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Study of seasonal variations of Phytoplankton and their correlation with physicochemical parameters of Budaki Medium Irrigation Tank, Shirpur. Dist.Dhule(M.S.) India.

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ABSTRACT

Seasonal variation of Phytoplankton density and species richness was studied of Budaki Medium Irrigation Tank. This revealed that the density of phytoplankton was maximum in summer, while it was minimum in winter. Maximum species richness of phytoplankton was recorded in summer, while minimum species richness was recorded in winter. The phytoplankton structure depends on a variety of environmental factors that include various physico-chemical factors. The Pearson correlation was calculated by keeping phytoplankton as dependent variable and other abiotic factors as independent variables.

Key Words: *Budaki, phytoplankton, Seasonal variation, density, species richness, correlation,*

INTRODUCTION

The world planktons comes from an Ancient Greek word which means "floating," or "drifting and the literature is described by Hensen (1987) and Thurman,H.V(1997). Plankton are the microscopic and aquatic forms of animals that freely float in aquatic environment and these are the community which is made up of tiny plates, These organisms float through water bodies both fresh and salty around the globe. Primarily, plankton live in the sunny zone of the aquatic environment, even though some species are found in much deeper water. Some planktons play an important role to maintain food chain (nutrient) in the aquatic ecosystem. Their absence in the water body indicates an aquatic disproportion.

According to Emiliani, C. (1991), the study of planktons is called planktology, a planktonic individual is referred to as a plankter . Generally there are two types of plankton. Phytoplanktons are plant like they obtained their energy in the form of carbohydrates by photosynthesis. Several are unicellular found in large groups called blooms that change the colour of water body. Zooplankton possesses animal-like characteristics, and can sometimes get very large. According to the Chandrashekhar and Kodarkar, (1997), the concept of biological indication of water quality is rising and important aspect of aquatic assessment. Therefore many workers have used plankton as an indicator for monitoring quality of water and status of pollution. Phytoplankton plays an important role in the aquatic productivity, trophodynamics in aquatic environment.

Phytoplankton form good indicators of water quality as they have rapid turn-over time and are sensitive indicators of environmental stresses. Phytoplankton survey thus help to find out the trophic status and the organic pollution in the ecosystem (Ramchandra and Solanki 2007). Phytoplankton constitutes the basis of nutrient cycle of an ecosystem. Being primary producers they play an important role in maintaining the equilibrium between living organisms and abiotic factors. They are affected by physical, chemical and biological factors, making them valuable tool in monitoring programmes. On the basis of this, many workers have emphasized that algal communities as a whole serve as reliable indicators of pollution (Patrick, 1950; Palmer, 1969; Nandan and Patel, 1985). In India, many lakes and reservoirs have been studied for the water quality assessment and development of fisheries (2006; Shridhar *et* *al*., 2006; Tiwari and Chauhan, 2006; Tas and Gonulol, 2007; Tiwari and Shukla, 2007). However, there are still many aquatic ecosystems that have remained unexplored. Several studies on phytoplankton diversity of ponds, lakes and reservoirs have also been conducted in India (Shridhar *et al*, 2006; Tiwari and Chauhan 2006; Tas and Gonulol, 2007; Senthilkumar and Shivkumar, 2008; Ekhande,2010; Patil,J.V.,2011), and abroad (Round, 1985; Cleber and Giani, 2001; Sandra *et al*., 2007) revealing the importance of this type of study. In the present study of Budaki Medium Irrigation Tank that receives the southwest monsoon, it is an first attempt to find out the effect of season on phytoplankton community and water quality assessment.

STUDY AREA

The Ambad Nallah is a medium size irrigation tank, constructed on the junction of Ambad and Sossniya nallas near village Budki at a distance of about 1Km to the north of village Budki Taluka – Shirpur, Dist Dhule, Maharashtra. It was constructed in 1977; it is situated at 21°-32′36 latitude and 74°-51′41 longitudes. The catchments area of the project is 38.85 sq. Km. The water from the tank is perennial and is utilized for irrigation and drinking purpose as well as for pisciculture. A large number of major and minor carps are bred by tender owners. However the basic data on the water quality of the tank is not available.

Google Satellite image of Budki Medium Irrigation Tank (21^{0}32'36N 74^{0}51'41E)

MATERIALS AND METHODS

The study area BMIT was visited at monthly interval during the two year period (2009 and 2010).The sample water contain (phytoplankton and zooplankton) was collected at the periphery of study site at three stations namely BMIT A, BMIT B and BMIT C. in between 8 to 10 AM. According to Edmonson, (1963) ten liters of water was filtered through the plankton net No. 25 of bolting silk with mesh size 64 micron. Net was washed with the water by inverting it to collect the plankton attached to the net and the volume of sample was made to 100 ml. The collected samples was taken in separate vials and preserved to 1 ml of 4 % formalin and 1 ml of Lugol's Iodine at the BMIT site. Ten ml of sample from each station was further concentrated by centrifuging at 2000 RPM for 10 minutes. For quantitative estimation of plankton, one ml well mixed sample was taken on 'Sedgewick Rafter Cell'. To calculate density of plankton the averages of 5 to 10 counts were made for each sample and the results are expressed as numbers of organisms per liters' of collected sample water. Qualitative study of phytoplankton and zooplankton were carried out up to the genus/species level using the standard keys given by APHA (1998), Sarode and Kamat (1984), Philipose (1967) and Edmondson (1963). The two year study data (-2009 to -2010) was pooled for four months and three seasons and analyzed for seasonal changes, with respect to summer (February, March, April, and

