Journal of Experimental Sciences Vol. 2, Issue 3, Pages 56-59 [2011]
www.jexpsciences.com

JES Life Sciences

Regular Article

Pigment diversity and biomass of phytoplankton in lentic water bodies of Bhadravathi taluk, Karnataka-India

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ABSTRACT: The present investigation revealed that biomass of phytoplankton by chlorophyll estimation method shows that Chl.a, Chl.b and Chl.c distributions were unequal. The minimum concentration of Chl.a was 0.112mg/L during November at BVTS3 and maximum .077 mg/L was recorded same station in the month of December. The Chl.b concentration was 0.0023mg/L minimum during October at BVTS1 and maximum 0.6118mg/L during August at BVTS3 and 0.0083 mg/L Chl.c was minimum during October at BVTS3 and maximum 3.894 in October at BVTS4.The correlation coefficient of six physico-chemical parameters show fluctuating the positive and negative correlation with different chlorophyll pigments. The Chl.c shows positive correlation with magnesium but others not. In BVTS1 of Chl.a, b and c show positive correlation with water temperature, pH bicarbonate and other stations were not showed the positive correlation.

Key words: Biomass, Chlorophyll pigments, Physico-chemical parameters, Correlation coefficient

Introduction

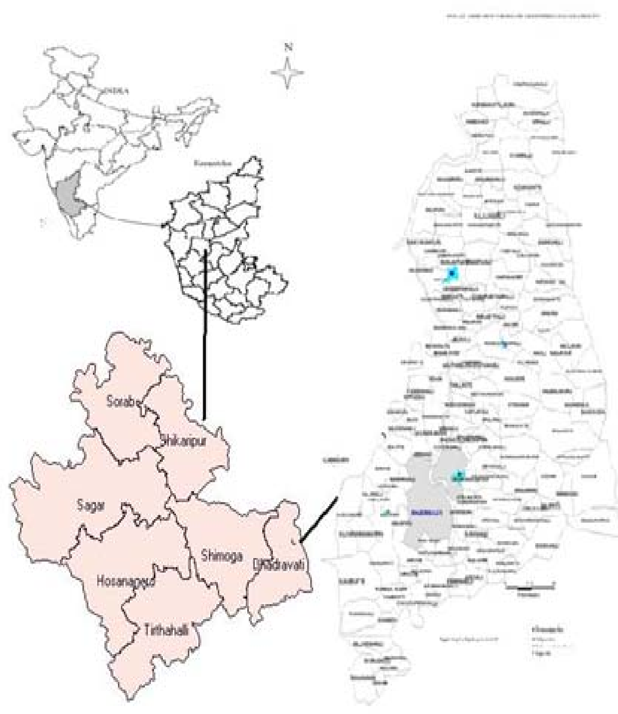
Freshwater ecosystems have been used for the investigation of factors controlling the distribution and abundance of aquatic organisms. The physical and chemical characteristics of water bodies affect the species composition, abundance, productivity and physiological conditions of aquatic organisms (Bagenal, 1978). Like most plants, most phytoplankton is autotrophic; they contain chlorophyll pigment that enables them to fix solar energy by photosynthesis, converting carbon into an energy form transferable to other parts of the aquatic food. Because photosynthesis removes carbon dioxide from the atmosphere and releases oxygen, the global primary production due to phytoplankton is an important variable in climate models. There are also more subtle but extremely important effects on global biogeochemistry. For example, it has been suggested (Charlson *et al.* (1987) that dimethylsulphidereleased by phytoplankton algae is a major source of cloud condensation nuclei. Pronounced environmental gradients should favour the distribution of phytoplankton indefined layers, that in their most obvious expression concentrate large proportions of algal biomass into surface blooms, deep chlorophyll maxima or benthic layers(Klausmeier and Litchman, 2001; Clegg et al., 2007). It has been confirmed that the ratio of light absorption at 480 and 665 nm by acetone extracts of phytoplankton pigments may be a useful indicator of nutritional status of natural phytoplankton populations (Heath *et al,* 1990). Quantification of phytoplankton biomass and community composition is important for understanding the structure and dynamics of fresh water ecosystems. There are many methods to determine phytoplankton biomass. Of these, the analysis of chlorophyll pigments to characterize phytoplankton biomass is widely used. The algal biomass of phytoplankton can be expressed as number of organisms per unit volume but since plankton population vary greatly in their size distribution, number alone do not give adequate picture of population dynamic or of the diversity and structure of the ecosystems (A.P.H.A 1980.) Chlorophyll *a* is a pigment that is found in most photosynthetic organisms, so its quantification is used as an indicator of the amount of photosynthetic material in water bodies. Stevenson and Smol (2003), surveys to determine the taxonomic composition of algae in the phytoplankton community are a useful means by which to assess biotic integrity and begin to diagnose causes of environmental problems

