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Studies on monthly variations in phytoplankton diversity of hot water spring Atri, Odisha, India.

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Abstract: Phytoplankton in Atri hot water Spring of Odisha investigated monthly basic from January 2012 to December 2013. Result revealed that diversity of species Chlorophyceae % whereas Cyanophyceae and Bacillariophyceae were composed. The physicochemical parameters such as water temperature, PH, total alkalinity, chloride and phosphate were significantly related to phytoplankton abundance.

Key words: Monthly variations; Phytoplankton; Atri; Diversity.

Introduction

Phytoplankton was used as indicator of water quality (APHA, 2005) Phytoplankton the most important biological phenomenon in nature in which the entire array of the life depends, is the integral component of water ecosystem which determines the primary productivity of the system. It is the bio-indicators of water pollution. Its appearance, disappearance, density and pattern of distribution depend upon biotic and a-biotic factors (Gupta *et al.,* 2005, Komala Lewitus *et al.,* 1998, Escaravage *et al.,* 1999). The present dissertation complies the date of two consecutive years (2012 and 2013) of study on qualitative (Taxonomic identification) and quantitative survey of various phytoplankton of hot spring Atri (standing stock and percentage composition of planktonic tax)

Materials and Methods

The plankton samples were collected by a plankton net of standard bolting silk cloth No- 25 (Mesh size 0.03 - 0.04 mm) Planktons were collected in every month of the sampling 100 liters of water sample by a plastic bucket of 20 liters capacity through the plankton net. Finally, plankton sediment volume was adjusted to 30ml in the plankton net tub and preserved in 4% formaldehyde solution. The samples wear then taken to the laboratory for qualitative and quantitative estimation under the binocular stereoscopic microscope using a Sedgwick rafter type counting cell (1ml capacity) Escaravage and Prins (2002). After shaking the container congaing concentrated sub sample, 1 ml was quickly drawn a wide mouth pipette and poured in the plankton counting cell. All the organism encountered were represented in absolute number. About ten counting of each sample were made and the data represented in the text were average values of the counting.

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The density of population of the three major groups of algae viz. Chlorophyceae, Bacillariophyceae and Cyanophyceae were estimated seasonally from 2012 to 2013. The percentage of occurrence of three groups was calculated every month by taking their value from density population (Reynolds *et al.,* 2001)

Results

The phytoplankton composition of Atri was constituted mainly Chlorophyceae, Cyanophyceae and Bacillariophyceae Variation in the qualitative and quantitative estimation of phytoplankton was noted seasonally with the bimodal fluctuation of individual group in the table 1.

Table 1: Phytoplankton abundance of Atri during 2012 and 2013

Phytoplankton	2012	2013
Total species (nl^{-1})	12	11
Total number (nl^{-1})	110 – 667	132 – 681
Chlorophyceae species (nl^{-1})	7	6
Chlorophyceae number (nl^{-1})	42 – 433	58 – 412
Cyanophycae species (nl^{-1})	3	3
Cyanophycae number (nl^{-1})	19 – 65	21 -63
Bacillariophyceae species (nl^{-1})	2	2
Bacillariophyceae number (nl^{-1})	47 - 221	45 - 223

The total number of species belonging to different taxonomic groups were 12 in 2012 & 11 in 2013. Thirty-three genera comprising of 12 species (7 and 6 in 2012 and 2013 of Chlorophyceae, 2 of Bacillariophyceae and 3 of Cyanophycae were identified Bimodal nature of population peaks for whole phytoplankton was observed during winter and summer in term of percentage of distribution and standing stock. Among the Phytoplankton, Chlorophyceae was dominated in numerical form as well as percentage composition. Primary peak stage of plank tonic blooming was reported during winter and secondary peak was noticed during summer. Chlorophyceae showed its peak period

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only during summer, while Cyanophyceae showed the primary peak during summer and secondary peak during winter. The standing stock and percentage composition of phytoplankton flora showed the seasonal fluctuation due to the variation in composition of its different groups seasonally. Among the Phytoplankton, Cyanophyceae was dominated in numerical form as well as percentage composition. Primary peak stage of plank tonic blooming was reported during winter and secondary peak was noticed during summer.

