Indian Journal of Environmental Sciences 22(2) 2018, pp.89-94
Green Earth Foundation
ISSN 0971-8958

DIVERSITY AND ABUNDANCE OF PHYTOPLANKTON WITH RESPECT TO PHYSICO-CHEMICAL PARAMETERS IN ASHTAMUDI WETLAND, KERALA, INDIA

M. Badusha* and S. Santhosh
PG and Research Department of Zoology, NSS College, Pandalam, Pathanamthitta, Kerala-689501
***Corresponding Author**

ABSTRACT

Water quality index (WQI) is one of the reliable tools to examine overall water quality status. It also helps Diversity and abundance of phytoplankton were estimated in the Ashtamudi Lake situated in the Kollam district of Kerala state. 52 species of phytoplankton were recorded from six sampling stations of the lake. The species with highest number of population was *Blue green algae*. *Oscillatoria and Chatoceros* were the most common species. Phytoplankton are influenced by physico-chemical parameters such as water temperature, pH, turbidity, DO, BOD, nitrate, sulphate and phosphate. The minimum phytoplankton abundance was observed at station S_3 (Kandachira Kayal) having maximum BOD whereas their abundance maximum was at S_1 (Near Ashramam) because of higher concentrations of nutrients such as nitrate and phosphate. Phytoplankton species diversity reaches its maximum at station S_6 (Palliyamthuruttu-Vellimon side), where turbidity was minimum.

Key Words: Ashtamudi Lake, phytoplankton, diversity, abundance, physico-chemical parameters

.

INTRODUCTION

Estuaries form a transition zone between river and maritime environments. They are subjected to both marine influences such as tides, waves, and the influx of saline water and to riverine influences such as flows of freshwater and sediment. The mixing of sea and freshwater provide high levels of nutrients both in the water column and sediment making estuaries among the most productive natural habitats in the world (McLusky and Elliott 2004). The productive behaviour of estuaries is because of abundant availability of autotrophs, the phytoplankton, benthic algae and green rooted plants which ensure maximum utilization of sunlight for photosynthesis. The estuaries present unique environmental characteristics that result in high biological productivity because of abundance of plankton which are part of the aquatic food chain.

Phytoplankton are the key primary producers in the estuaries. These are at the base of the food chain in the aquatic environments and are most important among the primary producers (Chiu et al. 1994). They move with the water bodies and can be flushed in and out with the tides. Plankton, particularly phytoplankton, has long been used as indicators of water quality. Because of their short life span, plankton responds quickly to environmental changes. Plankton play a very important role in organic production in the estuary; their occurrence and abundance indicate water quality, level of pollution and have great significance in the exploration of fisheries. Present study was made to study phytoplankton abundancity with reference to water quality in Ashtamudi wetland which is now under threat of degradation and loss of biodiversity due to solid waste dumping, use of mechanized boats, tourism and other anthropogenic activities which may adversely impact primary producers in the ecosystem and thereby disrupt the entire food chain. This study will help to understand the effect of water quality on the occurrence of phytoplankton.

Study Area

Ashtamudi wetland, situated in the Kollam district, Kerala (Lattitude-8°592 N Longitude-76°362 E), is the second largest wetland in Kerala with a palm shaped extensive water body and eight prominent arms. For the present study, six sites selected were; Near-Ashramam (S_1), Sambranikodi (S_2), Kandachira Kayal (S_3), Thekkumbhagom (S_4), Pattamthuruthu (S_5) and Palliyamthuruttu-Vellimon (S_6).

Near Ashramam (Kollam "S_1") is highly polluted by oils from tourist boats and with faecal contamination. The drainage waste from the transport bus stand and KTDC is also discharged directly into this region. Sambranikodi (S_2) is a comparatively non-polluted area but adjacent region is filled with sea sand of the Ashtamudi estuary. The samples were collected from the boat channel of this region. Kandachira Kayal (S_3) is highly polluted with intensive coconut husk retting activity and coconut wastes from the coir-manufacturing unit are disposed off. In Thekkumbhagam (S_4), the bridge construction is going on. This area is also polluted with oil from speed -boats used for local transport. Pattamthuruthu (South of Monro-thuruttu "S_5") is the region where one of tributaries of the Kallada River joins. Palliyamthuruttu-Vellimon (on Kanjirakode Kayal) site (S_6) is situated in between the Vellimon (Resort area) and the Kanjirakode Kayal. Average depth of this area is 15 to 20 feet. Water is clear and bottom of the kayal bears lots of macrophytess.