Perhaps the most important reason for preferring chlorophyll a in phytoplankton biomass determination is that it is the main photosynthetic pigment in all oxygen –evolving photosynthic organisms while other algal pigments(chlorophylls b and c, carotenoids and phycobillines),have limited distribution and are, therefore, considered as accessory or secondary pigments (Akpan 1994). The present investigation of phytoplankton aims that there was any stability of biomass irrespective of seasons and what are the core factors affecting for their production. Whether it a single factors or not. All the experiments were done in Bhadravathi Taluk of Shimoga district, Karnataka during the period of July 2010 to December 2010 (Six months, which covers two seasons). No longer have been undertaken much attention about the biomass of phytoplankton in lentic water bodies of Bhadravathi Taluk.

Study area

Geographically, Bhadravathi Taluk lies in the central parts of the Karnataka state, in the south-east corner of the Shimoga district. The latitude and longitude coordinates of Bhadravathi town are 13° 50' N and 75° 42'E.Bhadravathi taluk borders, shimoga taluk of Shimoga district of the west, Honnali taluk of Devangare district of the north, Channagiri taluk of Devangare district of the east and Tarikare taluk of Chikmagalure district to the south. The total area taluk is around 690sq//km and it's at an altitude of around 580m above sea level (Fig.1).

Fig: 1. Study area with the sample station at Bhadravathi taluk



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ISSN: 2218-1768

Geographical co-ordinates of Sample Stations are: Siddapura Lake,-BVTS1)(13˚ 50' 13.1"N, 75˚ 40' 54.5"E); Devanarasipura Lake-BVTS2),(13˚ 84' 12.3"N, 75˚ 72' 13.2"E); Koppa lake-BVTS3)13˚ 58 ' 41.3"N, 75 ˚ 42' 36.5"E);Kodihosure lake- BVTS3) (13˚ 56 ' 21.7"N, 75˚ 47' 46 .9"E) with an average elevation from the sea level is 602.5 meters.

Materials and Methods

For present investigation four sample stations were selected viz. BVTS1 which located outs trick of Bhadravathi municipality South West direction and BVTS2 which located within the Bhadravathi municipality area North East direction and other two sample stations such as BVTS3 and BVTS4 lay North West and North East directions. These sample station are directly and indirectly dependence on local community of taluk. The monthly samples were collected from each sample stations for estimation of biomass of phytoplankton. The following physico-chemical water parameters were determined; water temperature, dissolved oxygen, P^H, Free carbon dioxide, Bicarbonates and magnesium (APHA (1995). The samples were collected from the surface water by clean glass bottle 30cm away from the water surface and composite sampling was followed for biomass estimation. P^H of water sample: Method: Electrical Method: Water Temperature, Method: Field Thermometer; Estimation of Magnesium, Method: Calculation method; Estimation of Dissolved Oxygen (DO) Method: Winkler's modified Method; Estimation of free carbon dioxide by titrimetric method.

