

# Pollution Induced Structural and Physico-Chemical Changes in Algal Community: A Case Study of River Pandu of North India

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**Abstract**—The study area receives a wide variety of wastes generated by municipalities and the industries like paints and pigments, metal processing industries, thermal power plants electro-processing industries etc. The Physico-chemical and structural investigation of water from river Pandu indicated high level of chlorides and calcium which made the water unsuitable for human use. Algae like *Cyclotella fumida*, *Asterionella Formosa*, *Cladophora glomerata*, *Pediastrum simplex*, *Scenedesmus bijuga*, *Cladophora glomerata* were the dominant pollution tolerant species recorded under these conditions. The sensitive and less abundant species of algae included *Spirogyra* sps., *Merismopedia* sps. The predominance colonies of *Zygnema* sps, *Phormidium* sps, *Mycrocystis aeruginosa*, *Merismopedia minima*, *Pandorina morum*, seems to correlate with high organic contents of Pandu river water. This study assumes significance as some algae can be used as bioindicators of water pollution and algal floral of a municipal drain carrying waste effluents from industrial area Kanpur and discharge them into the river Pandu flowing onto southern outskirts of Kanpur city.

**Keywords**—Kanpur, North India, Physico-chemical, Pollution, River Pandu.

## I. INTRODUCTION

THE River Ganga is a major river in Uttar Pradesh catering to the needs of agriculture and human consumption. It branches such as river Pandu at Kanpur district (Fig.1) runs through different regions where major industries are located. The wastes generated from these industries usually contain a wide variety of organic and inorganic pollutants including solvents, oils, grease, plastics, plasticizers, phenols, heavy metals, pesticides and suspended solids. The indiscriminate dumping and release of wastes containing the above mentioned hazardous substances into rivers might lead to environmental disturbance which could be considered as a potential source of stress to biotic community [1], [6]. These industrial effluents contaminated the river water with a variety of heavy metals acting as point sources. Some of the metals are important for the growth, development and health of living organisms [3], [4]. But the same metal may be considered toxic one as its concentration exceeds to the normal permissible limit [5], [6]. There have been indiscriminate discharge of factory effluents, into the river Pandu and the present study was undertaken to assess the pollutional status

of the river and consequent impairment in its water quality and algal community due to various reasons like scarcity of information available on the algal community of the river. Algae are the natural inhabitants of the aquatic ecosystem and they constitute an integral part of the river ecosystem throughout the year and are capable of thriving under diverse habitats. They occur frequently in polluted and unpolluted waters, and an inverse relationship generally exists between the pollution load and algal diversity [4], [7], [8]. The quality of water was monitored based on its organic and inorganic constituents, biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved oxygen (DO), and density of algal pollution.

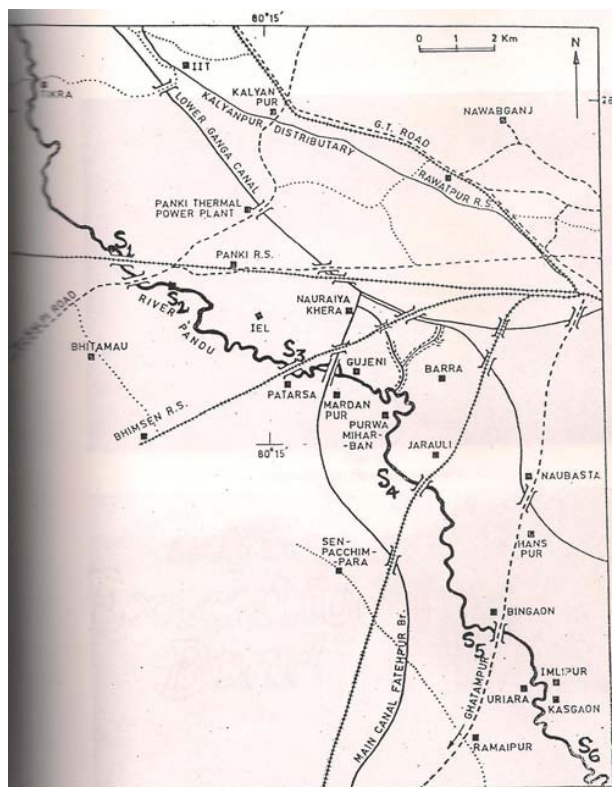


Fig. 1 Section of the river passing through the Kanpur showing the location of the sampling sections

## II. MATERIALS AND METHODS

Water from Pandu River near industrial area at Kanpur was collected in large sterile bottles brought to the laboratory and analyzed immediately for various parameters. Algae and waste water sample were collected monthly from six sites as per standard procedure [2]. The first sampling sites was *Station 1* Panki Thermal Power Plant, *Station 2* Panki Municipal drain, *Station 3* Ganda Nala downstream of the confluence point of Panki Municipal Power Plant drain with the river, *Station 4* Halwa Khonda village downstream of station 3, *Station 5* App. 15 kms downstream of station 4, *Station 6* River flanked on both sides by agricultural fields.