MATERIALS AND METHODS

The study was conducted during the summer month of Kerala viz., March-2017. The water samples filled in 20L plastic cans were fixed in Lugol's iodine and preserved in 4% formaldehyde. These were kept undisturbed for 48 hours to settle planktons and later concentrated to 10mL or 50mL depending on plankton abundance after siphoning out supernatant solution with a plastic tube, one end of which was closed with a bolting silk (20µm) to prevent loss of buoyant phytoplankton. Numerical estimation of phytoplankton was made by Sedgwick-Rafter cell method (Trivedi and Goel 1986) and identification as per the standard methods prescribed by Prescott (1962), Sarma and Khan (1980), Gopinathan (1987) and Santra et al. (1989).

The surface water samples were collected in 2L plastic cans from the selected sampling stations for the analysis of various physico-chemical parameters. Samples for DO and BOD estimations collected in BOD bottles were immediately fixed with Winkler A and B. The water temperature was measured at the site itself using mercury thermometer. The pH also was recorded in the field itself. Before the collection of samples, the containers were thoroughly rinsed with the water to be sampled and samples were labelled properly. Collected water samples were brought immediately to the laboratory for the estimation of various physico-chemical parameters. Hydrographic data were recorded after analysis following standard methods as given in Table 1.

Table 1. Methods used for the analysis of water quality parameters

No.	Parameters analyzed	Methods adopted and instruments used	References
1.	Temperature (°C)	Mercury Thermometer	----
2.	pH	Elico pH meter	(APHA, 1998)
3.	Turbidity (NTU)	Turbidimetric method, Nephelometer (Systronic 132)	(APHA, 1998)
4.	DO (mg/L)	Winkler's method	(APHA, 1998)
5.	BOD (mg/L)	Winkler's method (5 day incubation)	(APHA, 1998)
6.	Nitrate (mg/L)	Brcinemethod, Spectrophotometer (Systronics 106)	(Grasshoff, 1999)
7.	Sulphate (mg/L)	Turbidimetric method, Spectrophotometer (Systronics 106)	(APHA, 1998)
8.	Phosphate (mg/L)	Snannous chloride method, Spectrophotometer (Systronics 106)	(Grasshoff, 1999)

RESULTS AND DISCUSSION

53 species of phytoplankton were identified from 6 sampling stations during the present study (Table 2). Among them *Actinoptychus, Bellerochea, Ditytum, Leptocylindrus, Lithodesmium and Westella* were only found in Sambranikodi (S_2), *Tribonema* species at Thekkumbagam (S_4) while *Johannesbaptistia, Penium* and *Senedesmus* only at Pattamthruthu (S_5). The variations in phytoplankton abundance and their diversity with respect to different water quality characteristics of Ashtamudi backwaters are given in Fig.1 to 7.

The phytoplankton showed variations because of diverse physico-chemical conditions in the six stations of Ashtamudi Lake. Total number of phytoplankton populations ranged from 12Cells/L at Kandachira Kayal (S_3) to 450600Cells / L at Near Ashramam (Kollam city) (S_1). Total number of phytoplankton and the major groups at different stations are given in Fig. 1 to 7.

At Station 1 phytoplankton count was 450600 Cells /L (Fig. 1) and major species were *Chaetoceros* (600 Cells /L) and *Blue green Algae* (450000 Cells/L) (Fig. 2). Among six stations maximum number of phytoplankton population (450600 Cells/L) and minimum number of species (2) were at Station 1.