May.), Monsoon (June, Jully, August, and September), Winter (Octomber, November, December and January). Further, the Mean, Standard Error of Mean (SEM) were calculated for each season and One Way ANOVA with no post test for various parameters for four seasons was performed using Graph Pad Prism version 3.00 for Windows (Graph Pad Software, San Diego California USA). The Pearson Correlation was calculated by keeping phytoplankton as dependent variable and abiotic factors as independent variables with the help of SPSS 7.5 for Windows. The P value for ANOVA is non significant if P > 0.05 (ns), Significant if P < 0.05 (*), Significantly significant (**) if P < 0.001 and highly significant if P < 0.0001.

RESULTS AND DISCUSSION

Total Phytoplankton

In the investigation of BMIT during the study period of two year (2009 to 2010) total 37 genera and 59 species of phytoplankton were identified at BMIT belonging to four taxonomic assemblages Cyanophyceae(Blue green algae), Chlorophyceae (Green algae), Bacillariophyceae (Diatoms), and Euglenophyta.

Table.1 Seasonal Variations in density of different groups of phytoplankton (/l) with two years mean percentage density at Budaki during .2009 to 2010.

Parameters	F value (F3 22)	Summer	Monsoon	Winter	Two years %
Tot. Phy.	67.2	3219 ± 61.6	1656± 130	2932 ± 104	-
Cyano.	65.65	521± 37.1	357± 27.9	866 ± 30.5	22.19
Chloro.	71.8	721.0± 62.77	483.5 ± 42.95	1358 ± 52.60	32.62
Bacill.	65.56	1926 ± 116.4	703.5 ± 76.29	721.0 ± 55.70	42.65
Eugle.	5.43	50.88 ± 4.320	115.5 ± 14.05	74.38 ± 17.31	2.53

(Tot. phy.-Total phytoplankton, Cyano.-Cyanophyceae, Chloro.-Chlorophyceae, Bacill.- Bacillariophyceae, and Eugle.-Euglenophyta).

Table. 2 Seasonal Variations in Species richness of different groups of Phytoplankton (No.of Species) with two years mean % density at Budiki M.I.tank during 2009 to 2010.

Parameters	F value (F322)	Summer	Monsoon	Winter	Two years %
Tot. Phy.	20.18	23.25 ± 0.45	21.50 ± 0.56	18.88 ± 0.44	-
Cyano.	7.00	3.5 ± 0.32	4.50 ± 0.50	5.5 ± 0.26	21
Chloro.	79.59	3.37 ± 0.18	5.5 ± 0.18	6.12 ± 0.44	24
Bacill.	172.8	15.38 ± 0.26	8.37 ± 0.37	11.33 ± 0.25	47
Eugle.	23.95	1.00 ± 0.0	3.12 ± 0.44	0.62 ± 0.18	7

(Tot. phy.-Total phytoplankton, Cyano.-Cyanophyceae, Chloro.-Chlorophyceae, Bacill.- Bacillariophyceae, and Eugle.-Euglenophyta).

Maximum density of phytoplankton noted at BMIT in summer may be attributed to maximum sunlight and higher temperature as is reported to stimulate growth of the aquatic autotrophs (Vyas and Kumar,1968; Murugavel and Pandian, 2000; Hujare, 2005, Patil J.V 2011). The role of photoperiod and temperature in determining density of phytoplankton has been reported by Bhardwaja.(1940). Additional, the water level decreases in summer under Indian climatic conditions, the phytoplankton aggregates resulting in their increased density. pH is also a factor that influences plankton density. The higher pH (alkaline pH) is favorable for the growth of phytoplankton Unini (1984) and Hujare, (2005).The pH of water changed with the changes in the climatiological and vegetational factor as reported by Kant and Kachroo (1971) and George (1961) found the high pH value increases the growth of algae. At study site BMIT the Atmospheric Temperature, Transparency, TDS, TH and pH are positively correlated with total density of phytoplankton while negatively correlated with WT,WC,TS, TSS and DO. (Table.3). Available literature indicates that temperature is one of the important determining factors for phytoplankton density and shows positive correlation Unni and Pawar, (2000). However, various classes as well as individual species of algae have minimum, optimum and maximum temperatures for growth Palmer, (1980). An opposite position occurs during monsoon when the water cover is highest, plankton get more distributed resulting in decline in their density. The abundance of phytoplankton was recorded lowest during monsoon season, when the water column was remarkably stratified to a large extent because of heavy rainfall, high turbidity caused by run-off, reduced salinity, decreased temperature and pH, overcast sky and cool conditions. However, during this season, freshwater algal forms like *Anabaena sp, Oscillatoria sp, Chlorella sp, Nostoc sp, Lynbya sp, Spirogyra sp ,Volvox sp,* were noticed . In addition the short photoperiod and lower temperature of higher altitude may not be much favorable to phytoplankton density. However, once the lake is stabilized the productivity increases resulting in higher density compared to monsoon. When compared with phytoplankton density of other water bodies like reservoirs in plains of Maharashtra More and Nandan, (2000); Jawale and Patil, (2009), tropical reservoirs in Brazil Cleber and Giani,(2001) and Kavery river Mathivanan *et al*., (2007) the density of phytoplankton at BMIT was lower.

