Phycodiversity in tenughat thermal power station at Lalpania District Bokaro, Jharkhand

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SUMMARY

The present communication deals with the diversity of phytoplanktons and analysis of water to assess the impact of waste disposal of TTPS (Tenughat Thermal Power Station) on plankton community in different seasons. The river Damodar and its tributaries provide sufficient amount of water to support different types of industries along its basin. The Tenughat thermal power station under Jharkhand Government was designed with the objectives to supply an assured quantum of 25 to 47 cumecs of water throughout the year for industrial use in the basin area. The Tenughat dam is on Damodar river which is one of the largest dam in Jharkhand. Tenughat thermal power plant releases effluents in the form of total suspended solid, ash content coal as well as oils and grease which is directly added to the river. Three sampling sites were selected from the study area. Phytoplanktons were collected from the three different sites in different seasons during May 2007 to May 2008 and arranged class wise in tabular form. Average of the ash concentration and load data of river Damodar was also compared with dominancy of phytoplankton. Altogether 56 phytoplankton taxa of four different classes *viz*. Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae were recorded from the above three sites. Higher abundance of Cyanophyceae and Bacillariophyceae due to the presence of higher ash content and suspended particulate matters at all the sites indicated the pollution status and organic enrichment.

Key words : Ash content, Phytoplankton, Seasonal variation, Species diversity index.

Jharkhand state being rich in mineral resources in the country is an ideal place for industrial settlement. Damodar river and its tributaries provide sufficient amount of water to support different types of industries. It has accelerated the growth of electric power and so, most of the thermal power stations are along its basin. Tenughat thermal power station is one of the super power station along Damodar river basin.

Tenughat Vidut Nigam Limited (TVNL) is the major contributor of power to Jharkhand state which is registered under 1956 companies act fully owned by state of Jharkhand. TVNL solely supplies about 400 MW power to the state. Tenughat thermal power station is the only unit under TVNL sprawling over 1800 acre surrounded by Lugu mountain (The second highest peak of Jharkhand), full of lakes, falls and dam on Damodar river. It is worth seeing and also a reputed tourist place. The targeted installed capacity of 3690 MW is to be completed in four phases. The first phase is of 2*210 MW capacity. Second phase is of 3*210MW, third phase is of 2*660MW and phase four is of 3*660 MW capacity.

The river Damodar receive effluents from thermal power plant in the form of ash content coal, suspended particulates and oils and grease in several tones per day (TPD). They usually meet the river in untreated form. The addition of these effluents not only influences the micro flora of fresh water but also favors the development of variety of new biota, reducing it unfit for human consumption.

The phytoplankton communities have been studied in some of the Indian rivers e.g Ganga, Yamuna, Hooghly, Cauvery, Gomati and Sone (Krishnan and Venkatraman 2006), but phycodiversity of Damodar river related to its species diversity index (H')has not been explored earlier.

Phytoplankton is the fundamental components of aquatic ecosystem as they are major sources of biologically important and liable organic carbon located at the base of food chain. Investigation on plankton in relation of hydrography has been carried out by several authors in India (Nandan, 2005).

Present study focuses attention on a comprehensive study of phytoplankton with reference to their species diversity index and percentage contribution during different seasons at three different sites.

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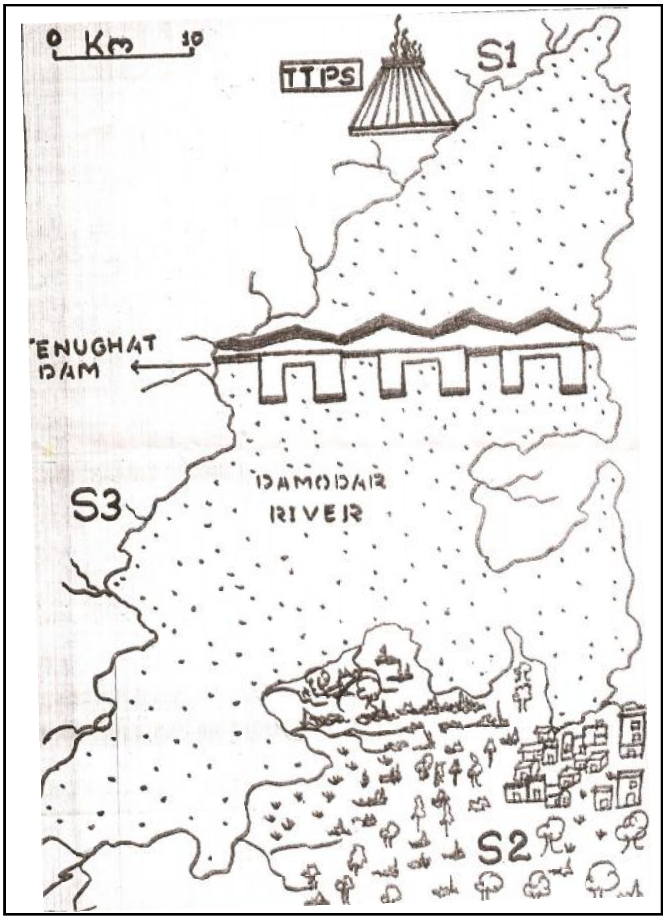
MATERIALS AND METHODS

