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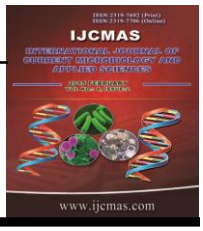

Original Research Article

Multiplicity of phytoplankton diversity in Tungabhadra River near Harihar, Karnataka (India)

B. Suresh*

Civil Engineering/Environmental Science and Technology Study Centre, Bapuji Institute of Engineering and Technology, Davangere-577 004, Karnataka, India
**Corresponding author*

Keywords

Phytoplankton, multiplicity, Tungabhadra river.

A B S T R A C T

Water is one of the most important precious natural resources required essentially for the survival and health of living organisms. Tungabhadra River is an important tributary of Krishna. It has a drainage area of 71,417 sq km out of which 57,671 sq. km area lies in the state of Karnataka. The study was conducted to measure its various physico-chemical and bacteriological parameters including levels of algal community. Pollution in water bodies may indicate the environment of algal nutrients in water. They may also function as indicators of pollution. The present investigation is an attempt to know the pollution load through algal indicators in Tungabhadra river of Karnataka near Harihar town. The study has been conducted from May 2008 to April 2009. The tolerant genera and species of four groups of algae namely, Chlorophyceae, Bacilleriophyceae, Cyanaophyceae and Euglenophyceae indicate that total algal population is 17,715 in station No. S3, which has the influence of industrial pollution by Harihar Polyfibre and Grasim industry situated on the bank of the river which are discharging its treated effluent to this river. The population of algal species is 75,849, in station No. S1, 68,056 station No S2 and 38,915 station No S4. The correlation and inter correlation among the physico-chemical parameters along with phytoplankton groups have been made the results obtained are tabulated and discussed.

Introduction

Water is one of the most important precious natural resources required essentially for the survival and health of living organisms. In India 80 % of the surface water is exposed to pollution. Pollution taking place in surface water may bring about on enrichment of algal nutrients in water. Surface water due to man's increased activities. The discharge of domestic wastes, solid waste, industrial waste discharge, agricultural runoff from surroundings areas which enter into the river bodies through different drains and channels of rivers may cause the river pollution.

Tungabhadra River in Karnataka is an important tributary of Krishna. It has a drainage area of 71,417 sq.km out of which

57,671 sq.km lies in the state. It covers a distance of 293 km in the state and is getting polluted due to rapid industrial growth, domestic and agricultural activities in the region. Pollution is as old as man himself, in prehistoric time the population was very thin, the man used to move from place to place in search of food and better living. The district Davangere is located in the central part of Karnataka state (India) between latitude $14^{O}17'$ to $14^{O}35'$ N and longitude $75^{O}50'$ to $76^{O}05'$ E covering an area of 6500 sq. km at an average altitude of 540 m above Mean Sea Level (MSL).

The river Tungabhadra is bifurcating the adjoining district namely Haveri. Four strategic locations are selected for the limnological studies of algae from various aquatic habitats of lotic environment of the river has been made as studied extensively in India. Research studies on the Limnological aspects are of great significance in developing resources of a water body. The seasonal variations of physical – chemical factors have a profound effect on the distribution and population density of both fauna and flora (Hassa 1998). The abundance of phytoplankton and zooplankton in the fresh water bodies is greatly regulated by the physico-chemical factors (Muhauser et al 1995). In the present study phytoplankton diversity in Tungabhadra River are reported.

Materials and Methods

The water and algal samples were collected at regular intervals of 15 days at 4 stations for one year. During the present Investigation four different stations were chosen on the basis of algal occurrence and human activities.

Station (S_1): The site of this habitat is located at the upstream city before the river enters into city.

Station (S_2): This station is located on the main stream of river Tungabhadra in a place just near the confluence point of sulekere stream (Tributary)

Station (S_3): This station is located at the down stream of Harihar Polyfibers effluent discharge (near Harlapura).

Station (S_4): This sampling station is located about 2 km away from confluence point (S_2).

Sampling: Physico-chemical analysis of water is done as per standard methods recommended by APHA (1995) and Trivedy and Goel (1986). Algae were preserved in 4% formaldehyde for identification using key provided by Smith (1950), Prescott (1978) for *Chlorophyceae* and *Euglenophyceae;* Desikachary (1959) for *Cyanophyceae* and Hendey (1964) for *Bacilleriophyceae.*

Statistical Analysis: Correlation and inter correlation matrices were compared separately for the physico-chemical parameters and phytoplanktons.

