DYNAMICS OF CYANOPHYCEAE IN LENTIC WATER BODIES OF KORATAGERE TALUK OF TUMKUR DISTRICT, KARNATAKA, INDIA

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ABSTRACT

The restoration, conservation and management of lentic water bodies require proper understanding of an ecosystem. Assessment and monitoring of such water bodies provide the base line data on the condition of ecosystem. The present paper deals with the distribution and ecology of Cyanophyceae in relation to physico-chemical characteristics of water in four lentic water bodies of Koratagere taluk of Tumakuru district. Composite samples were taken at monthly intervals for the enumeration of Cyanophyceae. Total of 16 species under 12 genera were identified from all the four lakes studied. Gokalakatte lentic water body harboured 30.23% followed by Gattla gollahalli lentic water body (25.58%), Birdenahalli lentic water body (23.26%) and Tumbadi (20.93%). Seasonally, all the lentic water bodies recorded maximum density of Cyanophyceae during summer. Population of Cyanophyceae showed significant positive correlations at 5% level with temperature of air (r=0.727), temperature of water (r=0.717), sulphate (r=0.873), nitrate (r=0.740) and silica (r=0.810). Dissolved oxygen and free carbon dioxide exhibited negative impact on Cyanophycean population. Species of Anabaena, Microcystis and Oscillatoria have appeared during the entire period of investigation by resisting the stress caused by organic pollutants. Hence, these organisms are considered as pollution indicator organisms

Key words: Physico-chemical, Cyanophyceae, Correlation, Periodicity, Density

INTRODUCTION

The members of Cyanophyceae capable of fixing gaseous nitrogen occur in fresh water, marine and terrestrial habitats. They play an important role in balancing aquatic ecosystem and helps in improving soil fertility. The class Cyanophyceae includes simplest microscopic living autotrophic plants which are referred as only known oxygen producing prokaryotes. Because of compactness of protein molecules and their bonds in the protoplasm Cyanophycean members show an adoptability of life to extremes of environment including high temperature of hot springs and low temperature of Polar Regions. The gelatinous sheath helps them to withstand long periods of desiccation. Cyanophyceae is one of the major groups of phytoplankton in fresh water ecosystems capable of producing toxic blooms (Carmichael *et al*., 1990). Cyanophycean dynamics is influenced by the nutrients and physico-chemical characteristics of water and their distribution is influenced by biotic and abiotic factors (Sharathchandra and Rajashekar, 2013). Cyanophyceae, one of the chief components of the aquatic ecosystems form the base of the food chain. Besides their beneficial aspects they also cause most of the water quality problems if they are not properly managed (Smith, 1988). Ecology and distribution of fresh water Cyanophyceae has been studied by Singh(1960), Zafar(1967), Munawar (1970), Philipose (1972), Puttaiah *et.al*., (1982), Sankaran Unni (1984), Hegde and Bharathi (1985), Puttaiah and Somashekar (1987), Sudhakar *et al*., (1991), Manikya reddy and Venkateswaralu (1992), Swarnalatha and Narasinga rao (1993), Pandey *et al*., (1999), Sethi *et.al*., (1912), Rajesh kumar *et.al*., (2013) and Sharathchandra and Rajashekar (2013). In spite of the considerable work done on the ecology and dynamics of Cyanophyceae in lentic water bodies in different parts of the country, the similar studies has not been carried out in the lentic water bodies of Koratagere taluk of Tumkur district in the state of Karnataka. Therefore, the present study is an attempt to study the diversity and dynamics of Cyanophyceae with respect to physico-chemical characteristics of water.

MATERIAL AND METHODS

Koratagere taluk of Tumkur district in the state of Karnataka is situated in the Deccan plateau of peninsular India between $13^{0}31^{I}$ North latitude and $77^{0}13^{I}$ East longitude at 2700 feet's above mean sea level. Gattla gollahalli, Gokalakatte, Tumbadi and Birdenahalli are the four lentic water bodies from here onwards referred to as lakes situated within the radius of 15 kilometers from Koratagere town selected for the present investigation. The three lakes which are situated away from urban settlement are under pressure from domestic activities, agricultural runoff, encroachments for agricultural practices and establishment of brick kilns during pre-monsoon periods. The other lake Gokalakatte which is situated within the Koratagere town is under enormous pressure as it has become the dumping site of domestic seawage and solid waste.