The whole study area had been divided into three sites on the basis of upstream and downstream zones of river as shown in the map:-



Site – I:

S1: This zone is 2km upstream at Tenughat thermal power plant in Lalpania. Here effluents are added in the form of total suspended particulates and oils and grease. It is a type of mediterranean zone.

Site – II:

S2: This zone is 1 km ahead downstream at Tenughat block. This site is residential area of local people of Tenughat block. Here, the most conspicuous source of pollutants are sewage released by the inhabitants of the area.

Site – III:

S3: This zone is stagnant zone below Tenu dam. Here only roadway bridge is present which is used by the transporter and public vehicle.It is linked with the main road towards capital of Jharkhand state, Ranchi.

Phytoplankton samples were collected at monthly interval from the above three sites of the study area during the period of May 2007 to May 2008. The samples were brought to the laboratory, micrometric measurement was done and camera lucida drawings were made. The collected phytoplankton were identified with the help of standard literatures, books monographs and arranged class wise in tabular form. Seasonal variation were noted and the percentage composition of each class was calculated.

Species diversity index (H') was calculated by using Shannon and Wiener's (1949) formula:-

$$H' = p\ pi \log_2 pi\ldots$$
$$i = 1$$

where,

H' = species diversity per individual.

Pi = proportion of the samples belonging to the species.

Species richness (SR) was calculated as described by Gleason (1922)

$$SR = S - 1 / \log_e N$$

where, S = number of species of a particular sample and

N = natural logarithm of total number of individuals of all the species in the sample.

Average of the concentration and load of ash content and between May 2007 to May 2008 were collected from the Tenughat thermal power station (TTPS) as shown in Table 2.

RESULTS AND DISCUSSION

During the observation made from May 2007 to May 2008, total 56 phytoplankton taxa were identified from three sampling sites. Out of 56, 17 sp. belongs to Cyanophyceae, 13 sp. from Chlorophyceae, 2 sp.from Euglenophyceae and 25 sp. belongs to Bacillariophyceae (Fig. 1).

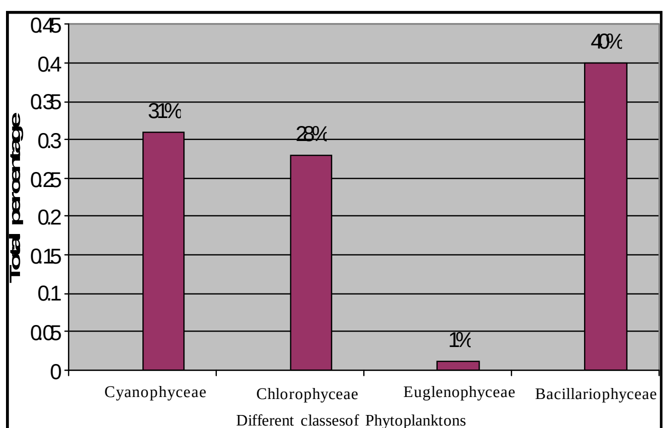


Fig. 1 : Graphical presentation of total percentage of species diversity index of phytoplanktons during May 2007 to May 2008

