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Monitoring of Plankton Indicators for Assessment of Pollution Status of the Yamuna River at Kalpi (U.P.) India

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ABSTRACT

Present investigation deals with the role of plankton indicators to assess the pollution status of the Yamuna river at Kalpi (U.P.). Pollution status of the river was assessed by employed Palmer's Algal species Pollution Index. Samples were collected at four sampling sites on the Yamuna river for a period of one year in each month of every season. Samples were analyzed for physico-chemical parameters and identification of recorded planktons with try to find correlation between them. 25 genera of phytoplankton belonging four groups Chlorophyceae, Euglenophyceae, Bacillariophyceae and Cyanophyceae and 16 genera of zooplankton belonging four groups Protozoa, Rotifera, Cladocera and Copepoda were recorded and identified. Recorded pH, Conductivity, Turbidity, T.D.S., PO4, B.O.D. and C.O.D. were beyond the drinking water limit of WHO while T.H., Cl, SO4 and NO3 were under the limit and D.O. was satisfactory to good condition. Presence of pollution indicator algal forms i.e, Euglena viridis, Oscillatoria limosa, O. tenuis, Scenedesmus quadricauda, Stigeoclonium tenue, Synedra ulna, Ankistrodesmus falcatus, Oscillatoria chlorina, Chlorella vulgaris, Cyclotella meneghiniana and presence of dominant Rotifer's zooplankton population with Brachionus calyciflorus shows signs of organic pollution in studied water. Sampling site S4 was more polluted but S3 and S2 site was moderately polluted and S1 lack of organic pollution. In S4 sampling site pollution index score was high with high physico-chemical parameters.

INTRODUCTION

Certain species have well defined ecological requirements and their presence, absence, frequency and relative abundance in water ways can be used as an indication of water-quality conditions. Planktons that respond rapidly to environmental changes, with the identification of particular indicator species they have been very useful in assessing water quality. They predicts the degree and level of pollution before the effect of pollutants starts. Routine monitoring of plankton communities is reliable and relatively less expensive compared to the cost of assessing toxicant pollutants. Qualitative and quantitative analysis of different group of planktons have led to establishment of indicators and indices which can be used to assess the pollution status of water bodies. Pearsall (1932) was the first to show clear correlation between organic pollution with Cyanophycaen and Bacillariophycean member. Nygaard (1949) mentioned that phytoplankton association could be used as an index of pollution. Palmer (1969) made the first major attempt to identify and prepare a list of genera and species of algae with reference to the tolerance of organic pollution. Palmer, 1969 on the base of own work developed pollution index for rating of pollution of water. The number and species of phytoplankton serves to determine the quality of a water body (Bahura, 1991). Sladecek (1983) recognized that dominance of Rotifers is indicator of polluted water.

Plankton of fresh water bodies have been studied by several workers (Gunale and Balakrishnan, 1981; Khare, 1999; Mishra and Tripathi, 2002; Khare, 2006; Ferdous and Muktadir, 2009; Jindal and Sharma, 2011; Ishaq and Khan, 2013; Khare and Saxena, 2013; Kshirsagar, A.D., 2013; Singh *et al*., 2013; Barinova and Chekryzheva, 2014; Kumar et al, 2015 and Kumar et al, 2016). But there is little information about plankton indicators of the Yamuna river for assessment of pollution status in study area. So this study was undertaken in which an attempt has been made to analysis of physico-chemical parameters and identification of recorded planktons with try to find correlation between them.

AIMS AND OBJECTIVES

Objectives of the study was to monitoring of plankton indicators for assessment of pollution status of the Yamuna river at Kalpi stretch by analysis of relation between recoded physiochemical parameters and planktons identified.

MATERIAL AND METHODS

Study area: The study was carried out at Kalpi stretch of the holly river Yamuna which flows 1376 km from Yamunotri to Allahabad. Kalpi is a historical city of jalaun district of U.P., lies to the southeast bank of Yamuna on Kanpur Jhansi highway and falls under 26^0 7' 14" N latitude to 79^0 44' 59" E longitude with an average elevation of 112 meters. 5 Km. length of Yamuna at Kalpi from in front of Vyas Mandir (u/s) to Raid drain opening (d/s) was under study programme (fig.– 1).

