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Temporal variations of phytoplankton diversity in relation to seasonality of hydro chemical characteristics in Gokulakatte wetland ecosystem in Koratagere, Karnataka

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Abstract

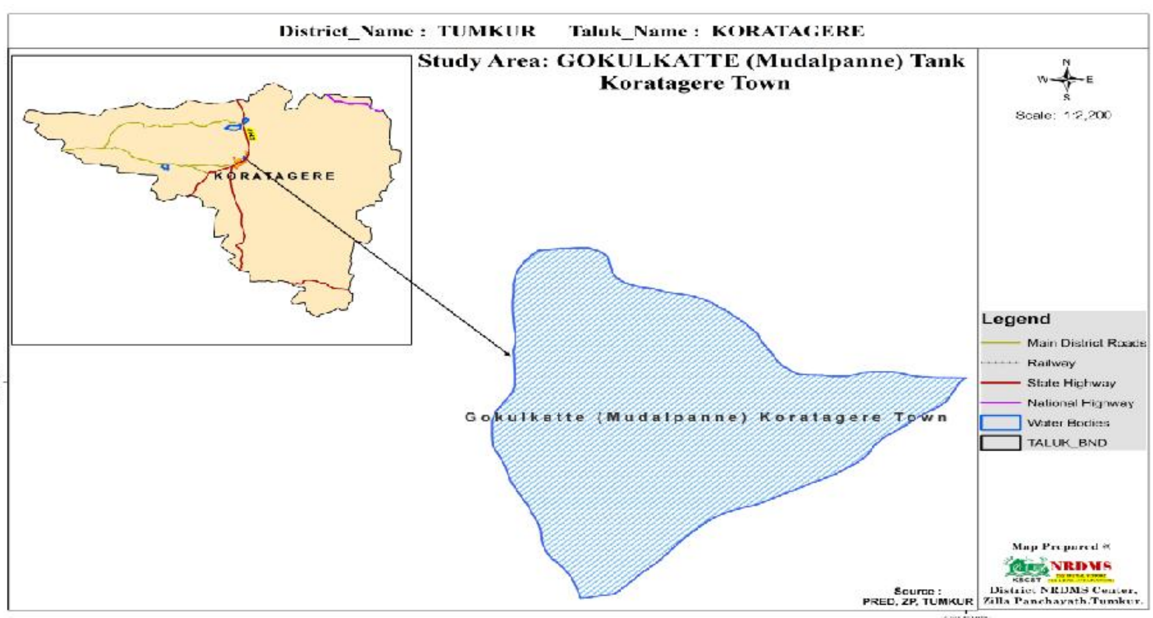
The concentration and variation of hydro chemical features in a wetland ecosystem supports the phytoplankton population. Productivity of a wetland ecosystem exclusively depends on the diversity and density of phytoplankton along with abiotic characteristics. The contemporary studies on Gokulakatte wetland ecosystem was focused on phytoplankton ecology, where its community structure is due to cycling of hydro chemical parameters and abiotic factors. The hydro chemical parameters and phytoplankton dynamics were studied for a period of 12 months from June 2018 to May 2019 on monthly interval by following the standard methods. Seasonal variation and interrelationships of hydro chemical factors with phytoplankton groups were statistically evaluated and discussed in detail. Present study revealed rich diversity of phytoplankton with a total of 21 genera and 32 species belonging to 4 taxonomic groups dominated by Cyanophyceae (37.5%) followed by Euglenophyceae (28.12%), Chlorophyceae (18.75%) and Bacillariophyceae (15.62%). Presence of 11 pollution tolerant species out of total of 32 species, Euglenophyceae being the second largest group with comparatively higher density coupled with Euglenophycean index value of 0.47 of Nygaard's trophic state indices and Palmer's algal species index score of 18 confirmed that the wetland ecosystem is organically polluted and eutrophic in nature.