Water samples at a depth of two feet's were collected from each lake in black colored plastic containers of 3 liters capacity at monthly intervals for a period of two years for the analysis of physico-chemical parameters. Standard methods (APHA 1998) were followed during collection, preservation and analysis of water samples. Temperature of air and water were measured on the spot. Water samples were fixed on the spot for the estimation of dissolved oxygen. All the physico-chemical parameters were expressed in terms of mg/l except pH. Temperature of air and water are expressed in terms of ^{0}C, turbidity in terms of NTU and conductivity in terms of µs/cm.

For the enumeration of Cyanophyceae one liter of water samples from each lake were collected simultaneously with the help of plankton net (no. 25, mesh size 64 μm) at monthly intervals for two years and fixed with 20 ml of 1% lugol solution for 24 hours. 100 ml of the sediment is subjected to centrifugation at a speed of 1500 rounds per minute for 45 minutes and 10 ml of the sediment is labeled and preserved for further studies. Camera lucida technique was adopted for the enumeration of Cyanophyceae. Identification of Cyanophyceae up to the level of species was made using the literature - Deshikachary (1959) and Prasad and Srivastava (1992). Results of the physico-chemical characteristics and density of Cyanophyceae were statistically evaluated using carl's-pearsons correlation coefficient to know the relationship between the physico-chemical characteristics and the population of Cyanophyceae.

RESULTS AND DISCUSSION

The occurrence of Cyanophyceae in aquatic habitats is interpreted with respect to variation in the physico-chemical characteristics of waters (Sharathchandra and Rajashekar, 2013). The species diversity and the dominance of individual species of Cyanophyceae were affected by the nutrient status of ambient water (J.Pandey *et.al* 2000). Cyanophycean members form blooms in the stagnant waters of certain tropical wetlands (Prescott, 2004). The blooming of Cyanophycean members is a common phenomenon in the eutrophication of wetland ecosystems (Moss *et.al.*, 2006). Cyanophyceae are the most prevalent and harmful for people and limit the convenient use of water (Pitois *et.al.*, 2001). Temperature, pH, dissolved oxygen, carbon dioxide, nitrates, phosphates and oxidizable organic matter regulate the presence and abundance of Cyanophyceae in fresh water bodies (Rao 1953, Singh 1960, Munawar 1970, Philipose 1972, Sudhakar *et.al.*, 1991, Manikya Reddy and Venkateswaralu 1992, Swarna latha and Narasingarao 1993). Murulidhar and Yogananda Murthy in the year 2015 reported that, the seasonal dynamics of Cyanophyceae is positively correlated with air and water temperature, nitrates and sulphates. Two yearly average values of physico-chemical characteristics of water of all the four lakes are shown in Table-1.

Gonzalves and Joshi (1946) and Pendse *et.al.*, (2000) were of the opinion that, Temperature during summer acts as an important factor in promoting the growth of Cyanophyceae. Similar observations have also been made in the present investigation where, Cyanophyceae recorded their maxima during summer in all the four lakes (Figure-1) and the same has been confirmed by Statistical analysis where, the temperature of air and water exhibited direct bearing on the distribution and periodicity of Cyanophyceae and significant positive correlation was established between temperature of air and water with the population of Cyanophyceae (Table-3). Singh (1960) observed that, high temperature associated with high carbon dioxide accelerates the growth of Cyanophyceae. The present findings are in partial agreement with that of Singh (1960) as carbon dioxide showed negative correlation with the periodicity and abundance of Cyanophyceae (Table- 3) which recorded maximum density during summer. Prescott (1938) and Rao (1977) were of the opinion that, neutral P^H favors the growth of Cyanophyceae. The present study also ends up with similar observations where, P^H in all the four lakes remained slightly above neutral (7.0) favoring the growth of 16 species of Cyanophyceae (Table 1 and 2). Electrical conductance is the ability of a substance to conduct the electrical current. Conductivity in water is the property caused by the presence of various ionic species. T.V.Ramachandra and Malavikaa solanki (2007) reported that conductivity of the range 284.67-307.33 µS/cm indicates less dissolved solids and no major source of pollution from the catchment. Conductivity in the present investigation ranged between 86.35 µS/cm and 210.97 µS/cm which is in conformity with the findings of the said researchers. Conductivity however, remained as an independent variable (Table-3). Dissolved oxygen is an important parameter in an aquatic ecosystem which is required for an aerobic metabolism of all aquatic organisms (Wetzel, 1975). Positive correlations between number of Cyanophycean species and dissolved oxygen were noticed by Hosmani (1987) and Bhave and Borse (2001) but in the present investigation dissolved oxygen remained as an independent variable. Singh *et.al.* (1969) reported that, higher values of phosphates and nitrates with low dissolved oxygen favored the growth of Cyanophyceae. In the present investigation dissolved oxygen ranged between minimum of 7.47 mg/l and a maximum of 8.08 mg/l. Turbidity and biological oxygen demand in the present investigation remained as independent variables and have not supported the growth and abundance of Cyanophyceae (Table-3). The values of phosphate and nitrate remained very low in all the lakes which yet, harbored good number of Cyanophycean members. Statistical evaluation has revealed that, dissolved oxygen showed negative correlations with Cyanophyceae. Similar observations have been made by Samules *et.,al* (1979) however, nitrate has a direct bearing on the population of Cyanophyceae showing significant positive correlation (Table-3). Hence, our results are not in agreement with the findings of singh *et.,al* (1969). Sulphate is an important mineral for the growth of the phytoplankton which enters into the water body from the catchment area through surface run off. Relatively higher concentration of sulphate is observed in the present study which could be attributed to the agricultural runoff from the surrounding agricultural lands during monsoon. Statistically significant positive correlations between concentration of sulphate and Cyanophyceae were noticed (Table-3)