Sampling and Analysis Four sampling stations named as S1- in front of Vyas Mandir, S2- Kila Ghat, S3- Peela Ghat and S4- just after Raid drain opening were selected for the sampling purpose. The samples were collected monthly till

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one year (October 2013 to September 2014) from selected sampling stations.

For physico-chemical parameters, water samples were collected in plastic bottles of two litre capacity and were kept in darkness at 4 ^{0}C till analysis in laboratory. Water temperature was measured by thermometer and pH was measured by pen pH meter at sampling site. Other parameters like Cond., Turb., T.D.S., T.H., T.A., Cl, SO_4, PO_4, NO_3, D.O., B.O.D. and C.O.D. were analysed in the laboratory according to the standard methods (APHA, 2005;Trivedi and Goel, 1986 and Adoni, 1985).

For plankton sampling, samples were collected by use of plankton net between 8.0 AM to 9.30 AM at every selected sampling sites. Samples were taken at mid stream 0.5 to 1m below the surface of water. Collected concentrated plankton samples (10 ml) were fixed and preserved in 5% formalin. Plankton samples were examined under high power microscope and identified with the help of standard books and monographs (Smith, 1950; Desikacharya, 1959; Prescott, 1962 and Adoni, 1985). Palmer's Algal species pollution index was employed for rating of water samples to study the pollution status of river Yamuna.

RESULTS AND DISCUSSION

Physico-chemical Parameters: Maximum water temperature (W.T.) 31.55^{0}C was recorded in S4 sampling site and minimum temperature was 15.30 ^{0}C in S1. The pH value was in range from 7.59 at S1 & S2 to 8.75 at S4. Conductivity of the Yamuna water was recorded in the range of 327 µS/cm at S1 to 1061 µS/cm at S4 during study period. The value of Turbidity was fluctuate from 25.0 NTU at S1 to 202 NTU at S4. Total Dissolved Solid (T.D.S.) value was in range from 455 mg/l at S1 to 678 mg/l at S4. Recorded Total Hardness (T.H.) of the Yamuna water was in the range of 83.5 mg/l (minimum at S1) to 150.9 mg/l (maximum at S4). Maximum value recorded of Total Alkalinity (T.A.) was 217.0 mg/l at S4 and minimum value was 89.5 mg/l at S3. Chloride (Cl) was varied from 13.0 mg/l at S1 to 50.5 mg/l at S4. Minimum recorded value of Sulphate (SO_4) value was 11.00 mg/l at S1 while maximum was 30.65 mg/l at S4. Phosphate (PO_4) of Yamuna water was in the range of 0.50 mg/l at S1 to 1.77 mg/l at S4. Nitrate (NO_3) was recorded in range of 0.36 mg/l at S1 to 4.90 mg/l at S4. Dissolved Oxygen (D.O.) value was ranged from 5.99 mg/l at S4 to 8.55 mg/l at S1. Biochemical Oxygen Demand (B.O.D.) maximum recorded value was 12.15 mg/l at S4 and minimum value was 3.15 mg/l at S1. Chemical Oxygen Demand (C.O.D.) of the Yamuna water was varied in between 10.75 mg/l at S1 to 27.30 mg/l at S4.

Recorded pH, Conductivity, Turbidity, T.D.S., PO_4, B.O.D. and C.O.D. were beyond the drinking water limit of WHO while T.H., Cl, SO_4 and NO_3 were under the limit, mostly T.A. was more than the limit. D.O. was satisfactory to good condition (table no- 1). All most all (except D.O.) physico-chemical parameters were found high in S4 sampling site. Because a big drain of Kalpi municipality is meeting with Yamuna before this site. D.O. was found high in S1 site because of less pollution.

Phytoplankton: Recorded and identified phytoplanktons were belongs to 35 species of 25 genera of different groups like as Chlorophyceae, Euglenophyceae, Bacillariophyceae and Cyanophyceae (table no -2). Chlorophycean genera were dominant fallowed by Cyanophycean and Bacillariophycean genera among recorded phytoplankton.