Keywords: Gokulakatte, Wetland, Diversity, Phytoplankton, Hydrochemical

Introduction

Gokulakatte wetland ecosystem of Koratagere taluk in Karnataka is tolerating various stress over the years including human interference, anthropogenic activities, regular agricultural practices, meteorological variability, fishing and being used as dumping site of municipal waste substances hence it is under threat. To understand the ecosystem properly and to arrive at suitable remedial measures a more detailed analysis of spatiotemporal variation in phytoplankton composition and abundance are urgently required. However, present study has provided baseline data on the diversity, relative and seasonal abundance of phytoplankton along with seasonality of few hydro chemical parameters and their interrelationships.

Phytoplankton are simplest, microscopic, floating chlorophyllous, autotrophic, thallophytic cryptogams act as primary producers and occupy the lowest trophic level and initiates the food chain of an aquatic ecosystem (Waniek and Holliday, 2006). Phytoplankton in aquatic ecosystem comprises of many species and genera under various taxonomic groups, where some of the species of phytoplankton divide and redivide forming water blooms. Hutchinson (1932) and Seenayya (1971) were of the opinion that, a particular group of phytoplankton appears and reproduces in a wetland ecosystem possessing specific hydro chemical parameters. It is noted that another wetland ecosystem harbouring similar hydro chemical parameters may not support the similar species of phytoplankton. Hence, it is very difficult to consider phytoplankton belonging to different groups together for studies on diversity, density and periodicity. Therefore, they should be independently considered to understand diversity, density and periodicity. The studies on seasonality of phytoplankton in fresh water bodies has been studied by Kaur *et.al.*,(2001). Similar studies were carried out by Jarousha (2002). Phytoplankton in water bodies act as indicators of quality of water (Trainor, 1984 and Palmer, 1959) who also stated that the eutrophic water bodies support lesser diversity with very few dominant species. However, unpolluted lentic habitats support rich diversity. Venkataramanan *et.al.*,(1994) were of the opinion that phytoplankton act as potential organisms in monitoring the water quality in lentic water bodies**.**



Source: NRDMS, Zilla Panchayat, Tumkur

Figure-1: Location of Gokulakatte wetland in Koratagere Taluk

Table-1: Morphometric features of Gokulakatte wetland ecosystem

Sl No	Morphometric Features	
1	Basin	North Pennar
2	Sub basin	Jaymangali
3	Bund type	Earthen
4	Bund length	360 meters
5	Width of the bund	1.80 meters
6	Bund height	5 meters
7	Catchment	0.71 Km^2
8	Area benefited	9.60 hectares
9	Purpose	Irrigation and domestic

Figure-2: View of wetland in the foothills

Figure-3: View of wetland with urban settlement around

Materials and Methods

Study site

Gokulakatte is situated in the centre of Koratagere town near old bus stand between geo coordinates of $13^0 31^I$ North latitude and $77^0 13^I$ East longitude is more or less triangular in shape (Figure-1) having an average depth of around 4-6 feet's having earthen bunds located in the foot hills (Figure-2) with urban settlement all round (Figure-3). It receives water from Gopalaswamy hill slopes and also from upstream Goobala katte tank during monsoon. Gokulakatte wetland is facing anthropogenic pressure as it receives agricultural runoff during monsoon from the upstream paddy fields and also town sewage through open drains from North-Western part. Water of this wetland appears to be contaminated as this wetland is being used as a dumping site for solid wastes (Figure-2) and also sewage.

Angiospermic flora such as, species of Ipomoea, Cyperus, Parthenium, Jatropa, Euphorbia, Cymbopogan etc., are commonly seen along the peripheral region of the wetland with commonly seen fishing and domestic activities. Detailed morphometric features are appended in table-1.

Sampling and Analysis

Sub-surface water samples were routinely collected at an interval of 30 days from two designated sites in acid washed poly-ethylene cans and mixed thoroughly for composite sample. Air temperature, water temperature and PH were measured on the spot at the time of sampling. Water samples were fixed on the spot for the estimation of dissolved oxygen and rest of the hydro chemical factors were analysed within 24 hours. Methods of APHA (2005) were fallowed during sampling, preservation and analysis. For taxonomic identification and enumeration of phytoplankton water samples were preserved in 2% Lugol's iodine solution for sedimentation and centrifugation. Camera lucida diagrams were drawn and species level identification was made using monographs. Density of phytoplankton was calculated using Sedgwick-Rafter cell.