Cyanophyceae showed the primary peak during summer and secondary peak during late monsoon (winter) The standing stock and percentage composition of phytoplankton flora due to the variation in composition of its different groups seasonally.

Abundance

Phytoplankton from the sample water taxonomically identified and recorded with their scientific names. They are classified into three group's viz. (1) Chlorophyta (2) Cyanophyta and (3) Bacillariophyta. All total 12 species of Phytoplankton were found during two years of investigation (Jan 2012 to Dec 2013) (Table 1) 12 species were observed during 2012 and 11 species were observed during 2013 (Table 1) During 2012 all total 7 species and during 2013 all total 6 species of Chlorophyta, 3 species of Cyanophyta and 2 species Bacillariophyta in both the year were identified (Table 1)

Table 2: Standing crop and % distribution of major phytoplankton 2012

Month	Total phytoplankton	Chlorophyceae		Cyenophyceae		Bacillariophyceae	
	n/I	n/I	%	n/I	%	n/I	%
Jan	548	385	70.255	63	11.496	100	18.248
Feb	667	397	59.520	49	7.346	221	33.133
Mar	653	398	60.949	51	7.101	204	31.240
Apr	646	430	66.563	64	9.907	152	23.529
May	703	433	61.593	65	9.246	205	29.160
Jun	516	366	70.930	42	8.139	108	20.930
July	411	278	67.639	31	7.542	102	24.817
Aug	165	048	29.090	19	11.515	98	59.393
Sept	110	042	38.181	21	19.090	47	42.727
Octo	337	188	55.786	23	6.824	126	37.388
Nove	232	054	23.275	22	9.482	156	67.241
Dec	478	285	59.623	29	6.066	164	34.309

Table 3: Standing crop and % distribution of major phytoplankton 2013

Month	Total phytoplankton	Chlorophyceae		Cyanophyceae		Bacillariophyceae	
	n/I	n/I	%	n/I	%	n/I	%
Jen	558	395	70.788	61	10.931	102	18.279
Feb	663	398	60.030	42	6.334	223	33.634
Mar	654	399	61.009	43	6.574	212	32.159
Apr	597	412	69.011	61	10.217	124	20.770
May	681	396	58.149	63	9.251	222	32.599
Jun	454	302	66.519	44	9.691	108	23.788
July	441	298	67.573	39	8.843	104	23.582
Aug	182	62	34.065	21	11.538	99	54.395
Sept	132	58	43.939	29	21.969	45	34.090
Octo	371	188	50.673	30	8.086	153	41.239
Nove	246	75	30.487	28	11.382	143	58.130
Dece	488	305	62.500	32	6.557	151	30.942

Table 4: Seasonal Rhythm in Physico-Chemical Parameters of Atri During 2012

Month	Water Temp(C^0)	pH	DO^2 mgl^{-1}	Chloride mgl^{-1}	Nitrate mgl^{-1}	Phosphate mgl^{-1}	Total Alkalinity mgl^{-1}
Jan	56	6.7	1.5	8.42	0.175	0.039	14
Feb	56	6.7	1.4	9.1	0.23	0.024	17
Mar	57	6.7	1.6	8.3	0.24	0.017	20
Apr	56	6.6	1.5	7.52	0.142	0.013	24
May	56	6.5	1.4	6.1	0.173	0.039	21
Jun	56.1	6.5	1.0	6.0	1.3	0.027	18
July	56.1	6.6	1.2	8.3	2.02	0.020	13
Aug	56.1	6.7	1.3	3.23	2.04	0.016	7
Sept	57	6.7	1.3	7.4	1.8	0.046	4
Octo	56	6.7	1.4	8.1	2.2	0.027	6
Nove	56	7.0	1.4	6.08	2.12	0.029	9
Dece	57	6.7	1.5	6.4	1.9	0.024	11