Table 2. Phytoplankton recorded in the study

Name of organisms/species				
Ankistrodesmus	*Cocconeis*	*Hydrodictyon*	*Oscillatoria*	*Skeletonema*
Asterionella	*Coscinodiscus*	*Johannesbaptistia*	*Penium*	*Spirogyra*
Biddulphia	*Cosmarium*	*Korshikoviella*	*Peridinium*	*Spirulina*
*Blue green algae**	*Cyamatopleura*	*Lithodesmium*	*Phormidium*	*Stephanodisus*
Caloneis	*Cymbella*	*Meiosira*	*Pinnularia*	*Stephanopyxis*
Camphylodiscus	*Ditylum*	*Melosira*	*Pleurosigma*	*Streptotheca*
Ceratium	*Fragilaria*	*Mougeotia*	*Rhopalodia*	*Synedra*
Chaetoceros	*Gonatozygon*	*Navicula*	*Schizomeris*	*Tabellaria*
Closterium	*Gonyaulax*	*Nitzschia*	*Schroederia*	*Tribonema*
Lyngbya	*Gyrosigma*	*Nodularia*	*Senedesmus*	*Triceratium*
				Ulothrix
				Westella

**We could not identify this dominant species, as it shows similarities with other species.*

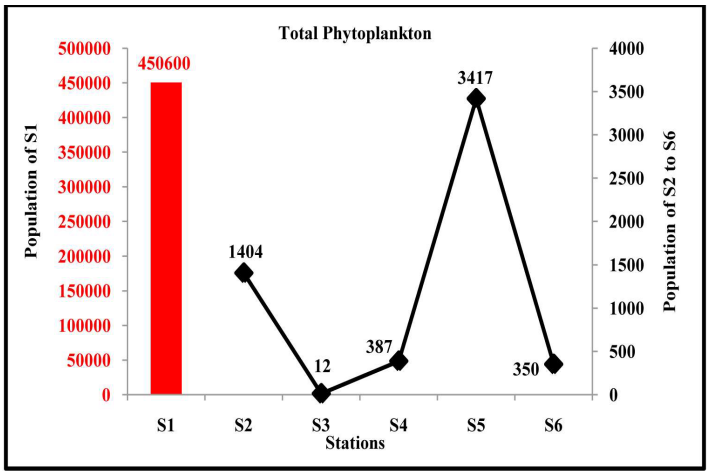

Fig. 1. Variations in phytoplankton counts at six stations in Ashtamudi Lake

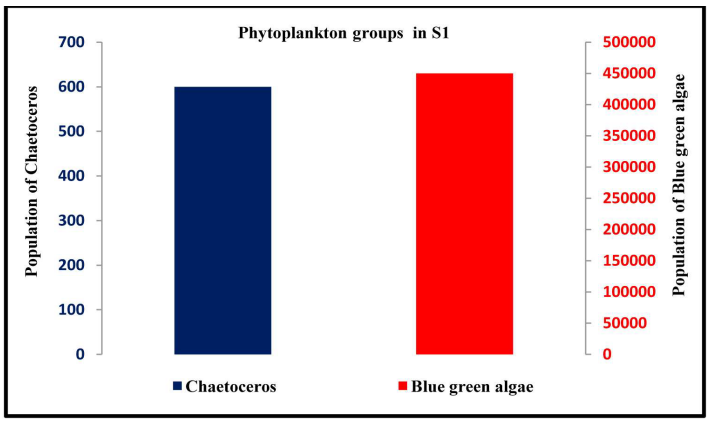

Fig. 2. Phytoplankton counts at S_1

At Sambranikodi (S_2), 25 species having total numbers of 1404 Cells/L were recorded (Fig. 1). *Chaetoceros* was the dominant species having maximum count (1177Cells/L) whereas counts of other species were low varying between 1- 53 Cells/L (Fig. 3).