For assignment of biomass of phytoplankton, Chlorophyll estimation method was done. Surface water samples were collected at fifteen days intervals, from the sample station in clean, 1 litre plastic containers at 15cm below from the water surface and taken to the laboratory for analyses which were carried out within five hours of sample collection. Chlorophyll pigments were determined according to Golterman (1979). Water sample (500 ml) was filtered through a millipore filter paper (size, 0.15µ) and one or two drops of magnesium carbonate suspension was added as an aid to retention, besides guarding against the development of acidity in the filtrate. Pigments were extracted from the filtrate using 90% acetone and the optical density of the solution was determined spectrophotometrically at wavelengths 750 Å, 663 Å, 645 Å, 630 Å and 430 Å (Strickland & Parsons 1960). To obtain extinction due to chlorophyll alone, the background extinction value at 750 Å was subtracted from values at other wavelengths, and the various chlorophylls were calculated from the equations of Strickland & Parsons (1960) listed below.

Chl a (mg l^{-1}) = 15.6 $D^1$663 – 2.0 $D^1$645 – 0.8 $D^1$630

Chl b (mg l^{-1}) = 25.4 $D^1$645 – 4.4 $D^1$663 – 10.3 $D^1$630

Chl c (mg l^{-1}) = 109 $D^1$630 – 12.5 $D^1$663 – 28.7 $D^1$645

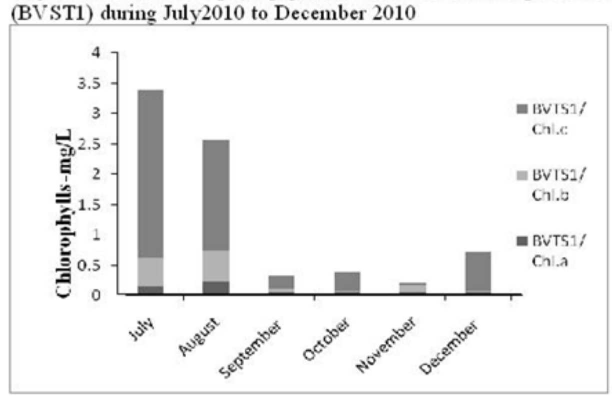
Where, $D^1$663 = $D^1$665 – $D^1$750:$D^1$645 = $D^1$645 – $D^1$750 and D1630 = $D^1$630 – $D^1$750

Results and Discussion

The results were show high fluctuating biomass of phytoplankton distribution within six months periods of July 2010 to December 2010. Four sampling stations were selected such as BVTS1, BVTS2, BVTS3 and BVTS4, (Bhadravathi Taluk Station).All the sampling station within 690sq/km of Taluk boundary. All sample stations were show irregular patterns Chl.a, Chl.b &Chl.c distributions and chlorophyll pigments were give mixed correlations six physic-chemical parameters. The minimum concentration of chla was 0.112mg/L during November at BVTS3 and maximum .077 mg/L was recorded same station but month of December. The Chl.b concentration was 0.0023mg/L minimum during October at BVTS1 and maximum 0.6118mg/L during August at BDVTS3 and 0.0083 mg/L Chl.c was minimum during October at BVTS3and maximum 3.894 mg/L in October at BVTS4.

BVTS1: The biomass of Phytoplankton particularly the Chlorophyll-a show minimum during in the month of August was 0.052 mg/L and maximum 0.223 mg/L during September. Chlorophyll-a, is a principal pigments of green algae even though, it found in Euglena, Diatoms. Since chlorophyll is an unique component of plant matter and essential for photosynthesis, the determination of chlorophyll *a* concentration has been recognized as one of the most useful methods of estimating the algal biomass (Jasprica and Caric, 1997).Chlorophyll-b was minimum 0.0023 mg/L during October and maximum 0.516 mg/L during September; they main constitute in Euglena and green algae. The chlorophyll-c also present it has minimum 0.037 mg/L during November and maximum 2.785 mg/L during July, it mainly considered as a accessory pigment although, it is main pigments of Bacilliariophyta, it was distributed throughout sampling periods. In fresh water chlorophyll-c mainly contained in Diatoms, but November the Chl-a and Chl.b overcome the chlorophyll-c that means population density of diatoms was less compare to Chlorphyceae, Cyanphyceae and Euglenophyceae. In terms of pigment distribution, chlorophyll *c* has been observed to be the dominant pigment. Since the pigment is usually associated with diatoms, especially with the photo-synthetic dinoflagellates (Richards 1952; Strain & Manning 1942a; Strain *et al*. 1943) the most abundant group of phytoplankton in the study stations was diatoms. **Fig.2**

