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Occurrence of Rotifers and its Relation to the Water Quality during the Bioremediation process in Lake Kacharali, Thane, MS, India

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Abstract

Thane city is known for its lake, however over the years with increase in human population and the related anthropogenic activities the lakes have been neglected. The neglect had lead to severe pollution of the lakes affecting the ecology as well as the livelihood of the locals dependent on the lakes. The Thane Municipal Corporation started the process of bioremediation of lakes in Thane city from the year 1999 by using selected, preadapted, nonpathogenic microbes. Lake Kacharali was the first one to undergo the process and prior to the bioremediation process the lake was physically cleaned of all the floating macrophytes. The physico-chemical parameters to assess the water quality along with the phytoplankton and zooplankton to understand the biological diversity were undertaken from the beginning of bioremediation process in January 1999 till June 2000. Among the zooplankton Rotifera comprise the integral part of the food chain and are important link between the nanoplankton and the carnivorous zooplankton. They play a major role in cycling of organic material and constitute a large portion of the diet of larval fish. During the study 13 species of the rotifera were observed and varied from 50 ind/100 L to 5876 ind/100 L. The diversity of rotifers is indicative of the ecological factors of the water body. The bioremediation process was observed to be successful as the water quality and rotifer diversity revealed mesotrophic conditions from the initial eutrophic conditions.

Keywords: Rotifers, water quality, mesotrophic, lake kacharali, bioremediation.

Introduction

Natural resources are the important wealth of our country, water is one of them. Since it is a dynamic system containing living as well as nonliving organic, inorganic, soluble as well as insoluble substances. Its quality is likely to change day by day and from source to source. Any change in the natural quality may disturb the equilibrium system and would become unfit for designated uses[1]. The problems of our ecosystem are increasing with the advancement in technology[2], the trend of urbanization in India is exerting stress on civic authorities to provide basic requirement such as safe drinking water, sanitation and infrastructure[3]. The water quality, aquatic flora and fauna of lakes are closely linked to the water and energy budgets, mixing, stratification and other physical aspects of a lake[4,5]. Phytoplankton is the base of food web in lakes and fish production is linked to phytoplankton production[6]. Moreover, number and species of phytoplankton serves to determine the quality of a water body[7]. Similarly the primary consumers i.e. the zooplankton is an important component in understanding the trophodymanics and trophic progression of water body while indicating the extent of pollution[5]. Most lakes have a natural life cycle, proceeding from oligotrophic to eutrophic condition. Environmental pollution from human activities is a major challenge of civilization today[8]. Prolonged discharge of industrial effluents, domestic sewage and solid waste dump causes the groundwater to become polluted and create health problems[9-10]. Proper management of lake must be preceded by hydrological and limnological observations for its complex physical, chemical and biological systems[11].

Among the zooplankton the rotifer comprises an integral part in the aquatic food chain. Their role as a link between the nanoplankton and the carnivorous zooplankton is well established[12]. Due to their short developmental period and fast reproductive rate characterized by parthenogenetic production[13], rotifers can rapidly populate vacant niches and convert primary production into a form useable for secondary consumers producing up to 50 % of the total plankton biomass[14]. The present study aimed at documenting the occurrence of rotifers during the bioremediation process in the macrophyte infested and anthropogenically polluted Kacharali Lake in Thane city.

Study area: Thane city in Maharashtra (Latitude 18°.42' to 20°.20' N and Longitude 70°.25' to 73°.44' E) is guarded by Yeoor hills of Sahyadri ranges on one side and the Thane creek on other side. Thane city, formerly called as Shristhanaka during the Shilahar Empire, had 60 odd lakes and was called as the city of lakes[15]. Of the than 60 lakes 35 are now in existence with the Thane Municipal Corporation (TMC) having taken on the responsibility of conserving lakes using bioremediation method. Among the existing lakes Kacharali (area ~ 1.75 ha) is

the first one to undergo the process of bioremediation involving selected, pre-adapted, nonpathogenic microbes; figure 1. The lake is centrally located and is opposite to the TMC office, making monitoring of the bioremediation easy. The lake was highly impacted by human encroachments while being polluted due to effluent and sewage discharge. Prior to the bioremediation process the lake was cleaned of all weeds as well as the release of pollutants was stopped.

Material and Methods

The Lake was sampled monthly from January 1999 to June 2000 for analyzing physico-chemical parameters and nutrients using standard methods[16]. The water samples were collected in clean plastic carboys from three locations of the lake and the data averaged to give an overall representation of the lake. Phytoplankton and zooplankton was collected by towing the plankton net (45µm mesh) using the boat in a circular direction about 15 meters away from the edge of the lake. The planktons were concentrated, fixed and observed under the compound microscope using the standard protocol[17].