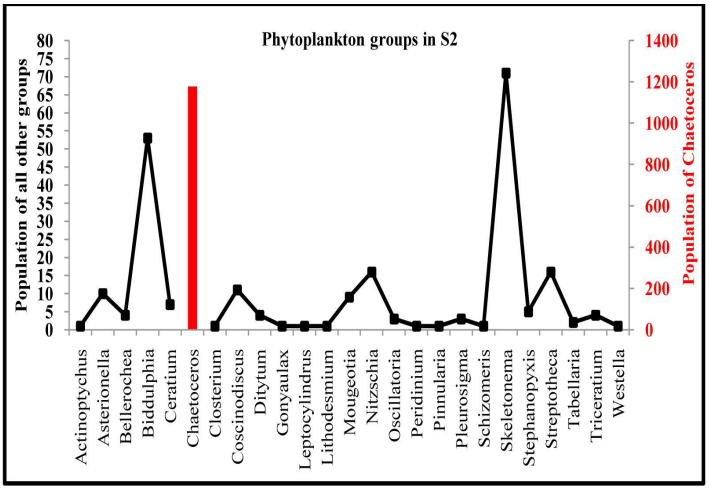

Fig. 3. Phytoplankton counts at S_2

At Kandachira Kayal (S_3), 10 species of phytoplankton having total number of 12 Cells /L were present (Fig. 1). *Gonyaulax and Oscillatoria* were having 2 Cells/L each while other species having only 1Cell/L were; *Coscinodiscus*, Blue green algae, *Gonyaulax*, *Lyngbya*, *Mougeotia*, *Nitzschia, Peridinium, Pleurosigma and Stephanopyxis* (Fig. 4).

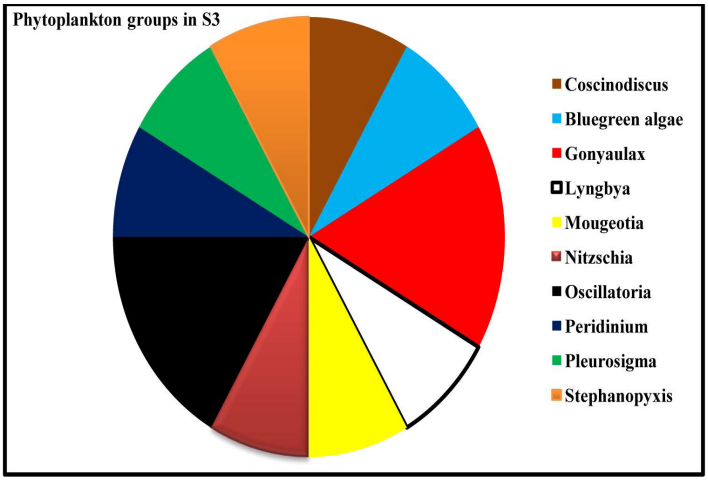

Fig. 4. Phytoplankton at S3

18 species of phytoplankton having total number of 387 Cells/L were recorded at Thekkumbhagom (S_4) (Fig. 1). *Chaetoceros* (335 Cells/L) was the most dominant species similar to that in Sambranikodi (S_2) while others (1-14 cells/L) had very thin populations (Fig.5).

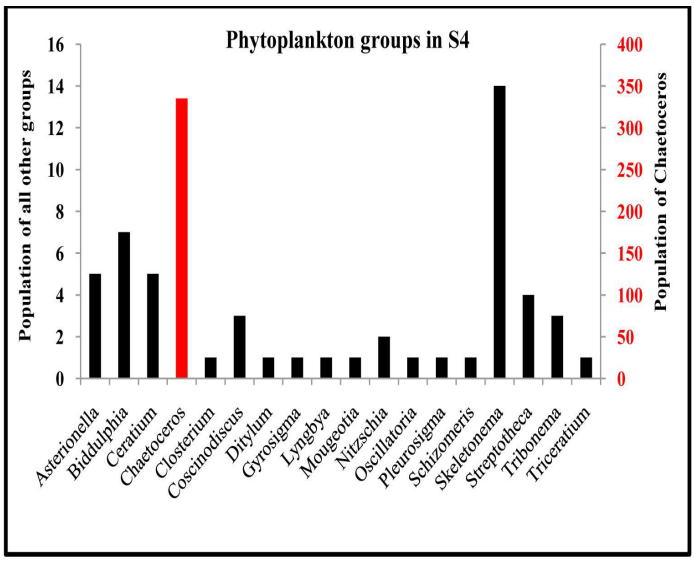

Fig. 5. Phytoplankton counts at S_4

Phytoplankton counts at Pattamthuruthu (S_5) were 3417 Cells /L (Fig 1). In this station, 16 species of phytoplankton were recorded (Fig 6). *Chaetoceros* (3003 Cells/L) was the most dominant species similar to that in Sambranikodi (S_2) and Thekkumbhagom (S_4) followed by *Oscillatoria* (243 Cells /L), *Gonyaulax* (23 Cells /L), *Penium* (15 Cells /L) and *Tabellaria* (15 Cells /L). The remaining 11species had very thin population (1- 4 Cells/L).

