of the present investigation favours the growth of Oscillatoria and Microcystis as reported earlier by Rani *et al.*, (2016) <sup>[30]</sup>, Naik *et al.*, (2005) <sup>[25]</sup>. In the present study the dominance of Cyanophyceae indicates the eutrophic nature of the pond especially distribution of *microcystis* and *oscillatoria* denotes the occurrence of polluted as well as eutrophic nature of the pond as reported by Misra (2007) Rani *et al.*, (2016) <sup>[30]</sup>.

Chlorophyceae was the second dominant order in the present investigation are *Ankistrodesmus*, *Chlamydomonas sp.* *Closterium naviculae*, *Oedogonium sp.* The maximum number of chlorophyceans was recorded during summer season similar to the earlier reports of (Rawat and Trivedi 2018) <sup>[31]</sup>. This may be due to high temperature and alkalinity in the pond water during summer. Rajagopal *et al.*, (2010) <sup>[29]</sup> noticed that Dissolved oxygen, pH, and alkalinity play a major role in the distribution of Chlorophyceae. Chlorophyceae are the bio indicator of organic pollution said by Palmer (1980) <sup>[7]</sup> and Misra and saksena (1993) <sup>[32]</sup>.

The Bacillariophyceans species *pinnularia sp.* *Fragillaria sp.* *Synedra sp.* In the present investigation the presence of luxurious growth of *fragillaria sp.* indicate the eutrophic nature of the pond as evidenced by the report of Bhattacharya *et al.*, (2011) <sup>[5]</sup>. Bacillariophyceans was more abundantly present in post monsoon season during December to February mainly it was influenced by high DO, water temperature, pH, Calcium and nitrate reported by Rani *et al* (2016) <sup>[30]</sup>. In the present investigation also Dissolved oxygen, nitrogen, and chloride were maximum during post monsoon season. Similar investigation was made by Padhi *et al.*, (2010) <sup>[28]</sup> and Bhattacharya *et al.*, (2011) <sup>[5]</sup>.

Euglenophyceae comprises 6 species, the maximum was recorded during summer, Rawat and Trivedi 2018 reported the same. The highest temperature, pH, and chloride might have played and major role in growth and development of Euglenophyceae. Seeneyya (1971) reported that the temperature above 25°C was good for the growth of Euglenophyceae. High pH was favourable for the growth of Euglenophyceae (Ashwani *et al.*, 2012; Sedamkar and Tikke, 2011) <sup>[2, 12]</sup>. In the present investigation also the temperature was above 25°C during summer this season was favourable for the growth of Euglenophyceae groups.

The least number of Dinophyceae species was recorded in this present study as literature reveals this Dinophyceae groups were mostly present in very low numbers. Sipauba-Tavares *et al.*, (2010) <sup>[35]</sup> and Hosmani and Mruthunjaya (2012) <sup>[18]</sup> have also reported the occurrence of this group (Dinophyceae) in very small numbers. These findings are in line with the observations noticed in the present study.

## Correlation Study

correlation study between the physico chemical parameters and the phytoplankton reveals that all the five group of phytoplankton in this study has positive correlation with Dissolved Oxygen, it indicates the healthy state of the selected pond. Roy *et al.*, 2016 find out the same in their studies.

## Diversity Indices Study

The Shannon Index and Simpson's index of Diversity recorded mostly high in the month of November in the study area. In the present investigation high species diversity in water receive more amount of sewage from the agricultural land, domestic effluents, washing vehicles from the nearby study area. Similar trend was observed by Nandan and patel (1992) <sup>[26]</sup>, Davies and Ugwumba (2013) <sup>[9]</sup>. The minimum value was mostly falls on May month in the study area similar study was done by Rajgopal *et al.*, (2010). Barve and sonawane (2017) <sup>[3]</sup>.

In the present study Pielou's evenness index was found maximum during October month and the minimum evenness found on May month. This could be due to nutrients level in the water. Similar study was made by Kensa and Ida (2017) [21], and Manickam *et al.*, (2017) [22] done the work in sular lake of Coimbatore.