Table 5: Seasonal Rhythm in Physico- Chemical Parameters of Atri During 2013

Month	Water Temp(C)	pH	DO² mgI⁻¹	Chloride mgI⁻¹	Nitrate mgI⁻¹	Phosphate mgI⁻¹	Total Alkalinity mgI⁻¹
Jan	56	6.7	1.5	8.53	0.164	0.034	17
Feb	56	6.8	1.4	9.2	0.288	0.023	20
Mar	56	6.8	1.6	8.4	0.22	0.013	21
Apr	57	6.7	1.2	7.6	0.15	0.012	25
May	56.2	6.6	1.4	6.2	0.17	0.035	19
Jun	56.2	6.5	1.0	6.2	1.65	0.036	14
July	56	6.6	1.1	8.2	1.93	0.021	10
Aug	56	6.7	1.2	9.3	2.12	0.017	8
Sept	56	6.8	1.3	7.3	1.13	0.041	5
Octo	56	6.8	1.3	8.5	2.14	0.032	7
Nove	56	7.0	1.4	6.12	2.135	0.029	9
Dece	56.5	6.7	1.5	6.3	1.653	0.025	12

Total phytoplankton were observed to be maximum 703 in May and minimum 110 in September during 2012 and maximum 681 in May minimum 132 September during 2013 (Table 2). Out of the total species percentage of Chlorophyta was 53.844 % and 46.156 % during 2012 and 2013 respectively. Whereas percentage of Cyanophyta was 21.425% and 23.078% during 2012 and 2013 respectively. The Bacillariophyta was 24.741% and during 2012 and 2013 respectively. With its bimodal nature, population of whole Phytoplankton reached its peak on the month of May in each year, 2012 and 2013. This is revealed from the percentage of distribution and standing stock reflected in Table 2 & 3.

Chlorophyta reached its peak in the month of May with 433 (n/I) during 2012 and in the Month of April 412 (n/I) during 2013. Minimum of standing crop (n/I) was observed to be 110 and 132 during 2012 and 2013 respectively in the month of September each year. Whereas Cyanophyta reached its peak in the month of May with 65 (n/I) and 63 (n/I) during 2012 and 2013 respectively. Minimum of standing crop (n/I) was observed to be 19 and 21 during 2012 and 2013 respectively in the month of August. Similarly, Bacillariophyta reached its peak 221 (n/I) and 223 (n/I) in the month of February during 2012 and 2013 respectively. Minimum of standing crop (n/I) was observed to be 47 and 45 during 2012 and 2013 respectively in the month of September. (Table 2 & 3)

Discussion

The present investigation had been discussed in relation to the Phytoplankton composition, frequency, periodicity of dominant species in different Physicochemical conditions of the aquatic environment. Presence of the three groups of Phytoplankton viz. Chlorophyceae, Cyanophyceae and Bacillariophyceae (diatoms) agrees with finding of (APHA, 2005) in other riverine systems of India.

The volume and percentage contribution of phytoplankton vary from month to month in Atri. Further, the availability of phytoplankton in the riverine ecosystem depended upon its phytoplankton Reduced numbers of phytoplankton had been reported from acidic water and it was supported by Lewitus *et al.,* (1998).

The maximum number of phytoplankton population was recorded in rain to summer May to summer and minimum in wither demonstrated that phytoplankton has a remarkably adaptability to change in salinity. The maximum numerical abundance of the Phytoplankton community in the post monsoon might be attributed to the impact of nutrients through surface run off during monsoon at high precipitation rate. This increase in algal density and diversity was perhaps due to the nutrient load in the water during monsoon which might be due to distribution of algal from in any habitat depends on the natural changes in environmental conditions, seasonal variation, water quality and the relative adaptability of species. The results of the present study indicated that moderate flow of water provides benefits to increase phytoplankton population during winter and early summer month. Similar result had also been observed by LeQuere *et al.,* 2005. observed winter peak of Chlorophyceae too. The plankton community on which the whole aquatic depends directly or indirectly was largely influenced by the interaction of number of factors (Lewitus *et al.,* 1998) However, during the investigation it is noticed that the effect of physical forces like light and heat is great limn logical significance as they are solely responsible for many of the phenomena like thermal stratification, chemical stratification, diurnal and seasonal variations in the number and distribution of plankton, spatial distribution of micro-and macro organisms, and Cyclomorphosis etc. further higher value of sulphure may not be favorable for growth of the algae in the hot spring system. Thus, water quality has a greater influence on the ability of aquatic plants and animals to exist and grow in a stream, lake pond or bay and pointed out that a number of physical, chemical and biological environmental circumstances acting simultaneously must be taken to consideration in

understanding the fluctuations of plankton population. The effect of pollutants coming from various anthropogenic activities and factors operating on land are more pronounced at the interface. As a. major element in aquatic biota, the algal column often exhibits dramatic challenges in response to different types of pollutants.