The significance of total hardness in regulating the dynamics of Cyanophyceae has been studied by Sudhakar *et.al.*,(1991) and were of the opinion that, the total hardness and Cyanophyceae exhibited positive relation with each other. No such positive correlations were observed in the present investigation (Table-3). Sharathchandra and Rajashekar (2013) were of the opinion that alkalinity and total hardness are not favorable for the occurrence and richness of Cyanophyceae. The present study also acknowledged similar observations. Whitton *et,al.*, (1986) and Santra (1990) reported negative correlations between Silicates and number of species of Cyanophyceae. However, statistical analysis in the present investigation revealed that, silicates showed a positive correlation and have a direct impact on the distribution of Cyanophyceae (Table-3)

CONCLUSION

From the foregoing observations of the present investigation it is concluded that summer periods are favorable for the abundant growth of Cyanophycean members. The present findings throw a light on indicator organisms where species of Anabaena, Microcystis and Oscillatoria

resist the stress caused by organic pollutants. Occurrence and Periodicity of the above said organisms indicate that they act as pollution indicator organisms.

Table – 1 Two yearly averages of physico-chemical parameters

Sl.No.	Physico-chemical parameters	G G Halli	Gokalakatte	Tumbadi	Birdenahalli
1	Air temperature	29.5	29.7	31.04	30.13
2	Water temperature	26.4	27.16	27.62	26.75
3	pH	7.07	7.04	7.11	7.04
4	Turbidity	27.3	37.37	15.25	11.99
5	Conductivity	104.70	210.97	86.35	97.95
6	Dissolved oxygen	7.93	7.60	7.47	8.08
7	Free CO_2	10.98	8	3.05	1.66
8	BOD	1.78	1.25	1.22	2.14
9	Total hardness	67.56	60.66	92.83	112.91
10	Total alkalinity	77.91	60.29	62.58	40.91
11	Chloride	28.38	25.31	37.13	47.34
12	Sulphate	73.86	39.91	30.22	30.53
13	Phosphate	0.81	0.23	0.18	0.28
14	Nitrate	6.48	0.4	0.395	0.69
15	Silica	35.31	109.85	139.06	40.48

Table – 2 Diversity of Cyanophyceae

Sl.No.	Name of the organisms	Lakes			
		G G Halli	Gokalakatte	Tumbadi	Birdenahalli
1	Anabaena spiroides	+	+	+	+
2	Arthospira tenuis	+	+	-	+
3	Coccochloris peniocystis	+	-	-	+
4	Chroococcus turgidus	++	++	+	-
5	Cylindrospermum muscicola	+	-	-	+
6	Gloeocapsa minuta	+	+	-	+
7	Gloeocapsa punctata	-	++	+	+
8	Merismopedia glauca	+	+	-	+
9	Microcystis aeruginosa	+	+++	+	+
10	Microcystis viridis	+	++	-	-
11	Myxosarcina burminsis	-	+	+	-
12	Oscillatoria chlorina	+	+	+	-
13	Oscillatoria princepes	-	+	-	-
14	Oscillatoria tennis	-	+++	+	++
15	Phormidium molle	-	+	+	-
16	Spirulina spiroides	+	-	+	+