Results and Discussion

The water quality is characterized by various physico-chemical parameters. These parameters change widely due to many factors like source of water, type of pollution, seasonal fluctuations etc. The urban pond is influenced by several extrinsic factors which may alter the structural and functional components of such ecosystem[18]. The average physico-chemical and nutrient values are given in table 1. The water temperature was seen to follow the atmospheric temperature; the overall light penetration was 58.765 ± 10.273 cms while the Total Suspended Solids average was 152.94 ± 128.051mg/L. there was no significant relationship between the light penetration and the suspended solids. The water was alkaline due to the treatment and the salinity in the Lake showed a negative correlation with alkalinity. DO is an important indicator of ability of a water body to support aquatic life[19]. The overall average DO was 6.353 ± 0.965 mg l/L; the values recorded were always above the saturation limit this was because during to the treatment there was continuous artificial aeration in the lake that kept the DO at an optimum level. Over the period of time during treatment the DO levels showed a gradual increase crossing 7mg/L. Among the nutrients the Calcium and Nitrates were low while the Silicates and the Phosphates were high. This could be attributed to two factors one the high pH helped in the formation of calcium carbonate while the phosphates were released from the sediments that were enriched due to the anthropogenic activities.

Nutrients are generally considered to be the limiting factors for phytoplankton production, during the present study the average phytoplankton was 14610 ± 52.9 no/100L. The phytoplankton in the lake comprised of 23 genera representing Chlorophyceae, Cyanophyceae, Bacilariophyceae, Xanthophyceae and Euglenophyceae. The genera that were most dominant include the *Pediastrum spp., Oscillatoria spp., Anabaena spp., Navicula spp., Nitzschia spp. and Tribonema spp.* The phytoplankton showed significant positive correlation with pH, silicates and calcium, while CO_2 and Phosphates had negative correlation.

The zooplankton mainly comprised of copepoda, rotifera and cladocera the other plankters included eggs, nauplii and ostracods. Among the copepods the cyclopoid copepods constituted 44% of the population density. The significance of rotifer population as the quantitatively dominant class in zooplankton has been recorded in many Indian lakes[5]. However in the present study they occupied the second position in the order of abundance. 13 species of rotifer were observed and varied from 50 ind/100 L to 5876 ind/100 L. The rotifera were mainly represented by *Brachionus spp.* and *Keratella spp.* as is common in most of the Indian Lakes; table 2. Both the genera are cosmopolitan in distribution and by far the best known genera from Indian waters[20]. Rotifera are known to be influenced by temperature, however in the present study the influence was insignificant (r=-0.1594) explaining the dominance of the copepods. Plankton production depends upon carrying capacity of environment and nutrient factors[21]. Among the nutrients it has been reported that the abundance of calcium has a certain influence on rotifers[22]. In the present study rotifers were negatively correlated with the calcium content in water limiting its abundance. Similarly, the PO_4-P also exhibited a negative correlation with the rotifer density. However, the nitrates and silicates were seen to favour the density of rotifers.

The ecological studies of rotifers often over estimate abiotic interactions and neglect the biotic ones[23]. The community structure, diversity and biomass of rotifers are governed by nutritional ecology of each species[24]. Generally rotifers feed on particulate organic matter apart from assimilation of dissolved nutrient substances from surrounding waters[25]. They feed on algae, diatoms, dinoflagellates and also bacteria. The bacteria enters the food chain through a three step link i.e. bacteria -> bacteriavorous nanoplankton -> ciliates -> rotifers[26]. Rotifers are reported to graze on phytoplankton in the same way as cattle graze on vegetables[4]. Rotifers function as a limiting factor for phytoplankton density with high density of *Brachionus spp.* is attributed as a causative agent for control of phytoplankton[5]. It is well established that composition and abundance of phytoplankton is greatly regulated by zooplankton, wherein the increase in the quantity of phytoplankton will result in the increase in abundance of zooplankton. Zooplankton plays an active role in the modification and remineralization of the particulate organic matter in the water column[27]. Zooplankton are the grazers on the phytoplankton and a food base for the carnivorous as well as omnivorous fishes.[28] In the Kacharali lake there was no such correlation, except a weak association between the Rotifers and Bacilariophyceae species. The zooplankton including the rotifers was mainly fed on organic detritus and bacterial population which was in abundance as it was used in the treatment of the lake.