So far the report of Escaravage and Prins, (2002) is concerned, the seasonal variation in a plankton population is a common phenomenon and has been attributed to many factors. During the study it was observed that the phytoplankton population was comparatively high during winter and early summer and low in rainy. The lowest population in the rainy season may be attributed to unfavorably hydrographic and physicochemical conditions of the water, which corroborated with the reports of Escaravage and Prins, (1999) and had also recorded the low density of plankton during rainy season due to high influx of flood water and rain washings and ultimately much of it was also lost in the heave draw-down. The concentration decreased during monsoon floods, but increased rapidly with decline in water current and turbidity during post-monsoon month. The lower values for the plankton communities during monsoon season may be attributed to high inflow of water from the catchment area changing the hydrology of the river system as a result of dilution (LeQuere *et al.,* 2005)

Phytoplankton shows the seasonal variation in composition (nI-1) with the periodic maxima and minima of Chlorophyceae, the maximum number of total phytoplankton during summer season and winter season indicates the good physicochemical condition in relation to the phytoplankton population. The high values of the phytoplankton number reflect entropc conditions. The high density of Phytoplankton was caused due to increased levels of phosphorus and nitrogen of which the former acts as primary limiting factor. It was because phosphorus is most rapidly and commonly used by vast majority of algae and the algal growth was affected when phosphorus level was below the critical level (Kauppila *et al.,* 2004)

The phytoplankton increases more in number after post monsoonal period and reaches its peak during early summer utilizing phosphate and nitrogen from the medium showing an inverse correlation ship with these nutrients (with phosphate r=-1.094; $p<0.01$ and with nitrogen r=-0.087; $p< 0.01$) During winter and early summer the phosphate and nitrogen contens decrase with increase of autotrophy level.

The maximum phytoplankton population found from winter and summer leading to higher productivity in summer, may be due to the favorable condition of the water. In season, the population was low, probably due to increased rainfall, the increase in water level, high water current, increase turbidity run off and dilution effect of flood. Similar had also been observed by kumar *et al.,* (2005)

Chlorophyceae

Amoung Chlorophyceae, the dominant species are Ulothrix zonata, Spirogyra sp, Cosmarium reniforme are majority of algae and the algal growth was affected when phosphorus level was below the critical level (Komala *et al.,* 2013)

Bacillariophyceae (Diatoms)

The results of analysis of variance showed a greater variation in both seasons and sampling point. Lewitus *et al.,* 1998 reported that in winter and spring the group Bacillariophyceae showed apak density in lake Ohakari, Newzealand Kumar *et al.,* (2005) observed that the Bacillarian population was known to be the inhabitant of polluted water in Jhelum river, Kashmir.

Species Diversity and Equitability

It was observed that throughout the studies the values were very low. The high diversity index value indicated that Cyanophyceae and Bacillariophyceae grow richly in the polluted area whereas Chlorophyceae cannot tolerate the pollutants to the same degree as Cyanophyceae and Bacillariophyceae However in the present study it was revealed that the percentage contribution of different groups of phytoplankton to total plankton community varied from season to season.

The higher diversity of phytoplankton species at the pollution free sites might be attributed to the more favorable environmental conditions. For instance, while there was more light penetration due to low total dissolved solids, dissolved oxygen was high due to greater primary productivity. The low diversity values associated with the sewage disposal site may be due to pollution stress imposed by sewage effluent and reduced transparency the maximum value H (Shannon-Weaver Index) was observed from winter to summer when physical environmental conditions were normal and lowest values during June-July to October when the environment was disturbed due to rains. According to (APHA, 2005) the Shannon weaver Index reflects the change in community brought about by the environmental. The present observation support to (Komala *et al.,* 2013) who opined that higher values of H indicates the absence of stress factor and the low values appear during monsoon.

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