EFFECT OF URBANIZATION ON ALGAL BIODIVERSITY

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Abstract

River Gadhi is a small river that flows down the mountains toward Panvel town and passes across the town to join the creek. During its stretch of 16 km it has an impact of various anthropogenic activities which increase towards town. As a result of various activities as well as point and not point sources of pollution, there is change in the species richness and abundance. Most of the genera found at upstream sites were pollution sensitive. The downstream sites showed more diversity and density but were dominated by pollution tolerant genera.

Key words: Urbanization, Pollution tolerant genera, River, Phytoplankton

Introduction

Biodiversity is an important component of freshwater systems and is controlled by temperature and hydrology. Urbanization can degrade water quality and alter watershed hydrology, with profound effects on the structure and function of both riparian wetlands (RWs) and aquatic ecosystems downstream (Hogan and Walbridge, 2007). The maintenance of biodiversity is one of the important keys to the retention of these ecosystem services (Palmer *et al.*, 1997, 2000). Diverse assemblages of species may be able to use resources more efficiently and thus generate more productive ecosystems. They may also offer increased resistance against ecosystem collapse in the face of disturbance (Loreau *et al.*, 2001, Cardinale *et al.*, 2002). A biological approach to water quality monitoring—biomonitoring—incorporates the use of stream organisms themselves as a basis for pollution detection.

Material and Methods

The present study was undertaken on river Gadhi and its reservoir. The river originates from a reservoir in the mountain and flows across Panvel town to meet the creek. Along its stretch 7 sites were selected, out of which four (S1 to S4) are away from town and three (S5 to S7) are close to town. The impact of anthropogenic activities gradually increases from upstream to down stream. The samples were collected monthly for a period of 16 months and analyzed for the density and diversity of phytoplankton. Using a wide mouth container, 500 ml of surface water sample was collected from different spots at every site from near the boundaries of the river and the reservoir. The samples from every station were preserved in separate container for phytoplankton. For immediate fixation, Lugol's Iodine solution made in formalin was used in the field and later 4% formaldehyde was used for long term preservation. The phytoplankton were concentrated by allowing them to settle for about 15 to 20 days and then the upper water was decanted by using a rubber tube. The phytoplankton were identified by using standard identification keys (Fritsch, 1979; Sarode and Kamat, 1984; Bellinger, 1992). For quantitative estimation, the counting was done by using Lackey's Drop method (APHA 1985).

Results and Discussion

During the study period, total 73 different genera were noted belonging to Bacillariophyceae, Chlorophyceae, Cyanophyceae, Dinophyceae, Euglenophyceae, Cryptophyceae and Xanthophyceae. Minimum 41 genera were recorded at S1. The maximum 60 genera were recorded at the sites S3 and S5. At S2, S4, S6 and S7 the number of genera recorded were fifty five (55), fifty three (53), fifty four (55) and fifty seven (57) respectively. Among all sites the density of phytoplankton was maximum at S4 and constituted 30% of the total density i.e 4,11,27,342 u/l. The minimum density was at S1 which constituted only 2% i.e 28,75, 778 u/l. S5 ranked second which made 26% of the total phytoplankton density. The site S6 and S7 shared 16% and 17% respectively. The share of S3 and S2 was only 5% and 4% respectively. The order of dominance of population density was S4>S5>S7>S6>S3>S2>S1.

Various classes and abundance of their genera is mentioned below-

Chlorphyceae

During the present study the Chlorophyceae constituted the largest group in terms of population density and species diversity with 33 genera reported through out the study period and contributed little more than 35% of the total population density of the phytoplankton. The sitewise order of dominance was S7>S5>S4>S6>S3>S2>S1 having 25, 24, 24, 24, 30, 21 and 13 genera respectively. Among the various genera observed during the present study *Chlorella, Coelastrum, Cosmarium, Crucigenia, Golenkinia, Oocystis, Pediastrum, Scenedesmus, Sphaeocystis* were common to all the sites (Fig. 1) having their increased densities at downstream sites (Table 1). Palmer (1969), Bucka (2004), Reddy (2007) and Jain and Kumavat (2009) observed *Scenedesmus* at polluted sites. Cronberg (1982), Fott (1969) observed the presence of *Pediastrum* at nutrient rich sites. Antagonestic observations were noted by Jeelani *et al.* (2005) who recorded the presence of *Pediastrum* spp. at least polluted with lower levels of nutrients. *Chlorella* was found to be pollution tolerant by Javed and Mahmood (2000), Issa and Ismail (1994), Venkateshwaralu *et al.* (1990), Reddy *et al.* (1991) and Bhonge *et al.* (2007). The genera like *Ankyra, Goelocystis, Selanastrum, spirogyra, Staurastrum and Ulothrix* were confined to upstream sites indicating water as clean to moderately pollute. The diversity and was more at downstream sites, but had more number of pollution tolerant genera.