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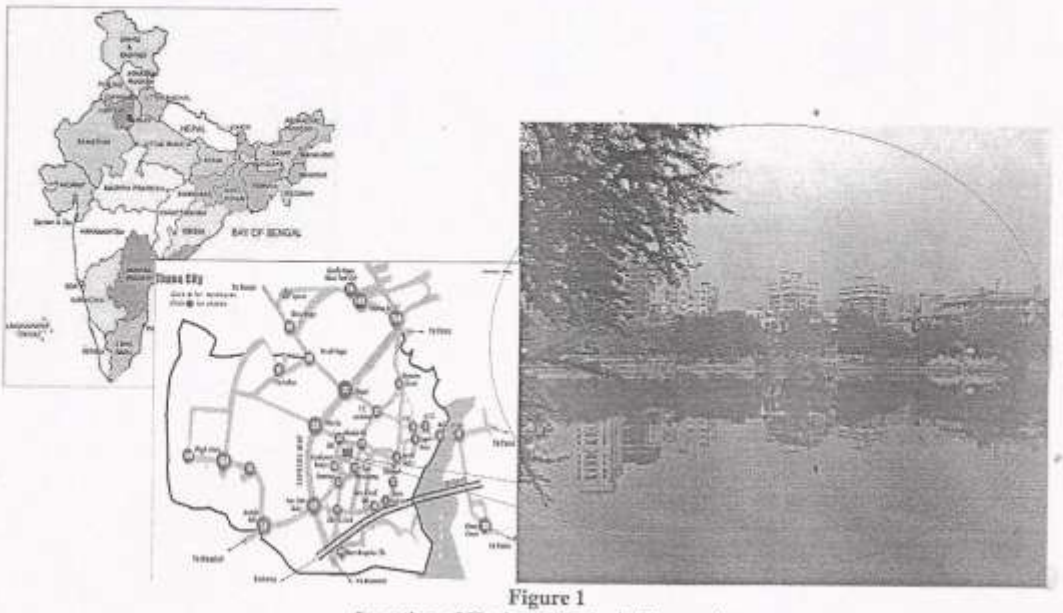

Figure 1
Location of Kacharali Lake in Thane city

Table-1
Average Physico-chemical parameters and nutrients recorded in the Kacharali Lake

Parameter	Average	Standard Deviation
Water Temperature (°C)	26.700	2.921
Light Penetration (cms)	58.765	10.273
Suspended Solids (mg/L)	152.941	128.051
Total Dissolved Solids (mg/L)	582.353	371.206
pH	8.002	0.630
Salinity (ppt)	0.150	0.042
Dissolved Oxygen (mg/L)	6.353	0.965
Free CO_2 (mg/L)	0.609	0.788
Total Alkalinity (mg/L)	128.324	49.056
Total Hardness (mg/L)	174.294	72.719
Calcium Hardness (mg/L)	30.278	16.114
Magnesium hardness (mg/L)	16.045	15.456
SiO_3-Si (mg/L)	10.789	7.175
PO_4-P (mg/L)	0.158	0.259
NO_3-N (mg/L)	0.113	0.041
Phytoplankton (no/100 L)	14610.00	52.9
Total Zooplankton (no/100 L)	3719.0	5768.0
Copepoda (no/100 L)	1664.00	2153.0
Rotifera (no/100 L)	1126.588	1413.081
Cladocera (no/100 L)	381.80	468.70

Table-2
Average values of the rotifer diversity observed in Kacharali lake

Rotifers	Average (no/100 L)	Standard Deviation
Brachionus calyciflorís	455.176	1021.842
Brachionus caudatus	62.235	101.273
Brachionus diversicornis	194.294	280.764
Brachionus falcatus	76.706	99.118
Brachionus forficula	3.941	16.250
Brachionus angularis	14.412	38.925
Brachionus Plicatalis	152.294	280.009
Keratella sp.	112.529	192.100
Testidunella sp.	10.412	33.337
Horarella sp.	11.941	36.906
Anuropsis sp.	2.471	10.186
Asplanchana sp.	15.765	65.000
Rotatoria sp.	7.882	22.251
Synchaeta sp.	2.118	8.731
Trichotria sp.	1.471	6.063
Mytilina sp.	1.471	6.063
Filinia sp.	1.471	6.063

Conclusion

The study revealed that the water quality of the eutrophicated lake Kacharali considerably improved with the increase in DO levels and reduction in the CO_2, Total hardness, total alkalinity and Calcium content. However there were no significant variations in the other nutrients of the lake due to leaching from the sediments into the water column. The phytoplankton was more dominant in the lake as compared to the zooplankton. Among the zooplankton the rotifers were observed to be limited by the nutrient availability and mostly fed on organic detritus and bacterial population contrary to the commonly observed pattern of phytoplankton regulation. Overall the lake was observed to improve in its water quality from eutrophic to mesotrophic.

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