Water Quality and Phytoplankton as an Indicator of Pollution in a Mambazhathurayar Reservoir, Kanyakumari District, Tamil nadu, S. India.

X. Mary Jacintha[1], D. Deleep Packia Raj[2] and R. Raja Jeya Sekar[3]

1. Reg. No: 12367, Research Scholar(part time-external), Department of Zoology, Scott Christian College, Manonmaniam Sundaranar University, Nagercoil, Tamilnadu, India. Email.id: justinjesy@gmail.com.
2. Research Guide, Department of Zoology, Scott Christian College, Manonmaniam Sundaranar University, Nagercoil, Tamilnadu, India.
3. Research Co-Guide, Department of Zoology, St Hindu College, Manonmaniam Sundaranar University, Nagercoil, Tamilnadu, India.

ABSTRACT

Water plays major role in biodiversity conservation hence the need for its protection. The integrity of an aquatic ecosystem can be accessed through the physico-chemistry and phytoplankton structure. Samples were collected monthly from the study site for 12 months from July 2016 to July, 2017. Nutrient concentration (phosphate) was comparatively higher in the dry season than south west and North West monsoon. Four phytoplankton divisions including Bacillariophyceae (29species), Chlorophyceae (19 species), Chrysophyceae (12 species), and Myxophyceae (09 species) were identified. The most dominant among the pollution indicators were *Pleurosigma directum*, *Synedra nana* and *Euglena granulate*. Phytoplankton count also registered higher value during non-rainy months. The distribution of the plankton shows that they are sensitive to changes in levels of nutrients and other interactions with one another and with other factors. As such the plankton can be good indicators of water quality. The seasonal and spatial distribution of the plankton in this study shows that, they are sensitive to changes in levels of nutrients and other interactions with one another and with other factors. As such the plankton can be good indicators of water quality.

Keywords: plankton, nutrients, indicators, ecosystem and structure.

Introduction:

Human society relies on freshwater for domestic, industrial, agricultural and other goods and services. These needs have subjected the ecosystems which include rivers, streams, lakes and ponds to increasing contamination by a variety of mineral, agrochemicals and organic pollutants due to higher frequency of allochthonous input from anthropogenic activities. The rapid pollution of water resources and risk of extinction is placed at the top of these environmental issues. Increasing population, unplanned industrialization and urbanization are also accelerating this process day by day. Therefore, protecting our water resources and improving trophic conditions have been given greater importance recently. Soylu and Gonulol, 2010; Bellinger, and Sigee, 2015; Dochin *et al*., 2017; Caroppo *et al*., 2018)

The study will provide vital information that can help to identify the negative impacts of human activities on such ecosystem. The information can serve as tool for advocacy of policies to protect the ecological system for sustainable utilization. The objective of this study was to determine the pollution index of Mambazhathurayar reservoir by assessing the water quality and phytoplankton structure of the ecosystem. This is because human activities such as rice cultivation which employ the use of herbicides, growing of vegetables with organic manure (animal droppings) and car washing all take place with the river. The study will provide vital information that can help to identify the negative impacts of human activities on such ecosystem. The information can serve as tool for advocacy of policies to protect the ecological system for sustainable utilization.

Methodology:

Study area:

Mambazhathurayar reservoir is a small irrigation dam located near villukkuri in Kanyakumari district of Tamil nadu. The sampled location lies between 12^0 33’ and 11^0 40’ north latitude and 70^0 45’ and 75^0 35’ east longitude.

Physicochemical Variables

Samples were collected monthly from the study site for 12 months from July 2016 to July, 2017. The pH, Alkalinity, total dissolved solid (TDS), dissolved oxygen were estimated. Samples for nitrate, iron, silicate and orthophosphate were collected and analyzed in the laboratory using spectrophotometric machine (Model: 721D) according to the standard methods of Association of Official and Analytical Chemistry (AOAC), 2003). All the parameters were measured in triplicate.

Plankton Enumeration

On coming to the laboratory, the phytoplankton samples were condensed by centrifuging 100ml of the sample to10mI. The concentrated sample was taken for enumeration with Sedgwick-Rafter counting chamber. Identification was done to species level, using keys in Palmer (1980) for phytoplankton.

