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HYDROCHEMISTRY AND PLANKTON DIVERSITY OF TUNGABHADRA RESERVOIR BELLARY DISTRICT, KARNATAKA

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Abstract- The present work focused on physico-chemical parameters, diversity and seasonal abundance of phytoplankton in Tungabadhra reservoir Bellary District for the period of February 2009 to January 2010. We have observed monthly fluctuations of different diversity i.e 21algal genera belong to five groups, of which 4 genera of cynophycease, 5 genera of chlorophyceae, 4 genera of euglenophyceae, 1 genera of desmid and 6 genera of diatoms. Among the plankton diatoms were the dominant group throughout the study period. The high numerical abundance of phytoplankton individuals was recorded in southwest monsoon season and northeast monsoon season while low density was observed in the summer season. The seasonal fluctuations, correlation with physico-chemical variable, diversity indices and evenness indices were analyzed for all plankton.
Keywords- *Physico-chemical parameters, seasonal fluctuations phytoplankton, Diversity indices, Tungabadhra Reservoir*

INTRODUCTION

Most aquatic systems around the world, including rivers, lakes and reservoirs, have undergone changes because of human-induced disturbances from land-use activities centered on agriculture and industrial activities, and human settlements [11]. Reservoirs are complex and dynamic ecosystems and it is important to understand how these ecosystems operate and respond to change for an efficient management [20] Among the freshwater organisms pytoplankton, as primary producers, an extremely diverse forms the vital energy source at the first trophic tier. As they also serve as food to many aquatic animals, they also have an important role in the material circulation in aquatic ecosystems by controlling the growth, reproductive capacity and population characteristics of aquatic biota. The first phytoplankton (marine cyanobacteria) probably appeared almost 3 billion years ago [7]. Since then, phytoplankton oxygenated Earth's atmosphere, have undergone dramatic diversification (including founding the lineage of terrestrial plants) and numerous extinction events, and conquered the freshwater realm. Today they account for approximately half of Earth's primary productivity [5, 6,10]. Phytoplankton community composition profoundly affects the biogeochemical cycling of many elements [5]. Phytoplankton groups also differ in their edibility and nutritional value for higher trophic levels [18], they can produce toxins that negatively affect water quality and higher trophic levels [1]. Furthermore, their standing crops exhibit variations that depend on several factors, including the supply of major nutrients, light availability; grazing by zooplankton, water mixing regimes, basin morphometry [17].

Moreover, no recent studies can be documented in this reservoir concerning the phytoplankton community structure, which necessitates constant monitoring of ecological conditions in the reservoir as a means of providing a current database of its environmental conditions. Accordingly, the goal of this study was to investigate the spatial and seasonal variations in phytoplankton species composition, numerical cell density and biomass, in relation to changes in water quality parameters.

STUDY AREA

The Tungabadhra reservoir under study is one of the major reservoir of the Bellary district located between north latitude 15^{O} 90' and East longitude of 76^{O} 55' .

MATERIALS AND METHODS

The study was carried out between October 2009 and September 2010. Four sampling stations were selected. During the study, horizontal samples were collected monthly from each sampling station for species identification using plankton net with a 55 µm mesh size as recommended [13]. The samples were preserved in a 5% formaldehyde solution and then enumerated using an inverted microscope with a counting chamber. In the counting process, every colony and threadlike organism was considered an individual unit. Phytoplankton species were identified from the literature. The cell volume of each phytoplankton species was computed by applying average dimensions for each species from each sampling station. Phytoplankton diversity was expressed by Simpson index as defined [16].

The water samples and zooplankton samples were collected on the monthly basis from the two lakes for the period of one year, from February 2009 to January 2010. The physico-chemical variables were estimated as per the Standard Method (APHA, 1998).

RESULTS AND DISCUSSION

In the present investigation physico-chemical parameters viz., rainfall, humidity, air and water temperature, pH, dissolved oxygen, total alkalinity, total hardness, calcium, magnesium, chloride, nitrate, phosphate, sulphate and total dissolved solids are depicted in table 1. A detailed investigation was carried out to obtain diversity and seasonal density of phytoplankton communities of Tungabadhra reservoir.

Monthly fluctuations and seasonal variations of phytoplankton are presented in Table 2 and Table 3 and diversity values presented in Table no 4 respectively.