Waste water sample were subjected to physico-chemical analysis as per standard procedure [2]. Biological studies investigation includes both qualitative as well as quantitative analysis of algal samples. Benthic algae were collected and relevant literature pertaining to algae was consulted for algal identification [4], [8], [9].

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## III. ISOLATION AND ANALYSIS OF ALGAE SAMPLE

Plankton forms were collected by using plankton net made by bolting meshed silk cloth of  $10\mu\text{m}$  and fixing a conical flask of 100 ml at the narrow end. For taking the samples for qualitative analysis the net was towed for 5 minutes just below the surface of water. Tows were restricted to a small area around each sampling point. The samples were immediately transferred to other bottle and preserved by adding 4% formalin to each of the sample. The qualitative estimation was done by taking 1 ml sample from the stock samples at each time replicated 5 times. Uniform distribution was set by agitating the samples thoroughly. Identification of planktonic organisms was done with the help of monographs, i.e. phytoplankton up to class level.

From the water sample 5 ml was centrifuged for 15 mins. The pellet containing algae was washed with sterile distilled water for 2-3 times. To the pellet 5 ml of 20% of water was removed by repeated washing in sterile distilled water. The sample was further stored in 70% alcohol and analyzed. Algae were identified based on morphological features [17], [18]. Permanent slides were made using DPX numbered and stored for further references. Algae were stained in Lactophenol, Cotton blue [16] and identified on the basis of morphological and reproductive features.

## IV. RESULTS AND DISCUSSIONS

The highly alkaline nature of river water was revealed by the elevation of pH from 7.8 to 8.4. The optimum level is put generally around pH 7. The increase in pH could be due to either increased of carbonates and or increased photosynthetic activities of producers [15]. The higher carbonate and bicarbonate levels observed in the present investigation could

have contributed to the alkalinity of water samples and the latter possibility is quite unlikely in the absence of producer organism [10]- [14].

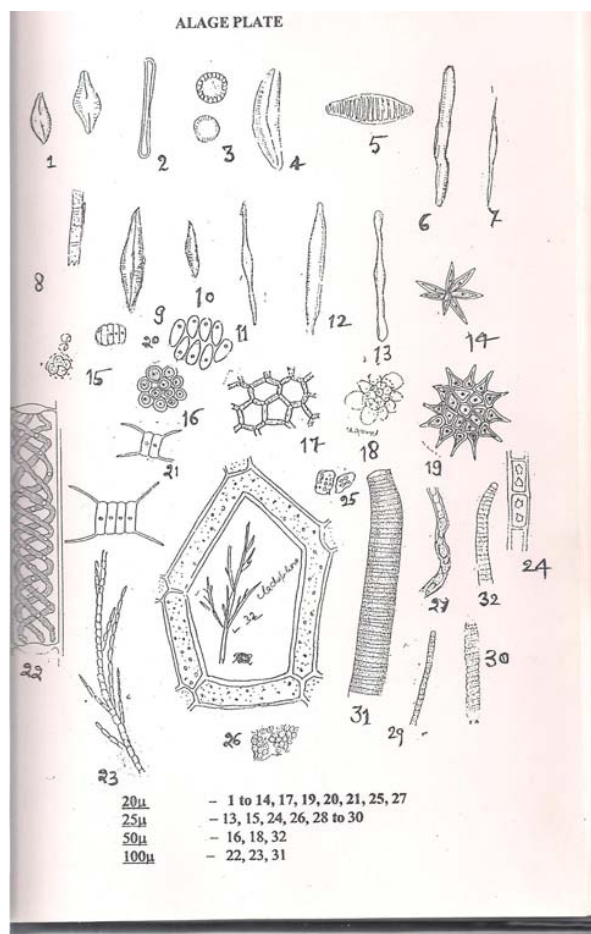


Fig. 2 Represents the morphological features of different Algae

Results are given in Table I gives wide variation noticed in these parameters are due to diverse chemical and technical procedures used in different industries and variations in the quantity of waste discharged at time. A stretch on the drain was highly colored due to discharge of colored wastes draining out from a particular industry. The drain water was murky and black and temperature of the drain water ranges from  $33-37.6^{\circ}\text{C}$  and was well with the bio-kinetic range to support the ground of bio-organic odor varied from, ammonical to organic pungent or fecal foul. pH was always alkaline. Transparency ranged from nil to hardly 1.6 cm and that too near the drains confluence with the river where its bottom is made of bricks and water flows downwards through the staircase to pollute the river.

Anoxygic condition prevailed in the drain throughout the study period except monsoon when the traces of oxygen were detected. Greater flow and the turbulence favored the natural dissolution of atmospheric oxygen in the drain water during

the monsoon. Table III shows the co efficient of algal similarity values among different stations. Biological oxygen demand (BOD<sub>5</sub>) ranges from 34.7-149.0 mg<sup>-1</sup> indicating heavy load of bio-degradable matter in the effluents. Table I show high BOD values were obviously due to sewage effluents in the drain. Besides BOD effluent was also quite rich in chemically oxidizable matter as in obvious from the high COD values effluents are devoid of any DO but high BOD.

