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Comparative Studies on Phytoplanktonic community structure Of River Yamuna and Western Yamuna Canal in Relation To Industrial Pollution in Yamuna nagar (Haryana), India

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Abstract:- Phytoplankton contribute significant role in aquatic ecosystem as their abundance is directly related with river's water quality. The present studies deals with the phytoplanktonic population of river Yamuna and Western Yamuna Canal and the effect of industrial pollution on their distribution and diversity. Three sampling stations were selected on river Yamuna and western Yamuna canal as pre-effluent point, point of influx of effluents and post effluent point (few Kms downstream from point of influx of effluents). Thirtyfive taxa from river Yamuna and sixteen taxa from western Yamuna canal have been observed belonging to Chlorophyceae, Bacillariophyceae, Cyanophyceae and Dinophyceae. Among Chlorophyceae *Chlorella spp.*, *Ulothrix spp.*, *Dactyloccous spp.*, *Netrium spp.* and *Volvox spp.* were the common taxa observed at both river Yamuna and Western Yamuna canal. Among Bacillariophyceae and Cyanophyceae *Surirella spp.*, *Navicula spp.*, *Synedra spp.*, *Oscillatoria spp.* and *Synechococcus spp.* were the common taxa at both the selected sites. However they all showed a decreasing trend at the point of influx of pollution from pre-effluent point but in case of western Yamuna canal their number further goes down at post effluent point. In river Yamuna only taxon *Dactyloccous spp.* showed a decreasing trend at post effluent point. *Cladophora spp.*, *Ankitodes spp.*, *Chaetophora spp.*, *Diatoma spp.*, *Spirulina spp.* and *Nostoc spp.* were the taxa found only in western Yamuna canal but not in river Yamuna. The abundance, distribution, total population, group percentage and species diversity were studied and correlated with pollution indicating water quality characteristics. Species diversity values indicated a decrease from pre-effluent point to effluent discharge channel and post effluent discharge point in river Yamuna and western Yamuna canal.

Keywords:- Industrial effluents, Phytoplankton, River Yamuna, Species diversity, Water quality

I. INTRODUCTION

Rivers have always been used as a source for dumping waste materials as industrial effluents. These industrial effluents badly affect the overall ecology of the river. The nature and health of any aquatic body can be measured qualitatively and quantitatively by the abundance and distribution of its biotic community. A progressive decrease in the number of individual of each taxa is generally observed with an increase in pollution.

Phytoplankton are the founder of the aquatic food chains. Any change in their structure directly decreases its productivity (Malhotra *et al*., 2014). Phytoplankton has been used for long with great success in estimation and measurement of the health of the aquatic ecosystem. Higher diversity means longer food chain and more cases of symbiosis increasing stability (Bhatnagar *et al*., 2013).

The industrial belt of Haryana is mainly situated along the north-eastern part of the state along with Yamuna. Yamunanagar is one of the major industrial cities of Haryana. The river Yamuna and western Yamuna canal along its path through Yamunanagar receives effluents from many industries which are affecting its overall ecology. Western Yamuna canal flows through the centre of the city and are getting effluents from paper, timber and sugar industries and municipal and sewage waste whereas river Yamuna flow along the side of the city making boarder with district Saharanpur of Uttar Pradesh, getting effluents from sugar industry, agriculture runoff and municipal and sewage waste. Keeping in view the above facts the present study has been undertaken to shed light on current status of phytoplanktonic community of both lotic water bodiesin relation to the effects of industrial effluents.

II. MATERIALS AND METHODS

Yamuna river and western Yamuna canal meander through/along the city Yamunanagar and are subjected to sewage and industrial effluents input through several point and non-point sources. Keeping in view the pollution sources, these two lotic water bodies, viz., western Yamuna canal and Yamuna river were selected for present studies. Three sampling stations were established and numbered Y1, Y2 and Y3 on river Yamuna and W1, W2 and W3 on western Yamuna canal consecutively downstream (Fig. 1) based on pollution load.

Plankton samples were collected by filtering 25 L of water through plankton net of mesh size 50µm with demarcating collecting tube. These samples were collected in 100 ml plastic bottles and concentrated samples were then made up a standard volume of 50 ml with distilled water. Samples were preserved with 4% buffered formalin.

The abundance of Phytoplankton was expressed as organisms L^{-1}. The organisms counted by drop count method were expressed per litre using formula:

$$\text{Total Planktons } L^{-1} = \frac{\text{Number of Organisms per drop X Vol. of conc. sample in ml}}{\text{Volume of original sample in litres X Vol. of one drop}}$$

Species diversity of phytoplankton was determined using Shannon and Weaver diversity index method (Shannon and Weaver, 1963; Washington, 1984).