Result and Discussion

Dissolved Chemical parameters

The average values of physico-chemical parameters of 4 stations of river are shown in Table-1. The range and average population of 4 groups of algae at 4 stations of river are shown in Table-2. The algal composition of 4 groups of algae of the river is as shown in Table- 3. Correlation coefficients (r value) have been studied to find out the inter-correlation among various physico-chemical parameters and Algal groups which are given in Table - 5.

Variations of water temperature were well marked with respect to different seasons. The study of temperature plays important role in controlling the abundance of phytoplankton (Singh, 1960). The maximum pH value of 7.57 was recorded in June at Station S3 and Maximum of 8.10 in October at the Station S1. The pH of river water was observed to be in the range of 7.57 to 8.1 indicating alkaline throughout the period of study. Generally pH of water promotes the growth of algae (Geroge, 1961). In present study higher values of pH are recording winter and lower during the monsoon season similar observation have been reported by (Bandopandhyay & Gopal, 1990).

The solids remaining in water after filtration are called Total Dissolved Solids. Dissolved solids may be organic or inorganic in nature. Precisely, the dissolved solids are composed mainly of carbonates, bicarbonates, chloride, sulphate, calcium, magnesium, phosphate, nitrate, sodium, potassium and iron (Trivedy & Goel, 1986). Study indicates that the total dissolved solids contents vary from 129.27 to 357.45 mg/l. The maximum concentrations of total dissolved solids were recorded at station S3 in monsoon and minimum was estimated in station S1 in winter. The maximum values of total dissolved solids during monsoon might due to the gradual increase in the entry of domestic sewage, detergents and industrial waste to the river stream as reported earlier by (Gonzalves and Joshi, 1946).

Langenegger (1990) and Edet (1993) have described the importance of Electrical Conductivity. Values of electrical Conductivity obtained during the study are from 235.04 to 595.76 µmohs/cm (Table–1). There occurred seasonal and spatial variations with minimum value in station S1 during monsoon and maximum value in station S4 during pre-monsoon season. Dissolved Oxygen content is important for direct need of many organisms and affects the solubility and availability of many nutrients, therefore the productivity of aquatic ecosystem Wetzel (1983) is based on oxygen concentration. During the present study lowest average value of dissolved oxygen 6.80 mg/l was obtained in station S3 and recorded highest value of dissolved oxygen to 8.10 mg/l in the station S1. Higher dissolved oxygen indicates the abundance growth of phytoplankton De et al (1991) and related zooplankton leading to higher biological activity which was observed in river water. A low content of dissolved oxygen is a sign of organic pollution, tolerance limit of dissolved oxygen is not less than 6 mg/l (Kudesia, 1985). The factors affecting the oxygen balance in water bodies are input due to atmosphere and photosynthesis and out put from respiration, decomposition and mineralization of organic matter losses the oxygen to atmosphere. Hence, the oxygen balance in water becomes poorer as the input oxygen at the surface and photosynthetic activities of heterotrophs are enhanced.

Biochemical oxygen Demand (BOD) is the most important parameter to measure the pollution load in an aquatic system. In the present study higher value of BOD and COD is reported as 5.28 mg/l and 186.42 mg/l at station S1 and station S3 respectively. Due to oxidation of the organic waste by natural microorganisms causes high BOD the same trend has been noticed for COD (Basu, 1966). In general the values of the COD and BOD are not related since these 2 tests measures 2 different characteristics but on the other hand if the effluents do not change drastically the COD/BOD ratio for polluted water from mill remain fairly constant (Kshirsagar, 1968).

The amount of calcium and magnesium are found relatively higher in all samples. The hardness values are also found in range 80.58 to 97.00 mg/l. this is probably due to addition of domestic sewage, detergents and industrial wastes along the bank of river. Nitrate in water bodies is responsible for the growth of blue green algae Abdul Jameel (1998) higher concentration of nitrate is an indication of organic pollution and eutrophication. In the present study relatively low values of nitrate was observed. Nitrate concentration varied between 2.71 to 8.46 mg/l. The minimum value obtained is at station S4 in monsoon, maximum value is obtained at station S3 during pre-monsoon (Table -1).

Sulphate is an important mineral substance for phytoplankton growth (Boney, 1989). Sulphate enter into the water body from the catchment area through surface run off. Since the study area is bordered by agricultural lands where sulphate fertilizers are used in plenty, relatively higher concentrations of sulphate observed could be attributed to the run off from these agricultural lands.