In the present investigation High margalef's richness value was observed during the month of March. The high species richness is characterized by large food chain. Mukherjee (1997) [24] reported the same. The minimum value also falls on the month of May. The presence of Organic Carbon in water during the dry period is responsible for the higher species richness value during observation. Certain species such as adequate sensitive species thrive well along with higher tolerance species in this mildly polluted water.

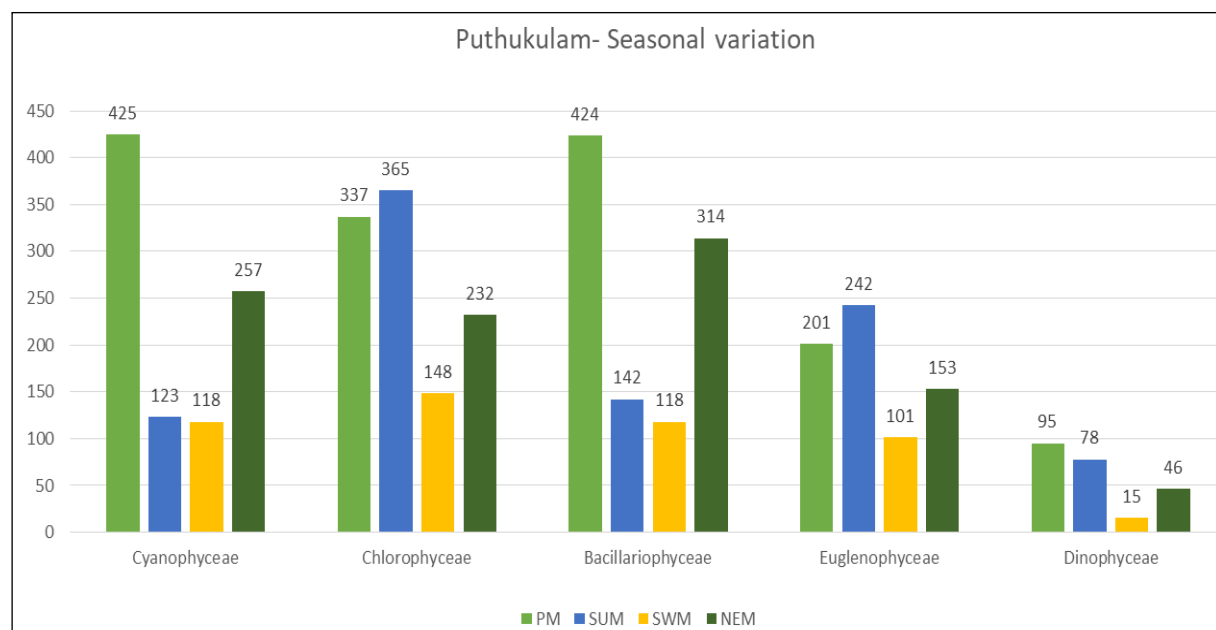
### Conclusion

In the present investigation in the Puthukulam pond reveals that phytoplankton diversity shows highly variation during the post monsoon, Summer, Southwest monsoon, and Northeast monsoon throughout the study period. The diversified phytoplanktons are grouped into Cyanophyceae, Chlorophyceae, Bacillariophyceae, Euglenophyceae and Dinophyceae. The growth of phytoplanktons are reduced during South west and Northeast monsoon season mostly the growth reached the peak during post monsoon and Summer season. The Physico-chemical analysis ensures the phytoplankton diversity of the selected Puthukulam pond. Thus the present study concluded that different abiotic factors directly or indirectly influence the phytoplankton diversity. The basic information of the phytoplankton distribution and abundance would form a useful tool for further ecological assessment and monitoring of Puthukulam pond.