Fig.2.Different Chlorophyll pigments distribution in sample Station-1 (BVST1) during July2010 to December 2010



Another exciting finding that Chl.a, has positive correlation with water temperature(r= 0.287), $_P$H (r=0.349), Bicarbonates (r=0.65) dissolved oxygen (r=0.0143) and also Magnesium(r= 0.0642) whereas only free carbon dioxide (r= -0.352) negatively correlated. It means one factor is limiting the production of phytoplankton biomass.Table.1.But in case of Chl.b has positive correlation with water temperature (r=0.323), $_P$H (r=0.298), Bicarbonates (r=0.0.47) and Magnesium (r=0.077), but dissolved oxygen (r=0.122) and free carbon dioxide (r= -0.552); it revealed that compare to Chl.a here was two main factors have negative correlationTable.2. The Chl.a and Chl.c have similar finding both have only free carbon dioxide (r= -0.367) negatively correlated **Table.3**. All pigments have positively correlated with water temperature, PH, bicarbonates and magnesium in BVTS1.There is evidence, for at least one fresh water algae, that the rate of photosynthesis at light and carbon-source saturation is lower when bicarbonates is being used than free carbon dioxide is being used (Raven 1968).

BVTS2: In station 2 has higher biomass compared to BVTS1, minimum Chl.a was 0.0208 mg/L during August and maximum 0.2264 mg/L during December and Chl.b has minimum 0.018mg/L during July and Maximum 0.3579 mg/L during December an**d** Chl.c has minimum .0317 mg/L and maximum 1.2011mg/L during July. In Station-2 has maximum biomass during in the month of December except Chl.c it was during the month of July even though, Chl.c dominant over other pigments except month of November .**Fig.2.** The chlorophyll – a, shows positive correlations with $_P$H, Bicarbonates and Magnesium but negative correlation with water temperature, dissolved oxygen and free carbon dioxide.HCO_3^- and CO_3^{2-} is very alkaline water are of special importance in relation to the availability of carbandioxide for photosynthesis , and their relative concentration are linked with the concentrations of hydrogen ions (Beadle,1974)**Table.1.** Chl.b shows positive correlation with $_P$H, bicarbonates, free carbon dioxide but negatively correlated with water temperature, dissolved oxygen and magnesium. Interesting finding here was only magnesium has negative correlation except all were positive correlation **Table.2.** Chl.c has similar trends with Chl.a **Table.1&3.**

Fig.3. Different Chlorophyll pigments distribution in Sample Station-2(BVTS2) during July 2010 to December 2010

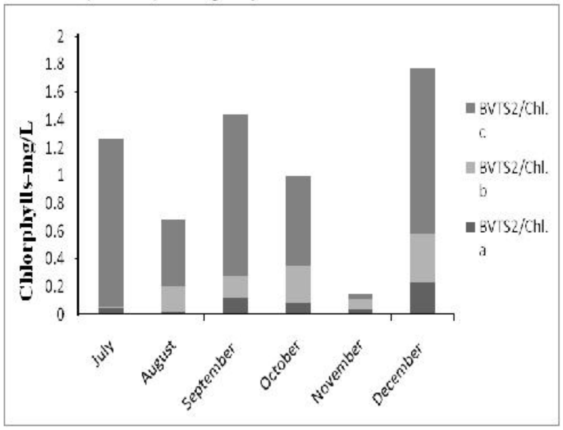


Table.2. Correlation coefficient of ***chl.b*** with five physic-chemical parameters of different sample stations of Bhadravathi Taluk for the period of July 2010 to December 2010