Table. 3 Pearson correlation of total Phytoplankton density along with individual group with Abiotic parameters of Budaki M.I.Tank during 2009 to 2010.

Sr. No.	Parameter	Total Phyto.	Cyano.	Chloro.	Bacillario.	Eugleno.
1	Atmospheric Temperature	.032	.584**	-.653**	.588**	.155
2	Water Temperature (WT)	-.049	-.551**	-.614**	.528**	.174
3	Water Cover (WC)	-.420*	.156	.268	-889**	-.303
4	Total Solids (TS)	-.397	-.841**	-.886**	.371	.512
5	Total Suspended Solids (TSS)	-.826**	-.850**	-857**	-.183	.865**
6	Total Dissolved Solids(TDS)	.000	-.626**	-.686**	.664**	.140
7	Transparency	.680**	.830**	.848**	.013	-.759**
8	Carbon Dioxide (CO_2)	.162	-.61**	-.693**	.609**	.160
9	Dissolved Oxygen (DO)	-.027	.605**	.648**	-.665**	-.110
10	Chloride	-.056	-.635**	-.705**	.603**	.262
11	Total Hardness (TH)	.563**	.063	-.056	.710**	-.329**
12	pH	.678*	.310	.298	.542**	-.544**
13	$NO3^-$	-.567**	-.713**	-.716**	.013	.472*
14	$PO4^{-3}$	-.657**	-.817**	-.860**	.022	.688**
15	SO4	-.869**	-.825**	-.819**	-.272	.915**
16	CA	.608**	.088	.060	.685**	-.401
17	Mg	.642**	.258	.196	.583**	-.512*

Calcium is an important part of plant tissue, as it increases the availability of other ions and reduces the toxic effects of NO_3^- Manna and Das, (2004). As per the present study Calcium in the form of Total hardness may be playing a vital role in the growth of phytoplankton resulting in significant positive correlations in total phytoplankton density with total hardness. While the influence of difference in the substratum and surrounding area is noted for those chemical parameters on which biota depends (Table 4A.5). Further, present results showed significant positive correlation between phytoplankton and abiotic factors.

In the present study the sequence of percentage density and species richness in decreasing order were Bacillariophyceae > Chlorophyceae > Cyanophyceae > Euglenophyta (Table. 1) indicating no traces of eutrophication. This is supported by the representation of various species belonging to the four group studied. At study site BMIT , lake in tropics, 59 species of phytoplankton that include 9 Chlorophyceae (Blue green algae) , 30 Bacillariophyceae (Diatoms), 14 Cyanophyceae (Green algae) and 6 Euglenophyta did showed oscillations. Among these, Bacillariophyceae appeared to be the dominant group. The nutrient increase in a lake due to human activities in the catchments, leads to change of Flora from Diatom assemblage to those of greens and blue greens Hutchinson, (1967). The nutrient enrichment at BMIT is reflected as increase and decrease in these three groups quantitatively as well as qualitatively over major part of the year in accordance to nutritional changes. Species richness of total phytoplankton in the BMIT also showed significant oscillations ($P < 0.0001$, F_3 22 67.21) with decreasing trend from summer to monsoon to minimum in winter.

Cyanophyceae (Blue Green Algae)

Pulle and Khan (1995) studied on seasonal variation in primary production in Isapur Dam Maharashtra. Water temperature plays an important role in the periodicity of blue green algae Hutchinson, (1967) as moderately high temperatures support their growth Tucker and Loyd, (1984); Naik *et al*, (2005). The density of cyanophyceae (Table-1) at BMIT was maximum in winter and early summer .Similar result was reported by Mazher Sultana and Dawood Sharief (2004). However, a negative correlation with AT at 0.01 level and non-significant with WT at BMIT .The same observation was recorded by Patil J.V.,(2011) ,Ekhande, (2010) and Bhatt *et al.* (1999). There are significant differences of opinion regarding the effect of pH on abundance of algal flora. However, the pH of BMIT was alkaline throughout the study period with maximum in summer and minimum in winter. The individual cyanobacterial species have considerable specializations and are intolerant of a high degree of environmental variability Padisak and Reynolds, (1998). Though the abundance was low in summer in present study maximum nine species of blue green algae were recorded from study site. These species are *Microcystis viridis, Aphanocapsa montana*, *Spirulina subtillissma*, *Oscillatoria limosa*, *Phormidium ambiguum*, *Lyngbya bergei*, *Nostoc spongiaeformae* and *Anabaena amphique sp.*

In the investigation ay BMIT the water was showing pH around 7.9, the seasonal density of Cyanophyceae was high. Among other parameters significant positive correlations were observed between total hardness and density of Cyanophyceae as is also observed by many authors Krishnan, (2008), and significant negative correlations with CO2 Johnston and Jacoby, (2003) are of the judgment that low dissolved CO2 suitable for growth of Cyanophyceae. The nutrients NO_3^-, and PO_4^{-3} were significantly negatively correlated with Cyanophyceae density .Hence, the utilization of the nutrients for the growth results into higher density. The significant correlation between Cyanophyceae density and PO_4 are observed at BMIT, the similar result recorded in the research by Tiwari and

Chauhan,(2006) ,Izaguirre *et al.,* (2004) .At BMIT, the average two year percentage was 21 % (Table. 1) of total species richness.