**Table 1:** Seasonal variation of physico-chemical parameters in Puthukulam pond during the study period

Sl. No	Physico-Chemical Parameters	PM	SUM	SWM	NEM
1	Turbidity (NTU)	5	6	4.3	3.0
2	Temperature (° C)	27.9	30.5	28.9	27.5
3	pH	7.0	7.1	7.7	7.5
4	DO (mg/l)	8.3	7.5	7.1	8.1
5	EC (ds/m)	408.3	388.3	210.0	188.6
6	TDS (mg/l)	279.6	259.0	148.0	139.3
7	TH (mg/l)	166.6	134.0	90.0	86.7
8	TA (mg/l)	106.3	118.3	66.7	50.7
9	Ca (mg/l)	27.3	40.3	17	18.3
10	Mg (mg/l)	20.0	13.3	11.6	12.3
11	Na (mg/l)	21.6	31.6	10.7	10.7
12	K (mg/l)	7.7	9.3	5.7	4.3
13	Cl (mg/l)	50	49.3	32.3	29.3
14	So4 (mg/l)	9	13	4.0	3.0
15	Po4 (mg/l)	0.15	0.49	0.45	0.61
16	No3 (mg/l)	5.7	5	4.0	3.0

(PM- Post Monsoon, SUM- Summer, SWM- South West Monsoon, NEM- North East Monsoon)



(PM- Post Monsoon, SUM- Summer, SWM- South West Monsoon, NEM- North East Monsoon)

**Fig 1:** Seasonal variation of phytoplankton groups in Puthukulam pond during the study period

**Table 2:** Monthly occurrence of identified phytoplanktons in Puthukulam pond during the study period

S. No	Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<b>Bacillariophyceae</b>													
1	<i>Synedra ulna</i> .	+	+	+	+	-	-	+	+	+	+	+	+
2	<i>Pinnularia sp.</i>	+	+	+	-	-	-	+	+	+	+	+	+
3	<i>Pinnularia biridis</i>	+	+	+	-	-	-	+	+	+	+	+	+
4	<i>Fragilaria crotonensis</i>	+	+	+	+	-	-	-	+	-	+	+	+
5	<i>Fragilaria brevistriata</i>	+	+	+	+	-	-	-	+	-	+	+	+
6	<i>Cymbella sp.</i>	+	+	+	+	-	+	+	+	+	+	+	+
7	<i>Synedra acus</i>	+	+	+	+	-	-	+	+	+	+	+	+
8	<i>Rhizosolenia alata</i>	+	+	+	+	-	-	+	-	-	+	+	+
9	<i>synedra sp.</i>	+	+	+	+	-	+	+	+	+	+	+	+
<b>Chlorophyceae</b>													
1	<i>Ankistrodesmus sp</i>	+	+	+	+	-	-	+	+	+	+	+	+
2	<i>Chlamydomonas microsphaera</i>	+	+	+	+	-	-	+	-	-	+	+	+
3	<i>Chlamydomonas sp.</i>	+	+	+	+	+	-	-	+	+	+	+	+
4	<i>Closterium navicular</i>	+	+	+	+	+	+	+	+	+	+	+	+
5	<i>Oedogonium globosum</i>	+	+	+	+	-	-	+	+	+	+	+	+
6	<i>Oedogonium sp.</i>	+	+	+	+	+	+	-	-	+	+	+	+
7	<i>oedogonium crispum</i>	+	+	+	+	+	+	-	+	-	+	+	+
8	<i>Oedogonium anomalum</i>	+	+	+	+	+	+	-	+	+	+	+	+
9	<i>Oedogonium nodulosum</i>	+	+	+	+	+	+	-	+	+	+	+	+
<b>Cyanophyceae</b>													
1	<i>Phormidium corium</i>	+	+	+	+	-	-	+	+	+	+	+	+
2	<i>Oscillatoria Princeps</i>	+	+	+	+	-	-	-	-	-	+	+	+
3	<i>Microcystis</i>	+	+	+	+	+	-	-	-	+	+	+	+
4	<i>oscillatoria curviceps</i>	+	+	+	+	-	-	+	+	+	-	+	+
5	<i>Scytonema</i>	+	+	+	+	-	-	-	-	-	+	+	+
6	<i>Tolypothrix</i>	+	+	+	-	-	-	+	+	+	+	+	+
7	<i>Anabaena sp.</i>	+	+	+	-	+	+	+	+	+	+	+	+
8	<i>planktothrix rubescens</i>	+	+	+	-	-	+	-	+	+	+	+	+
9	<i>Planktothrix agardhii</i>	+	+	+	-	-	+	-	+	+	+	+	+
10	<i>Oscillatoria limosa</i>	+	+	+	+	-	-	+	+	+	+	+	+
<b>Euglenophyceae</b>													
1	<i>Eutreptiella gymnastica</i>	+	+	+	+	+	+	+	-	-	+	+	+
2	<i>Leporcinclis Fusiformis</i>	+	+	+	+	+	+	+	-	+	-	+	+
3	<i>euglena acus</i>	+	+	+	+	+	+	+	-	-	+	+	+