In present investigation 10 pollution tolerant species like as *Euglena viridis, Oscillatoria limosa, O. tenuis, Scenedesmus quadricauda, Stigeoclonium tenue, Synedra ulna, Ankistrodesmus falcatus, Oscillatoria chlorina, Chlorella vulgaris, Cyclotella meneghiniana* were recorded. These species of algae are indicator of organic pollution (Palmer, 1969).

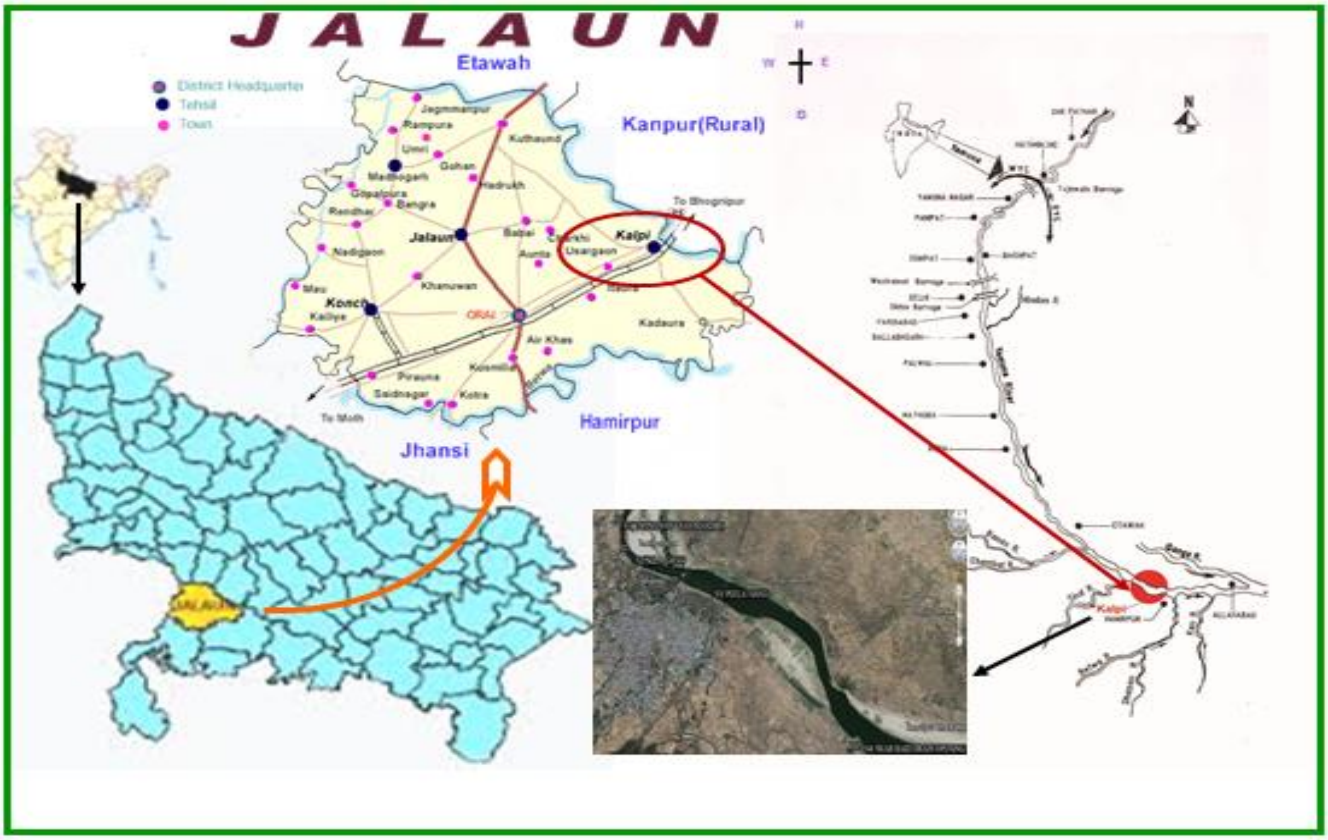

Fig 1. Location Map of Study Area with Map of the Yamuna River.

Table No 1. Physico-chemical Status (min. and max. mean value of 4 sampling stations) of the Yamuna river and comparison with permissible limit of W.H.O. (World Health Organization) for drinking water.

