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Seasonal variations and biodiversity of phytoplankton in Harsool-Savangi dam, Aurangabad, India

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Abstract

The present study concerns seasonal variations, correlation coefficient and biodiversity indices of phytoplankton during January to December, 2008 in the Harsool-Savangi dam, Aurangabad, India. A total of 35 genera were recorded out of which 15 were Chlorophyceae, 7 Bacillariophyceae, 7 Cyanophyceae and 6 Euglenophyceae. Present study revealed maximum percentage wise compositions of Chlorophyceae at north site 41.91%, Bacillariophyceae at west site 32.70%, Cyanophyceae at south site 19.50% and Euglenophyceae at west site 11.47%. Minimum percentage wise compositions Chlorophyceae at south site 37.80%, Bacillariophyceae at east site 28.15%, Cyanophyceae at west site 17.47% and Euglenophyceae at north site 10.57%. Margalef's index (R_1) and Menhinick index (R_2) values (4.12 and 0.56) were found to be highest at south site and lowest values (3.77 and 0.38) were found at north site. Simpson's index (I) values (0.30) were found to be the highest at north site and lowest values (0.29) were found at south, east, and west sites. Shannon – Weiner index (H') values (1.26) were found to be the highest at south, east, and west sites and lowest values (1.24) were found at north site. Maximum species evenness was recorded at south site; minimum at north site. Maximum population density of Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae (1923, 1173, 889 and 541 organisms l^{-1}) were recorded at north site in summer and minimum (108, 195, 67 and 24 organisms l^{-1}) were recorded at south site in monsoon, respectively.

Key words

Phytoplankton, Seasonal variation, Biodiversity indices, Harsool-Savangi dam

Introduction

Phytoplankton converts solar radient energy into biological energy through photosynthesis as primary production. It plays an important role in conditioning the microclimate, helps in regulating the atmospheric level of O_2 and CO_2, vital gases for life. Apart form primary production, phytoplankton plays an important role as food for herbivorous animals. Distribution of phytoplankton and their variation at different zones of a water body is known to be influenced by physico-chemical parameters of water. Phytoplankton study provides a relevant and convenient point of focus for research on the mechanism of eutrophication and its adverse impact on an aquatic ecosystem. Algal flora constitutes a vital link in food chain and its productivity depends on water quality at a given time (Meshram and Dhande, 2000).

A prior knowledge of the phytoplankton for any scientific utilization of resources is always helpful (Chandhary *et al.,* 2001). A lot of work has been carried out in India on the phytoplankton of fresh water habitats (Pandey *et al.,* 1993; Jawale and Kumawat, 2000; Sahat *et al.,* 2001; Das *et al.*, 2002; More and Nandan, 2003; Sirsat *et al.,* 2004; Pawar and Pulle, 2005; Pawar *et al.,* 2006; Khapekar and Nandkar, 2007; Laskar and Gupta, 2009 and Hosmani, 2010).

The planktonic study is a very useful tool for the assessment of water quality in any type of water body and also contributes to understanding of the basic nature and general economy of the lake (Pawar *et al.*, 2006). In these systems phytoplankton is of great importance as a major source of organic carbon is located at the

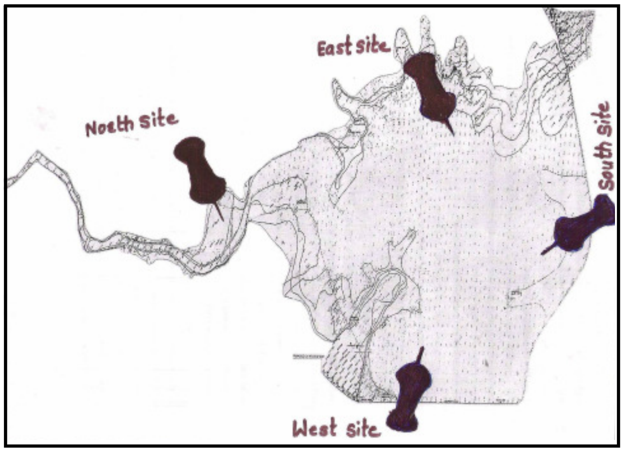

Fig. 1: Showing four sites *i.e.* south, north, east and west

base (Gaikwad *et al.,* 2004). The maintenance of healthy aquatic ecosystem are dependents on the abiotic properties of water and the biological diversity of the ecosystem (Harikrishnan *et al.,* 1999).