Results and Discussion

Table-2: Descriptive statistics and seasonal variations of Hydro Chemical Parameters

Sl NO	Hydro-Chemical Parameters	Summer	Rainy	Winter	Mean	Standard Deviation
1	Air temperature	33.6	32.1	30.35	32.29	2.911
2	Water temperature	30.75	30.25	28.6	30.04	3.141
3	pH	6.97	6.59	7.17	6.97	0.192
4	Turbidity	62	71	51.12	61.37	10.410
5	Electrical conductivity	98.25	122	98.62	124.29	36.188
6	Dissolved oxygen	3.26	3.42	3.73	3.47	13.054
7	BOD	2.86	3.10	1.92	2.62	0.214
8	Total hardness	144.25	228.87	190	149.67	57.906
9	Sulphate	299.4	228.88	79.94	112.92	34.711
10	Chloride	108.96	104.31	34.36	53.78	20.301
11	Phosphate	2.81	2.85	1.95	1.15	0.252
12	Silica	0.20	0.38	0.27	5.18	1.660

Seasonal variation of hydro chemical parameters with descriptive statistics is appended in table-2. Sulphate in wetland increases with the entry of sewage and agricultural runoff. Concentration of sulphate in polluted water bodies is high (Zutshi and Khan, 1988). Sulphate concentration in the present study was recorded high during summer and that of low during winter with a mean of 112.92 mg/l (Table-2) and falls within the desirable limit of 200 mg/l as lay down by WHO and similar findings were made by Murulidhar and Murthy (2015). During the present study a total of 32 species under 21 genera belong to four taxonomic groups were identified of which Cyanophyceae formed the bulk with 37.5 % followed by Euglenophyceae (28.12 %), Chlorphyceae (18.75 %) and Bacillariophyceae (15.62 %) (Figure-5)

Table-3: Diversity and distribution of Cyanophyceae

Sl No	Cyanophyceae	
1	*Anabaena spiroides*	+
2	*Arthospira tenuis*	+
3	*Chroococcus turgidus*	++
4	*Gloeocapsa minuta*	+
5	*Gloeocapsa punctata*	++
6	*Microcystis aeruginosa*	+++
7	*Microcystis viridis*	++
8	*Oscillatoria tenuis*	+++
9	*Oscillatoria chlorina*	+
10	*Oscillatoria princeps*	++
11	*Phormidium molle*	+
12	*Spirulina spiroides*	+

Index

+++	++	+
Above 500 Org / l	100 to 500 Org / l	1 to 50 Org / l

Paramasivam and Srinivasan (1981) were of the opinion that polluted water bodies show luxuriant growth of Cyanophyceae and dominates over Chlorophyceae and Bacillariophyceae and the present studies also arrives at the same opinion. Tripathi and Pandey (1995) recorded high density of Cyanophyceae during summer and that of low in winter which is in line with present study where similar observations were made. We have recorded 12 species of Cyanophyceae under 8 genera comprising 37.5 % and emerged as the biggest group. Seasonal maxima of Cyanophyceae observed during summer and that of minima during winter (Table-7, Figure-4). Table- 3 emphasizes the diversity and distribution pattern of Cyanophyceae where, *Microcystis aeruginosa*, *Oscillatoria tenuis* appeared abundantly (above 500 org/l). *Anabaena spiroids*, *Microcystis aeruginosa*, *Oscillatoria tenuis and Oscillatoria princeps* were observed in all the three seasons. 3 out of 12 species such as *Oscillatoria tenuis*, *Oscillatoria chlorina and Oscillatoria princeps* were tolerant to organic pollution (Palmer, 1959). Karl Pearson's correlation matrix in table-9 revealed that, hydro chemical parameters such as temperature of air and water, biological oxygen demand, sulphate, chloride and phosphate showed positive correlations with the population of Cyanophyceae at significant level. However, dissolved oxygen established inverse relationships with density and periodicity of Cyanophyceae similar observations were made by Murulidhar (2022). Total hardness regulates the dynamics of Cyanophyceae. Shalini *et.al.*,(2018) observed no such correlations. However, present study witnessed inverse relation with Cyanophyceae and remained in contrary with the findings of the above researchers.