COD value indicates the presence of high concentration of both bio-degradable and non bio-degradable pollutants in there. COD value is remarkably high in station 2. Total solid and suspended solid concentration is maximum in station 1.

Phosphate compound are multifariously used in number of chemical processes and are also in integral part of domestic detergent have phosphate concentration ranging between 1.6 mg<sup>-1</sup> to 4.4 mg<sup>-1</sup> in diverse effluent is quite normal. Average algal population (n=10), species number, percentage species reduction (in comparison to station 1) and diversity index values are given in Table II where as Table IV depicts the data pertaining to degree of taxonomic similarity among the algal spectrum at different stations. Highest taxonomic similarity existed between upstream station 1 and the last downstream station 6 indicating that somewhat similar conditions existed at these stations.

TABLE I  
PHYSICO-CHEMICAL CHARACTERISTICS OF THE EFFLUENTS AT DIFFERENT STATIONS

Parameter	Panki TPP Drain	Panki Muncipal Drain	IEL	Ganda Nala	Halwakhend Drain	COD	IS:2490,198 1
Present status	untapped	-	-	-	-	-	-
Colour	Murky black	Murky back/Red brown	Murky	Murky	Black	Murky black	*
Odour	Foul	Organic/pungent	Faecal foul	Faecal foul	Faecal foul	Faecal foul	*
pH	6.1	8.1	7.1	7.1	7.1	7.9	
Temp.°C	34	38.2	37.4	35.1	0.32	31.1	
Transp.	Nil	Nil	Nil	Nil	Nil	Nil	
Total solids	899	1028	1254	1241	1012	660	
Suspended solids	1542	173	251	225	189	90	140
DO	-	-	-	-	-	-	
BOD5	141	200	229	235	229	130	35
COD	313	460	475	425	302	279	225
Nitrate	ND	ND	ND	ND	ND	ND	-
Ammonia	142.2	219.0	107	106	125	129	49
Urea	0.09	1.0	0.01	0.01	1.01	0.0	0.0
Chloride	120	155	285	279	168	125	1020
Phosphate	1.2	2.1	4.4	4.2	1.9	2.5	2
Oil & Grease	+	+	+	+	+	+	+

All values in mg<sup>-1</sup> except color, odor, temperature (°C), pH and transparency (cms.).

+ Presence.

\* Presence all efforts should be made to remove color and odor as far as possible.

TABLE II  
AVERAGE ALGAL POPULATION (N=24), SPECIES NUMBER, PERCENTAGE SPECIES REDUCTION, DIVERSITY INDEX VALUES AT DIVERSE STATIONS

	S1	S2	S3	S4	S5	S6
Algal population % reduction	168	84	146	195	314	242
Species Number	25	10	13	19	21	25
Shannon-Wiener Index	6.36	1.72	2.8	3.0	3.6	4.0
Margalef's J.S Index	6.16	1.06	1.9	2.4	2.8	3.5
Redundancy Index	0.29	0.14	0.19	0.20	0.22	0.26

Average number of individuals<sup>-1</sup>

TABLE III  
CO-EFFICIENT OF ALGAL SIMILARITY VALUES AMONG DIFFERENT STATIONS

Stations	1	2	3	4	5	6
S 1	-	0.17	0.37	0.41	0.52	0.80
S 2	-	-	0.52	0.76	0.39	0.17
S 3	-	-	-	0.61	0.53	0.36
S 4	-	-	-	-	0.65	0.36
S 5	-	-	-	-	-	0.61

Co-efficient of similarity

TABLE IV  
ALGAE RECORDED IN THE DRAIN WATER AND THEIR RESPECTIVE ABUNDANCE

Algae	Stations						Total No.
	S1	S2	S3	S4	S5	S6	
<i>Cyclotella fumida</i>	+	+	+	+	+	-	843
<i>Asterionella Formosa</i>	+	+	-	+	+	-	769
<i>Cladophora glomerata</i>	+	-	+	-	-	+	608
<i>Pediastrum simplex</i>	+	+	-	-	-	+	590
<i>Scenedesmus bijuga</i>	+	+	-	+	-	+	586
<i>Cladophora glomerata</i>	+	-	+	-	+	-	562
<i>Mycrocystis aeruginosa</i>	+	+	-	-	+	+	499
<i>Merismopedia minima</i>	+	-	-	-	-	+	480
<i>Pandorina morum</i>	+	+	+	+	-	+	466
<i>Oscillatoria saline</i>	+	+	+	-	+	-	414

#### V.CONCLUSION

The river water is a natural medium for the growth of aquatic flora and the fluxing of the wastes by natural or anthropogenic factors cause a disturbance in its composition. This causes the change in the optimum conditions favorable for the growth of the aquatic flora. Thus it may be concluded that pollution of the river has attained alarming dimensions, adversely its algal community which serves as natural

oxygenator of the river. If all the necessary measures are taken by Government and non-Government, simultaneously and seriously can go along a long way in alleviating and abating further deterioration of the river with a view to restore its natural unpolluted and healthy ecosystem. All tables and figures you insert in your document are only to help you gauge the size of your paper, for the convenience of the referees, and to make it easy for you to distribute preprints.

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