S.N.	Physico-chemical Parameters	S1 Min	S1 Max	S2 Min	S2 Max	S3 Min	S3 Max	S4 Min	S4 Max	Mean Min.	Mean Max.	Maximum permissible limit for drinking water (W.H.O.)
1.	Water Temp.(^{0}C)	15.30	31.47	15.40	31.48	15.50	31.50	15.80	31.55	15.50	31.50	-
2.	pH	7.59	8.67	7.59	8.68	7.60	8.70	7.62	8.75	7.60	8.70	6.5-8.5
3.	Conductivity(µS/cm)	327	1059	328	1060	329	1060	336	1061	330	1060	300
4.	Turbidity (NTU)	25	199	26	200	26	199	27	202	26	200	5.0
5.	T.D.S. (mg/L)	455	674	459	675	458	673	459	678	458	675	250-600
6.	T.H. (mg/L)	83.5	146.9	85.0	149.9	84.0	147.9	85.5	150.9	84.5	148.9	500
7.	T.A. (mg/L)	90.5	214.2	91.5	216.6	89.5	214.6	94.5	217.0	91.5	215.6	200-600
8.	Cl (mg/L)	13.0	46.5	15.5	49.0	13.5	47.0	16.0	50.5	14.5	48.50	250-1000
9.	SO_4 (mg/L)	11.00	29.00	11.06	29.85	11.03	29.50	11.11	30.65	11.05	29.75	250
10.	PO_4 (mg/L)	0.50	1.72	0.52	1.74	0.51	1.73	0.55	1.77	0.52	1.74	0.5
11.	NO_3 (mg/L)	0.36	4.20	0.39	4.70	0.37	4.60	0.40	4.90	0.38	4.60	50
12.	D.O. (mg/L)	6.02	8.55	5.99	8.52	6.00	8.53	5.99	8.52	6.0	8.53	2-6
13.	B.O.D. (mg/L)	3.15	11.90	3.27	12.00	3.23	11.95	3.35	12.15	3.25	12.00	3
14.	C.O.D. (mg/L)	10.75	26.30	10.80	26.90	10.85	26.70	11.00	27.30	10.85	26.80	10

Table No 2. List of recorded *phytoplankton i*n the Yamuna river at study area (Kalpi Stretch).

Chlorophyceae	
Genera	**Species**
1. *Ankistrodesmus*	*falcatus*
2. *Chlorella*	*vulgaris*
3. *Chlorococcum*	*infusionum*
4. *Cladophora*	*fracta*
5. Cosmarium	*tenue*
6.Closterium	*sp.*
7. *Hydrodictyon*	*reticulatum*
8. *Pediastrum*	*simplex*
Pediastrum	*tetras*
9. Scenedesmus	*quadricauda*
10. *Spirogyra*	*condensate*
11. *Stigeoclonium*	*tenue*
Euglenophyceae	
Genera	**Species**
1. Eugelna	*acus*
Euglena	*viridis*
2.Phacus	*caudatus*

Bacillariophyceae	
Genera	**Species**
1. Cyclotella	*meneghiniana*
2. Melosira	*sp.*
3. Navicula	*viridula*
4. Nitzschia	*angustata*
5. Synedra	*ulna*
Cyanophyceae	
Genera	**Species**
1. Anabaena	*fertilissima*
2. Lyngbya	*gracilis*
Lyngbya	*magnifica*
Lyngbya	*spirulinoidus*
3. Merismopedia	*elegans*
Merismopedia	*punctata*
Merismopedia	*glauca*
4. Microcystis	*aeruginosa*
5. Nostoc	*sp.*
6. Oscillatoria	*clorina*
Oscillatoria	*limosa*
Oscillatoria	*subbrevis*
Oscillatoria	*tenuis*
7. Phormidium	*calciola*
Phormidium	*uncinatum*

Table No 3. Pollution tolerant species of Algae recorded in four sampling sites of the Yamuna river at Kalpi stretch in order of decreasing emphasis(Palmer, 1969).