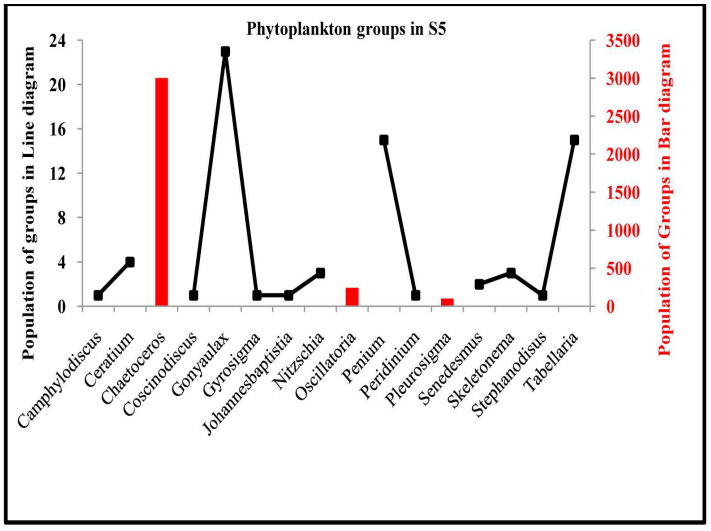

Fig. 6. Phytoplankton counts at S_5

41 species having total number 350 Cells /L were recorded at Palliyamthuruttu-Vellimon side (S_6) (Fig. 1, 7). *Tabellaria* (29 Cells/L), *Fragilaria* (23 Cells/L) and *Closterium* (18 Cells/L) were the dominant species in the community while the remaining 38species had very thin populations (1-8Cells/ L).

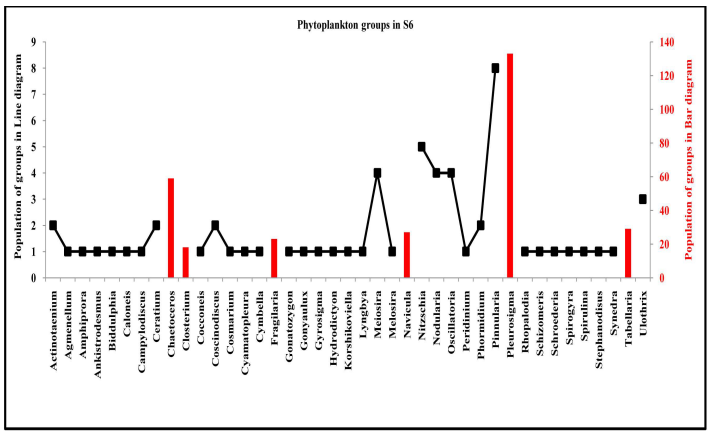

Fig. 7. Phytoplankton counts at S_6

Phytoplankton population has become an essential parameter to assess the state of pollution in aquatic ecosystems, as the biological diversity in stressed environment becomes poor (Prasad and Saxena 1980). Station S_1 had lowest number of species (2 species) because of maximum oil pollution from tourist boats and with faecal contamination while Station S6 had the maximum number (41 species) due to the less polluted nature.

Among six stations, S_3 recorded the lowest number of phytoplankton population (12 Cells /L) possibly due to the highly polluted nature of the Lake in this region. A substantial increase in population size at S_2 and S_5 was because of the comparatively non-polluted nature of the Lake at these sites. Similar observations have been reported from the Ashtamudi Lake by Nair et al. (1984a) and Sobha and Miranda (1987).

Physico-chemical characteristics of water at various sites are given in Table 3.