According to Brunberg and Blomqvist (2002) *Microcystis* is a widely distributed organisms which dominates the phytoplankton community in nutrient rich lakes. *Microcystis aeruginosa* is one of the main pollution producers of Lakes Kearns and Hunter, (2001), Lindholm *et al,* (2003). Its presence poses a threat to the aquatic ecosystem. The degree to which water may be affected by these algae must therefore well monitor. Interestingly, instead of *Microcystis. virdis* was recorded from BMIT. Further, other two pollution indicator genera *Anabaena* and *Oscillatoria* that produces neurotoxins characterized as contact irritants were also recorded at study area of BMIT but in low density. According to Mischke and Nixdorf, (2003). The presence of *Anabaena* and *Oscillatoria* indicates beginning of biological pollution. Members of Oscillatoriaceae family are known to tolerate the combination of intermittent nutrient deficiency and low light conditions. Such conditions are produced by the frequent but irregular mixing of water in summer and they built up very dense population that increases turbidity. However, in summer the nutrient deficiency and high light conditions due to increase in transparency prevail. At higher temperature with high CO2 and low oxygen levels in summer *Oscillatoria sp., Microcystis sp., Nostoc sp.* and *Anabaena species* flourish Tiwari and Chauhan, (2006). According to Seenayya,(1972);More(1997) the occurance of *Microcystis sp* ,the toxin producing blue green in the blooms of Cyanophyceae is a significant feature of tropical freshwater ecosystems are attributed to nutrients, particularly to phosphorus enrichment. Zaffar (1994) observed that the presence of diatoms was due to concentration of phosphate as it was tallied in present investigation. Increased detection of 'cyano-toxins' in water bodies has generated a complex change for water resource managers all over the world Johnston and Jacoby, (2003). Other factors that regulate Cyanophyceae are high water temperature, stable water column, low light availability, high pH, low dissolved CO2 and low total N to P ratio TN: P ratio Welch, (1992); Paerl, (1988). However, in the present study the Cyanophyceae and Chlorophyceae are positively significantly correlated (Table. 3) indicating that the members of Cyanophyceae are not dominating the system. Natural systems are characterized by a variety of biotic and abiotic factors coupled with multiple species interactions. Although nutrient concentrations are considered fundamental for the development of cyanobacterial blooms, many other variables are involved in their ecological success (Dokulil and Teubner, 2002). Population density of Cyanobacteria is expected to be moderate in natural and unpolluted water bodies. However, in nutrient rich water bodies, they grow abundantly and their density increases to millions of cells per liter leading to a Cyanobacterial blooms Sangolkar *et al.,* (1999). No such condition is noted at BMIT over the two year study period

Chlorophyceae (Green Algae)

Presence of Green algae are the second dominant group of density as well as diversity(Table.1,2) Chlorophyceae the free living phytoplankton, is mostly limited to shallow waters and attached to the submerged plants or found in moist soil. Maximum density of green algae was recorded in winter when temperature and photoperiod are minimum at BMIT (Table.1). Many workers reported the distribution and abundance of chlorophyceae; Huddar, (1995); Islam *et al*., (2001). In the present study as noted for other groups the minimum density of chlorophyceae in monsoon may be attributed to the dilution effect due to the rains as well as drifting of algae along with the water. Like Cyanophyceae the maximum density of Chlorophyceae was recorded in winter and low during summer indicate that their contribution is low in increase in total plankton density of summer. The Chlorophyceae is the second dominant group recorded at BMIT which is coincide with the predominance of the diatoms over the green algae noted by Baruah *et al*. (1993) and Krishnan *et al*. (1999).

In cold climatic conditions, an increase in organic load commonly leads to a shift in the ecosystem from Diatom-dominated flora to green and blue green in the form of nutrient input due to human activities in catchment (Patrick, 1970). In the present study of BMIT though the diatoms dominated over green algae quantitatively as well as qualitatively Chlorophyceae was second dominant group with average density 32.62%. Further, significant seasonal variations recorded in the density of Chlorophyceae indicate their dependence on physico-chemical as well as biological components of the system. Among biological components of BMIT, Chlorophyceae is positively correlated to Bacillariophyceae and Cyanophyceae at the level of 0.01, adding to the total density while negatively with the minor group Euglenophyta. However, among physical parameters AT and WC has negative effect whereas WT has no significant effect on Chlorophyceae. Total solids and suspended particles prevent growth of Chlorophyceae and its dissolved components have no significant effect indicating that chemical components have less influence on Chlorophyceae. Further, CO_2 has negative influence ($P < 0.05$) while dissolved oxygen do influence chlorophyceae. Rather, the nutrients have significant negative relations as they are trapped by growing Chlorophyceae population. The alkaline nature of water body has been reported to promote the dense growth of Chlorophyceae (Gulati and Wurtz, 1980). The BMIT remains alkaline all throughout the year. Chlorophyceaen phytoplankton order of Chlorococcalean is known to prefer inorganic nutrients providing alkaline pH and moderately high temperature (Rao 1995;Krishnan, 2008) and thrive well in water rich in NO_3 than phosphates. Total hardness and transparency also influence Chlorophyceae density positively Bhatt *et* al., (1999).