Table-4: Diversity and distribution of Euglenophyceae

Sl No	Euglenophyceae	
1	*Euglena acus*	+++
2	*Euglena gracilis*	+++
3	*Euglena proxima*	++
4	*Euglena viridis*	++
5	*Phacus ankylonoton*	+
6	*Phacus caudatus*	++
7	*Phacus indicus*	++
8	*Tracheolomonas armata*	+++
9	*Tracheolomonas robusta*	+

A total of 9 species were identified under 3 genera in Euglenophyceae where 7 out of 9 species were abundantly seen (Table-4). The group is emerged as second biggest group with 28.12% among the other groups of phytoplankton (Figure-5). Rainy season recorded highest density and that of lower density was seen in summer (Figure-4). *Euglena viridis* emerged as most tolerant to organic pollution (Palmer, 1959). Seenayya (1971), Munawar (1974), Hegde and Bharathi (1985), Puttaiah and Somashekar (1985), Hosmani (2012), Murulidhar and Murthy (2019) worked on distribution and ecology of Euglenophyceae. Hosamani (2012) was of the opinion that the presence Euglenophyceae in water bodies indicates organic pollution the same is true to the present investigation also. Mohammed Naser *et.al.*,(2013) were of the opinion that the higher density of Euglenophyceae in water bodies is the cause for the eutrophic status which is also in conformity with our findings. Seenayya (1971) was of the opinion that lesser concentration of dissolved oxygen favours the growth of Euglenoids where, present study recorded low range of dissolved oxygen with a mean value of 3.47 mg/ l (Table-2) and noticed 9 species under 3 genera constituting 28.12% of the total phytoplankton population confirming the above findings and similar observations were made by Munawar (1974), Puttaiah and Somashekar (1985). Further, high temperature coupled with higher intensity of light supports the growth and multiplication of Euglenoids which later form water bloom (Seenayya, 1971) later Hegde and Bharathi (1985) observed predominant growth of Euglenoids in presence of temperature in the range of 30^{0}C to 35^{0}C. Present investigation recorded 32.29^{0}C as mean value of air temperature and that of water temperature was 30.4 ^{0}C (Table-2) and harboured 9 species under 3 genera. Though, the diversity is found to be less, the abundance is found moderately high (Table-7) hence, our findings are partially compatible with that of the above researchers. Statistically, Euglenoids did not show either positive or negative relationship with any hydro chemical parameters (Table-9).

Table-5: Diversity and distribution of Chlorophyceae

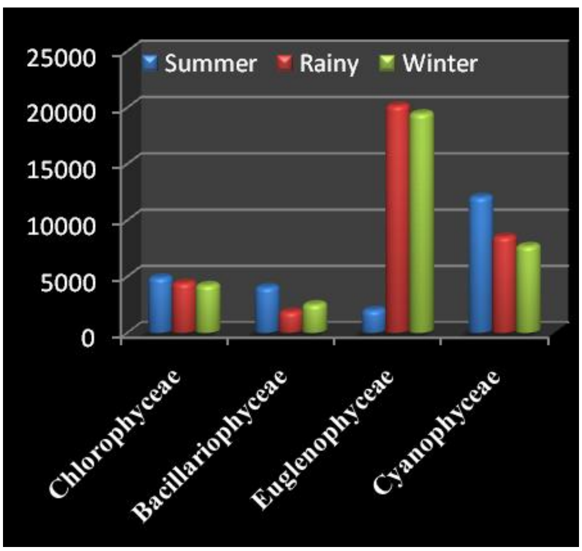
Sl No	Chlorophyceae	
1	*Ankistrodesmus falcatus*	++
2	*Crucigenia tetrapedia*	++
3	*Oocystis gigas*	++
4	*Pediastrum duplex*	+
5	*Senedesmus quadricauda*	+
6	*Tetraedron muticum*	++