Biological parameters

In the present study forty three species of phytoplankton have been recorded of which fifteen belongs to Chlorophyceae, twelve to Cyanophyceae, ten to Bacillariophyceae and six to Euglenophyceae (Table – 4). The annual periodicity shows Chlorophyceae dominance which constitute 39.60% of the total phytoplankton population, followed by Cyanophyceae of 28.70%, Bacilleriophyceae of 22.1% and Euglenophyceae of 9.65%.

George (1961) observed that high pH value promotes the growth of algae. Similar results were observed in the present study. It was also observed that the pH favored the growth of chlorococales as observed by Gonzalves and Joshi, (1946) and Zafar (1964). The concentration of Dissolved Oxygen decreased along the stretch of river from station one to four. This is due to addition of domestic, agricultural and industrial waste. Dissolved Oxygen content was higher in rainy and winter season in the present investigation. The results obtained are in agreement with the findings of Singh (1960) and Singh (1965).

Review of literature revels that there are two types of growth periods for phytoplankton. many workers have proved that the maximum development of phytoplankton is during summer and minimum in winter (Philipose, (1960), Kumar and Dutta, 1991). While Kimar (1990) estimated that the intensity of phytoplankton is grater during summer, post monsoon and winter and is lowest in monsoon (Saha and Chaudhary, 1985). The results obtained indicates that maximum density of phytoplankton during July and minimum during January in Tungabhadra river during study period.

Significant correlations were estimated between phytoplankton density and physico-chemical parameters of water (Table–5). Cyanaophyceae showed highly significant and positive correlationship with Temperature and phosphate. The chlorophyceae showed significant and negative correlationship with pH, Dissolved Oxygen, Total dissolved Solids and phosphate and the Bacilleriophyceae showed significant and negative correlationship with temperature, pH, Dissolved Oxygen, Nitrates and Sulphates and the Euglenophyceae showed significant and negative correlationships with temperature, Dissolved oxygen, Nitrates, Chlorides, Sulphates, total Dissolved Solids and Phosphates where as significant positive correlationship was obtained with BOD and COD.

The total phytoplankton density showed significant correlation ship with conductivity. Different groups of phytoplankton consume phosphate and inorganic forms of nitrogen in their metabolic activity at different times, thus showing negative correlationship. The present correlations between phytoplankton groups with one or other parameters of water are in agreement with earlier observations of Anjana. S, (1998), Munawar (1970, 1974) and Verma and Mohanty (1995). Thus it may be concluded that the density of phytoplankton is dependent on different abiotic factors either directly or indirectly.

The above discussion is based on the study of phytoplanktons in Tungabhadra river, studied over a period of one year from May 2008 to April 2009. The water and algal samples were collected at regular intervals of 15 days at 4 stations for one year. The results obtained on the limnological parameters are tabulated. The most tolerant genera and species of four groups of algae namely, Chlorophyceae, Bacilleriophyceae, Cynaophyceae and Euglenophyceae indicate that total algal population is 17,715 in station No. 3, which has the influence of industrial pollution from Harihar Polyfibre and Grasim industry situated on the right bank of the river and discharging its treated effluent to this river.

The population of algal species is 75,849 at station No S1, 68,056 at station S2 and 38,915 in station No 4. Further it was observed that the annual periodicity shows Chlorophyceae dominance and constituted 39.60% of the total phytoplankton population which was followed by Cyanophyceae 28.70%, Bacilleriophyceae 22.1% and Euglenophyceae 9.65% in the Tungabhadra river throughout the year at selected stations. This may be due to the fluctuation of physico-chemical parameters of the water body in the above stations.

Table.1 Average values of physico-chemical parameters at 4 stations of Tungabhadra River from May 2008 to April 2009

Sl.No	Parameters	Station S1	Station S2	Station S3	Station S4
1	Temperature, ^{O}C	29.00	28.50	30.00	29.50
2	pH	8.10	7.98	7.57	7.86
3	Turbidity, NTU	5.00	10.00	18.00	8.00
4	Electrical Conductivity µ mohs/cm	235.04	332.23	595.76	294.60
5	Dissolved Oxygen, mg/l	8.10	7.70	6.80	7.60
6	Biological Oxygen Demand, mg/l	5.28	4.50	4.80	5.10
7	Chemical Oxygen Demand, mg/l	66.92	81.33	186.42	94.50
8	Nitrates, mg/l	8.46	4.86	9.00	2.71
9	Chlorides, mg/l	35.22	45.94	146.94	51.00
10	Sulphates, mg/l	7.67	9.25	14.82	8.45
11	Total Dissolved Solids, mg/l	129.27	199.32	357.45	162.03
12	Phosphates, mg/l	0.46	0.68	1.13	0.56
13	Total hardness as $CaCo_3$, mg/l	83.75	80.58	89.42	97.00
14	Calcium as Ca, mg/l	52.70	580.00	141.40	50.00
15	Magnesium as Mg, mg/l	31.00	36.00	48.00	47.00