Bacillariophyceae

During the study period diatoms were at second dominant place among all the classes. It contributed 35% of the total phytoplankton density. In all 23 genera were recorded under this category. The maximum 21 genera were recorded at S5. The minimum 16 genera were recorded at sites S1, S4 and S7. Site S2 had 20 genera and S3 and S6 had 17 genera. The genera like *Cyclotella, Melosira, Navicula, Rhizosolenia, Thalassiosira, Triceratium* are densely distributed to downstream sites including site S4 (Table 1, Fig. 2). According to Tewari *et al.* (2005) though the *Rhizosolenia* increases with increased salinity but cannot tolerate highly saline water. Its increased density at site S4 could be indicative of the saline water which could be due to direct inlet of the sewage of Ashram located on its bank as well as the drainage from the buffalo stable present nearby. The *Cyclotella* spp. which was dominant at S5 was recorded as euryhaline species and its density is maximum at intermediate salinity concentration (Roubeix and Lancelot, 2008). It could be possible that the salinity of water was higher downstream due to sewage inlet. According to Bhonge *et al.* (2007) and Hujare (2008) occurrence of *Melosira* spp. throughout the year indicated that the river was polluted. Ndiritu *et al.* (2006), Philibert *et al.* (2006), Atazadeh *et al.* (2007) also noted abundance of *Navicula* spp. at downstream sites.

The main upstream genera include *Cymbella, Coscinodiscus, Fragillaria, Frustulia, Gomphonema, Gyrosigma, synedra.* The presence of *Gomphonema* in clear water is also indicated by Ndiritu *et al.* (2003). Atazadeh (2007) noted the abundance of *Fragilaria* at cleaner headwater. According to Dzeroski and Grbovic (1995) *Cymbella* is used as an indicator of clean to mildly polluted waters. Javed and Mahmood (2000) reported total absence of *Synedra* spp. at highly polluted sites. Though *Synedra* spp. was present down stream, it population count was less, where as more frequently observed at sites S1 and S2 which agrees with Javed and Mahmood(2000). On the contrary Newall and Walsh (2005) observed the presence of *Synedra* spp. in organically polluted water which supports the presence of this species at sewage receiving site S4.

The above observations indicate that there is negative impact of urbanization on phytoplankton. Though the number of genera increases towards downstream sites, they are pollution indicators.

Cyanophyceae

The class Cyanophyceae contributed 22 % in the total phytoplankton density. In all 14 genera were noted during the present study out of 25 known genera of this class. The downstream sites showed more density than upstream sites. Though the genera like *Aphanotheceae, Gloeocapsa, Merismopedia, Microcystic, Oscillatoria* were present at all sites, they were more abundant at downstream (Table 1). Abundance of *Oscillatoria* at organically polluted sites or sites with nutrient enrichment is also observed by Palmer (1969), Martin and Haniffa (2003), Reddy (2007). According to Palmer (1969) and Kumar (1990) the abundance of *Mocrocystis* spp. indicates nutrient enrichment. Fonseca and Bicudo, (2008), Bucka (2004) also recorded *Microcystis* as more frequent taxa in eutrophic reservoir. It shows organic pollution (Holmes, 1987). According to Shen and Song (2008) under low nutrient condition nontoxic strains of *Microcystis* grow. On

the contrary Javed and Mahmood (2000) state that the *Microcystis* spp. was mostly absent at highly polluted sites. *Arthospira, Anabena and Nostoc* were present only at downstream sites. Kolkwitz and Marsoon (1908) have stated this genus as indicator of heavy metal pollution. The absence of *Arthrospira* spp. in highly polluted water was noted by Javed and Mahmood (2000).

Table-I : Sitewise densities of various genera in each class

Sites Phytoplankton	S1	S2	S3	S4	S5	S6	S7
Chlorophyceae							
Actinastum	—	—	2800	—	10063	7000	6299
Ankyra	16275	—	354	—	—	7350	7000
Ankistrodesmus	—	6300	1400	326324	9012	7350	8750
Chetophora	—	—	350	—	—	—	—
Chlamydomonas	—	141920	15449	879269	138248	10325	1051749
Chodatella	—	2800	2275	15400	10499	17500	578
Chlorococcum	—	963	2975	735	4288	5950	2888
Chlorella	8968	122765	26643	658117	283580	189782	638651
Closterium	—	16100	350	11319	6562	6125	1662
Coelastrum	1750	83123	2283282	728505	17938	43049	140227
Cosmarium	2581	5460	6825	316873	26949	28350	4813
Crucigenia	1750	68423	152105	20694	108195	217169	110686
Euastrum	—	—	—	184358	—	—	—
Gloeocystis	—	18899	26040	—	—	—	1312
Golenkina	652	436734	1197535	1444449	5726212	4609540	85481
Kirchriella	—	6650	12556	51100	19949	21875	13738
Micractinium	—	—	176657	78748	20124	—	366622
Monoraphidium	—	55561	21353	6475	18375	1488	10496
Oedogonium	—	—	—	—	—	—	126872
Oocystis	32641	1138	95108	178584	101408	24675	15292
Pediastrum	10500	149008	808406	1171630	352876	1377240	253485
Richteriella	—	—	61686	39199	52586	92835	14000
Scenedesmus	25152	228493	295646	1859731	2883151	1097752	900386
Selanastrum	350	—	2886	—	—	—	—
Sphareocystis	1574	30099	794162	239049	301339	228199	24500