Table – 3 Carl pearson's correlation matix

Physicochemical parameters V/S cyanophyceae

Sl.No.	Physico-chemical parameers	Cyanophyceae
1	Air temperature	0.727 0.000*
2	Water temperature	0.717 0.000*
3	pH	0.239 0.261

4	Turbidity	-0.019 0.931
5	Conductivity	-0.171 0.424
6	Dissolved oxygen	-0.448 0.028
7	Free CO_2	0.449 0.028
8	BOD	0.359 0.085
9	Total hardness	-0.401 0.052
10	Total alkalinity	-0.379 0.067
11	Chloride	-0.064 0.765
12	Sulphate	0.873 0.000*
13	Phosphate	0.131 0.541
14	Nitrate	0.740 0.000*
15	Silica	0.810 0.000*

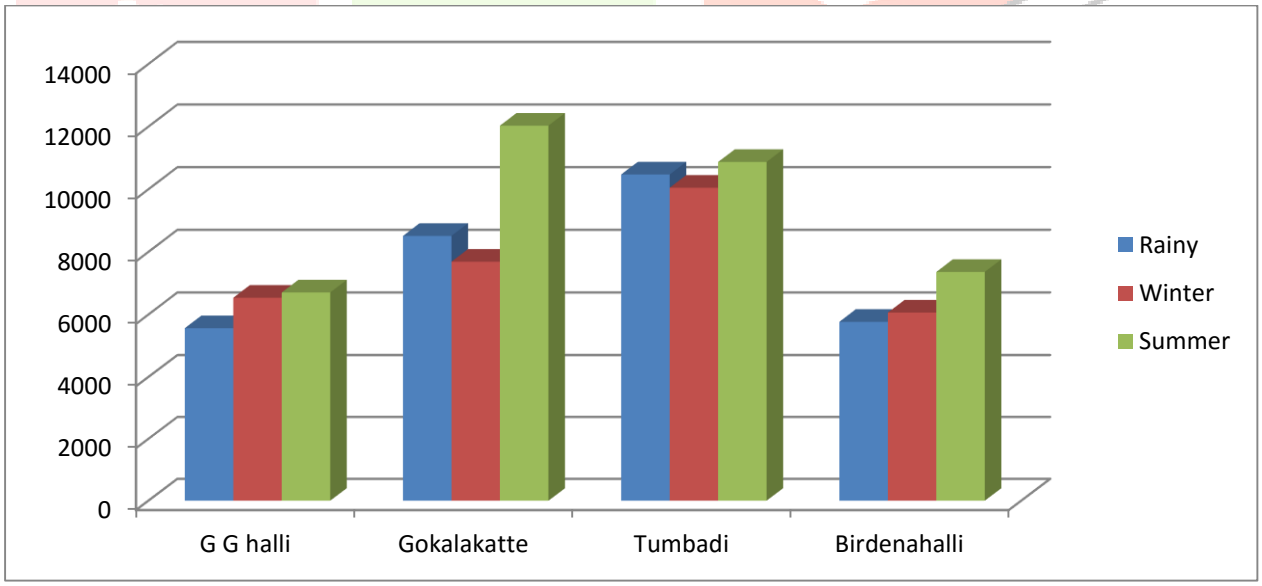

Figure-1 Seasonal dynamics of Cyanophyceae

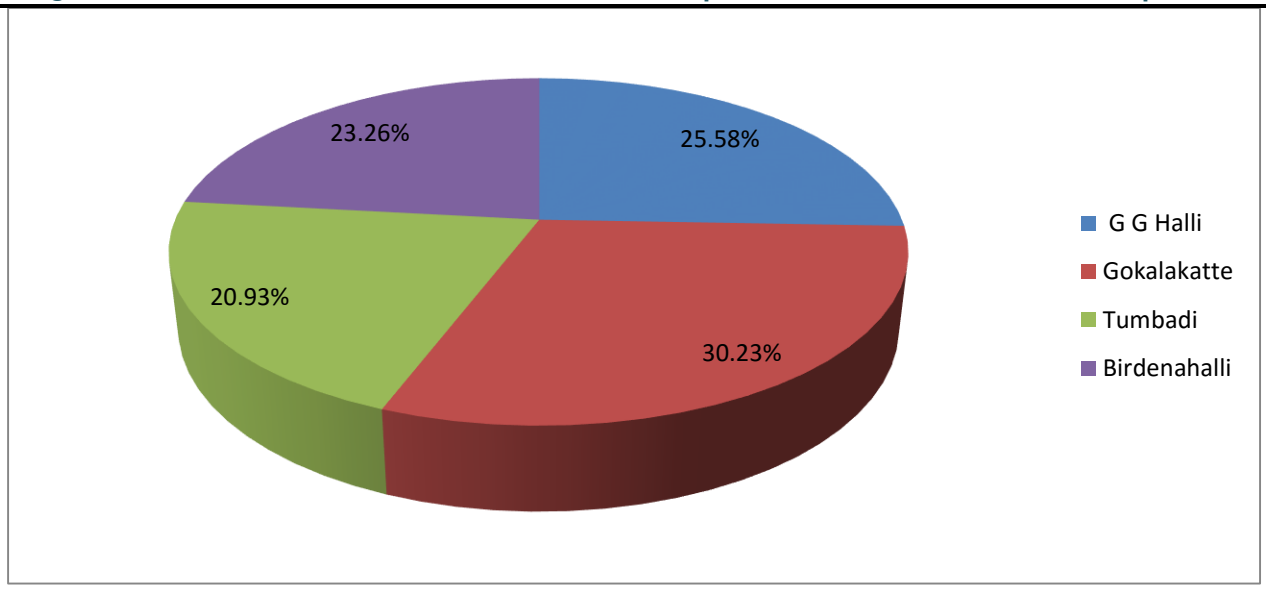

Figure-2 Relative abundance of Cyanophyceae in lakes of Koratagere taluk

REFERENCES

[1] APHA, 1998. Standard Methods for the Examination of Water and Waste Water (20th Edn) American Public Health Association, Washington DC

[2] Bhave, S.K. and Borse, P.V. 2001.Seasonal variation in temperature, dissolved oxygen, Ph and salinity and their influence on planktons in Aner river water. Jalgaon, Maharastra. Pollution Research.20:79-82.

[3] Carmichael, W.W. Mahmood, N.A. and Hyde,E.G. 1990. Natural toxins from Cyanobacteria (blue green algae) Marine toxins: Origin, structure and molecular pharmacology Ed.Hall, S and Strichartz, G. American chemical society, Washington DC:87-106.