Results and Discussions:

Physicochemical variables

The physico-chemical complexes of different sampling stations are appended in Table 1. Temporal variation in air and water temperature observed could be attributed to seasonal changes in weather condition since the variable was directly linked to season. Temperature was an important ecological factor as it directly affected the behaviour and productivity of organisms and dissolution of gases in water (Dixit and Tawari, 2007). Although there was high variability in water temperature of lotic systems due to the flow condition, especially in the rainy season when flow velocity was high, productivity in the dry season could be enhanced by increased water temperature and higher residence time. Higher TDS was observed in the dry season and could be due to higher concentrations of dissolved ions in the water bodies at that period. This could be linked to higher water temperature recorded in the dry season which Dixit and Tawari, (2007) suggested that it enhances the solubility of salt.

Nutrient concentration (phosphate) was comparatively higher in the dry season than south west and North West monsoon. This could be due to the washing off and accumulation of inorganic phosphate from fertilizer and the product of the microbial degradation of glyphosphate herbicide used on the riparian farmland into the river bed. Higher level of microbial activities enhanced by higher environmental temperature may lead to the release of phosphate locked up in sediment thereby increasing the concentration in the dry season. Benslama and Boulahrouf, (2013) reported that increase in environmental temperature as observed in the dry season in this study enhances microbial activities which release nutrients that are locked up underneath the earth.

Phytoplankton Species Composition

Four phytoplankton divisions including Bacillariophyceae (29species), Chlorophyceae (19 species), Chrysophyceae (12 species), and Myxophyceae (09 species) were identified from the study site (Table 2). Phytoplankton species identified among the divisions that were indicators of pollution include *Biddulphia laevis, Fragilaria species, Navicula species, Pleurosigma directum*, *Synedra nana, Surirella splendida*, *Spirogyra africana, Microcystis aeruginosa, Oscillatoria species, Anabaena species* and *Euglena granulata*, *Ankistrodesmus fractus*, *Coscinodiscus species*, *Nitzschia closterium* and *Hemidiscus cuneiformis* (Table 2). The most dominant among the pollution indicators were *Pleurosigma directum*, *Synedra nana* and *Euglena granulate*. Phytoplankton count also registered higher value during non-rainy months.

The presence of *Ankistrodesmus fractus, Aulacoseira granulata, Biddulphia laevis, Coscinodiscus specie, Fragilaria species, Navicula species, Pleurosigma directum, Synedra nana, Surirella splendida, Spirogyra africana, Microcystis aereginosa, Oscillatoria species* and *Anabaena species* in the river during the study indicated that it is under pollution pressure. The proliferation of these species could be due to high nutrient concentrations of the river especially in the dry season when it was enhanced by low flow condition, higher rate of evaporation and low water level. Okogwu and Ugwumba, (2013) recorded peak phytoplankton abundance in the dry season and attributed it to increased temperature, solar radiation and water residence time while Ewa *et al*. (2013) linked it to increased solar radiation. The presence of *Ankistrodesmus fractus, Aulacoseira granulata, Biddulphia laevis, Coscinodiscus specie, Fragilaria species, Navicula species, Pleurosigma directum, Synedra nana, Surirella splendida, Spirogyra africana, Microcystis aereginosa, Oscillatoria species* and *Anabaena species* in the river during the study indicated that it is under pollution pressure. The proliferation of these species could be due to high nutrient concentrations of the river especially in the dry season when it was enhanced by low flow condition, higher rate of evaporation and low water level. Edward and Ugwumba, (2013) and Onyema, (2013) observed some of the species as indicators of pollution in their study at Egbe reservoir and Iyagbe lagoon. This study revealed that the water quality parameters, such

as temperature, pH and phosphate play a decisive role in altering the phytoplankton distribution. Human anthropogenic activities are the main causative agents in the increase of nutrients (phosphate, chloride and calcium) level in the river that supports the growth of *Microcystis* sps whose presence in water will render it unfit for drinking. Pannard *et al.*, (2007) reported that depending on the season the phytoplankton responses differed with respect to nutrient and light conditions, and to the intensity of stratification and mixing. The high abundance of phytoplankton in pre monsoon coincided with entry points of nutrients into the reservoir. Walker *et al.,* (2001) reported the input of nutrients, is the most significant factor affecting phytoplankton biomass and distribution in the Nyara estuary. They showed that when not receiving pulses of nutrients through freshwater inflow the estuary is a predominantly low nutrient, low phytoplankton biomass, stratified system, dominated by microbial food web. However, this state is altered rapidly by flood events. Barlow *et al.,* (2006) are of the opinion that because of upwelling, phytoplankton biomass and composition, in Namibian waters are highly variable.