Chlorophyceae with 6 genera and 6 species constituting 18.75% remained as third largest group (Table-5, Figure-5). *Ankistrodesmus falcatus*, *Pediastrum duplex* and *Tetraedron muticum* were the pollution tolerant species (Palmer, 1959). Singh (1960), Munawar (1970), Sigrid Haande *et.al.*(2007), Rakesh Kumar *et.al.*, (2012), Barauah *et.al.*, (2013) and Sushma Das *et.al.*, (2013) worked on ecology of Chlorophyceae and concluded that the concentration of dissolved oxygen in water is a prerequisite for the growth and abundance of Chlorophyceae. However, Hegde and Bharathi (1985) gave a different opinion where according to them dissolved oxygen did not show any relationship with Chlorophyceae present study also recorded similar observations. During the present study mean value of dissolved oxygen is recorded was 3.47mg/l (Table-2) which supported poor diversity of Chlorophyceae (Table-5). Seasonally, Chlorophycean population reached its peak during summer and winter witnessed lower density (Table-7, Figure-4). Statistically, sulphate and chloride had a positive bearing where as conductivity, total hardness and silica had a negative bearing on the distribution and diversity of Chlorophyceae (Table-9) hence our findings were not in conformity with the findings of above researchers.

Table-6: Diversity and distribution of Bacillariophyceae

Sl No	Bacillariophyceae	
1	*Melosira granulata*	++
2	*Navicula cuspidata*	++
3	*Navicula cryptocephala*	+++
4	*Surirella ovata*	++
5	*Synedra acus*	+++

Gokulakatte wetland supported 4 genera and 5 species with 15.62% of the total phytoplankton population (Figure-5). Except *Surirella ovata* all other 4 species were emerged as pollution tolerant species (Table-6). Seasonally, Bacillariophyceae reached peak during summer and the density was lowest during rainy (Figure-4). Karl Pearson's correlation matrix revealed that the concentration of sulphate and chloride showed positive correlation with the density of Bacillariophyceae and regulates the growth where as pH, dissolved oxygen and total hardness remained inversely correlated to the Bacillariophycean population (Table-9).



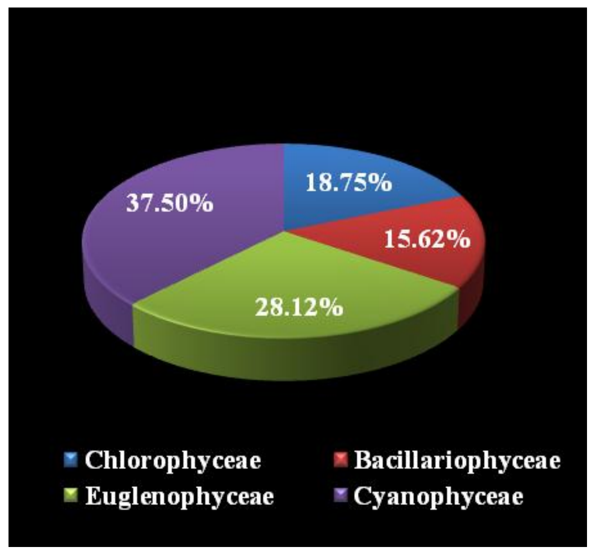


Figure-4: Seasonal variation of Phytoplankton **Figure-5: Relative abundance of Phytoplankton**

Table-7: Seasonal abundance of Phytoplankton (Org/l)

Sl No	Phytoplankton	Summer	Rainy	Winter
1	Chlorophyceae	4879	4406	4215
2	Bacillariophyceae	4024	1850	2506
3	Euglenophyceae	2005	20150	19444
4	Cyanophyceae	12032	8511	7688

Table-8: Nygaard's Tropic state indices

Sl No	Index	Status of wetland
1	Myxophycean Index	0.0 (oligotropic)
2	Chlorophycean Index	0.0 (oligotropic)
3	Euglenophycean Index	0.47 (Eutropic)

Table-9: Karl Pearson's correlation coefficient between Hydro Chemical parameters and Phytoplankton