$D = - \sum ni/ N \log_2 ni/N$

D = Species Diversity

ni = Number of individuals of i^{th} species

N = Total number of individuals in the sample

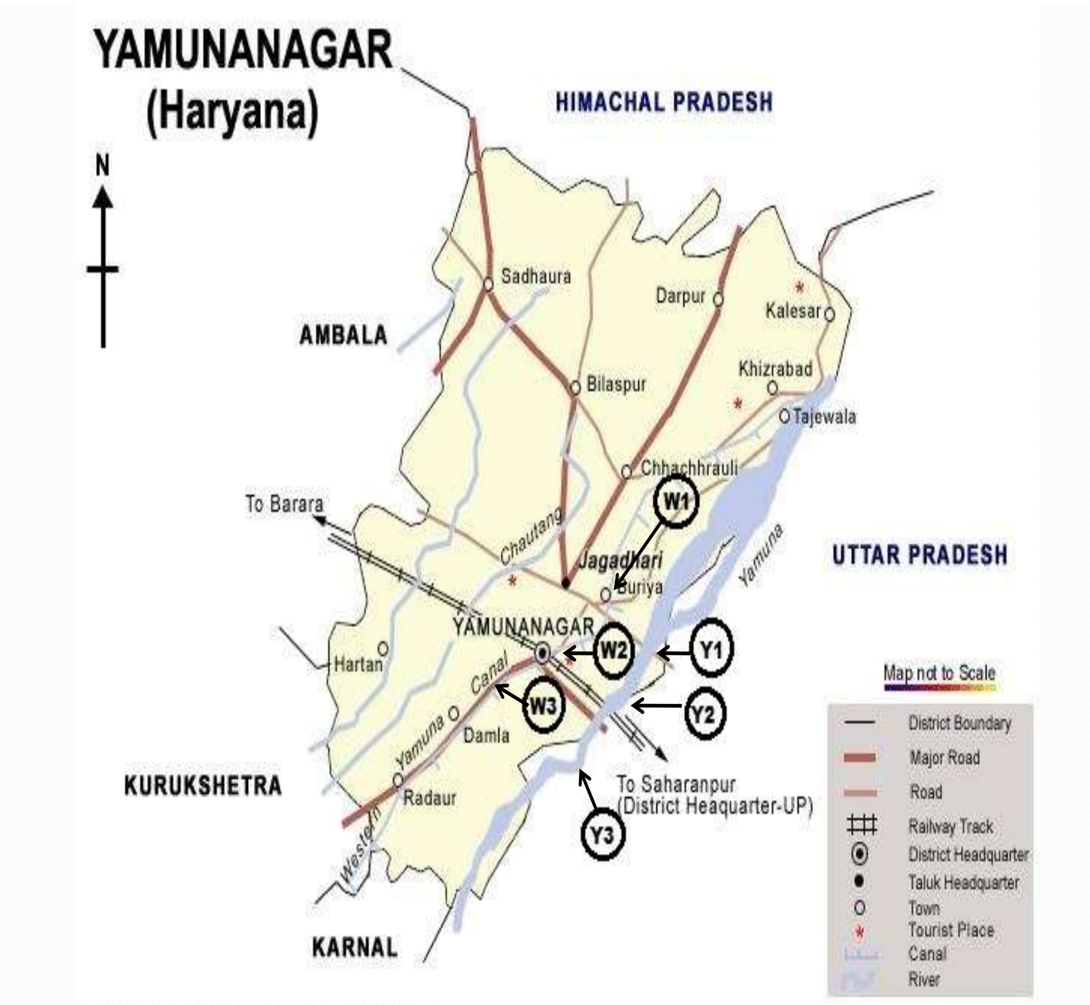


Fig. 1- Map of Yamuna nagar showing location of selected stations on river Yamuna and Western Yamuna canal.

III. RESULTS AND DISCUSSION

Thirty five taxa contributed to the phytoplankton community at river Yamuna belonging to Chlorophyceae (21), Bacillariophyceae (10), Cyanophyceae (3) and Dinophyceae (1) whereas sixteen taxa was observed at western Yamuna canal belonging to three main groups, viz., Chlorophyceae (8), Bacillariophyceae (5) and Cyanophyceae (3). The percentage distribution of Chlorophytes was dominant at both the lotic water bodies. Patil *et al.* (2012) and Hamaidi-chergui *et al.* (2013) have also reported highest composition of this group.