BDVTS1	Water temperature	$_P$H	Bicarbonate	Dissolved oxygen	Free carbon dioxide	Magnesium
Chl-b(mg/l)	0.323	0.298	0.47	-0.122	-0.552	0.077
BDVTS2						
Chl-b(mg/l)	-0.61	0.426	0.246	-0.36	0.409	-0.301
BDVTS3						
Chl-b(mg/l)	-0.302	-0.0804	-0.0223	0.303	0.519	0.754
BDVTS4						
Chl-b(mg/l)	-0.259	0.0194	-0.038	-0.064	-0.098	0.6012

Table.1. Correlation coefficient of ***chl.a*** with five physic-chemical parameters of different sample stations of Bhadravathi Taluk for the period of July 2010 to December 2010

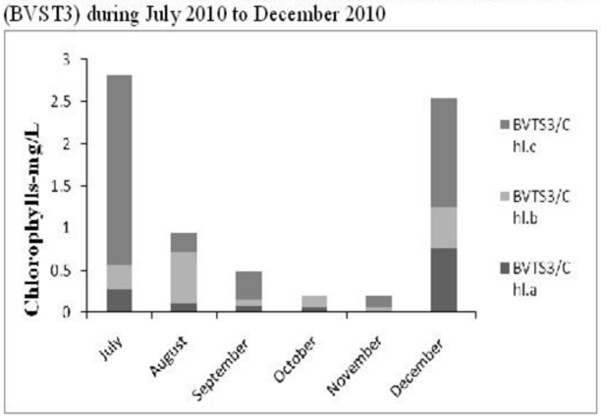
BDVTS1	Water temperature	$_P$H	Bicarbonates	Dissolved oxygen	Free carbon dioxide	Magnesium
Chl-a(mg/l)	0.287	0.349	0.65	0.0143	-0.352	0.0642
BDVTS2						
Chl-a(mg/l)	-0.665	0.563	0.087	-0.525	-0.0083	0.051
BDVTS3						
Chl-a(mg/l)	-0.578	-0.038	-0.257	0.359	-0.359	0.385
BDVTS4						
Chl-a(mg/l)	0.241	0.31	-0.285	0.756	-0.2761	-0.545

Table.3.Correlation coefficient of ***chl.c*** with five physic-chemical parameters of different sample stations of Bhadravathi Taluk for the period of July 2010 to December 2010

BDVTS1	Water temperature	PH	Bicarbonates	Dissolved oxygen	Free carbon dioxide	Magnesium
Chl-c(mg/l)	0.184	0.364	0.3433	0.331	-0.367	0.0957
BDVTS2						
Chl-c(mg/l)	-0.19	0.482	0.111	-0.511	-0.14	0.0306
BDVTS3						
Chl-c(mg/l)	-0.302	-0.0804	0.427	0.303	0.519	0.754
BDVTS4						
Chl-c(mg/l)	0.056	0.0735	-0.318	0.287	-0.388	0.811

BVTS3: Station3 has moderately high biomass compared to station 1&2. Here minimum Chl.a was 0.0112 mg/L during November and maximum 0.77mg/L during December; here minima and maxima in winter season. Chl.b has minimum 0.0512 mg/L during November and maximum 0.6118 during August, here minima and maxima at different seasons and also Chl.b was dominant over Chl.a. The Chl.c has minimum 0.0083 mg/L during October and maximum 2.253 during July. It means the distribution of diatoms fluctuation from season (Monsoon) to season (winter). Fig.4. In station-3 Chl.a has positive correlation with dissolved oxygen and magnesium but it was negatively correlated with water temperature, $_P$H, bicarbonates, and free carbon dioxide. The present results support the statement of (Mohapatta .S.P 1987) that the oxygen and carbon dioxide concentration usually behave reciprocally.**Table.1.**