The communities of algae in the Tungabadhra reservoir were represented by members of cynaophyceae, chlorophyceae, Euglenophyceae, desimds and diatoms. During the present investigation 26 genera were identified out of which 4 genera were belongs to Cynophyceae, 5 were of chlorophyceae, 4 of euglenophyceae, 1 of desmid and 6 of diatoms.

Among the all phytoplankton of Reservoir diatoms constituted the main bulk of algal population are all the seasons in the reservoir and this group occurred throughout the study period with fluctuations in cell number. Diatoms were represented by ten species out of these seven species belonging to five genera were recorded in all seasons except *Nitzschia linearis*, *synedra ulna* and *S. acus* were not present in April to June. This was the first dominant group constituting 74% of the annual total phytoplankton. The maximum number of diatoms encountered in the month of December (5650 org/l) and minimum number was noticed in the month of March (1878 org/l) respectively. Though this group was represented by 6 numbers of forms, only *Navicula sphereophora* was present in great number (12570 org/l) virtually controlled the annual fluctuations of the group. The genus *Navicula Sp* includes three species such as *N.sphaerophora, N. rhomboids* and *N.mutica* and all three present throughout the study period. The second dominant species was *Pinnularia gibba* 1020 org/l and lowest number noticed by *Synedra ulna* (800 org/l) respectively. Diatoms considered to be the best indicators of quality and trophic status of the waterbody [2,3].Temperature and pH will play key role in the distributions of diatoms and abundance diatoms will more in colder months. The maximum abundance of diatoms was encountered in the winter season and low was noticed in summer season. present findings are agreeable with earlier reports [16,17].

Chlorophyceae are free living and planktonic, mostly confined to shallow water and are attached to the submerged plants or found on moist soil [8,9]. This was the second dominant group with 18% of the total population of annual phytoplankton of Tungabadhra reservoir. This group was represented by six species and the maximum density of chlorophyctes was observed in the month of September (1535 org/l) followed by August (1952 org/l) and minimum number was noticed in the month of April (50 org/l) respectively. The maximum density was observed in northeast monsoon season and low population was recorded in the summer season. Some others [16,17,18] reported that maximum abundance of chlorophyceae was in wineter months. This observation is an agreement with present findings. Among the chlorophyctes *A. falcatus* was dominant species and present in all seasons (4089 org/l), second dominant genus was *Scenedesmus* and low density was recorded by pediastrum tetras (42 org/l) respectively. The earlier studies to undersatand the behaviour of chlorophytes to physico-chemical conditions indicate that the specific role played by a factor in the occurrence of this group is not satisfactorily understood. Many others [4, 13, 20] have elucidated that phosphate, calcium and low level of pH values support the dense population of chlorophytes In this present study the results are agreeable with earlier work. The maximum concentration of dissolved oxygen may be due to accelerated photosynthetic activity. Generally that the high concentration of dissolved oxygen favorable water temperature favored the thick growth of chlorophceae. Similar observations have been made in the present investigation.

The chlorophyceae population was correlated at 1% with water temperature(r=-0.6408), chloride (r=-0.6244), total alkalinity (r= -0.5855) and calcium (r=0.5862).

In present study the euglenophyceae composed of five species belonging to four genera with 5% of total plankton population of Tungabadhra reservoir.

This is the third dominant group and was not present in all the months and this group was remain absent from April to July except *E. triptis*. The maximum density of *euglenophyceae* was observed in the month of October (580 org/l) and minimum was noticed in the month of April (20 org/l). The maximum number of individuals was observed in southwest monsoon season (1916 org/l) and low population was recorded in the summer season (397 org/l). Among the euglenophytes, *E.acus* and *E. triptis* were dominant species with 840 org/l and 1332 org/l respectively. The low density was recorded by *Phacus orbicularis* (26 org/l). The maximum density in winter and low density in summer may be do to high dissolved oxygen level coupled with low level of pH. Earlier reports stated that the temperature around 26^{O}C to 28^{O}C is favorable for abundant growth of these organisms. Similarly the maximum number was observed in Tungabadhrareservoir when the temperature is around 27 ^{O}C to28 ^{O}C.

The eglenophytes population was correlated at 1% with pH(r=-0.6432) and chloride (r=-0.7485).

