Table 1. Zooplanktons of Betana wetland.

SN	Genus	Family	Order
1	Arcella spp.	Arcellidae	Rhizopoda
2	Paramecium spp.	Paramecidae	Holotrichida
3	Voticella spp.	Vorticellidae	Peritrichida
4	Keratella spp.	Brachionidae	Rotifera
5	Brachionus spp.	Brachionidae	Rotifera
6	Philodina spp.	Philodinidae	Rotifera
7	Filinia spp.	Testudinellidae	Rotifera
8	Daphnia spp.	Daphnidae	Cladocera
9	Moina spp.	Daphnidae	Cladocera
10	Diaphansoma spp.	Sididae	Cladocera
11	Macrothrix spp.	Macrothyricidae	Cladocera
12	Nauplius larva of Apus.	Cyclopidae	Cladocera
13	Cyclops spp.	Cyclopidae	Cladocera
14	Diaptomus spp.	Diaptomidae	Cladocera
15	Cypris spp.	Cypridae	Ostracoda
16	Monohystera sp.	Monohysteridae	Monohysteridea
17	Mosquito larva.	Anophelidae	Diptera

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Bioremedial Treatment of Industrial Waste Water Using *Rhodobacter sphaeroides*

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Received: 02.03.2009, Accepted: 23.07.2009

***Key words*:** Bioremediation, Bioreactor, *Rhodobacter sphaeroides*

Mathura, the birth place of Lord Krishna, is a rapidly growing city in the Uttar Pradesh province of India. A large number of industries are being operated here, including textile printing units, silver vibrators etc. The effluents from these industries contain

many harmful chemicals such as synthetic dyes, detergents, silica powder, sulphuric acid, hydrochloric acid, detergent and several dyes.

Majority of these industries do not have a 'water treatment plant' due to lack of rigid administrative implementation and high cost involved. Due to insensitive attitude of the government machinery at local level, all industrial effluents are being dropped directly, through more than a dozen wide drains into the historic and religious river Yamuna. This adversely affects the aquatic life and the river ecosystem. The purpose of the present study was to remediate the quality of these effluents to some extent using biological agents. Many workers have reported that several species of some photosynthetic bacteria such as *Rhodobacter* sp. are helpful in improving the quality of water. The aim of this study was therefore, to assess the efficacy of some *Rhodobacter* species in improving the quality of industrial effluents.

Rhodobacter is a Gram -ve, non-sulphur purple, facultative photoheterotrophic bacterium capable of growing phototr-ophically or chemotrophically as either a heterotroph or lithotroph in the presence or absence of O2, depending on the energy source. In present investigation, a common species of *Rhodobacter* i.e., *Rhodobacter sphaeroides* (ATH 2.4.3) *ATCC no*. 17025 was used.

The effluent samples were collected from various outlets from the industrial area in the city in clean bottles. One part of the samples was analysed for physico chemical parameters in the laboratory using APHA (1989) guidelines. The parameters tested, include- nitrates, sulphates, phosphate, ammonia and metal ions (Hg^{2+}, Cu^{2+}, Pb^{2+}, CrO_4^{2-}). The other part of the sample was used for bioremedial treatment. It was filtered and divided into four parts A, B, C and D. All four parts were inoculated with *Rhodobacter sphaeroides* then A was kept in anaerobic and light conditions, B was kept in aerobic and light conditions C was kept in anaerobic and dark conditions and D was kept in aerobic and dark conditions.

The strains of the *Rhodobacter sphaeroides* were obtained from ATCC (Global Bioresource Centre), pure cultures (inocculum) were developed to increase the number of bacteria using Sistrom's minimal medium. Stirred tank Bioreactor (Batch type) was used for the bioremediation programme. The bioreactor has a two litre capacity glass column (tank). The glass tank bioreactor was selected to provide necessary lightening conditions for the growth and action of bacteria. A tungsten lamp was placed 40 cm away from the glass column ($200W/m^2$ intensity).

500 ml of sample plus 500 ml Sistrom's minimal medium was taken into the reactor and 10 ml of inocculent was added to it. For optimal mixing the agitator system was set at 10 rpm. The bacteria were able to grow in the changed medium as log phase achieved well in time in both cases. Two readings were taken, one after 6 hours of mixing and another after 24 hours of mixing.

pH is an important valuable indicator which shows the acidic or alkaline nature of water. The pH of effluent sample was alkaline. This was mainly because of a high concentration of ammonia in the sample water. A reduction in the pH was noted during and after the treatment in all the cases. This was perfectly correlated with the values of ammonia. Due to increasing concentration of oxygen, ammonia was oxidized to nitrates. So, nitrates exhibited a trend opposite to that of ammonia. Hence, a

Tables 1-2. Changes in physico-chemical parameters by *R. sphaeroides* in different conditions.