Table 1 : Seasonal variation of phytoplankton abundance and diversity

Sr. No.	Name of Phytoplanktons	Different seasons								
		Rainy			Winter			Summer		
		S1	S2	S3	S1	S2	S3	S1	S2	S3
	Class -Cyanophyceae									
1.	*Microcystis protocystis* Kirch.	+	+	-	-	+	-	+	+	-
2.	*Microcystis aeruginosa* Kuetz.	+	+	-	-	+	-	-	+	-
3.	*Chroococcus turgidus* Naeg.	-	-	-	-	-	-	-	+	-
4.	*Gloeocapsa strata* (Turp.) Kuetz.	-	-	-	-	-	-	-	-	+
5.	*Aphanothece gravelli* (Hass.) Rabenh.	+	+	-	-	+	-	-	-	-
6.	*Merismopedia glauca* Ehr.	-	+	-	-	-	+	-	-	-
7.	*Merismopedia elegans* Smith	-	-	-	-	-	+	-	-	-
8.	*Oscillatoria chlorine* Kuetz.	+	-	-	+	-	-	+	-	-
9.	*Oscillatoria limosa* Ag. ex Gomont	+	+	-	+	-	-	-	-	-
10.	*Oscillatoria wilei* Gardner et. Drouet	+	+	-	-	+	-	-	+	-
11.	*Cylindrosper mum majus* Kuetz.	+	-	-	-	+	-	-	-	-
12.	*Nostoc sphaenum* Vau.	+	-	-	-	+	-	-	-	-
13.	*Anabaena microspora* Kuetz.	+	-	-	-	-	-	-	+	-
14.	*Scytonema bohneri* Sch.	-	-	-	-	-	-	-	+	-
15.	*Calothrix membranaceae* Sch.	-	+	-	-	-	-	+	-	-
16.	*Gloeotrichia pisum* Thurs.	-	-	-	-	+	-	+	-	-
17.	*Gloeotrichia natans* Rabenh.	+	-	-	-	-	+	-	+	+
	Class- Chlorophyceae									
18.	*Chlorococcum infusionum* Manegh.	+	-	-	-	-	-	-	-	+
19.	*Schroederia indica* Philipose	-	-	-	-	+	-	-	+	-
20.	*Sorastrum spinulosum* Naeg.	+	+	-	-	-	+	-	-	+
21.	*Glaucocystis angulata* Bohl.	+	+	-	+	-	-	+	-	-
22.	*Coelastrum microsporum* Naeg.	+	+	-	+	-	-	-	-	+
23.	*Scenedesmus arcuatus* Lamm.	-	+	+	+	+	-	+	+	-
24.	*Stigeoclonium helveticum* Vis.	+	+	-	-	-	-	+	-	-
25.	*Chaetophora elegans* Ag.	-	-	-	-	+	-	+	-	-
26.	*Oedogonium amphulum* Mag.	-	-	-	-	+	-	-	+	+
27.	*Oedogonium crassiusculum* Wittr.	+	+	-	-	-	-	+	-	-
28.	*Oedogonium vulgaris* Wittr.	+	-	-	-	-	-	+	-	-
29.	*Zygnema cylindrosporum* Czurdae	-	-	-	-	+	-	-	-	-
30.	*Closterium abruptum* West.	-	-	-	-	+	-	-	-	-
	Class-Eugleno phyceae									
31.	*Euglena circularis* Goj.	+	+	-	+	-	-	-	-	-
32.	*Euglena proxima* Dang.	+	-	-	-	-	+	-	-	+
	Class-Bacillario phyceae									
33.	*Melosira sulcata* Ehr.	+	+	+	-	-	+	-	+	-
34.	*Cyclotella kuetzingiana* Th.	+	+	-	-	-	-	-	-	-
35.	*Synedra ulna* Ehr.	+	-	+	-	-	+	-	-	+
36.	*Cocconeis pediculus* Ehr.	+	-	+	-	-	-	-	+	-
37.	*Navicula cancellata* Donk.	-	+	-	+	-	-	+	-	-
38.	*Navicula forcipata* Grov.	-	+	-	-	-	+	-	-	-
39.	*Navicula gastrum* Ehr.	-	-	+	-	+	+	+	+	-

Contd..... Table 1

Table 1 contd.......

