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EFFECTS OF SEWAGE ON PHYSICO-CHEMICAL CHARACTERISTICS AND MACRO–ZOOBENTHIC COMMUNITY OF RAMGARH LAKE, GORAKHPUR, U. P.

Sanjeev Kumar Srivastava[1], Mahima Chaurasia[2] and Tuhina Verma[2]
[1]SRMS College of Engineering & Technology, Bareilly (U.P.) India and [2]Dr. Ram Manohar Lohia Avadh University, Faizabad (U.P.) India, E-mail: tuhinaverma19@gmail.com, mahimaenv@gmail.com, Corresponding Author: Mahima Chaurasia

Abstract: *The community of organisms that live on, or in, the bottom of a water body is known as "benthos". The benthic community is complex. It includes a wide range of organisms from bacteria to plants (phytobenthos) and animals (zoobenthos) and from the different levels of the food web. Effects of sewage on macro–benthic community and physico–chemical characteristics of Ramgarh Lake, Gorakhpur, U.P., have been investigated during July 2016 to June 2017. Altogether 20 species of macro–benthic organism were collected and their abundance was noted. Continued disposal of sewage into Ramgarh Lake has deteriorated its water quality. The Zoobenthic communities clearly indicate the degree of pollution.*
Keywords: *Plant, community, animal, macro–benthic organism, water.*

Introduction: Ramgarh Lake is spread over 669.73 ha near Gorakhpur city on Gorakhpur-Deoria highway, which lies between Lat. $26^0$13'N and $27^0$29'N and Long. $83^0$05'E and $83^0$56'E. The height above sea level ranges from 107m in northwest to 93m in the southeast. The Lake has been receiving urban sewage through a wide network of drain during the past few years. The everlasting cleanliness and sanctity of Ramgarh Lake has severely deteriorated. There are several stretches along its course where the river is grossly polluted. Although extensive work has been done to qualify the degree of Lakes, few studies have attempted to examine the relationship between physic–chemical and bacteriological characteristics of water with a view to establish the degree of organic pollution. Some workers have used biological indices, using macro invertebrates in assessment of water quality [1, 2, 3]. The effects of sewage on the macrobenthic community of the lake are not well understood. The lake in vicinity of Gorakhpur (U.P.) is largely polluted due to massive discharge of domestic sewage which has a device impact on the macrobenthic fauna occurring in this habitat. Keeping this in view, the present study was undertaken to examine the effects of sewage on the physico-chemical characteristics and macrobenthic fauna at major discharge point.

Materials and Methods

Two sampling sites were selected for the present study. The lake at this site receives domestic sewage continuously from vast adjoining densely populated area through a large drain. Site-1 is 10 m upstream of discharge point and Site-2 is 5 m down of discharge point. Water samples were collected separately from four sites at monthly intervals between 9.00 am to 11.00 am, from July 2016 to June 2017. Physico-chemical analysis and biological parameters of water were studied following the standard methods [4, 5, 6]. In the laboratory, materials were transferred to a white enamel tray, where the animals were sorted out manually and identified to the lowest possible taxonomic level. Mean density values of the triplicate samples were converted to individual per meter square following standard procedures [7, 8, 9, 10].

Results and Discussion

Annual mean values of certain physico-chemical parameters and total annual densities of macro-zoobenthic organism of two sites of lake are presented in Table 1 and Table 2, respectively. The study reveals that the continued disposal of sewage into the river has deteriorated its water quality of such an extent that the river stretch between site-1 and site-2 appeared grossly polluted. The water of site-1 reflects unpolluted condition due to absence of effluent discharge at this site. Disposable sewage at site-2 reduces water transparency (21.79±10.26cm), pH (7.72±0.14) and dissolved oxygen concentration (4.27±1.08 mg/L) of receiving water through chloride (30.24±5.23 mg/L), nitrate-nitrogen (0.081±0.01 mg/L) and phosphorus (0.0216±0.01 mg/L) are added to the lake. At the disposal site decomposition of organic matter exert a demand on the oxygen resources of lake.