Species richness of Chlorophyceae with total 14 species and 11 genera of BMIT. These genera are *Ulothrix, Oedogonium, Bulbochaetae, Pediastrum, Eudorina, Spirogyra, Closterium, Staurastrum , Cosmarium. Volvax and Microspora* Of these *Closterium, Staurastrum* and *Cosmerium* are considered as desmids which indicate good quality of water and absence of desmids is an indication of heavy pollution of water Hosmani *et al.,* (2002). Detailed study of Desmid flora would be useful in managing the pristine quality of BMIT. According to Hutchinson (1967) desmids (e.g. *Cosmarium)* are associated with oligotrophic freshwater and in these, they may form an important food source for herbivore fish. The food chain relations of endemic and endangered species of fishes may include specific phytoplankton species. Moreover, the dominance of Desmids over Chlorococcales (e.g. Pediastrum) a group indicative of eutrophication Rott, (1984) in the lake may be considered as a positive biological sign to suggest that the trophic characteristics of the system is still within control. Further, the different species of Chlorophyceae have differential preference for magnesium and phosphate for their growth and high calcium content and low pH values favour their growth Munawar, (1974). Typical species of nutrient rich waters are *Mougeotia, Oocystis, Ulothrix, Spirogyra, Micractinium* Sreenivasan *et al.,* (1997). Among these genera *Ulothrix* and *Spirogyra* were recorded in BMIT in low density. According to Standards ISI 10500: 1991- Annexture-I, the species of *Coelastrum*, *Oocystis*, *Scendesmus*, *Zygnema*, *Chlamydomonas*, *Chlorella*, *Spirogyra*, *Tribonema* and *Closterium* are found in polluted waters. Of these only *Spirogyra* and *Closterium* were found in study area of BMIT in low density, The algal community structures thus suggest that the system is still under natural control as is evidenced by the dominance of sensitive species and rare occurrence of tolerant species ,this indicate that the water is not much polluted.

Bacillariophyceae (Diatoms)

The diatom constitutes an important component of the fresh water and marine plankton, the environmental factor such as physico-chemical and biological factors influence the abundance and species richness of diatoms, which is reflected in their seasonal variations(Table.1 and 2). According to Pearsall(1923); Schorder (1940); Patric.(1971) and Mahajan (2001),the temperature is the most important factor which affecting the growth of diatoms .Maximum diatom density were recorded in summer at BMIT as is also reported by Hujare (2005); Hafsa and Gupta (2009) and Jawale and Patil (2009); Ekhande(2010); Patil J.V.(2013). According to Sing and Swarup (1979) the high temperatures, phosphate, nitrate and calcium are the favorable parameters for the diatoms population in Suraha lake, The population of diatoms was considerably increased with increased of the concentration of phosphate (Zaffar1964; Hergenrader1980 and Pendse et.al. 2000). The highest number of Bacillariophyceae recorded during the period of highest temperature (Abbas, 1984). In addition the water quality in terms of concentration of organic matter, DO, pH, and other physical factor play an important role in the distribution of diatoms. Diatoms are reported to absorb phosphates in large quantities than their requirements Rutner, (1963) and Munawar, (1970). Philipose (1960) has reported direct relation of phosphate with diatoms. In present study, minimum to moderate phosphate were recorded in winter and summer respectively when the diatom populations were moderate to maximum. In additions Nitrates have also been given the prime importance in diatom ecology, Rao, (1955). Nitrate is also considered as the main controlling parameter in the periodicity of diatoms (Zaffar,1964 and Nandan and Patel,1986). However, in the present study the diatom density is positively correlated with the nitrate at the BMIT.

According to Nandan and Magar (2007) and Sharma (2009), the greater diatoms observed at summer and winter in their annual studies. The similar result found at BMIT. However, in present seasonal study a steady increase from winter to summer has been recorded at the BMIT. The effect of rains in distributing the plankton in general and resulting decline in their density stands true for diatoms too.

In the investigation at BMIT the total 30 bacillariophyceae specie were recorded belonging to 17 genera (Annexture) which dominated in density for three seasons. This indicate availability of their distinct nutritional requirements at BMIT. According to Patrick (1973) concluded that many species of diatoms can tolerate at various temperature range. The study of BMIT indicates that this group of species are found abundantly when water temperature fluctuated between winter and summer.

Accordance to Palmer, (1969) has listed the taxa emphasis with reference to pollution index. In the present study some of these pollution tolerant species were also observed in BMIT these are: *Navicula*, *Melosira*, *Gomphonema*, *Fragilaria*, *Surirella*, *Cymbella*, Similar taxa was also recorded by Nandan and Mahajan, (2007) at Suki Dam, Maharashtra. It is general observation that *Cymbella*, *Fragilaria species*, *Gomphonema* are commonly found in organically rich waters. And the clean water diatom species are *Amphora ovalis*, *Cymbella sp.*, *Pinnularia sp.* was also found in the waters of BMIT. This indicates that though not yet polluted, if the care is not taken may get polluted in future as it is having potential for deterioration and eutrophication under the influence of pollution and anthropogenic activities.