40.	*Navicula lyra* Ehr.	-	-	-	-	+	-	-	+	-
41.	*Nitzschia filiformis* Schut.	-	-	+	-	-	-	+	-	-
42.	*Nitzschia paradoxa* Gmel.	-	+	-	-	-	+	+	-	-
43.	*Nitzschia sigmoid* Sch.	+	-	+	-	+	+	+	+	-
44.	*Gomphonema anguastum* Kuetz.	+	+	-	+	-	-	+	-	-
45.	*Gomphonema angulosa* Kuetz.	+	-	+	-	+	-	-	+	-
46.	*Odontella sinensis* Grev.	+	-	-	-	-	+	-	-	-
47.	*Pinnularia ambigua* Cl.	+	-	+	-	+	+	-	-	+
48.	*Pleurosigma carcinatum* Dn.	-	+	+	-	-	-	-	+	-
49.	*Rhabdonema mirificum* Sch.	+	+	-	+	-	-	+	+	-
50.	*Rhizosolenia cylindricus* Cle.	-	+	-	-	-	-	+	-	-
51.	*Rhizosolenia styliformis* Cle.	+	-	-	+	-	-	-	+	-
52.	*Rhizosolenia hobetata* Bail.	+	+	-	-	-	-	-	+	-
53.	*Rhizosolenia alata* Btw.	+	+	+	-	-	+	+	-	-
54.	*Cymbella cymbiformis* Ag.	+	-	-	-	-	-	-	+	-
55.	*Cymbella tumida* Breb.	-	+	-	-	-	-	+	-	-
56.	*Cymbella ventricosa* Kuetz.	+	+	-	-	-	+	-	+	-

(-) = Connotes absence, (+) = Connotes presence

Percentage composition of Cyanophyceae ranged between 0 and 65.6%. No cyanophycean members was observed during many months of the present study period but a low percentage (1.0)% was observed during summer at site-3 and maximum percentage was observed during monsoon season at site -1. During winter season mostly it was observed from site - 2.

Percentage composition of Chlorophyceae ranged between 0 and 40.5%. Minimum percentage of 1.5 was observed during summer at site-2 whereas maximum was observed during Monsoon season at site-1.

Euglenophyceae constituted 1.0 % with the equal observation in winter, rainy and summer seasons They are observed at site- 3 only during all the seasons.From other sites it was totally absent.

Percentage composition of Bacillariophyceae ranged between 0.95 and 80%. Minimum percentage was recorded during summer at site-3 while maximum percentage was recorded during monsoon at site-1.

Overall the density of phytoplankton taxa was highest during rainy season and was lowest during summer season (Table 1).

It is clearly observed from Table 2 that enormous amount of oils and grease as well as several tones of ashes were generated per day from the thermal power plant. These were hazardous pollutants which was mixed with the river water. They directly influenced the aquatic community. It was responsible for the existence of pollution tolerant algae in the river water.

The dominance of Bacillariophyceae is natural as their silicate wall have affinity for ash contents. The Cyanophycean members have also a high affinity for ash contents and can out compete other algae when nutrients are low.

In the present study density of phytoplankton was found to be directly dependent on ash percentage and

Table 2 : Average of concentration / load of the unit and ash generated per day

Name of the unit	Discharge M^3/hrs.	TSS		Oils and Grease	
		Concen.mg/l	Load TPD	Concen.mg/l	Load TPD
TTPS (Tenughat Thermal Power Station)	2387.97	6919	336.36	5.0	0.286
“	Installed capacity (MW)	Coal used (TPD)		Ash content per cent	Ash generated (TPD)
	780	8000		50 - 55	4000

disturbance from various non point sources. It is clearly observed by replacement of Chlorophyceae and placement of Bacillariophyceae and Cyanophyceae at all the sites (Gaikwad *et al.*, 2004).

So, it is clear from the above study that most polluted zone was site-1 which was dominated by the members of Bacillariophyceae e.g *Melosira, Synedra, Navicula, Nitzschia, Cocconeis, Gomphonema, Pinnularia, Pleurosigma, Rhabdonema, Rhizosolenia* and *Cymbella*.

Site-2 is less polluted and was dominated by the members of Cyanophyceae e.g *Microcystis, Chroococcus, Gloeocapsa, Aphanocapsa, Merismopedia, Oscillatoria, Cylindrospermum, Nostoc, Anabaena, Scytonema, Calothrix* and *Gloeotrichia*.

Least polluted site was site-3 which was dominated by Chlorophycean members e.g *Scenedesmus, Stigeoclonium, Oedogonium* and *Closterium*.

Thus, change in density of the algal communities directly depends on the disturbance to their habitat and ecological factors.

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