Keeping this view in mind, the present study was undertaken to assess seasonal mean values, orderwise total percentage, species richness, species diversity and species evenness in Harsool-Savangi dam, Aurangabad, India.

Materials and Methods

In the present study, plankton sampling was taken for one year (January to December, 2008) at four different sites (south, north, east and west) during summer (February, March, April and May), monsoon (June, July, August and September) and winter (October, November, December and January) seasons (Fig. 1).

Plankton analysis: Plankton net (mesh size 25 µm) was swept on surface water (Secchi's disc transparency zone) and plankton collected were transferred into separate plastic bottle/containers. Surface water (100 l) was sieved through plankton net to obtain planktons.

These planktons were fixed and preserved in 4% formalin. The formalin fixed plankton samples were centrifuged at 1500-2000 rpm for 10-12 min. The phytoplanktons settled at bottom were diluted to a desirable concentration in such a way that they could be easily counted individually under compound binocular microscope and phytoplanktons were measured and multiplied with the dilution factors using Sedgwick Rafter cell (Welch, 1948; Smith, 1950; Dhanpati, 2000; APHA, 2005).

Species diversity, species richness and species evenness were calculated as per Ludwick and Reynold (1988). Shannon and Weaver (1949) and Simpson (1949) diversity index values were also calculated.

Results and Discussion

Diversity of phytoplankton: Detailed microscopic examination of phytoplanktons revealed 4 families consisting of 35 genera of phytoplankton in the order: Chlorophyceae (15 genera), Bacillariophyceae (7 genera), Cyanophyceae (7 genera) and Euglenophyceae (6 genera). The following species were observed: *Chlorella sp., Hydrodicton sp., Chlamydomonos sp. Chara sp., Cladophora sp., Closterium sp., Cosmarium sp., Oedogonium patulum, Oedogonium sp., Pediastrum duplex, Pediastrum simplex, Pediastrum sp., Spirogyra sp., Ulothrix zonata* and *Volvox sp.* (Chlorophyceae); *Diatom sp., Navicula subtilis, Navicula accomda, Navicula sp., Nitzschia denticulate, Nitzschia sp.,* and *Pinnularia sp.* (Bacillariophyceae); *Anabaena sp., Anabaena beckii, Microcystic sp., Nostoc sp., Oscillatoria chlorina, Oscillatoria cortiam* and *Spirulina sp.* (Cyanophyceae); *Euglena acus, Euglena granulate, Euglena sp., Euglena elongate, Phacus sp.* and *Trachelomons sp.* (Euglenophyceae).

The average and total seasonal variation for Chlorophyceae were maximum during summer at north site (32.05 and 1923 org l^{-1}) and minimum during monsoon at south site (1.8 and 108 org l^{-1}) . Maximum Bacillariophyceae were recorded during summer at north site (41.89 and 1173 org l^{-1}) and minimum during monsoon at south site (6.96 and 195 org l^{-1}). Average and total seasonal variation for Cyanophyceae was maximum during summer at north site (31.75 and 889 org l^{-1}) and min during monsoon at sourth site (2.39 and 67 org l^{-1}). Similarly, for Euglenophyceae it was maximum during summer at north site (22.54 and 541 org l^{-1}) and during monsoon at south site (1.1 and 24 org l^{-1}), respectively (Table 1).