Euglenophyceae

In the present investigation of BMIT the abundance of Euglenophyta showed seasonal variation attributed to temporal variation in physico-chemical parameters. Maximum density of euglenophyta was recorded in monsoon, the similar observation also reported by Hafsa and Gupta (2009). Euglenophyta are found commonly in small water bodies which is rich in organic matter. According to Palmer (1969) showed that the Euglenophyta are the biological indicators of organic pollution. Several species are known as indicators of organically polluted environment; Hafsa and Gupta, (2009).Kumar et.al (1974) observed the blue green and euglenoid flagellates were mostly associated with organically rich effluents low in DO. Accordance to Munwar (1972); Tripathi and pandey (1995) and Hegde and Sujata(1997) and are reported that high water temperature ,phosphate, nitrate, low dissolved oxygen and carbon dioxide supported the growth of euglenoids. Euglenophyta was the group represented in the lowest percentage density in the research area of BMIT water with annual average percentage density of only 2.53 %. When its seasonal variations are considered higher density of Euglenophyta were recorded in the monsoon and lowest in the summer. Maximum euglenoids in monsoon can be attributed to influx of rainwater which carries high amount of organic matter from the drainage. Accordance to Pendse et. al.(2000) reported that the higher euglenophyta population during monsoon period when the water shows sufficient amount of dissolved oxygen and good amount of nutrients.

According to Duttagupta *et al*., (2004); Bhuiyan and Gupta (2007) Iron, Calcium and Magnesium play a great role in stimulating and maintaining euglena blooms. Drastic decrease in the population of euglenophyta in winter has been attributed to the use up of essential nutrients during their bloom and bust period in monsoon. Venkateswarlu et.al. (1981) reported that euglenoid bloom occur in sewage infested polluted water where organic matter and iron concentration are high .

In present investigation in BMIT , Total Phytoplankton density was positively correlated with CA Trans., chloride, TH ,WT and pH while negatively with WT, WC, TSS,TS, $NO3^{-}$ l and $PO4^{-3}$. The density of Euglenophyta showed positive correlations with WT,WC, TSS, TS, and NO_3 and negative correlations with TDS, Trans., TH , pH, Trans. And DO.(Table). The similar result was reported by Ekhande (2010), Patil J.V (2011).

In the BMIT water only six species of Euglenophyta belonging to two genera representing in a minute 7% of the total diversity of phytoplankton. Minimum species were observed such as *Euglena spirogyra and Euglena gaumei* most common in the monsoon. According to Alam and Khan, (1996) the occurance of *Euglena sp* and *Phacus sp*, are a direct indication of beginning of pollution load because both these species in generally, considered to be dominant and tolerant genera of polluted ponds. However, Tiwari and Srivastava (2004) found *Euglena sp.* and *Phacus sp.* in industrially polluted as well as non-polluted waters in North India and also observed that these are the species with greater ecological amplitude to their occurrence in aquatic systems exhibiting varying levels of pollution load. Though the pollution indicator species were found in BMIT their density and species richness were very poor, so for the proper management of this water body continuous monitoring will necessary.

In conclusion, BMIT water supports good diversity and density of phytoplankton with Bacillariophyceae as most common group while Euglenophyta the least. The Study area is not yet polluted, but in today's BMIT water is utilize for Human activities and domestic purposes. If care is not taken it can soon undergo deterioration and develop into a deteriorated habitat.

REFERENCES

[1] Alam, A. and Khan, A. A. **1996**. *Poll. Res*., **15** (3):287- 291.

[2] APHA, 1998. Standard methods for the examination of water and wastewater 20^{th} eds. American Public Health Association. American water works Association Water Environment Federation. Washington, D.C.

[3] Baruah, A., Sinha, A. K. and Sharma, U. P. **1993**. *J. Freshwater Biology*, **5**: 27-32.

[4] Bharadwaja, Y. 1940. Some aspects of the study of myxophyceae. *Proceedings of the Twenty-Seventh Indian Science Congress*, Madras,

[4] Bhatt, L. R., Lacoul, P., Lekhak, H. D. and Jha, P. K. **1999.** *Poll. Res.*, 18 (4): 353-358.

[5] Bhuiyan, J. R. and Gupta, S. **2007.** *J. Environ. Biol*., **28**(4): 799-802.

[6] Brunberg, A. K. and Blomqvist, P. **2002.** *J. Plankton Research*, 24(11): 12-22

[7] Chandrashekhar,**S.V**.A and M.S.Kodarkar.**1997**, *Indian J. Environ.* 39(2): 155-159.

[8] Cleber, C. F. and Giani, A. **2001.** *Hydrobiologia*, **445**: 165-174.

[9] Dokulil, T. M. and Teubner, K. **2002**. *Hydrobiologia*, 438: 1-12.

[10] Duttagupta, S., Gupta, S. and Gupta, A. **2004**. *J. Environ. Biol*., **25**: 369-373.

[11] Edmondson, W. T. **1963**. *Freshwater biology*, 2^{nd} edn. John Wiley and sons. New York, USA.