Phytoplankton	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12
Chlorophyceae	0.132	0.095	-0.33	-0.03	-.624**	-0.373	-0.16	-.588**	.468*	.556**	0.259	-.519**
Bacillariophyceae	0.18	0.034	-.506*	0.165	-0.22	-.530**	0.213	-.542**	.512*	.497*	0.402	-0.361
Cyanophyceae	0.013	0.092	-0.448*	-0.03	-.563**	-.415*	-0.06	-.579**	.587**	.593**	0.332	-.515*
Euglenophyceae	0.165	-0.26	-0.06	-0.19	-0.19	-0.397	0.098	-0.19	0.261	0.18	-0.07	0.032

P1-Air temperature, P2-Water temperature, P3-pH, P4-Turbidity, P5- Conductivity, P6-Dissolved oxygen, P7-BOD, P8-Total Hardness, P9-Sulphate, P10-Chloride, P11-Phosphate, P12-Silica,

Table-10: Palmer's algal species index

Sl No	Phytoplankton species	Score as per Palmer's algal species index
1	*Oscillatoria tenuis*	4
2	*Oscillatoria chlorina*	2
3	*Oscillatoria princeps*	1
4	*Euglena gracilis*	1
5	*Euglena viridis*	6
6	*Ankistrodesmus falcatus*	3
7	*Navicula cryptocephala*	1
	Total Score	**18**

Tropic status of Wetland

Euglenophycean index value of 0.47 of trophic state indices of Nygaard (1949) indicates that wetland is eutrophic (Table-8) in nature and it is confirmed by Palmer's algal species index score of 18 (Table-10) where a score of 15 to 19 is considered as probable evidence of high organic pollution (Palmer, 1969)

Conclusion

Presence of 11 pollution tolerant species out of total of 32 species, Euglenophyceae being the second largest group with comparatively higher density coupled with Euglenophycean index value of 0.47 of Nygaard's trophic state indices and Palmer's algal species index score of 18 confirmed that the wetland ecosystem is organically polluted and eutrophic in nature. Restoration of wetland for having balanced ecosystem should be taken up on priority by the authorities of local self government.

References

1. American Public Health Association (APHA) 2005. Standard Methods for the Examination of Water and Waste water (21^{st} ed. 1220 p).Washington DC:
2. Baruah P.P., Baruah .R and J.Thakuria. 2013. Chlorophycean diversity of Deepor Beel wild life sanctuary. Phykos. Vol. 43(2):33–42.
3. Hegde, G. R. and Bharati, S. G. (1985). Comparative phytoplankton ecology of fresh water ponds and lakes of Dharwad, Karnataka State, India. Proceedings of the National Symposium on Pure and Applied Limnology (ed. Adoni, A.D.). Bull. Bot. Soc. Sagar, 32: 24-29

