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Studies on Increasing Sewage Load in River Yamuna and Its Impact on Some Common Microbes

P. K. Agrawal
Department of Zoology, B.S.A. College, Mathura, U.P. (India)

Abstract: *River Yamuna at Mathura (U.P.) is badly polluted with sewage and garbage. Being historical and religious city, millions of pilgrims come every year and take bath in the river. This poses a great problem to river's ecology and sustainability. A study was carried out to assess pollution load in the river in different months and its impact on population size of some aquatic microbes. The key indicators of sewage waste load were Coliform count (MPN), BOD, sulphates, phosphates and ammonia. The susceptible microbes that were analysed included Spirogyra sp., Stylonychia sp., Vorticella sp. and species of Euglena. The study revealed that the river has a deplorable level of organic pollutants. The condition becomes worst in summers, when the amount of water in the river is scanty. The population of Coliform bacteria and Spirogyra was found very high in areas where organic pollutants were very high in amount. But other organisms like, Stylonychia spp. Vorticella spp. and Euglena exhibited a severe decline in the population count. This clearly indicated the imbalance in river ecology.*

Keywords*: Pollutants, BOD, Coliform bacteria, Sewage waste, Ecological balance*

I. Introduction

River Yamuna is an ancient and religious river of India. It originates from Yamunotri in the Himalayan region (Uttaranchal), flows through western and southern Uttar Pradesh and finally drains into the holy Ganga River at Allahabad. During its great course, it also flows through District Mathura (in western U.P.) Mathura was selected as study area as it is considered to be a historical and sacred place, being the birth - place of Lord Krishna. Millions of pilgrims visit Mathura every year and take bath in the holy river Yamuna. The sewage along with the garbage is disposed off either directly or indirectly into the Yamuna, through a number of wide drains and results in heavy water pollution. Further, Mathura is a growing industrial hub. A large number of cotton printing industries and silver vibrators are working here. Their effluents are being mixed directly in the river, creating a huge ecological stress. Due to severe river pollution, the life of bath takers, live stock and aquatic organisms is being sacrificed (Agrawal et al, 2000). In the present study, assessment of pollution load in river Yamuna and simultaneous fluctuations in the population count of some aquatic microbes was carried out.

II. Materials And Methods

Selection of sampling sites

Three sampling sites were selected - a. Site A (upstream), b. Site B (Middle) and c. Site C (downstream). Site A is located near AIR station. Site B passes through the middle of the city, while site is located near Gokul barrage. The sites were selected to compare the entry and exit loads so that the pollutant addition from the city, could be assessed.

Sampling

Water sample of river Yamuna was taken on 10^{th} of every month (between 7.30 A.M. to 8.30 A.M.). For BOD, the sample was taken in BOD bottles. Parameters like pH, BOD, ammonia, chlorides and sulphates were tested in the laboratory according to standard methods, prescribed by APHA (1989). Some common microbes, present in river water, were also considered as test organisms. These included Coliform bacteria, species of *Spirogyra*, *Stylonychia*, *Vorticella*, and *Euglena*.. The water sample for determining the population of these organisms was taken separately in 1 litre glass bottles. Samples were preserved at 4ºC in 4-5 % buffered formalin solution.

Population assessment

The population of Coliform bacteria was determined by MPN technique. For other organisms, microscopical counting method was used. The sample was concentrated using planktonic nets of different sizes and was then stored in a closed and labelled glass vials. It was mixed properly by thorough shaking and 0.5 ml of the sample was pipetted with a fractional pipette on a clean glass slide. The slide was examined microscopically. Counting and enumeration was done with the help of an occular micrometer. The entire procedure was repeated thrice for each sample and then averages were noted for more reliable results.

III. Results

The monthly observations for physico-chemical parameters and for population count have been shown in following table.