[12] Ekhande, A. P. **2010**. *Hydrobiological studies of Yashwant Lake with special reference to selected biodiversity*. Ph. D. Thesis submitted to the Maharaja Sayajirao University of Baroda, Vadodara, India.

[12] Emiliani, C. **1991**. *Journal of Paleontology* (Journal of Paleontology, Vol. 65, No. 2) **65** (2): 329.

[14] George, M.G.**1961**, *India hydrobiology*,(3): 265-273.
[15] Gulati, R. D. and Wurtz-Schuiz, **1980**. *Hydrobiologia*, **72**: 211-222.
[16] Hafsa, S. L. and Gupta, S. **2009**. *J. Environ. Biol.*, **30**(6): 1007-1012.
[17] Hegde G.R. and Sujata T. **1997** distribution of planktonic algae in three fresh water lentic habitat of Dharwad, phykos, **36**,49-53.
[17] Hergender, G.L. **1980**, *hydrobiology*.: 225-240.
[18] Hosmani, S. P., Nagarathna, P. and Mahadev, J. **2002**. *IJEP*, **22** (8):852-857.
[20] Huddar, B. D. **1995**. *Hydrobiological studies in lentic fresh water bodies of Hubli*. Ph. D. thesis, Karnatak Univ. Dharwad.
[21] Hujare, M. S. **2005**. *Hydrobiologial studies of some water reservoirs of Hatkanangale Tahsil (Maharashtra)*. PhD thesis submitted to Shivaji University, Kolhapur, India.
[22] Hutchinson, G. E. **1967**. A treatise on Limnology (ii) Introduction to Lake Biology and the limnoplankton. *John Wiley and Sons, Inc. New York, London.*
[23] ISI, **1991**. Indian standard specification for drinking water ISO: 10500, ISI, New Delhi.

[24] Islam, A. M., Choudhary, S., Abdullah, H. and Zaman, M. **2001**. *Ecol. Environ. Conserv*., **7**(1): 1-7.
[25] Izaguirre, I., O'Farrell, I., Unrein, F., Sinistro, R., Dos. M., Afonso, S. and Tell, G. **2004**. *Hydrobiologia*, 511:2536.
[26] Jawale, A. K. and Patil, S. A. **2009.** *J. Auua. Biol*., **24**(1): 7-12.
[27] Johnston, R. B. and Jacoby, J. M. **2003**. *Hydrobiologia*, 495: 79-91.
[28] Kearns, K. D. and Hunter, M. D. **2001**. *Microbial Ecology*, 42: 80-86.
[29] Krishnan, K. H., Thomas, S., George, S., Murugan, R. P., Mundayoor, S. and Das, M. R. **1999**. *Pollution Research*, **18**: 261-269.
[30] Krishnan, J. R. **2008**.Investigation on hydrobiology and water Quality parameters of periyar lake,Thekkady, Kerala. Ph. D. Thesis submitted to Mahatma Gandhi University, Kerala
[30] Kumar G.P., Bisaria L.M., Bhandari B.G.,Rana and V. Sharma **1974**. J. *Environ.Hlth* **16**: 247-255.
[31] Lindholm, T., Vesterkvist, P., Spoof, L., Lundberg-Niinisto, C. and Meriluoto, J. **2003**. *Hydrobiologia*, 505:129-138.
[32] Manna, R. K. and Das, A. K. **2004**. *Poll. Res*, 23: 29-38.
[33] Mathivanan, V., Vijayan, P., Selvi, S. and Jeyachitra, O. **2007**. *J. Environ. Biol*., **28**(2): 523-526.
[34] Mazher Sultana and Dawood Sharif **2004** *J.Aqua.Biol.*19(1): 15-18.
[35] Mischke, U. and Nixdorf, B. **2003**. *Hydrobiologia*, 502: 123-132.
[36] More, Y.S. **1997**, Limnological studies of Panzara dam and river. Ph.D. Thesis, North Maharashtra University , Jalgaon.
[37] Munawar, M. **1974**. *Hydrobiologia*, **45**(1): 1-32.
[38] Munawar, M. **1970**. *India. J. The Biotope, Hydrobiol.*, **35**: 127-162.
[39] Munawar, M. **1972** *Hydrobiology*, **39**(3): 307-320.
[40] Murugavel, P. and Pandian, T. J**. 2000**. *Hydrobiologia*, 430: 33-57.
[41] Naik, U. G., Bhosale,S.H., Rathod, J. L. and Bhat, U.G. **2005**. Diversity of phytoplanktonic groups in the river Kali, West Coast of India. *Proceedings of Senior Lecturer University Grant Commission*, Haveri, pp. 192-196.
[42] Nandan S. N. and R.J. Patel.**1986**, *IndianJ.Environ Hlth*.29(2); 160-161.
[43] Nandan, S. N. and Magar, U. R. **2007**. *Seaweed Res. Utiln*., **29**(1-2): 279-285.
[44] Nandan, S. N. and Mahajan, S. R. **2003**. Pollution indicating algae of hartala lake of North Maharashtra (India). *Trends in Life Sciences* (India), **18**(1): 49-57.
[45] Padisak, J. and Reynolds, C. S. **1998**. *Hydrobiologia*, **384**: 41-53.
[46] Paerl, H. W. **1988**. *Limnol. Oceanogr*., 33:823-847.
[47] Palmer, C. M. **1969**. Composite rating of algae tolerating organic pollution. *British Phycology Bullettin*, **5**:78-92.
[48] Palmer, C. M. **1980**. *Algae and water pollution*. Castle House Publication Ltd. New York, pp.4-110.
[49] Patil J. V., Ekhande A. P. and Padate G. S. **2013**. *Archives of Applied Science Research*, Scholars Research Library, **5** (1):172-176
[50] Patil J. V.**2011**. Study of selected faunal biodiversity of Toranmal area, Toranmal reserve forest, Ph.D. Thesis Submitted To, The Maharaja Sayajirao University of Baroda, Vadodara, Gujrat (India).
[51] Patric, R. **1971**, *Limnol. Oceanogr* (2): 405-421.
[52] Patrick, R. **1973**. *Limnology Ocenography*, **16**: 405-421.
[53] Patrick, R. **1970**. Aquatic communities as indices of pollution: Indicators of Environmental Quality, Plenum Publishing Corporation, New York, pp. 93 - 100.
[54] Pearsall, W.H.**1923**, *J.Ecol*,11:165-183.
[55] Pendase D.C., Yogesh shastri and Bharate **2000** *Env. and cons*.6(1) :93-97.