[4] Deshikachary, T.V.1959. Cyanophyta a Monograph. ICAR, New Delhi, India

[5] Gonzalves, E.A. and Joshi, D.B.1946.Fresh water algae near Bombay .I. The seasonal succession of algae in a tank at Bhandra. Journal of Bomb.Nat.Histt.Soc.46:154-176.

[6] Hegde, G.R and Bharathi, S.G.1985.Comparative phytoplankton ecology of fresh water ponds and lakes of Dharwad, Karnataka state,India.Proc. Nat. Symp. Pure and Appl.Limnology.Bull.Bot.Soc.Sagar.32:24-29.

[7] Hosmani, S.P.1987.Algal species diversity indices as a measure of water pollution. Acta Botanica Indiana.15:320-322.

[8] Jarousha, AKKH.2002.Analysis of the polluting elements of Ramgarh lake of Jaipur (Rajasthan) India. Algal biotechnology. Pointer Publisher, Jaipur. 247-259.

[9] Manikya Reddy, P. and Venkateswaralu, V.1992.The impact of paper mill effluents on the algal flora of river Tungabhadra. J. Indian Bot.Soc.71:109-114.

[10] Moss, B. Stansfield, J. Irvine, K. Perrow, M. and Philips, G.2006. Progressive restoration of a shallow lake: A 12 year experiment in isolation, sediment removal and bio manipulation. Journal of Applied Ecology.33 (1):71-86.

[11] Munawar, M., 1970.Limnological studies on fresh water polluted and unpolluted environments. Hydrobiol.39 (1):105-128.