4	euglena caudata	+	+	+	+	+	+	+	+	-	-	+	+	+
5	phacus orbicularis	+	+	+	+	+	+	+	+	+	+	+	+	+
6	Phacus platalea	+	+	+	+	+	+	+	+	+	+	+	+	+
	Dinophyceae													
1	Gonyaulax (dinoflagellate)	+	+	+	+	-	-	-	-	-	-	+	+	+
2	Nematodinium armatum	+	+	+	+	-	-	+	+	-	-	+	+	+
3	Gymnodinium sp	+	+	+	+	-	-	-	+	+	-	+	+	+

+ : present, -: absent

**Table 3:** Correlation between Physico chemical parameters with Phytoplankton at Puthukulam pond

Correlations																					
	Turbidity	Temperature	pH	DO	EC	TDS	TH	TA	Ca	Mg	Na	K	Cl	SO4	PO4	No3	B.phy	C.phy	Cy.ph	E.phy	D.phy
Turbidity	1																				
Temperature	.559	1																			
pH	-.370	-.081	1																		
DO	-.296	-.628*	-.359	1																	
EC	.432	.335	-.688*	.182	1																
TDS	.384	.263	-.682*	.210	.990**	1															
TH	.259	.098	-.665*	.292	.876**	.869**	1														
TA	.537	.368	-.528	-.039	.854**	.851**	.660*	1													
Ca	.496	.759**	-.390	-.145	.679*	.632*	.553	.677*	1												
Mg	-.042	-.168	-.562	.390	.419	.365	.627*	.237	.155	1											
Na	.478	.525	-.416	.035	.697*	.664*	.420	.854**	.780**	.124	1										
K	.213	.599*	-.411	-.102	.822**	.812**	.658*	.693*	.803**	.233	.673*	1									
Cl	.424	.389	-.673*	.142	.951**	.923**	.792**	.887**	.742**	.458	.811**	.836**	1								
SO4	.585*	.578*	-.532	-.031	.726**	.670*	.435	.835**	.763**	.220	.942**	.663*	.863**	1							
PO4	.378	.114	.117	-.490	-.157	-.160	-.146	.013	-.234	-.180	-.190	-.335	-.304	-.213	1						
No3	.285	.427	-.184	.085	.591*	.561	.382	.413	.532	.025	.545	.692*	.650*	.596*	-.553	1					
B.phy	-.611*	-.933**	-.058	.782**	-.285	-.210	-.073	-.379	-.625*	.207	-.415	-.481	-.329	-.505	-.273	-.354	1				
C.phy	.010	-.377	-.522	.489	.272	.297	.456	.222	-.092	.504	.117	-.061	.167	.005	.292	-.273	.462	1			
Cy.ph	-.594*	-.916**	.054	.824**	-.242	-.183	-.032	-.301	-.535	.227	-.311	-.461	-.269	-.427	-.319	-.301	.951**	.401	1		
E.phy	.174	.224	-.453	.379	.669*	.695*	.341	.572	.459	.017	.666*	.623*	.634*	.593*	-.294	.513	-.026	.127	-.010	1	
D.phy	-.294	-.576*	-.310	.601*	.136	.152	.356	.040	-.297	.570	-.053	-.185	.035	-.166	.188	-.346	.617*	.905**	.618*	.050	1

\*. Correlation is significant at the 0.05 level (2-tailed).