4. Hosmani, S.P. 2012. Fresh water diatoms as indicators of River water quality. Paripex-Indian Journal of Research 1(1): 36-38.
5. Hutchinson, G.E. 1932. Experimental studies in ecology. I. The magnesium tolerance of Daphnüdae and its ecological significance. Int. Rev. ges. Hydrobiol. 28:90-108.
6. Jarousha, A.K.K.H. (2002). Analysis of the polluting elements of Amgarh Lake of Jaipur (Rajasthan) India. Algal Biotechnology. Pointer Publishers, Jaipur. p:247-259.
7. Kaur, H.N., Jerath S. Kanwal & Bath, K.S. (2001). Aquatic Plant diversity of roper wetland Indian J. Environ. Sci. 6 (1):23-26.
8. Mohamed Naseer, K. M, Suresh kumar, S. 2013. Interaction between micro algal species richness and environmental variables in Peringalkuthu reservoir, Western Ghats, Kerala. Jourl. Environ. Biol. Vol: 34:1001-1005
9. Munawar, M. 1970. Limnological studies of fresh water ponds of Hyderabad, India -1.Journal of the Biotype Hydrobiologia, 35:127-162.
10. Munawar, M., 1974. Limnological studies on freshwater ponds at Hyderabad, India. Hydrobiologia 44: 13–28.
11. Murulidhar, V. N. and Yogananda Murthy, V. N. 2015. Ecology, distribution and diversity of phytoplankton in Teetha wetland Tumakuru district, Karnataka, India. International Journal of Environment and Pollution Research Vol.3, No.2, pp.1-12
12. Murulidhara, V.N.and Yogananda Murthy, V.N. 2019. Distribution and ecology of euglenoids in certain lakes of Tumakuru District, Karnataka, India. International Research Journal of Biological Sciences. Vol. 8(6), 12-17, June (2019). ISSN 2278-3202
13. Murulidhara, V.N. 2022 Assessment of Trophic Status of Bugudanahalli lake ecosystem of Tumkur, Karnataka by Nygaard's and Palmer's algal indices. International Journal of Research and Analytical Reviews Vol. 9(4): 879-884. E-ISSN 2348-1269
14. Nygaard, G. 1949. Hydrobiological studies onsome Danish ponds and lakes II. The quotient hypothesis and some new or little known phytoplankton organisms. Dat. Kurge. Danske. Vid. Sel. Biol Skr 7:1-293.0
15. Palmer, C.M. 1959 *Algae in water supplies* US Dept. of Health, Edu. and wel, pub Health service Cincinnati. *(1959)*
16. Paramasivam, M. and Srinivasan, A.1981. Changes in algal flora due to pollution in Cauvery River. Indian Journal of Environmental Health, Vol.23: 222-238.
17. Puttaiah, E.T. and Somashekar, R.K. 1985. Limnological studies on certain freshwater bodies of Mysore district, Karnataka.I - Ionic composition. Proc. Sym. Recent advances in plant sciences. pp. 381-386.
18. Rakesh Kumar, M.K., Seth and. Suseela, M.R 2012. Chlorophyceae of district Kangra of Himachal Pradesh. Phykos. Vol. 42(2):35–38.
19. Seenayya, G., 1971. Ecological studies on thephytoplankton of certain freshwater ponds of Hyderabad, India II,The phytoplankton I. I bid. 13 (1):55-88.
20. Shalini, B. R., Nagalakshamma, K.V and Murulidhara, V.N. 2018. Dynamics of cyanophyceae in lentic water bodies of koratagere taluk of tumkur district, karnataka, india. International Journal of Creative Research Thoughts. Vol.6 (1):1386-1391. ISSN: 2320-2882
21. Sigrid Haande, Thomas Rohalack, Ronald Semyalo, Pal Brettum, Bentl Edvardsen, Anne Lyche Solheim, Kai Sorensen, Petter Larsson, 2007. Phytoplankton dynamics and Cyanobacterial dominance in Murchison Bay of Lake Victoria (Uganda) in relation to environmental conditions. Limnologica-Ecology and Management of Inland Waters. Vol 41(1):20-29.DOI; 10.1016/j.limno.2010.04.001
22. Singh, V.P.1960.Phytoplankton ecology of the inland waters of Uttarpradesh. Proc.Sym. Agol. ICAR, New Delhi.pp: 220-222
23. Sushma Das Guru, Sonia Kumari and kalpana verma. 2013. Bio survey of algal population (Chlorophyceae) with limnological variables in some tropical fresh water shallow lakes. Phykos. Vol.43 (1): 68–76.

24. Trainor, F.R, 1984 Indicator Algal Assay Laboratory and fields approaches. *Algae as Ecological Indicators.* Ed. Shubert, Academic press London. *(1984, p 3 – 14).*
25. Tripathi, A.K. and Pandey, S.N. 1995 Water pollution. Ashish Publishing House, New Delhi, India.
26. Venkataraman, L.V. Krishi M. K. and Suvarnalatha G. 1994. Algae as tool for bio monitoring and abatemnent of pesticide pollution in aquatic system. *Phykos 33 (1 &2) (1994, p 171-193).*
27. Waniek, J.J. and Holliday, N.P. 2006. Large scale physical control on phytoplankton growth in the Irminger Sea, Part II: Model study of the physical and meteorological preconditioning. J. Mar. Sys. Vol. 59:219-237.
28. Zutshi, P.P. and Khan, A.U.1988. Eutrophic gradient in Dal Lake, Kashmir. Indian Journal of Environmental Health, Vol. 30(4): 348-354.

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