Parameters/ Microbes	Site	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
pH	A	7.8	7.9	7.5	8.2	8.5	8.5	8.6	8.2	8.3	7.9	8.0	7.6
	B	7.6	7.8	7.2	8.1	8.6	8.2	8.4	8.1	8.1	8.0	8.1	7.8
	C	8.0	8.1	7.9	8.3	8.5	8.8	8.8	8.4	8.0	8.1	7.8	8.2
BOD (mg/L)	A	41	58	63	81	101	115	105	95	78	69	54	44
	B	58	64	69	91	118	126	119	108	89	74	67	57
	C	46	59	67	89	98	110	108	98	83	62	58	51
Ammonia contents (mg/L)	A	0.29	0.38	0.31	0.45	0.69	0.85	0.81	0.83	0.69	0.52	0.49	0.33
	B	0.38	0.51	0.65	0.68	0.79	0.96	0.87	0.78	0.79	0.65	0.47	0.42
	C	0.34	0.41	0.58	0.69	0.72	0.95	0.92	0.89	0.75	0.66	0.41	0.39
Phosphate contents (mg/L)	A	3.5	3.8	4.1	5.8	5.9	7.5	8.1	7.1	6.7	5.8	6.1	5.2
	B	3.8	5.8	7.3	6.9	7.9	8.5	9.6	7.8	5.9	7.4	6.9	4.8
	C	4.9	5.4	6.7	5.8	8.9	8.2	9.1	6.9	78	5.6	5.0	4.2
Sulphates (mg/L)	A	562	630	498	580	770	861	814	778	714	681	701	645
	B	603	595	641	650	715	987	924	828	721	737	740	680
	C	587	605	584	619	709	847	907	837	747	709	685	621
Total Coliform (MPN) x1000	A	19.5	18.6	22.4	24.5	28.4	31.5	35.2	29.5	25.4	22.6	24.9	19.1
	B	24.1	22.8	25.6	27.4	32.5	36.8	30.5	30.8	27.4	26.5	27.6	25.8
	C	22.5	23.5	25.8	29.4	31.4	34.1	29.5	31.5	28.1	25.4	22.4	20.8
Spirogyra spp.	A	45	61	49	77	84	79	76	85	68	72	55	51
	B	41	58	76	84	92	108	87	99	87	75	67	49
	C	55	51	66	82	86	99	83	67	75	81	61	43
Stylonychia spp.	A	38	31	38	40	31	18	16	23	27	22	35	38
	B	31	27	20	18	10	12	18	16	19	27	22	35
	C	34	26	31	23	22	19	18	12	18	21	29	32
Vorticella spp.	A	28	21	23	17	12	15	10	19	22	16	21	25
	B	33	25	18	12	09	05	07	12	10	15	15	18
	C	29	32	21	19	09	11	10	15	16	21	18	19
Euglena	A	75	61	48	65	55	28	31	42	59	51	65	72
	B	56	40	32	28	30	22	29	35	32	48	39	42
	C	65	57	62	48	37	35	32	42	55	49	56	63

IV.Discussion

Above data clearly indicates that the river has severe organic load and very high BOD values. The degree of pollution was found to be very high at the middle site B. This is mainly because the site is located near the centre of city and it receives three wide drains that bring excreta and garbage of entire city into the river water. Pollution load was also higher at site C as compared to site A. This site is located near the industrial area and it receives two wide drains that pour the effluents of many *saree* printing industries and silver polishing plants. Seasonally, the pollution load was higher during summer (i.e., May, June and July) at all sites. This is because of presence of low amount of diluting water in the river (Hynes, 1978). So, the remaining water becomes highly concentrated with pollutants. Parameters like BOD and ammonia were found to be directly related with pollution load. When pollution load was high, the values of BOD were found to be very high. This is mainly because dissolved oxygen gets utilised in the oxidation of biological waste and also in the respiration of algae (Lieven Bervoets et al, 2005).

Ammonia is rapidly oxidised by certain microorganisms in natural water bodies from nitrite to nitrate, a process that requires the presence of dissolved oxygen. So, a high level of ammonia (sewage waste) can severely contribute to high BOD levels. High BOD levels and increased level of ammonia are indicators of heavy sewage (organic) pollution (Sharma et al, 1981). The values of phosphates and sulphates were also very high at site B compared to other two sites. Seasonally, the values were remarkably high during summers. These high values indicated a heavy organic load in the river during summers.

The Coliform population exhibited a positive trends with BOD, ammonia, chlorides and sulphates i.e., population was found very high, where pollution load was high. Therefore, highest population of these bacteria was recorded at Site B especially during summers. High level of Coliform again indicated the presence of heavy organic pollutants in the river (Agrawal et al, 2000). Coliform produce a bad and offensive smell in the water body. Coliform represented a negative trend with oxygen, probably because absence of oxygen leaves the waste untreated, which is favourable to the bacterial growth (Verma, Tyagi, Dalela, 1978). *Spirogyra* being an alga, exhibited a positive trend, mainly due to the accumulation of organic wastes (eutrophication). It exhibited a positive correlation with ammonia, chlorides and sulphates. High population of algae is the indicator of heavy pollution load in the water body (Klein, 1973). The population of *Stylonychia*, *Vorticella* and *Euglena* revealed a negative trend with BOD, ammonia, phosphates and sulphates. In summers, when the pollution load

was high, a minimum population of these species was recorded. This clearly indicated that such organisms cannot survive in high BOD environment and organic enrichment. (Sharma et al, 1981). Ammonia is the excretory waste in *Stylonychia and Vorticella.* So these organisms cannot survive in a medium, which has high ammonical contents.

V.Conclusion

The study reveals that the sites selected for study are badly polluted by sewage and effluents of many small scale industries. Site B is the worst affected as it receives the maximum sewage load. Upstream and downstream sites have comparatively lesser pollution load. The populations of test organisms like *Stylonychia, Vorticella* and *Euglena* have shown severe fluctuation. The population count remains very low when the pollutant load is high. This does not indicate a healthy ecological balance in the river.

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