\*\* . Correlation is significant at the 0.01 level (2-tailed).

**Table 4:** Diversity Indices of Phytoplankton species during the study period in Puthukulam

Months	Simpson's Index of Diversity	Shannon's diversity Index	Pielou's evenness Index	Margalef's richness Index
January	0.9685	3.529	0.9211	5.782
February	0.9662	3.494	0.8892	5.886
March	0.9677	3.528	0.9205	6.021
April	0.9558	3.259	0.8392	5.106
May	0.8986	2.415	0.7996	2.456
June	0.9183	2.633	0.8697	3.072
July	0.9327	2.929	0.8133	4.274
August	0.956	3.187	0.9314	4.737
September	0.9489	3.076	0.8665	4.607
October	0.9656	3.43	0.9358	5.437
November	0.9686	3.535	0.9266	5.874
December	0.9674	3.506	0.9008	5.751

## References

- Anand. Indian fresh water microalgae. Bishen Singh Mahendra Pal Singh, Dehradun, 1980, 98.
- Ashwani Dubey, Sandeep Kumar Shukla, Matadeen Bharti. International Journal of Research in Pharmaceutical and Biomedical Sciences, 2012;3(2):631-636.
- Barve MB, Sonawane DL. "seasonal diversity of phytoplankton with correlation of water quality parameters of lower dudhana dam, dist-parbhani (m.s) India", world journal of pharmacy and pharmaceutical sciences, 2017;6(7):828-843.
- Elayaraj B, Selvaraju M. International Letters of Natural Science, 2014a;16:145-156.
- Bhattacharya P, Avik KR, Choudary, Pal R. Freshwater diatoms from Kolkata with special references to their taxonomy. Indian Hydrobiol, 2011;13(2):98-112.
- Bureau of Indian Standards for Drinking Water Specifications, 2012.
- Palmer CM, Algae, Water Pollution. Castle House Publications Ltd. England, 1980, 123.
- Das J, Acharya BC. Hydrology and assessment of lotic water quality in Cuttack city. India. Water, air, soil Poll, 2003;150:163-175.
- Davis OA, Ugwumba OA. Effects of Tide on Zooplankton Community of a Tributary of Upper Bonny Estuary, Niger Delta, Nigeria. Int. J. Sci. Res. Knowled, 2013;1(9):325-342.
- Desikachary TV. Cyanophyta. Indian council of agricultural research, New Delhi, 1959.
- Desikachary TV. Atlas of diatoms. Monographs fase I, II, III and IV. Madras Science Foundation, Madras, 1987.
- Sedamkar EB, Mrs Jayashree Tikke. World Journal of Science and Technology, 2011;1(1):22-25.
- Fonge AB, Chuyong BG, Tening AS, Fobid AC, Numbisi NF. Seasonal occurrence, distribution and diversity of phytoplankton in the Douala Estuary, Cameroon. African Journal of Aquatic Science, 2013;1-11.
- Fritsch FE. The structure and reproduction of algae. Vol 1 and 2. Cambridge University Press, London, 1971.
- Hasan GO, Paul P. Mathisen, Don Pellegrino, Journal of Environmental Biology, 2007;28:493-502.
- Callieri C. Freshwater Reviews, 2008;1:1-28.
- Herrmann J. Freshwater biodiversity and Ecosystem functions; ideas and the case River Eman. In: Friberg N and Carl JD (Eds), Biodiversity in Benthic Ecology. Proc. Nordic Benth Meeting, Silkeborg, Denmark. Tech. Report, 1999:266:11.
- Hosmani S, Mruthunjaya TB. Distribution of phytoplankton in lakes of Tirumalkudal Narasipura of Mysore District. J. Res. Sci. Technol, 2012;1:28:32.
- Jasmine S, Rakibul Islam, Mosaddequr Rahman, Mostafizur Rahman M, Sayed Jewel A, Masood Z *et al.* Plankton production in relation to water quality parameters in lentic and lotic water bodies during post-monsoon season in the north western Bangladesh. Res. J. Agric. Environ. Manage, 2013;2:270:276.
- Komala HP, Nanjundaswamy L, Devi Prasad AG. An assessment of Plankton diversity and abundance of Arkavathi River with reference to pollution. Advances in Applied Science Research, 2013;4(2):320-324.
- Mary Kensa V, Jespin Ida C. "Phytoplankton diversity of Suchindram pond of Kanyakumari district, Tamil Nadu, south India", International Journal of Academic Research and Development, 2017;2(6):1135-1140.
- Manickam N, Saravana Bhavan P, Santhanam P, Bhuvaneshwari R, Chtrarasu P. 'Physico-Chemical characteristics and Phytoplankton biodiversity in Sular lake of Coimbatore, South India', Research Journal of Biotechnology, 2017;12(11):72-82.
- Mishra S. Diversity of algal taxa in certain freshwater ponds of khandwa (M.P) Indian Hydrobiol, 2007;10(2):335-342.
- Mukherjee B. Environmental Biology, tata Mc Graw Hill Publishing Company limited, New Delhi, 1997.
- Naik UG, Bhoslae SH, Rathode JL, Bhat VG. Diversity of phytoplanktonic groups in the river Kali, West coast of India. Proceeding of senior, Lecture University Grants Commission Haveri, 2005, 192-196.
- Nandan SN, Patel RJ. Ecological Studies of Algae. Ashish Publishing House, New Delhi, 1992.