Parameters	unit	Part A of the sample (Anaerobic light conditions)			Part B of the sample (Aerobic light conditions)		
		Before Mixing	After 6 hours of mixing	24 hours of mixing	Before Mixing	After 6 hours of mixing	24 hours of mixing
pH		8.8	8.1	7.2	8.8	8.2	8.1
Sulphates	mg/l	1.25	2.01	3.22	1.25	2.41	4.82
Sulphide	mg/l	8.34	6.12	4.54	8.34	6.20	3.80
Nitrates	mg/l	1.42	1.53	2.19	1.42	1.98	2.17
Ammonia	mg/l	9.45	9.39	1.34	9.45	9.42	4.28
Pb^{2+}	mg/l	1.02	0.79	0.47	1.02	1.01	0.95
CrO_4^{2-}	mg/l	0.12	0.10	0.07	0.12	0.11	0.08

Parameters	unit	Part C of the sample (Anaerobic dark conditions")			Part D of the sample (Aerobic dark conditions)		
		Before Mixing	After 6 hours of mixing	24 hours of mixing	Before Mixing	After 6 hours of mixing	24 hours of mixing
pH		8.8	8.7	8.5	8.8	8.0	7.6
Sulphates	mg/l	1.25	1.08	1.10	1.25	2.01	2.22
Sulphide	mg/l	8.34	8.52	8.39	8.34	7.60	5.50
Nitrates	mg/l	1.42	1.41	1.39	1.42	1.88	2.60
Ammonia	mg/l	9.45	9.43	9.94	9.45	9.37	2.20
Pb^{2+}	mg/l	1.02	0.98	0.91	1.02	0.87	0.51
CrO_4^{2-}	mg/l	0.12	0.12	0.11	0.12	0.10	0.05

higher value of nitrate contents was observed. In aerobic light conditions, no external air was given to the sample but significant reductions in ammonia values were noted. In these cases, the oxidizing conditions were developed by microbial photosynthetic oxygen (Bergey and Holt, 1994). This clearly shows that *Rhodobacter species* are good oxidizing biological agents which in the presence of light, even under anaerobic conditions, can have a strong oxidizing impact. (Niel *et al*., 1991). The conclusion further gains strength from the fact that in case of part C (where the condition was dark and anaerobic), instead of reduction, a slight increase in the ammonia value was noted. Also, there was no significant change in the pH value. Similar to nitrates, the sulphates exhibited an increase in the anaerobic light conditions and aerobic conditions. On the other hand, during both these conditions, a reduction in the value of sulphides was noted. This also proves that under anaerobic light condition, the oxidation of sulphides to sulphates was because of the photosynthetic oxygen, produced by the *Rhodobacter species*. Higher values of nitrates and sulphates show the degree of oxidation by the Rhodobacter species. (Bergey and Holt, 1994).

The impact of *Rhodobacter species* on metal ions like lead and chromium was also assessed. It was found that *Rhodobacter* has some definite impact on reducing the concentration of these metal ions. A slight but significant reduction in the amount of

Pb^{2+} and CrO_4^{2-} ions were noted in each experiment. The best reduction was noted in anaerobic light conditions. (Adenij, 2004).

From the above discussion and analysis it could be concluded that *Rhodobacter sphaeroides* is a metabolically diverse species, being capable of growing in a wide variety of growth conditions. It can be used commercially on a large scale to treat both industrial and municipal waste water. The best growth conditions for the species were found to be anaerobic light conditions, where its oxidizing impact becomes intense.

Bioremediation, using *R. sphaeroides* can be a cost effective and environmental friendly way to treat the contaminated sediments.

Acknowledgment

The authors are thankful to the principal, B.S.A. (P.G.) College, Mathura for providing the facilities required.

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Effect of Different Concentrations of Sewage on the Haematological Parameters of *Cirhinus mirghala* of Jalla (Pan) of Patna City

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Received: 21.01.2009, Accepted: 09.04.2009

***Key words*:** Sewage, Jalla (Pan), Patna City, *Cirhinus mirghala,* Haematological parameters

The Jalla (Pan) is situated in Patna city (25º37'N & 85º12'31"E). The feeding of pond is mainly through the sewage from the urbanized catchments area. The water is thus loaded with very high concentration of nutrients. The physico-chemical characters of raw sewage were analyzed as per APHA (1985). Juveniles of *Cirhinus mirghala* (2.5 f 0.5 g live weight) were procured and acclimated to laboratory conditions for a period of one month in de-chlorinated tap water. During the acclimation period; the fish were fed on pelletted feeds with 38% protein level. After characterization and static bioassay of the domestic sewage, the test fishes were exposed to chosen sub-lethal levels (50 to 100%) of domestic sewage which was taken in the plastic