Cynophyceae are well known to occurred diverse physico-chemical conditions with varying degree of abundance and can tolerate wide fluctuations in chemical factors. In the present investigation the cyanophyceae composed five species were recorded and their density was ranged from 2 to 120 org/l. The maximum pulses of chyanophyceae was observed in the month of October and November with 170 org/l and the low density was noticed in the month of April with 4 org/l. Among the cyanophytes *oscillatoria* was the dominant species and low population was recorded by *Sphaerocystis schroeteri* (54 org/l). The maximum number of individuals in winter (527 org/l) and low population in summer (76 org/l), thus clearly indicate that cynophyceae were favored by low temperature, low pH and high Dissolved oxygen.

In the present investigation the cyanophyceae correlated at 1% level with air temperature (r=-0.6197), dissolved oxygen (r=-0.5147) and negatively correlated with water temperature (r=-0.6408), total alkalinity (r=-0.5855) and calcium (r=-0.5345).

Desmids are group of phytoplankton that very sensitive to environmental changes and eutrophic conditions are not support their growth [3, 4]. Their more in number indicate the clarity and free of pollution of water body. The reservoir under investigation harbored only three species belonging one genus of desmids and they were absent from April to July an in other months they represented in very low population throughout the study period. The peak density was observed in the month of October (97 org/lit) and low density was recorded in the month of March (20 org/lit). Among the desmid group *Cosmarium tenue* was the dominant species and low number noticed by *cosmarium subtumidum*.

The occurrence of maximum desmids in southwest monsoon and low density in summer may attributed with high dissolved oxygen and low alkalinity The maximum abundance of desmids in the summer, while low number in summer. In the present study low phosphate and sulphates promote the growth of desmids. In the present investigation the desmids correlated with pH (r=-0.7191), chloride (r=-0.6817) phosphate (r=-0.6895) and sulphate (r=-0.8674).

Diversity studies

In the present investigation the dominance, Shannon Diversity Index, Simpson diversity index and Evenness of phytoplankton studied.

The cyanophyceae showed high dominance index (0.1416) followed by Desmids (0.1413), euglenophyceae (0.1408), chlorophyceae (0.1233) and diatoms (0.1005). The high Shannon Index showed by diatoms (2.369) > chlorophyceae (2.184)> cyanophyceae(2.084)> euglenophyceae(2.028)> desmids(2.009). The peak Simpson Diversity Index values showed by diatoms (0.8995) followed by chlorophyceae (0.8767), euglenophyceae (0.8592), desmids (0.8587) cyanophyceae (0.8584). The maximum evenness value recorded by desmids (0.932), diatoms (0.8902), euglenophyceae (0.8445), chlorophyceae (0.7405), cyanophyceae (0.7303).

The present investigation reveals that the Tungabadhra reservoir is exhibit seasonal variations in abundance and diversity of phytoplankton, the physico-chemical parameters of reservoir is fall under permissible limits and reservoir is productive.

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Table 1- Monthly variations in Physico-chemical parameters of Tungabadhra reservoir during February 2009 to January 2010.

Months	Air temp ^{O}C	Water temp ^{O}C	pH	DO	Cl_2	Total alka	Total hard	Ca+	Mg+	Nitrte	PO_4	SO_4
Feb 2009	32.5	28.8	8.8	8.4	70.5	170	177.4	54.1	7.7	1.06	0.13	5.8
March	34.2	29.5	9.5	8.4	64	153	152	48	8.1	1.04	0.1	6.0
April	36.1	30.9	9.1	7.4	66	141	196	44	6.0	1.12	0.06	5.2
May	41	37.3	8.6	9.6	68	144	196	40	5.7	0.55	0.1	5.3
June	31	28.2	8.9	12	68	143	142	48	5.7	0.41	0.19	4.8
July	31.2	27.6	8.7	13	69	151	153	49	6.7	0.32	0.16	3.7
Aug	30.8	27.5	8.6	12.5	56	99	154112	50	6.9	0.72	0.25	4.5
Sep	30.5	26.9	8.5	13.7	59	89	138	52	5.1	0.47	0.06	4.3
Oct	33.1	28.5	8.11	9.1	58	122	113	66	5.5	0.92	0.0	4.2
Nov	28.6	29.7	8.2	11.6	55	142	113.5	67	5.7	0.94	0.0	5.7
Dec	29.5	28.7	8.3	10.8	60	113	135	69	5.8	1.0	0.0	5.8
Jan 2010	33.1	30.3	8.5	11.5	67.6	140	145	53	5.8	0.99	0.0	5.1