Conclusion:

The study emphasizes the necessity of using phytoplankton as effective and appropriate method of biomonitoring for evaluation of river water quality. The phytoplankton are responsible for a percentage of all primary production in any given water body. The zooplankton, fish and other organisms in turn graze upon the phytoplankton. Therefore, the availability of phytoplankton directly affects the abundance and distribution of zooplankton. The seasonal and spatial distribution of the plankton in this study shows that they are sensitive to changes in levels of nutrients and other interactions with one another and with other factors. As such the plankton can be good indicators of water quality.

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Table -1 Shows Seasonal Variation and average (Mean ± SD) in water parameters during the study period-2017

Season	**Pre Monsoon**					**South-West Monsoon**					**North-West Monsoon**				
Stations	**S1**	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**
Atmos temp	29.60 ± 1.14	26.3 ± 2.81	29.2 ± 0.57	26.2 ± 2.01	29.00 ± 0.79	26.75 ± 0.95	26.75 ±01.29	26.75 ±1.5	25.62 ± 1.49	27.37 ± 1.03	27.66 ± 1.75	27.66 ± 1.32	27.50 ± 1.80	26.50 ± 1.80	27.33 ± 1.52
Water temp	26.80 ±0.57	23.7 ±0.97	25.4 ±0.54	23.5 ±0.5	24.9 ±0.74	22.6 ±0.75	22.62±1.25	22.5 ±1.29	21.5 ±1.29	23.00 ± 1.15	24.00 ±1.80	22.5 ±1.32	23.33 ±1.52	22.33 ±1.52	23.5 ±1.5
pH	6.82 ±0.20	6.66 ±0.19	6.78 ±0.23	6.66 ±0.23	6.83 ±0.23	6.98 ±0.14	6.91 ±0.16	6.96 ±0.12	6.96 ±0.14	6.98 ±0.13	6.69 ±0.24	6.69 ±0.24	6.73 ±0.25	6.66 ±0.24	6.71 ±0.24
Alkalinity	25.8 ±3.3	25.12	25.28	24.78	25.94	25.75 ±1.4	24.42	25.02	24.12 ±0.6	25.92	28.46	26.96 ±1.4	27.83	26.63 ±1.40	29.06 ±2.07

	2	±3.29	±3.30	±3.42	±3.65	4	±0.57	±1.35	6	±0.99	±1.96	0	±1.87		9
Oxygen	4.44 ±1.35	3.85 ±1.24	4.63 ±1.01	3.83 ±0.68	5.05 ±1.15	6.00 ±0.17	5.40 ±0.44	5.44 ±0.77	4.36 ±1.01	6.02 ±0.33	5.67 ±0.76	3.59 ±0.22	5.76 ±0.60	3.78 ±0.93	5.53 ±0.63
TDS	37.64 ±4.31	31.62 ±3.61	30.16 ±3.82	26.04 ±3.18	18.48 ±3.96	21.75 ±5.23	17.17 ±4.20	16.1 ±3.95	15.12 ±4.33	9.82 ±2.78	27.46 ±2.67	22.1 ±2.32	21.3 ±2.38	20.6 ±2.36	14.66 ±2.24
TSS	44.28 ± 10.27	25.68 ±2.08	23.24 ±1.60	22.2 ±1.73	18.54 ±1.14	37.9 ±4.64	34.95 ±2.40	30.3 ±1.53	26.85 ±1.53	19.55 ±2.10	27.66 ±0.50	24.46 ±4.10	21.43 ±2.25	22.73 ±6.50	18.13 ±4.71
Nitrite	0.18 ±0.18	0.09 ±0.06	0.17 ±0.19	0.09 ±0.06	0.18 ±0.24	0.14 ±0.02	0.20 ±0.01	0.16 ±0.05	0.23 ±0.05	0.15 ±0.02	0.10 ±0.02	0.11 ±0.04	0.10 ±0.01	0.12 ±0.03	0.11 ±0.02
Nitrate	1.61 ±0.05	1.55 ±0.13	1.55 ±0.13	4.24 ±6.04	1.61 ±0.05	1.75 ±0.10	1.77 ±0.10	1.76 ±0.03	1.81 ±0.09	1.90 ±0.22	1.61 ±0.02	1.50 ± 0.16	1.64 ±0.03	1.62 ±0.02	1.64 ±0.01
Calcium	58.73 ±0.74	50.94 ±0.57	51.4 ±0.52	50.55 ±0.92	56.74 ±0.93	52.25 ±1.27	45.75 ±0.82	45.44 ±0.69	43.84 ±1.16	54.71 ±0.86	38.48 ±1.80	34.54 ±1.15	35.54 ±0.54	34.62 ±0.89	37.96 ±0.49
Magnesium	12.2 ±0.29	13.02 ±0.27	12.25 ±0.30	12.53 ±0.36	11.55 ±0.27	7.08 ±0.66	7.84 ±0.56	7.19 ±0.30	7.67 ±0.64	7.61 ±0.67	5.37 ± 0.67	5.37 ±0.70	5.12 ±0.40	5.31 ±0.50	5.89 ±0.47
Nitrogen	11.99 ± 4.65	9.59 ±	9.59 ± 6.06	6.93 ± 6.54	10.40 ± 6.71	7.77 ± 0.56	6.75 ± 0.56	5.73 ± 0.55	4.72 ± 0.56	7.76 ± 0.55	8.87 ± 1.03	8.15 ± 1.45	7.08 ± 1.36	6.33 ± 1.45	8.82 ± 1.00