Maximum percentage of Chlorophyceae were found at north site (41.91%) and minimum at south site (37.80%). For Bacillariophyceae, maximum percentage (32.70%) was recoreded at west site and minimum at east site (28.15%). While maximum percentage of Cyanophyceae was found at south site (19.50%) and minimum at west site (17.47%) and for Euglenophyceae, maximum percent was found at west site (11.47%) and minimum at north site (10.57%), respectively. Seasonally, phytoplankton showed dominance during summer season followed by winter and monsoon season.

During summer, increasing temperature enhances the rate of decomposition due to which the water becomes nutrient rich similarly due to concentration followed by evaporation in summer season the nutrient concentration increases and abundant food present in form of photosynthesis (Santhanam and perumal, 2003). The high phytoplankton population density during the summer season could be related to stable hydrological factors and low water level; while low density during the monsoon season attributed to heavy flood and fresh water inflow. They were resumed again in monsoon due to dilution and high water level (Krishnamoorthy *et al.,* 2007).

Hassan *et al*. (2010) reported minimum density of phytoplankton during monsoon and maximum during summer in Euphrates river, Iraq. Similarly, Laskar and Gupta (2009) reported minimum density of phytoplankton during monsoon and maximum during summer in Chatla Lake, Assam. Banakar, (2005) reported

Table - 1: Orderwise average and total seasonal variations of phytoplankton's (organisms l^{-1}) at Harsool - Savangi dam during January - December, 2008

Site	Order	Average			Total			Grand total	Total percentage
		Summer	Monsoon	Winter	Summer	Monsoon	Winter		
South	Chlorophyceae	16.41±12.85	1.8±3.01	5.88±6.69	664	108	527	1446	37.80
	Bacillariophyceae	24.64±21.43	6.96±8.59	11.92±10.57	690	195	334	1219	31.86
	Cyanophyceae	17.10±9.63	2.39±4.12	7.14±6.10	479	67	200	746	19.50
	Euglenophyceae	12.45±7.36	1.1±1.56	3.79±3.40	299	24	73	414	10.82
	Total				**2132**	**394**	**1134**	**3825**	
North	Chlorophyceae	32.05±20.19	7.05±8.93	17.91±12.47	1923	423	1075	3421	41.91
	Bacillariophyceae	41.89±25.44	16.14±13.29	26.75±17.72	1173	452	749	2374	29.08
	Cyanophyceae	31.75±17.80	8.03±10.54	13.92±15.16	889	225	390	1504	18.42
	Euglenophyceae	22.54±17.59	3.45±5.03	9.95±11.36	541	83	239	863	10.57
	Total				**4526**	**1183**	**2453**	**8162**	
East	Chlorophyceae	25.25±14.76	4.91±5.81	11.81±9.63	1515	295	709	2519	41.20
	Bacillariophyceae	31.78±22.69	10.46±11.17	19.21±14.89	890	293	538	1721	28.15
	Cyanophyceae	24.03±14.50	5.25±7.93	11.9±11.62	673	147	357	1177	19.25
	Euglenophyceae	19.83±11.18	1.79±2.66	7.37±6.81	476	43	177	696	11.38
	Total				**3554**	**778**	**1781**	**6113**	
West	Chlorophyceae	20.68±14.21	3.03±6.03	8.46±8.79	1241	182	508	1931	38.34
	Bacillariophyceae	30.67±22.70	10.39±10.76	17.75±14.58	859	291	497	1647	32.70
	Cyanophyceae	18.75±12.71	3.53±5.46	9.14±7.80	525	99	256	880	17.47
	Euglenophyceae	16.95±10.89	1.16±1.55	5.95±4.38	407	28	143	578	11.47
	Total				**3032**	**600**	**1404**	**5036**	

Values are mean of five replicates ± SD

Table - 2: Annual variations of phytoplankton's biodiversity indices at Harsool – Savangi dam during January - December, 2008

Indices	Index	South site	North site	East site	West site
Species richness	(N_0)	35	35	35	35
	(R_1)	4.12	3.77	3.89	3.98
	(R_2)	0.56	0.38	0.44	0.49
Species diversity	(I)	0.29	0.30	0.29	0.29
	(H')	1.26	1.24	1.26	1.26
Species evenness	(E_1)	0.36	0.34	0.35	0.35
	(E_2)	0.10	0.09	0.10	0.10
	(E_3)	0.07	0.07	0.07	0.07
	(E_4)	0.97	0.96	0.97	0.97
	(E_5)	0.96	0.95	0.96	0.96

R_1 = Margalef's index, N_0 = No. of all species, H' = Shannon-Weiner index, I = Simpson's index, R_2 = Menhinick index, E_1-E_5 = Evenness index

the peak of phytoplankton during April while lowest peak in July and August in village pond at Imalia (Vidisha) India.