Table.2 The range and average population of 4 groups of alage at 4 stations of Tungabhadra River from May 2008 to April 2009

Stations	Algal Groups								Total Algal Population
	Chlorophyceae		Cyanaophyceae		Bacilleriophyceae		Euglenophyceae		
	Range	Average	Range	Average	Range	Average	Range	Average	
1	765-3464	2398	964-2998	1528	774-2686	1755	414-988	644	75849
2	684-3945	2377	754-2464	1195	678-2546	1584	248-824	515	68056
3	242-995	605	135-425	233	185-780	465	95-210	157	17515
4	698-1625	1223	565-1465	985	310-1045	735	188-656	300	38915

Table.3 Algal species recorded at 4 stations of Tungabhadra River. from May 2008 to April 2009

Species	Tungabhadra River Stations				
	1	2	3	4	Total species
Chlorophyceae	64	76	59	69	268
Cyanophyceaea	80	59	46	40	225
Bacilleriophyceae	44	41	33	38	156
Euglenophyceae	15	10	08	12	45
Total Species					**664**

Table.4 List of identified Phytoplankton species in the Tungabhadra River from May 2008 to April 2009

Chlorophyceae		**Cyanophyceae**		**Bacillariophyceae**		**Euglenophyceae**	
1	*Chlorell sp.*	1	*Nitschia sp*	1	**Spirulina sp**	1	*Euglena sp*
2	*Clesteriom sp.*	2	*Navicula sp*	2	**Microcystis sp**	2	*Pahcus sp*
3	*Cosmarium sp.*	3	*Cyclotella sp*	3	**Phermidium sp**	3	*Euglena minuta*
4	*Pediastrum duplex*	4	*Amphora sp*	4	**Lyngbya sp**	4	*Euglena spirogyra*
5	*Scenedesmus sp.*	5	*Pinnularia sp*	5	*Phormodium*	5	*Trachelomonas sp.*
6	*Spirogyra sp*	6	*Diatoma sp.*	6	*Anabaena*	6	*Euglena proxima*
7	*Ulotrix sp*	7	*Fragilaria*	7	*Oscillotoria*		
8	*Kirchineriella sp.*	8	*Melosires*	8	*Nostoc sp*		
9	*Glosterium*	9	*Nitschia*	9	**Spirulina sp**		
10	*Ankistrodesmus Sp.*	10	*Nitschia sp*	10	*Gomphonema sp.*		
11	*Pediastrum simplex*	11	*Lyngbya sp.*				
12	*Microspotrum sp.*	12	*Spirulina sp.*				
13	*Coelastrum sp.*						
14	*Schroderia sp.*						
15	*Tetrastrum sp.*						

Table.5 The correlation coefficient values among certain physico-chemical parameters of Tungabhadra River from May 2008 to April 2009

Pahysico-chemical characteristics	Phytoplankton groups				Total phytoplankton
	Chlorophyceae	Cyanophyceae	Baciileriophyceae	Euglenophyceae	
Temperature	0.92**	0.78**	-0.06	-0.48	0.31
pH	-0.60	0.52	-0.04	0.26	0.34
Turbidity	0.01	-0.09	0.18	0.16	0.02
Electrical Conductivity	0.45	0.42	-0.19	0.25	0.68*
Dissolved Oxygen	-0.14	0.58	-0.42	-0.35	0.38
Biological Oxygen demand	0.14	-0.23	0.31	0.08	0.21
Chemical Oxygen demand	0.05	-0.13	0.11	0.12	0.10
Nitrates	0.58	-0.28	-0.34	-0.62	-0.28
Chlorides	0.04	0.21	-0.29	-0.59	0.08
Sulphates	0.22	0.52	-0.26	-0.18	0.41
Total Dissolved Solids	-0.75**	0.42	0.12	-0.25	0.05
Phosphates	-0.72**	0.61	0.14	-0.05	0.44
Total Hardness	0.17	0.25	0.20	0.28	0.21
Calcium	0.17	0.26	0.19	0.24	0.18
Magnesium	0.14	0.20	0.20	0.29	0.19