[12] Murulidhar,V.N. and Yogananda Murthy,V.N. Ecology, Distribution and Diversity of Phytoplankton in Teetha wetland , Tumakuru district, Karnataka, India. International Journal of Environment and Pollution Research, 3(2):1-12.

[13] Philiphose, M.T., 1972. Notes on the ecology, role and possible control of some common blue-green algal blooms in Indian fresh water ponds in Deshikachary,T.V., (Ed).Taxonomy and Biology of the Blue-green algae.455-460.Madras University.

[14] Prescott, G.W. 1938.Objectionable algae with reference to killing of fish and other animals.Hydrobiologia.1:1-13.

[15] Puttaiah, E.T and Somashekar, R.K.1986.Distribution of Cyanophyceae in lakes of Mysore. Proc. All India Semenar on water quality in and around urban ecosystems and their management (Edn) K.S.Unni. Govt.P.G. College, Chindwara, M.P

[16] Rao, C.B. 1953.On the distribution of algae in a group of six small ponds. Journal of Ecology.41:62-71.

[17] Rao. 1977. An ecological study of three fresh water ponds of Hyderabad, India-I.Hydrobiologia.38:213-223.

[18] Santra, S.C. 1990. Freshwater algae of Westbengal .Prof. M O P Iyengar Centenary celebration volume.189-194

[19] Sharathchandra,K. and Rajashekar, M. 2013. Fresh water Cyanobacteria from Kaiga, Uttarakannada district in the western Ghats of Karnataka. Phykos.43 (2):51-66.

[20] Singh,V.P. 1960. Phytoplanktons of inland waters of Uttarpradesh. Proc. Symp. Algol. ICAR. New Delhi. 220-222

[21] Smith, D.W. 1988. Phytoplankton and cat fish culture: a review. Aquaculture.74: 167-189.

[22] Swarnalatha, N. and Narasinga Rao, A. 1992. Ecological evaluation of Cyanobacterial blooms. Science journal. 5 (spl issue):326-40.

[23] Pandey, j. Usha Pandey. and Tyagi, H.R. 2000. Nutrient status and Cyanobacterial diversity in a tropical lake. Journal of Environmental Biology.21 (2):133-138.

[24] Pendse, D.C. Yogesh Shastri. and Barhate. 2000. Hydrobiological study of percolation tank of village Dasane. Journal of Ecology, Environment and Conservation.6 (1); 93-97.

[25] Pitois, F.A. Jigorel. and Bertru, G. 2001. Colonization dynamics of an encrusting cyanobacterial mat in a hard water river (Eaulne,France) Journal of Geomicrobiol.18:139-155.

[26] Prasad, B.N. and Srivastava, M.N. 1992. Fresh water algal floora of Andaman and Nikobar islands. Edn. Bishen Singh Mahendra pal singh.Dehradun, India.1:369.

[27] Prescott, G.W. 2004. Algae of the Western great lake area. William C. Brown, Co.Iowa, 977

[28] Ramachandra,T.V. and Malvicaa solanki. 2007. Ecological assessment of lentic water bodies of Bangalore. Technical report on Environmental Information system (ENVIS) 25:83-84.

[29] Sankaran unni, K. 1984. Limnology of sewage polluted tank in central India. Int.Revue.Ges.Hydrobiologia.64 (4):553-565.

[30] Suri,V.K. Jaggi, R.C. and Puri,U.K.1995.Response of irrigated rice to blue green algae in the presence and absence of nitrogen and its residual effect in wheat. Journal of Crop research, Hissar. 9:403-406.

[31] Swarnalatha, N and Narasingarao, A. 1993. Ecological investigation of two lentic environments with reference to Cyanobacteria and water pollution. Indian Journal of Microbiol.3:41-48.

[32] Tripathi, A.K. and Pandey, S.N. 1995.Water pollution. Ashis Publishing house.92-286.

[33] Wetzel, R.G. 1975. Limnology, W.B.Sunders Co.,Philadelphia.

[34] Whitton,B.A. Talat, M.K. and Ibrahim, A.1986.Water chemistry and algal vegetation of streams in the Asir mountains, Soudi Arabia. Hydrobiologia.133:97-106.

[35] Zafar,A.R.1967.On the ecology of algae in certain fish ponds of Hyderabad, India, The periodicity. Hydrobiologia.3(1):96-112.