		6.34													
Phosphate	0.03 ±0.01	0.07 ±0.01	0.04 ±0.01	0.07 ±0.02	0.04 ±0.02	0.12 ±0.04	0.09 ±0.04	0.11 ±0.07	0.29 ±0.40	0.11 ±0.04	0.09 ±0.01	0.09 ±0.05	0.09 ±0.04	0.1 ±0.08	0.08 ±0.02
Silicon	2.88 ±1.17	3.57 ±1.13	2.94 ±1.20	3.41 ±1.17	3.16 ±1.26	9.25 ±3.01	7.27 ±2.32	8.51 ±3.35	6.62 ±1.78	10.33 ±3.90	5.36 ±0.42	4.86 ±1.40	5.51 ±1.12	4.96 ±1.08	5.32 ±0.46

Table 2. Shows Seasonal Variation and average (Mean ± SD) in plankton

Season		**Pre Monsoon**					**South-West Monsoon**					**North-West Monsoon**				
	Stations	**S1**	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**	**S1**	**S2**	**S3**	**S4**	**S5**
Phyto Plankton	**Myxophyceae**	10.47 ± 5.02	10.12 ± 6.00	11.18 ± 6.17	10.54 ± 4.28	10.72 ± 6.34	4.02 ± 3.96	3.77 ± 5.87	3.88 ± 4.80	3.87 ± 4.27	3.83 ± 5.10	4.02 ± 3.96	3.77 ± 5.87	3.88 ± 4.80	3.87 ± 4.27	3.83 ± 5.10
	Chlorophyceae	12.04 ± 5.46	12.67 ± 6.25	12.34 ± 4.92	12.86 ± 6.93	12.44 ± 5.37	2.21 ± 2.76	2.78 ± 2.84	2.24 ± 2.67	2.10 ± 2.43	2.22 ± 2.60	10.31 ±1.85	8.49 ± 2.49	9.79 ± 1.43	9.08 ±1.70	9.64 ± 1.98
	rysopceae	7.06 ± 2.93	7.17 ± 2.98	7.5 ± 3.57	6.9 ± 2.89	6.86 ± 3.16	4.05 ± 2.60	3.84 ±1.71	4.34 ± 2.21	3.78 ± 2.40	4.26 ± 2.68	16.15 ±2.91	16.25 ± 4.20	15.05 ± 4.93	16.73 ± 4.32	16.2 ± 4.48
	Bacillariophyceae	12.46 ± 5.03	13.07 ± 4.94	12.47 ± 5.37	12.59 ± 4.73	12.51 ± 4.83	3.59 ± 4.25	2.56 ±4.35	2.78 ± 4.33	2.8 ± 4.42	2.7 ± 4.45	9.15 ±1.62	8.12 ± 0.76	8.85 ± 1.55	8.61 ± 1.67	8.87 ± 1.10
	Total	**12.23 ± 4.16**	**12.24 ± 3.85**	**12.02 ± 4.33**	**12.44 ± 4.80**	**11.91 ± 5.70**	**3.27 ± 2.63**	**2.88 ±3.65**	**3.25 ± 3.32**	**2.45 ± 2.93**	**3.05 ± 1.96**	**8.57 ± 1.16**	**9.08 ± 1.24**	**8.95 ± 1.78**	**9.31 ± 1.21**	**9.41 ± 2.77**