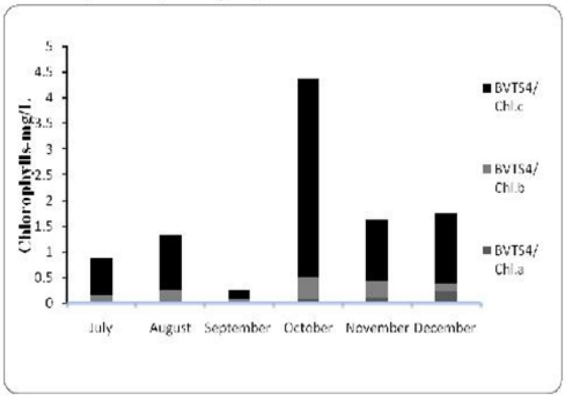
Fig.4. Different Chlorophyll pigments distribution in Sample Station-3 (BVST3) during July 2010 to December 2010



In Station-3 Chl.b shows a positive correlation with dissolved oxygen, free carbon dioxide and magnesium as station 2 whereas water temperature, $_P$H and bicarbonates were negative correlated, here three parameters counterparts of other three parameters Table.2. The Chl.c has a positive correlation with bicarbonates (r=0.427); dissolved oxygen(r=0.303); free carbon dioxide(r=0.519) and magnesium(r=0.754) and only two parameters seen negative correlation such as water temperature (r= -0.302) and P^H (-0.0804). Reported that fluctuation in pH values were mainly due to photosynthetic activity of Phytoplankton and other higher aquatic plants (Khan and Siddiqui .1978) Table.3.

BVTS4: In this station Chl.a were minimum 0.0204 mg/L during August and maximum 0.2404 mg/L during December i.e. minima and maxima at different seasons. But Chl.b with 0.0655 mg/L minimum during September and maximum 0.4035 mg/L during October i.e. both at transition stage of seasons (Monsoon and Winter).In case of Chl.c minimum was 0.1789 mg/L during September and maximum 3.8937 mg/L during October i.e. transition period of two seasons as same as Chl.b. Fluctuations in the photosynthetic ability of natural algal populations have been noted in recent years (Vcrduin 1957; Doty andOguri 1957; Holmes and Haxo 1958). At times these fluctuations have been associated with fluctuations in chlorophyll a (Yentsch and Ryther 1957; Shimada1958).**Fig.5.** In station-4 Chl.a has positive correlation with water temperature (r=0.241), $_P$H (r=0.31), and dissolved oxygen (r=0.756), but it was negatively correlated with bicarbonates (r=-0.285), free carbon dioxide (r= -0.2761) and magnesium(r= -0.545) Dissolved oxygen is governed by the photosynthesis activity and aeration rate (Gautam.A et.al., 1993).The distribution of dissolved in the lentic water is governed by a balance between input from the atmosphere, rainfall and loss by the chemical and biotic oxidations.**Table.1.**

Fig.5.Different chlorophyll pigments distribution in sample Station-4(BVTS4) during July 2010to December 2010



But in case of Chl.b indicated that a positive correlation with $_{P}$H (r=0.0194) and magnesium (r=0.6012) whereas negative relation with water temperature (r= -0.259), dissolved oxygen (r= -0.064, bicarbonates (r= -0.038) and free carbon dioxide (r= -0.098) **Table 3**. While Chl.c seen positive correlation with water temperature (r=0.056), $_{P}$H(r=0.0735), and dissolved oxygen (r=0.287), highly positive with magnesium (r= 0.811) but it was negatively correlated with bicarbonates (r= -0.318), free carbon dioxide (r= -0.388) **Table 4.** The use of Chlorophyll a in the prediction of algal biomass is widely known like other chlorophyll pigments maximum peak of Chlorophyll a obtained month of November at Station-2 Number of species found in a water body depends on several factors. Among these the season, habitats, the size of the lake and climatic of the area in which the water body is situated are most decisive. The concentration of Chl.a was less so the lentic water bodies of selected samples stations were oligotrophic in nature.

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