All parameters are expressed mg/l except pH

Table 2- Occurrence of phytoplankton in Tungabadhra reservoir during the February 2009 to January 2010

Species name	Feb 2009	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan 2010
CYANOPHYCEAE												
Oscillatoria	+	+	-	-	-	+	+	+	+	+	+	+
Microcystis aeruginosa	+	+	+	-	-	+	+	+	+	+	+	+
Sphaerocystis schroeterri	-	-	-	-	-	+	+	+	+	+	+	+
Oocystic saliteris	+	+	+	+	-	-	+	+	+	+	+	+
CHRLOROPHYCEAE												
Scenedesmus dimorphus	+	+		+	+	+	+	+	+	+	+	+
S. bijugatus	+	+	+		+	+	+	+	+	+	+	+
Ankistrodesmus falcatus	+	+	+	+	+	+	+	+	+	+	+	+
Tetrahedron trigonum	+	+	-	-	-	+	+	+	+	+	+	+
Crucigena irregularis	+	+	-	-	-	-	+	+	+	+	+	+
Pediastrum tetras	+	+	-	-	-	-		+	+	+	+	
EUGLENACEAE												
Egluena acus	+	+	-	-	-	-	+	+	+	+	+	+
Euglena triptis	+	+	+	-	-	-	+	+	+	+	+	+
Trachelomonas volvocina	+	+	-	-	-	-	+	+	+	+	+	+
Phacus orbicularis	+		-	-	-	-	+	+	+	+	+	+
Lepocinclis sphagnophilia	+	+	-	-	-	-	+	+	+	+	+	+
DESMIDS												
Cosmarium landelli	+	-	-	-	-		+	+	+	+	+	+
Cosmarium subtumidum	-	-	-	-	-	-	+	+	+	+	+	+
Cosmaricum tenue	+	+	-	-	-	-	+	+	+	+	+	+
Diatoms												
Cocconeis sp	+	+	+	+	+	+	+	+	+	+	+	+
Cymbella cymbiforms	+	+	+	+	+	+	+	+	+	+	+	+
Navicula sphaerophora	+	+	+	+	+	+	+	+	+	+	+	+
N. rhomboids	+	+	+	+	+	+	+	+	+	+	+	+
N. mutica	+	+	+	+	+	+	+	+	+	+	+	+
Cocconeis quarnerhsis	+	+	+	+	+	+	+	+	+	+	+	+
Pinnaularia gibba	+	+	+	+	+	+	+	+	+	+	+	+
Synedra ulna	+	+	+	+	-	-	+	+	+	+	+	+
S. acus	+	+	-	-	-		+	+	+	+	+	+
Nizschia linearis	+	+	-	--	-	-	+	+	+	+	+	+
Total	26	24	13	11	10	14	27	28	28	28	28	28

Table 3-Seasonal variation of total phytoplankton in Tungabadhra reservoir (org^{-l})

Species name	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec	Jan
Cyanophyceae	30	26	04	16	00	33	134	167	170	170	105	82
Chrlorophyceae	1048	332	50	60	87	1348	1952	1535	1463	1084	1284	626
Euglenaceae	257	120	20	00	00	00	394	257	580	432	490	414
Desmids	54	26	00	00	00	00	68	89	97	64	79	36
Diatoms	3520	4040	2112	1130	1048	1878	4602	5548	5228	5336	5636	3480
Total	4909	4544	2186	1206	1135	3259	7150	7596	7538	7086	7556	4638

Table 4- Diversity indicices of phytoplankton of Tungabadhra reservoir

Species name	Dominace _D	Shannoon_H	Simpson_1-D	Evenness
Cyanophyceae	0.1416	2.084	0.8584	0.7303
Chrlorophyceae	0.1233	2.184	0.8767	0.7405
Euglenaceae	0.1408	2.028	0.8592	0.8445
Desmids	0.1413	2.009	0.8587	0.8902
Diatoms	0.1005	2.369	0.8995	0.932