Table 3. Physico- chemical characteristics of Ashtamudi Lake

Parameters	Stations					
	S1	S2	S3	S4	S5	S6
Temperature (°C)	27.40	31.00	31.50	31.60	31.80	31.00
pH	6.70	8.20	7.20	8.10	8.10	8.20
Turbidity (NTU)	1.82	1.72	1.63	1.54	5.82	1.16
DO (mg/L)	4.45	8.86	3.16	6.29	7.51	8.12
BOD (mg/L)	7.05	1.62	7.38	5.65	3.24	2.43
Nitrate (mg/L)	0.46	0.06	0.19	0.14	0.08	0.13
Sulphate (mg/L)	46.94	68.87	54.04	62.14	60.17	66.39
Phosphate (mg/L)	0.09	0.01	0.01	0.02	0.01	0.01

Phytoplankton abundance is related with physico-chemical features (Quasim et al. 1972). Except in station 1, all other stations had higher temperature (> 31ºC). Generally the stations very close to the industrial area showed high temperature. The low surface water temperature at station S1 coincided with the maximum number of phytoplankton population. Gopinathan et al. (1984) have opined that although temperature by itself had no direct effect on production, it was possible that an increase in temperature would enhance the rate of respiration of planktonic algae and the energy stored during photosynthesis would be used by reducing their multiplication activity.

pH values ranged from 6.7 (S_1) to 8.2 (S2&S6) being maximum at station 2. However, slightly acidic pH was recorded at Near Ashramam (Kollam city). Stations with high pH showed more number of species abundancity, especially in station S_6. Ragothaman and Reddy (1982) have observed that less pH coincided with less phytoplankton productivity. The turbidity in the water samples ranged from 1.16 NTU (S_6) to 5.82 NTU (S5). It was found maximum at S_5 and minimum at S_6 during the study period. The major ecological effect of the higher turbidity is a marked reduction in the penetration of light that severely affects the primary productivity of aquatic ecosystem. The lowest turbidity at S6 coincided with maximum species diversity of phytoplankton. Nair et al. (1984) also made similar findings in the Ashtamudi Lake. Under conditions of severe turbidity, phytoplankton production may be negligible (Santhosh et al. 2007).

DO ranged from 3.16mg/L at S3 to 8.86 mg/L at S_2. A considerable rise in DO level was observed in S_2, S_5 & S_6 except S_1 where it declined. BOD ranged from 1.62 mg/L at S_2 to 7.38 mg/L at S_3. A considerable decrease in BOD was observed in S_2, S_3 & S_6 except S_1 having higher BOD. The maximum BOD at station S_3 coincided with minimum species abundancity, whereas higher values of dissolved oxygen at S_2 and S_6 coincided with maximum species abundancity. In Ashtamudi estuary Nair et al. (1984) and Nair and Abdul Aziz (1987) reported that phytoplankton productivity varied along with the fluctuations in the dissolved oxygen concentration.

In the present study nitrate ranged from 0.06 mg/L at S2 to 0.4 mg/L at S_1. The phosphate ranged from 0.01mg/L at S_2, S_3, S_5 and S_6 to 0.09 mg/L at S_1. Ketchum et al. (1958) suggested that phytoplankton production must be dependent only on the supplies of nitrate and phosphate in the natural water. In this study high concentration of nutrients were observed at S1 leading to maximum phytoplankton abundance. Availability of high amount of nutrients could be cause for high production of phytoplankton (Rao and Valsaraj 1984). Phosphate showed a marginal influence on phytoplankton abundancity. Mathew and Nair (1980) also made similar observations in the same estuary. The sulphate ranged from 46.94 mg/L at S_1 to 68.87 mg/L at S_2. The low sulphate content at S_1 clearly indicates hypo saline condition existing there and the phytoplankton abundance was highest at this sampling location. Thus in general, physico-chemical characteristics seemed to have a significant effect on phytoplankton.

The present study highlights the relationship between phytoplankton diversity and their counts with water quality of Ashtamudi Lake. Blue green algal member such as *Oscillatoria and Chatoceros* dominated phytoplankton community. Backwaters offer ideal habitat to flora, fauna and perform several other ecological roles. Ashtamudi Lake, the Ramsar site, is subjected to severe pollution by domestic sewage, agricultural activity and industrial wastes. Present study concludes that the quality of Ashtamudi backwater is rapidly declining. If the quantum of pollution of the lake persists like this or increases, the quality of water, fishes and other biota of the lake will get deteriorated at a greater magnitude, becoming a serious threat to mankind. Therefore a programme must be initiated for maintaining biodiversity of the region.

