Keywords: Anthropogenic pollution; Biomonitoring; Diatoms; Ecological indicators; Louis-Laclercq; Organic pollution

Introduction

Freshwater communities are very much sensitive to environmental variations [1]. Phytoplankton dynamics influence trophic levels and portability of water for human uses [2,3]. Monitoring of water quality with regards to physical and chemical parameters reflects instantaneous measurements while, biotic parameters developed during the recent years have served as an excellent tool in the area of water pollution studies and provides better evaluation of environmental changes [4]. Diatoms are potential indicators of water quality due to their sensitivity and strong response to physico-chemical and biological changes [5]. Juttner et al. [6] studied environmental changes using diatom assemblages, relationship between diatoms and the water chemistry parameters. According to him fluctuation of diatom species to various environmental changes can be early warning towards freshwater ecological problems. Their sensitivity to small changes in water quality makes them powerful indicators. Several studies on diatoms as bioindicators of pollution have been carried out earlier [7-12].

Biological monitoring is a fast and cost-effective approach for assessing the effects of environmental stressors, making it an essential tool [13]. Various indices have been developed for monitoring pollution in water bodies. One of the simplest and effective water quality index, utilizing diatom population is IDSE/5-the index of Saprobity-Eutrophication. This index is obtained from the OMNIDA GB 5.3 software which indicates the quality of water in terms of organic pollution as well as anthropogenic eutrophication. The design of OMNIDA Software for computation of diatom indices has facilitated the use of diatom based biomonitoring [14]. The software is a comprehensive data base having an inbuilt ecological data for 13,000 diatom species. Present study discusses diatoms as indicators of water quality of selected water bodies using Louis-Leclercq Diatomic Index of Saprobity-Eutrophication (IDSE/5) and the quality of water in terms of organic pollution as well as anthropogenic eutrophication.

Materials and Methods

Two water bodies each from North Goa (Syngenta Lake and Khandola Pond) and South Goa (Lotus Lake and Curtorim Lake) were selected for the study from January 2014 to December 2015 on monthly basis. Water samples were collected in the early hours as daily vertical migrations of organisms occur in response to sunlight and nutrient concentrations from the surface near the landward margins. Physico-chemical parameters such as pH, temperature, nitrates and phosphates were analysed using standard procedures [15]. For phytoplankton study one litre of water sample was collected in sterile plastic bottles (three ionechemtechniqu a Lake an

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		January to December 2014				January to December 2015			
Sr.No.	**Parameter / criteria**	**SL**	**KP**	**LL**	**CL**	**SL**	**KP**	**LL**	**CL**
1	Number of genera	10	2	12	12	10	2	11	10
2	population	78862	96925	14155	10763	11124	95525	99119	13000
3	Diversity	3.64	2.07	3.65	3.7	3.65	2.05	3.72	3.62
4	Evenness	0.98	0.89	0.98	0.97	0.96	0.88	0.98	0.95
5	Number of species	13	5	14	14	14	5	14	14
6	pH (R)	4-Alkaliphilous mainly occurring at pH >7	3-Circumneutral mainly occurring at pH 7	3- Circumneutral mainly occurring at pH 7	3- Circumneutral mainly occurring at pH 7	3- Circumneutral mainly occurring at pH 7	3-Circumneutral mainly occur-ring at pH 7	3-Circumneutral mainly occurring at pH 7	3-Circum-neutral main-ly occurring at pH 7
7	Salinity (H)	Fresh to brackish	2-Fresh to br brackish	2-Fresh to brackish	2-Fresh to brackish	2- Fresh to brackish	2, Fresh to brackish	2-Fresh to brackish	2-Fresh to brackish
8	Nitrogen Uptake metabolism (N)	2- Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen	2- Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen	2- Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen	2-Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen	2-Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen	2-Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen	2-Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen	2- Nitrogen autotrophic taxa tolerating elevated levels of organically bound nitrogen
9	Oxygen Requirement (O)	3-Moderate (above 50% saturation)	2- Fairly high(above 75% saturation)	3- Moderate (above 50% saturation)	3- Moderate (above 50% saturation)	2- Fairly high(above 75% saturation)	2- Fairly high(above 75% saturation)	3- Moderate (above 50% saturation)	3- Moderate (above 50% saturation)
10	Saprobity (S)	3-Alfa mesosaprobous	2- B mesosaprobus	3-Alpha mesosap-robous	3- Alpha meso-saprobous	3- Alfa mesosap-robous	2- B mesosaprobus	3-Alpha meso-saprobous	3-Alpha me-sosaprobous
11	Trophic state	5-Eutrophantic	4-Mesoeutrophantic	5- Eutrophentic	5- Eutrophentic	5- Eutrophantic	4-Mesoeutro-phantic	5- Eutrophentic	5- Eutrophentic
12	Moisture retention (M)	2- Mainly occurring in water bodies	2-Mainly occurring in water bodies	2- Mainly occurring in water bodies	2- Mainly occurring in water bodies	2- Mainly occurring in water bodies	2- Mainly occurring in water bodies	2- Mainly occurring in water bodies	2- Mainly occurring in water bodies
13	IDSE/5(Louis Leclercq Index)	3.31	3.52	3.53	3.46	3.47	3.52	3.16	3.47
14	% Indicators of organic pollution	30.65%	22.12%	21.23%	20.87%	19.63%	15.29%	32.59%	19.63%
15	Indicator organisms	GPAR, NHAL, NMIC, NMUT	NMUT	GPAR, NHAL, NMUT	GPAR, NHAL, NMUT	GPAR, NHAL, NMUT	NMUT	GPAR, NHAL, NMUT	GPAR, NHAL, NMUT
16	% indicators of anthropogenic eutrophications	27.19%	27.19%	15.28%	23.48%	15.32%	20.98%	18.71%	15.32%
17	Indicator organisms	AOVA, SPHO, SULN	NRHY	AOVA, SPHO, SULN	AOVA, SPHO, SULN	AOVA, SPHO, SULN	NRHY	AOVA, SPHO, SULN	AOVA, SPHO, SULN

Table 2: Ecological indicator values for selected water bodies (data derived from OMNIDA GB5.3 Software).

erefore, e ective and strong conservative measures should be taken to prevent the lakes from entering hypereutrophentic state and to

1	Acidobiontic	Optional occurrence at pH <5.5
2	Acidophilous	Mainly occurring at pH <7
3	Circumneutral	Mainly occurring at pH – values about 7
4	Alkaliphilous	Mainly occurring at pH >7
5	Alkalibiontic	Exclusively occurring at pH >7
6	Indifferent	No apparent optimum

pH (R).

S.No.	Water quality	Cl (mg/L)	Salinity
1	Fresh	<100	<0.2
2	Fresh brackish	<500	<0.9
3	Brackish fresh	500-1000	0.9-1.8
4	Brackish	1000-5000	1.8-9.0

Salinity (H).

S. No.	Nitrogen uptake
1	Nitrogen-autotrophic taxa tolerating very small concentrations of organically bound nitrogen
2	Nitrogen-autotrophic taxa tolerating elevated concentrations of organically bound nitrogen
3	Facul2

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