Sr. No	Name of Algal Species	Pollution Index	Sampling Sites			
			S1	S2	S3	S4
1	*Euglena viridis*	6	-	-	+	+
2	*Oscillatoria limosa*	4	-	+	+	+
3	*O. tenuis*	4	+	-	-	+
4	*Scenedesmus quadricauda*	4	-	+	-	-
5	*Stigeoclonium tenue*	3	-	-	+	+
6	*Synedra ulna*	3	-	-	+	+
7	*Ankistrodesmus falcatus*	3	+	+	-	-
8	*Oscillatoria chlorina*	2	-	-	+	+
9	*Chlorella vulgaris*	2	+	+	-	-
10	*Cyclotella meneghiniana*	2	+	+	-	+
Total Score			11	15	18	24

Key: + = present, - = absent

Similar observations were recorded by Gunale and Balakrishnan (1981), Khare (2006), Khare and Saxena (2013), Kshirsagar (2013) and Singh *et al*. (2013). Highest density of pollution tolerating phytoplankton was recorded at S4 sampling site fallowed by S3.

According to Palmer's pollution tolerating algal species index, rating score of S4 indicates high organic pollution, score of S3 & S2 moderately pollution and S1 score shows low organic pollution (table no - 3).

Algal species Pollution Index after Palmer (1969)

20 or more - Confirm high organic pollution 15 - 19 - Probable high organic pollution	Lower figure - Indicate lack of organic pollution

Zooplankton: In the present work 22 species of 16 different genera of zooplankton were identified (table no- 4) which belong to 22 species of 16 genera of different groups like as Protozoa, Rotifera, Cladocera and Copepoda. Along with 21 species of different group of zooplankton *Brachionus calyciflorus* was also recorded. Presence of *Brachionus calyciflorus* is considerd to be good indication of eutrofication (Sampaio *et al*., 2002). Among zooplankton Rotifer's population was dominant at S4 site during entire study span which shows high organic pollution at this site. Dominance of Rotifera is indicator of organic pollution (Sladecek, 1983).

Table No 4. List of recorded *zooplankton* in the Yamuna river at all sampling sites of study area (Kalpi).

Protozoa		**Rotifera**	
Genera	**Species**	**Genera**	**Species**
1. *Arcella*	*dentata*	1. *Asplanchna*	*intermedia*
2. Paramecium	*caudatum*	2. *Brachionus*	*calyciflorus*
3. Vorticella	*campanula*	*Brachionus*	*caudatus*
Cladocera		*Brachionus*	*falcatus*
Genera	**Species**	*Brachionus*	*plicatilis*
1. *Alona*	*rectangula*	*Brachionus*	*quadridentatus*
2. *Bosmina*	*longirostris*	*Brachionus*	*rubens*
3. *Ceriodaphnia*	*reticulata*	3. *Filinia*	*longiseta*
4. *Daphnia*	*carinata*	4. *Keratella*	*cochlearis*
5. *Moina*	*brachiata*	*Keratella*	*tropica*
Copepoda		5. *Philodina*	*citrina*
Genera	**Species**	6. *Polyarthra*	*sp.*
1. *Cyclops*	*bicuspidatus*		
2. *Macrocylops*	*albidus*		

CONCLUSION

Recorded pH, Conductivity, Turbidity, T.D.S., PO_4, B.O.D. and C.O.D. were beyond the drinking water limit of WHO while T.H., Cl, SO_4 and NO_3 were under the limit, mostly T.A. was more than the limit but D.O. was satisfactory to good condition. All most all (except D.O.) physico-chemical parameters were found high in S4 sampling site and presence of 10 pollution tolerant species like as *Euglena viridis, Oscillatoria limosa, O. tenuis, Scenedesmus quadricauda, Stigeoclonium tenue, Synedra ulna, Ankistrodesmus falcatus, Oscillatoria chlorina, Chlorella vulgaris, Cyclotella meneghiniana* indicates organic pollution. Highest density of pollution tolerating phytoplankton was recorded at S4 sampling site fallowed by S3. Palmer's pollution rating score of S4 indicates high organic pollution, score of S3 & S2 moderately pollution and S1 score shows low organic pollution. Presence of *Brachionus calyciflorus* and dominant Rotifer's population among zooplankton at S4 site during entire study span which shows high organic pollution at this site.

Pollution in the Yamuna river at Kalpi stretch can be prevented by trapping of municipal sewage drain, control of human activities, cattle bath, solid waste dumping and control in agricultural use of fertilizers, insecticides and herbicides.

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