** < 0.01, * <0.05

Figure.1 Map Shows Study Area Location Map of River Tungabhadra and four sampling stations

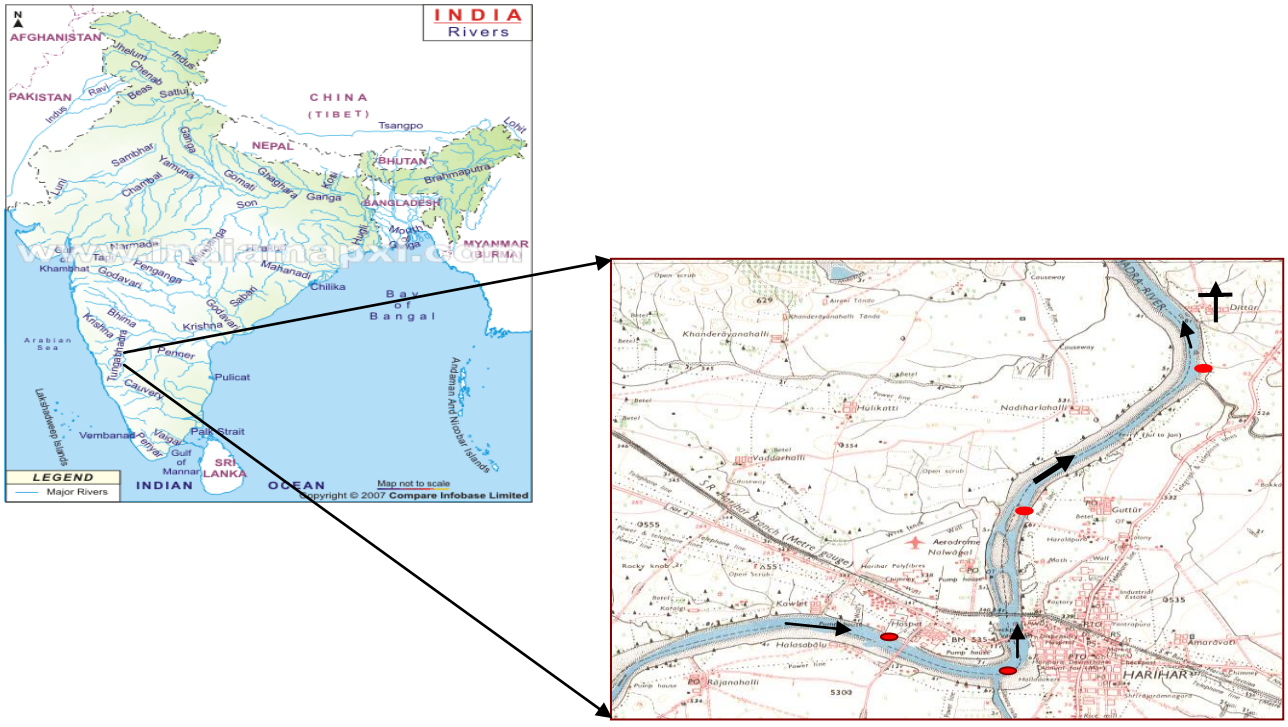

Table.4 Correlation Coefficient between the Phytoplankton in the study area

Stations	**Station S1**			
Taxa	**Chlorophyceae**	**Cyanophyceae**	**Baciileriophyceae**	**Euglenophyceae**
Rotifers	1.000			
Cladocera	-0.088	1.000		
Copepoda	0.319	0.462	1.000	
Protozoa	0.089	-0.141	0.128	1.000
Stations	Station S3			
Taxa	**Chlorophyceae**	**Cyanophyceae**	**Baciileriophyceae**	**Euglenophyceae**
Rotifers	1.000			
Cladocera	-0.049	1.000		
Copepoda	0.018	**0.524**	1.000	
Protozoa	0.166	0.254	0.251	1.000
Station S2				
Chlorophyceae	**Cyanophyceae**	**Baciileriophyceae**	**Euglenophyceae**	
1.000				
-0.135	1.000			
0.236	0.054	1.000		
-0.045	0.234	0.143	1.000	
Station S4				
Chlorophyceae	**Cyanophyceae**	**Baciileriophyceae**	**Euglenophyceae**	
1.000				
0.647	1.000			
0.368	**0.527**	1.000		
0.140	0.239	**0.528**	1.000	

** < 0.01, * <0.05

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