Phytoplankton showed a decreasing trend from pre-effluent point to the point of influx of effluents (Malhotra *et al.* 2014, Bhatnagar *et al*. 2013) but in case of western Yamuna canal their number further goes down at post effluent point (Fig. 2). This may be due to the diversion of path of flow of water at post effluent point so that station W3 was getting effluents in a more concentrated form.

Only ten taxa were observed as common at both river Yamuna and western Yamuna canal viz. *Chlorella spp., Ulothrix spp., Dactyloccous spp., Netrium spp., Volvox* spp., *Surirella spp., Navicula spp, Synedra spp., Oscillatoria spp.*and *Synechoccous spp.*. The present of these taxa at both water bodies showed their tolerant nature towards various effluents from different industries.

There were some taxa which were found only in western Yamuna canal but not in river Yamuna viz. *Cladophora spp., Ankitodes spp., Chaetophora spp., Diatoma spp., Spirulina spp. and Nostoc spp.* showing there sensitivity to effluents from sugar industries and wastewater from agricultural runoff. The value of measured DO was also low at river Yamuna in comparison to western Yamuna canal (Fig. 3).

Chlorella spp., Ankitodes spp., Oscillatoria spp. and Nostoc spp. were either absent or their number was very low at station W2, designated them as sensitive taxa whereas *Navicula spp., Surirella spp., Diatoma spp. and Spirulina spp.* were common taxa recorded from all the three stations on western Yamuna canal. The values of BOD, alkalinity and orthophosphate were also recorded high at station W2 from station W1 and W3 (Fig. 3).

Twenty six taxa were the only taxa, reported from river Yamuna but not from western Yamuna canal. These were *Cyclotella spp., Cocconies spp., Tabellaria spp., Neidium spp., Glenodinium spp., Stauroneis spp., Gomphonema spp., Nodularia spp., Zygnema spp., Closterium spp., Eudorina spp., Spirogyra spp., Micrasterias spp., Scenedesmus spp., Closteridium spp., Sirocladium spp., Pleurosigma spp., Rhizocolonium spp., Closteriopsis spp., Bulbochaete spp., Desmidium spp., Penium spp., Dactylococcus spp., Botrycoccus spp., Mougeotia spp.* and *Phormidium spp.*, showing their sensitivity towards the effluents from paper and timber industries. Western Yamuna canal showed highest value (304 mgL^{-1}) of total alkalinity at station W2, supporting the view of their intolerance to highly alkaline water.

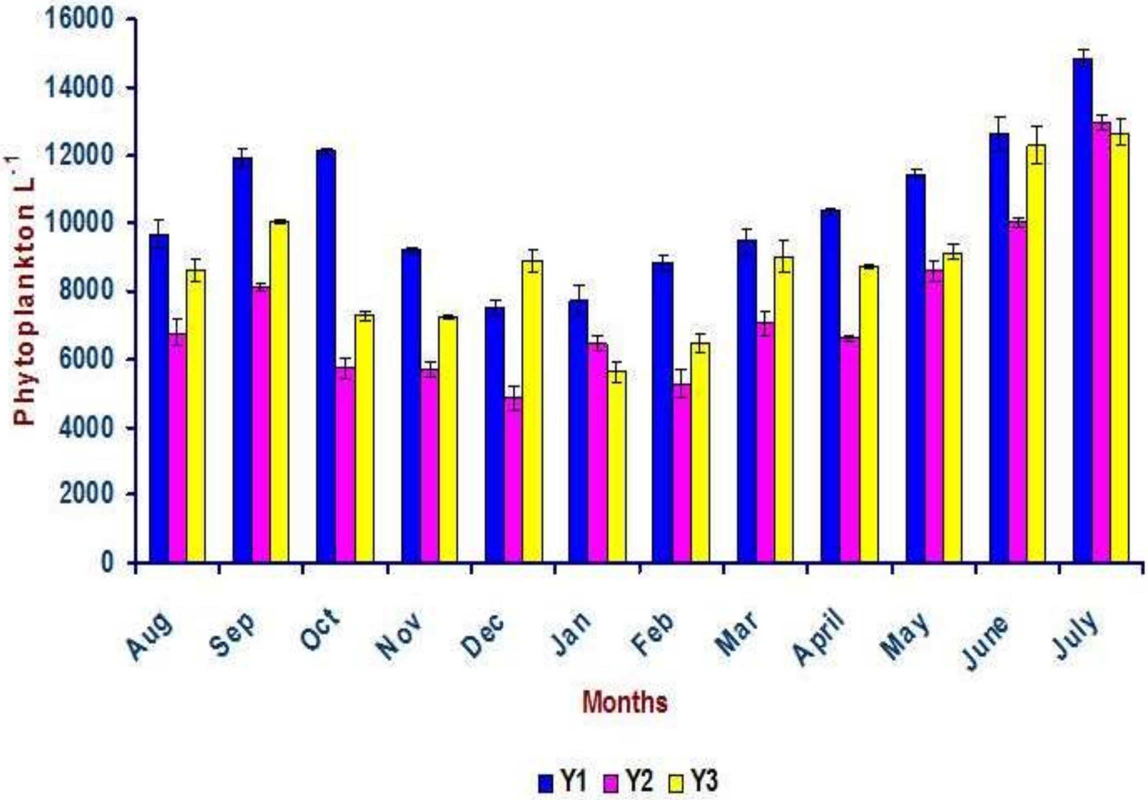
Navicula spp., Cocconies spp., Closterium spp., Micrasterias spp., Dactylococcus spp. and O*scillatoria spp.* were the common taxa found at all the three sampling stations on river Yamuna. However, there number goes decreased at the point getting effluents, yet there presence at this station showing there tolerance towards the effluents.