27. Ngodhe SO, Raburu PO, Achieng Alfred, "The impact of water quality on species diversity and richness of macroinvertebrates in small water bodies in Lake Victoria Basin", Kenya. *J. Ecol. Nat. Environ*,2013;6(1):32-41.
28. Padhi SB, Das PK, Swain PK, Behera G. Algal flora of the freshwater aquatic systems of Mohuda, Orissa. *Indian Hydrobiol*,2010;12(2):143-14.
29. Rajagopal T, Thangamani A, Archunan GA comparison of physico-chemical parameters and phytoplankton species diversity of two perennial ponds in Sattur area, Tamil Nadu. *J Environ Biol*,2010;31:787-794.
30. Rani VB, Kumari VB, Balasingh R. GS, 'Phytoplankton community, ecological status and bloom forming algae of a temple pond in Kanyakumari District', *International Journal of Botany Studies*,2016;1(6):08-12.
31. Rawat R, Trivedi S. Seasonal Diversity of Phytoplankton in Relation to Seasonal Changes in physicochemical Parameters of Khedi Kalan Station of Dholawad Dam of Ratlam District M. P. *International journal of pure and applied Bioscience*,2018;6(2):448-454.
32. Mishra SR, Saksena DN. *Environment and Ecology*,1993;1:625-629.
33. Sampathkumar P, Ananthan G. Phytoplankton. In: *Coastal Biodiversity in Mangrove Ecosystems*, UNU-INWEH-UNESCO- International Training Course Manual, 2007, 205-212.
34. Seenayya G. Ecological studies on the phytoplankton of certain freshwater ponds of Hyderabad, India II the phytoplankton I. *I bid*,1971;13(1):55-88.
35. Sipauba-Tavares LH, Millan RN, Santeiro RM. Characterization of a plankton community in a fish farm. *Acta. Limnologica Brasiliensia*,2010;22:60:69.