The macrobenthic organism sampled during the present study belonged to five major groups viz oligochaetes, polychatea, insect, pelecypoda and gastropoda (Table 2). Oligochaetes were the most dominant group in the Zoobenthic community. This group was more abundant at site-2 (399585±45919 ind/m^2). The other three group's polychaeta, insect and pelecypoda were represented by 3, 4, and 4 species, respectively. Gastropod represented by 8 species formed the largest group considering the number of species. Oligochaetes exhibited maximum density at the sewage affected sites-2. Brinkhurst have also observed that the oligochaetes were more abundant in polluted water [11]. Earlier workers have used oligochaetes as diagnostic tool in assessing the water quality [2, 12, 13]. Shukla *et al* proposed an index based on the abundance of oligochaetes which suggest that (1) an oligochaetes density of less than 1000 ind/m^2 indicated eligible pollution (2) a density between 1000 – 5000 ind/m^2 indicated mild pollution. According to this index the site-1 falls under relatively clear water zone and site-2 falls under heavily polluted zone. The oligochaetes approach was later modified by Goodnight and Whitely [14]. According to this, an aquatic habitat that had greater than 80% sludge worm (Tubifex) population were considered highly polluted between 60-80% as doubtful and areas with less than 60% as good condition. In the present study the percentage composition of oligochaetes in total macrobenthic density reflected that the water of site-2 (99.3%) come under the doubtful condition and site-1 (24.7%) as good condition. Also stated that high numbers and percentage of oligochaetes in total fauna is associated with high degree of water pollution [15].

The present study revealed that the polluted water supported a quantitative increase of oligochaetes and a reduction of Chironomidae from total Zoobenthic population (Table 2). Similar observation have also been noticed few earlier workers. Polychaetes and pelecypods were confined particularly at site-1. This adaptation indicates that highly polluted water does not support their life [16].

The values of similarity index between two sides indicated that discharge of sewage affects whole taxonomic groups of Zoobenthic community rather that an individual species. The high similarity value shows greater homogeneity which might be achieved with greater stability of environment in the present study. The degree of similarity between two sites exhibited high similarity in Zoobenthic community between site-1 of the lake, which was not directly affected by sewage discharge. The lowest values between site-1 and site-2 (33.3%) indicate a totally different species composition. The pond at site-2 is exposed to increasing amount of sewage effluent which is not conductive for stable Zoobenthic community.

The value of two sites indicates that the pond water at site-1 is relatively of better quality, as compared to site-2. Community dynamics studies conducted by several workers using macro-benthic organism recorded as reduction in diversity at the polluted zones. Shukla *et al* have also observed that the macrobenthic diversity tend to increase with increasing self purification in polluted pond [7, 17, 18, 3, 19].

From the present investigation, it is quite evident that the discharge of sewage into the pond has a decisive impact on its water quality and macrobenthic community. The present study leads to the conclusion that the combined use of some biological indices may perform a more reliable method to monitor the water pollution.

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Table 1: Physico-chemical characteristics of water of two sites of Lake from July 2016 to June 2017.

Parameter	Site 1	Site 2
Water Temperature (0C)	29.05±4.16	30.12±4.06
Transparency (cm)	47.78±12.41	21.79±10.26
pH	8.06±0.31	7.72±0.14
Dissolved Oxygen	8.13±1.34	4.27±1.08

Free Carbon dioxide	1.26±0.43	2.47±0.29
Carbonate alkalinity	9.12±2.14	5.43±0.97
Bicarbonate alkalinity	159.18±17.05	181.31±22.19
Chloride	17.53±2.61	30.24±5.23
Nitrate Nitrogen	0.36±0.07	0.081±0.01
Phosphate Phosphorus	0.083±0.023	0.0216±0.01
Biochemical Oxygen Demand	4.07±0.47	8.34±0.12

All the values are mean of three replicates and has been expressed as ppm except temperature and pH

Table 2: Total annual densities (ind/m^2) values of macrobenthic organization at two sites of the Lake during July 2016 to June 2017

Macrobenthic	Site 1	Site 2
Oligochaeta	241	321157
Nai simplex Pigust	2846	1143
Tubifex sp.		
Polychaeta		
Namalycastis indica	746	-
Neohhys polybrancha	119	-
Nepths oligobranchia	102	-
Insecta		
Chironomus plumosus Linn	2371	-
Strictochironomus sp.	268	-
Culicoides sp.	201	-
Drasgonfly sp.	262	-
Pelecypoda		
Parreysia favidens	284	-
Parreysin coerulea	873	-
Corbicula striatella	207	-
Noviculina gangetica	261	-
Gastropoda		
Belliamye crassa (Hotton)	002	343
Thiara Scabra (Mueller)	1198	973
Thiara tuberculta (Lamarc)	1204	962
Thiara tuberculta	1486	954
Total no. of Species	17	6
Total No. of Organisms	**12671**	**325532**

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