Sites Phytoplankton	S1	S2	S3	S4	S5	S6	S7
Spirogyara	—	7875	1040	2388	—	—	—
Staurastrum	—	11550	13650	124510	—	15750	—
Tetraedron	—	2800	10500	928181	11113	13650	—
Tetraspora	—	—	3543	15224	34737	—	50728
Tetrastrum	—	—	—	—	5200	—	—
Ulothrix	1838	2100	4900	—	—	10500	8750
Volvox	—	—	6825	—	3150	15050	—
Zygnema	1531	—	1050	350	6125	38500	350
			Bacillariophytes				
Achnanthes	7875	5250	—	—	437	—	—
Amphora	—	23100	—	918	350	—	—
Asterionella	15749	36924	23276	45937	22137	39550	19425
Caloneis	—	42262	—	—	350	6300	—
Cocconeis	5031	525	1190	4550	5722	—	1925
Coscinodiscus	15750	158530	21438	66970	55912	153032	71660
Cyclotella	69609	102408	57887	479190	8037010	664376	668487
Cymbella	787	105067	15706	41725	7175	16188	5688
Diatoma	—	—	1190	525	263	5250	—
Fragilaria	19642	59144	12376	20867	15487	3395	78748
Frustulia	—	4550	—	—	—	—	—
Gomphonema	41378	448350	55287	136535	128394	49174	26635
Gyrosigma	16534	195294	1793	—	1663	1050	—
Melosira	483420	43110	6256	281393	63830	168198	61950
Navicula	74922	165548	108076	68085	167292	271083	144954
Nitzschia	183479	348622	123633	614498	223032	675893	361300
Pinnularia	41429	132873	7525	1487	135710	120161	75817
Rizosolenia	1050	11200	—	1838465	2607	—	349980
Stauroneis	10850	26949	1881	—	13125	35525	—
Surirella	1925	788	4112	—	36020	7263	14000
Synedra	53107	142098	16773	1301155	36020	151897	40358
Thalassiosira	12338	—	700	9625	7133491	1531468	262674
Triceratium	—	—	—	—	—	—	5688

Sites Phytoplankton	S1	S2	S3	S4	S5	S6	S7
			Cyanophyceae				
Anabaena	—	—	—	—	12074	—	—
Anacystis	1838	—	—	656	2188	—	15050
Aphanothece	39772	788	41535	1441913	1724888	98747	49000
Apanocaspa	—	—	20124	—	—	—	—
Arhtropsira	—	—	—	233093	24675	87061	670250
Coccochloris	—	385	—	—	16100	—	—
Coelospharium	—	—	4025	—	—	—	—
Croococcus	—	538149	33851	269849	952869	24850	119941
Glococapsa	—	350	31937	128185	179197	42262	55124
Merismopédia	—	27474	20142	291194	83036	100723	43048
Microcystis	7875	13125	306643	2268571	232781	5151785	2185574
Nostoc	—	—	—	—	—	—	55124
Oscillatoria	66061	55736	70225	4704372	3816184	1479863	2212983
			Dianophyceae				
Peridinium	1532942	637324	29662	7478	16100	238694	291193
Ceratium	525	—	—	—	—	—	—
			Euglenophyceae				
Euglena	16100	25813	71634	12600	129149	167822	82179
Phacus	17588	118120	30082	—	897572	127922	1039490
			Cryptophyceae				
Cryptomonas	12950	45325	279993	1022751	722293	1840038	1806533
			Xanthophyceae				
Tribonema	875	6300	744	3500	14262	64399	87499

The presence of *Merismopedia* spp. in highly eutrophicated water was noted by Fonesco and Bicudo (2008). The increased variety and density at downstream sites are indicative of nutrient enrichment at these sites are under the direct impact of urbanization.

Dinophyceae

The class Dinophyceae was represented only by two genera namely *Peridinium and Ceratium*. The *Peridinium* was present at all sites having its more densities at upstream (Table 1) whereas *Ceratium* was noted only once at site S1 when the water was clean.

Euglenophyceae

The class was represented by *Euglena* spp. and *Phacus* spp. Both the genera were more dominant downstream except at S4 where it was minimum in density (Table 1). Das *et al.* (2007) reported the presence of *Euglena* spp. in organically polluted water. Its presence at downstream in post monsoon period indicates its preference to stagnant water which is in accordance with Kim and Boo (1996). According Javed (2006) *Phacus* spp. can tolerate high pollution level. Its high density at downstream sites is in accordance with his statement.

Cryptophyceae

The *Cryptomonas* was the only representative of this class having more densities at downstream sites (Table 1).

Xanthophyceae

Tribonema spp. was the representative of this class having more down stream density (Table 1).

Conclusion

From the various genera encountered during the present study, it is noted that the diversity and density was much at downstream sites receiving sewage which was dominated by the pollution tolerant genera indicating the sites S4, S5, S6 and S7 more polluted.

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