Maximum species richness in term of Margalef's index (R_1=4.12) and Menhinick index (R_2=0.56) was recorded at south site while minimum (R_1=3.77 and R_2=0.38) at north site, respectively. Similarily, maximum species diversity in terms of Simpson's index (I=0.30) and Shannon's-Weiner index (H'=1.26) at south, east and west sites and minimum Simpson's index (I=0.29) was found at south, east and west sites and Shannons-Weiner index (H'=1.24) at north site, respectively. Species eveness was recorded maximum at south site and minimum at north site (Table 2).

Phytoplankton species diversity index (PSDI) and Simpson's index (I) varied from 0 to 1, gives the probability that two individuals drawn at random from a population belong to the same species. Simply stated, if the probability was high both individuals belonged to the same species, then the diversity of the community sample was low. Shannon's index (H') combines species richness and species evenness components as an overall index of diversity. PSDI value of phytoplankton was higher at south site. The higher value of Shannon's index (H'), indicated greater species diversity. The greater species diversity means larger food chain and more cases of inter-specific interactions and greater possibilities for negative feedback control which reduced oscillations and hence increases the stability of the community (Ludwick and Reynold, 1988).

These diversity indices indicated that the ponds under study have a well balanced phytoplankton community that enjoyed an even representation of several species indicating the dynamic nature of this aquatic ecosystem. However, remedial measures should be undertaken to minimize the impact of pollution load as revealed by the ecological indicators. Equitability (evenness) was relatively high during the raining season indicating a reduction in the plankton diversity at this period (Adesalu and Nwankwo, 2008). This means that species evenness decreased with increasing size of the plankton population. The E_1, E_2 and E_3 indices were also sensitive to species richness while E_4 and E_5 were relatively unaffected by species richness.

However, little is known about the diversity of epipelic algae in lakes and dam reservoirs in Turkey (Sahin, 2004; Akar and Sahin, 2006). In the Balikli dam reservoir, it was observed that the seasonal changes in diversity showed an inverse pattern with species number. This indicates that species evenness decreased with increasing size of the algal population. Quantitative counts showed clear seasonal variation in phytoplankton cell numbers with maximum during early summer and autumn. Seasonal variations in abundance and composition of dam phytoplankton are usually affected by the discharge, morphometry, hydrology, trophic status, and light availability (Kumari *et al*., 2006; Reynolds, 2003; Reynolds, 2006; Leveque, 2006; Indra and Sivaji, 2006; Shiddamallayya and Pratima, 2008; Kolayli and Sahin, 2009).

In conclusion, chlorophyceae were the dominant phytoplankton group in the study period at Harsool-Savangi dam. The presence of a species will depend on its environmental tolerance, but the resources available to it will determine its abundance. If competition or predation is reduced or the food supply or suitable habitat increased, the species will become more abundant. In present study, basic information of the phytoplanktons distribution and abundance would form a useful tool for further ecological assessment and monitoring of ecosystems at Harsool-Savangi dam. Phytoplanktons were characterized by higher diversity, lower dominance and higher evenness with indefinite patterns of annual variations. High value of species richness at south site *i.e.* show longer food chain compare to other sites. Simpson index higher values at north site i.e. show the stable habitat (stability) compare to other sites. According to Shannon index values 0 > 1 at north site *i.e.* show the habitat is under stress polluted; 1 < 3 at south, east and west sites *i.e.* show not highly polluted.

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