ACKNOWLEDGMENTS

The authors thank the Research Department of Zoology, NSS College, Pandalam (University of Kerala) for facilities and encouragements. The facilities provided by the research departments of Botany and Chemistry, NSS College, Pandalam (University of Kerala) are greatly acknowledged.

REFERENCES

APHA. 1998. Standard Methods for the Examination of Water and Wastewater. United Book Press, Inc. Baltimore, Maryland, USA.

Chiu, H.M.C., I.J. Hodkiss and B.S.S. Chan. 1994. Ecological studies of phytoplankton in Tai Tam Bai, Hong Kong. Hydrobiologia 81-94.

Gopinathan, C.P., P.V.R. Nair and A.K.K. Nair. 1984. Quantitative ecology of phytoplankton in the Cochin backwater. Indian Journal of Fisheries 31(3): 325-336.

Gopinathan, C.P. 1987. A systematic account of the littoral diatoms of the South West Coast of India. Journal of Marine Biological Association of India 26(1&2): 1-31.

Grasshoff, K. 1983. Determination of nitrite. In: K. Grasshoff, M. Ehrhardt and K. Kremling (Eds.), Methods of Sea Water Analysis, Verlag Chemic Gymb Weinheim, pp. 419

Ketchum, B.H., J.H. Ryther, C.S. Yentsch and N. Corwin. 1958. Productivity in relation to nutrients. Rappt. Intern. Exploration Mer 144: 132-140.

Mathew, T and N.B. Nair. 1980. Phytoplankton of the Ashtamudi Estuary, Kerala. Indian Journal of Marine Sciences 9(4): 253-257.

McLusky, D.S and M. Elliott. 2004. The Estuarine Ecosystem: Ecology, Threats and Management. New York: Oxford University Press. ISBN 0198525087.

Nair, N.B., P.K. Abdul Azis, K. Dharmaraj, M. Arunachalam, K. Krishnakumar and N.K. Balasubramanian. 1984. Ecology of Indian Estuaries V: Primary productivity of the Ashtamudi Estuary South-West Coast of India. Proceedings of Indian Academy of Sciences (Anim. Sci) 93: 9-23.

Nair, N.B and P.K. Abdul Azis. 1987. Hydrobiology of the Ashtamudi estuary - a tropical backwater system in Kerala. Proceedings of National Seminar on Estuarine Management 268-280.

Prasad, B.N and M. Saxena. 1980. Ecological study of blue-green algae in river Gomati. Indian Journal of Environmental Health 22: 151-168.

Prescott, G.W. 1962. Algae of the Western Great Lakes Area. 2nd ed. Brown. Co. Dubuque, low, 1-997.

Qasim, S.Z., P.M.A. Bhattathiri and V.P. Devassy. 1972. The influence of salinity on the rate of photosynthesis and abundance of some tropical phytoplankton. Marine Biology 12(3): 200-206.

Ragothaman, G and Y.R. Reddy. 1982. Hydrobiology of Tapi estuary, Surat. Indian Journal of Marine Sciences 11(3): 256-258, 1982.

Rao, V.N.R and C.P. Valsaraj. 1984. Hydrobiological studies in the inshore waters of the Bay of Bengal. Journal of Marine Biological Association of India 26 (1-2): 58-65.

Santhosh, S., V. Sobha and J. Chanra Thara. 2007. Impact assessment of sea-sand filling in the paravur-kappil backwaters with special reference to phytoplankton productivity, Kollam District, Southern Kerala. Bulletin of Polar Science 1: 1-10.

Santra, S.C., V.C. Pal, T.M. Das, S. Sen, R. Saha, S. Datta and P.G. Dastidar. 1989. Phytoplankton of Bhagirathi-Hooghly estuary. An illustrative account. Indian Biologist 2(1): 1-27.

Sarma, Y.S.R.K and M. Khan. 1980. Algal taxonomy in India. Today and Tomorrow Book Agency. New Delhi. 1-153

Sobha, V and I. Miranda. 1987. Nature of plankton production in Kadinamkulam Lake and Ashtamudi estuary of Kerala. Proceedings of National Seminar on Estuarine Management, Trivandrum, pp. 307-317.

Trivedi, R.K. and P.K. Goel. 1986. Chemical and Biological Methods for Water Pollution Studies. Environmental Publications, Karad (India), pp. 248.