In river Yamuna and WYC the mean values of species diversity was found maximum at pre-effluent point. The values of species diversity was observed lowest at post effluent point (Y3) in case of river Yamuna whereas species diversity of phytoplankton decreased from station W1 to W2 and then remained the same at station W3 (Table 1). Salman *et al.* (2013) and Malhotra *et al.* (2014) also reported low values of species diversity at the point of influx of industrial effluents. Pollution indicating parameters, *viz.*, pH, conductivity, DO, BOD, COD, hardness and ammonia also showed higher values at stations W2 and Y2. So, above facts clearly depict that the industrial effluents are adversely affecting the phytoplanktonic population and diversity of both the lotic water bodies.

Table 1. Mean values of Species diversity of phytoplankton of river Yamuna and western Yamuna canal at various stations

	Pre-effluent point	Effluents induction point	Post effluent point
River Yamuna	**4.08 ± 0.14^{A}**	**3.91 ± 0.04^{A}**	**3.83 ± 0.04^{A}**
Western Yamuna Canal	**$2.9 \pm O.2^{A}$**	**2.5 ± 0.1^{A}**	**2.5 ± 0.2^{A}**

Means with different letters are significantly ($P<0.05$) different. (Data were analyzed by Duncan's multiple range test)



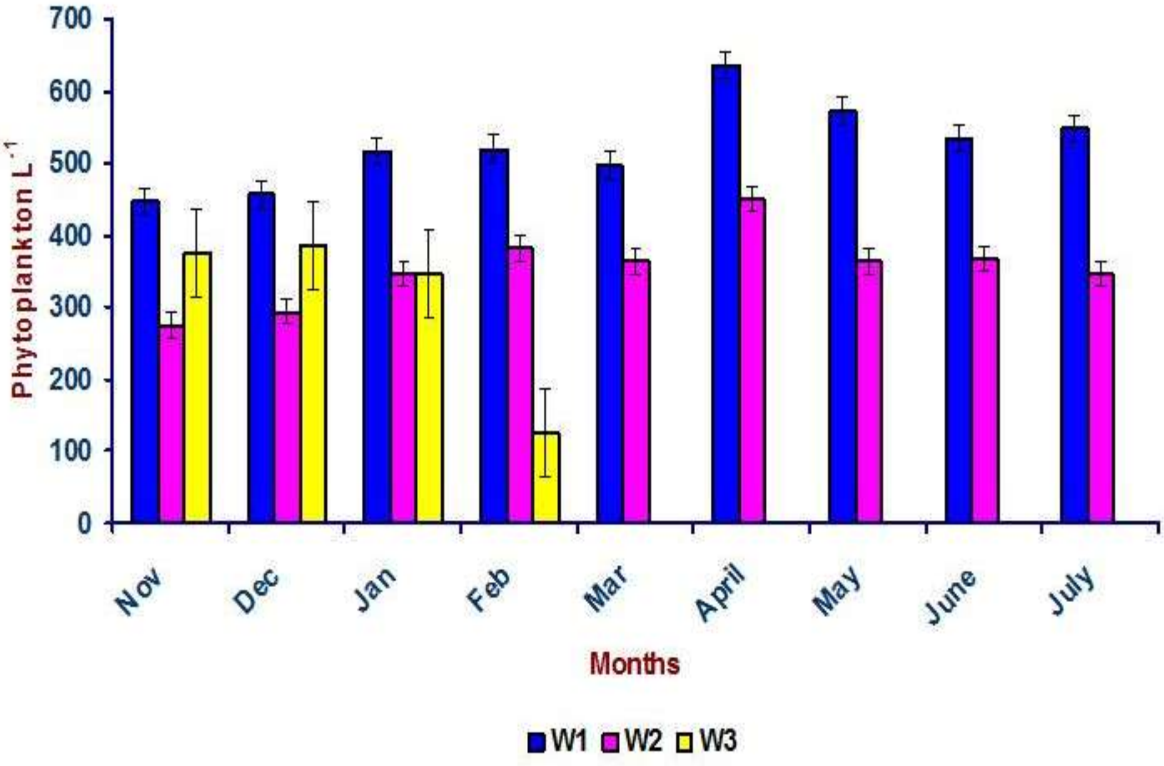


Fig. 2- Graph showing total number of phytoplankton of river Yamuna and Western Yamuna canal.

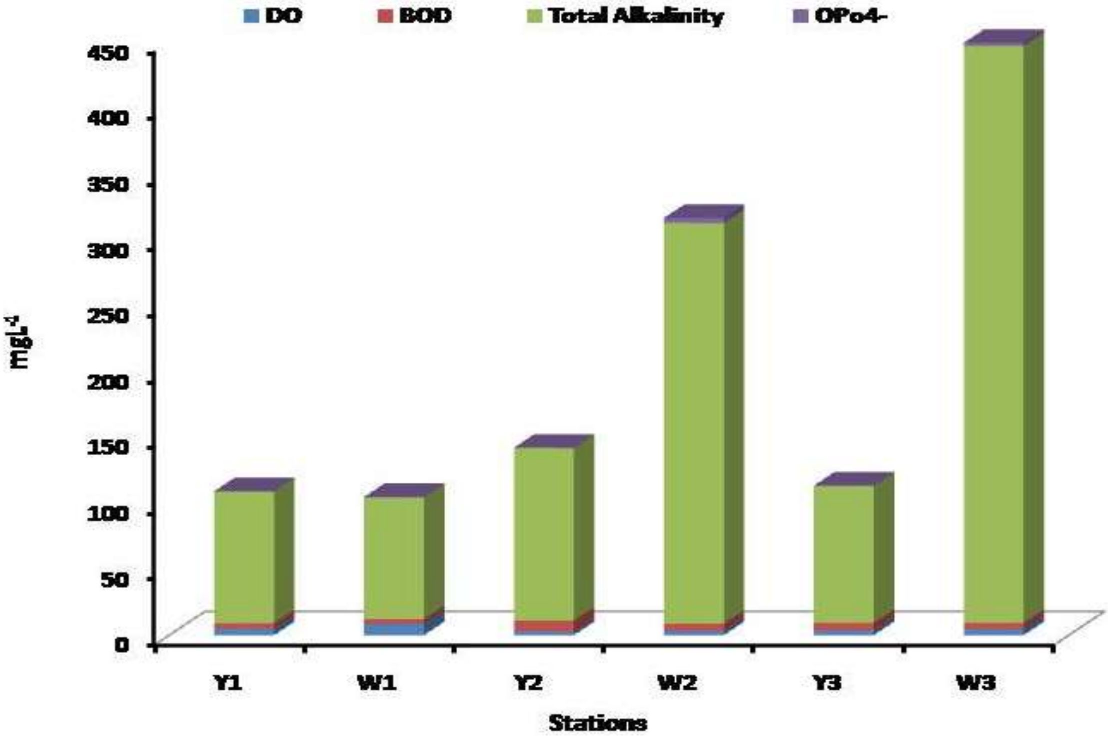


Fig. 3- Graph showing values of various physicochemical parameters of river Yamuna and Western Yamuna canal.

Photographs showing phytoplankton of various families.

IV. CONCLUSION

Western Yamuna canal has low phytoplankton biodiversity as compared to river Yamuna. Western Yamuna canal is getting effluents from more and diverse number of industries which is adversely affecting its ecosystem. Although river Yamuna has rich biodiversity yet the values are declining at the point of influx of effluents. So, in order to manage the pollution load of river Yamuna and western Yamuna canal it is recommended that various methods of sewage/industrial wastes treatment should be used before the disposal of effluents.

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