[56] Philipose, M. T. **1960.** , *Proc. Sym.Algology*, *ICAR*., 272-291. Philipose, M. T. **1967**. Chlorococcales ICAR New Delhi pp 356.
[57] Pulle, J. **S.** and A.M. Khan **2001.** *J. Aqua. Biol*., 16(2),19-23.
[58] Ramchandra, T. V. and Solanki, M. **2007.** Ecological Assessement of Lentic Water Bodies of Bangalore. *Envis Technical Report*: 25. Indian Institute of Science, Bangalore.
[59] Rao C.B. **1995**.*J.Ecol.***43**: 291-308.
[60] Rott, E. **1984.** *Hydrobiology*, **43**(1):34-62.
[61] Round, F. E. **1985**. *The Ecology of Algae*. Published by the Press Syndicate of the University of Cambridge, Cambridge.
[62] Rutner, F. **1963**. *Fundamentals of limnology*, University of Toronto Press. 295 pp.
[63] Sandra, M., Alves-da-Silva., Guilherme, H. and Maria, A. O. **2007.** Diversity and ecological considerations on pigmented euglenophyta in the state park of the Jacui Delta, Rio Grande Do Sul, Southern Brazil. *Biociencias, Porto Alegre*, **15**: 8-20.
[64] Sangolkar, L. N., Chaudhari, P. R. and Shivaraman, N. **1999**. *J. Ind. Assoc. Environ. Manage*., 26: 18-29.
[65] Sarode, P. T. and Kamat, N. D. **1984**. *Freshwater diatoms of Maharashtra*. Saikrupa Prakashan, Aurangabad.
[66] Schorder, H. **1940**, Die Algenflora der mulde pflanzenforschung, 21: 1-88
[67] Seenayya,A G**.1972** *Hudrobiologai* 39(1) : 247-271.
[68] Sharma, B. K. **2009**. *J. Threatened Taxa*, **1**(8): 401-410.
[69] Shridhar, R., Thangaradjou, T., Kumar, S. S. and Kannan, L. **2006**. *J. Environ. Biol*., **27**: 561-566.
[70] Singh, S. R. and Swaroop, K. **1979**. *J. Indian Botanical Society*, **58**: 319-329.
[71] Sreenivasan, A., Pillai, K. V. and Franklin, T. **1997**. *Indian Hydrobiology*, 2(2): 61-69.
[72] Tas, B. and Gonulol, A. **2007**. *J. Environ. Biol*., **28**: 439-445.
[73] Thurman, H. V. **1997**. *Introductory Oceanography*. New Jersey, USA: Prentice Hall College. ISBN 0-13-262072-3
[74] Tiwari, A. and Chauhan, S. V. S. **2006.** *J.Env. Biol*., **27**(1): 35-38.
[75] Tiwari, D. and Shukla, M. **2007**. *Nat. Environ. Pollut. Technol.*, **6**: 85-90.
[76] Tiwari, D. D**.** and Srivastava, N. **2004**. *Poll. Res.*, **23** (1):65-68.
[77] Tucker, C. S. and Loyd, S. W. **1984**. *Hydrobiologia*, **112**: 137-141.
[78] Unni, K. S. and Pawar, S. **2000.**. *Hydrobiologia*, **430**:87-96.
[79] Unni, K.S.**1984.** *Int.Review Ges. Hydrobio*.69: 553-565.
[80] Venkateshwarlu V., Rao C.J. and Rao A.N.**1881.** *Indian J.Bot*. **4**: 31-36.
[81] Vyas, L. N. and Kumar, H. D. **1968**. *Hydrobiologia*, **31**: 421-434.
[82] Welch, P. S. **1952**. *Limnology*, 2nd Eds., McGraw Hill Book Co. Inc., New York.
[83] Zafar, A.R. **1964**., *Hydrobiology*. 23: 179-195.