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A STUDY OF POLLUTION ON AQUATIC ORGANISMS OF RIVER YAMUNA IN DELHI

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Abstract

Fish diversity and pollution status in the Yamuna River in Delhi, India is due to Several industrial and urban centers sit on the banks of the Yamuna in Uttar Pradesh. We selected four sampling stations on the Yamuna for purposes of fish fauna and water quality analysis over the course of a calendar year (October 2016 – September 2018). The samples were analyzed for selected physico-chemical analysis, and we recorded the types of fishes as well. We observed that most physico-chemical parameters were in a suitable range for the survival and growth of fish fauna. We recorded 29 species of fishes, belonging to 21 genera of 10 families.

***Keywords**: Limnological status, physico-chemical parameters, fish diversity, Yamuna*

Pollutions from these two groups precipitate changes in the Yamuna's waters in terms of pH, turbidity, Total Dissolved Solids, Dissolved Oxygen, and Biochemical Oxygen Demand (BOD). Fishes in the Yamuna are strong indicators of pollution levels. By tracking changes in fish growth and reproduction rates, we can learn more about changes in the physico-chemical characteristics of the river water.

Fishes constitute an economically significant group of aquatic animals due to their importance in providing food to riverine communities and urban centers. As a food, fishes provide a wide range of nutritional gains, including protein, fat, vitamins A, D & E, and phosphorus. The fishing industry produces by-products to support several related industries including fish meal, fish protein, manure, shagreen, isinglass, glue, and other products.

Objectives: The objective of the present study is to assess the physico-chemical characteristics of river Yamuna at Delhi to understand its impact on fish fauna. As well, we will collect and identify fish fauna at this point in the river.

Material and Methods Study area: Yamuna is an historical city in the district Agra of Uttar Pradesh in India. For analyzing parameters, standard methods are employed as used in APHA (2005)

Result and Discussion: The observed physico-chemical parameters were tabulated and analyzed to understand the characteristics of water. Simultaneously, the fish fauna were also observed and identified and we explored possible corelations those water characteristics and the fish species (i.e., limnological status and productive capacity). Physico-chemical parameters: The recorded average of selected physico-chemical parameters of our four sampling sites is presented in Table 1 below. Water temperature: A maximum temperature (31.50 C) was recorded in June and minimum temperature (15.50 C) in month of January, for an average temperature of 25.380 C. As fishes require moderate temperature for growth and reproduction, the temperatures were found suitable for the survival and growth of fish fauna (Khanna and Bhutani, 2007). pH: The pH value ranged from 7.60 to 8.70. The maximum pH value (8.70) was recorded in June and the minimum (7.60) in January with average value 8.28. The pH of Yamuna river was alkaline in nature, which is a good indicator for fish survival (Khanna et al., 2013). Conductivity: Conductivity of the Yamuna water ranged from 330 µS/cm to 1060 µS/cm during our study period. The minimum conductivity was recorded in August and the maximum in June for an average value of 601.25 µS/cm. Turbidity: Turbidity values ranged from 26.0 to 200 NTU. The minimum value of turbidity was recorded in February and maximum value in August. The mean value of turbidity was 83.58 NTU. Overall, the turbidity of the Yamuna stayed under the limits that would prevent fish growth and reproduction. Total Dissolved Solid (TDS): The value of total dissolved solids in the Yamuna near Kalpi ranged from 458 to 675 mg/l. The minimum TDS levels were recorded in January and the maximum values in August for an average value of 564.58 mg/l. Total Hardness (TH): Recorded total hardness of the Yamuna river water ranged between 84.5 mg/l (minimum) to 148.9 mg/l (maximum). Minimum hardness was recorded in August and maximum hardness in June. The average recorded hardness was 111.48 mg/l. Total Alkalinity (TA): Maximum value (215.6 mg/l) of total alkalinity was recorded in June and the minimum value (91.5 mg/l) in January for an average value of 173.92 mg/l. Alikunhi (1957) reports that in highly productive water, the alkalinity ought to be higher than 100 mg/l. As the Yamuna was higher than that level for most of the year, it was suitable for productive fish cultures in terms of alkalinity. Chloride (Cl): Chloride ranged from 14.5 mg/l to 48.5 mg/l for a mean value of 26.88 mg/l over the study period. Minimum chloride value was recorded in August and maximum in May. Sulphate (SO4): Minimum sulphate levels (11.05 mg/l) were recorded in August while maximum (29.75 mg/l) levels occurred in June. The average value of recorded sulphates was 22.25 mg/l. Phosphate (PO4): Phosphate levels in the Yamuna ranged from 0.52 mg/l (in January) to 1.74 mg/l (in August). Average value of recorded phosphates was 0.82 mg/l. Nitrate (NO3): Nitrates ranged from 0.38 mg/l (in August) to 4.60 mg/l (in June) for an average value of recorded nitrate was 1.26 mg/l. Dissolved Oxygen (DO): The value of dissolved oxygen ranged from 6.00 to 8.53 mg/l. Minimum value of DO was recorded in June and maximum value in January. Average value of recorded DO for the observation period was 7.45 mg/l. This average is positive for a healthy fish culture. Biochemical Oxygen Demand (BOD): Maximum value (12.00 mg/l) of biochemical oxygen demand was recorded in June and minimum value (3.25 mg/l) in September for an average value of 7.71 mg/l. Recorded BOD was also satisfactory for fish growth and survival on this stretch of the Yamuna. Chemical Oxygen Demand (C.O.D.): The chemical oxygen demand of the Yamuna ranged from 10.85 mg/l (August) to 26.80 mg/l (June). The average value of recorded COD was 21.2 mg/l. Fish Fauna: In the present study, we have recorded 29 species of fishes belonging to 21 genera and representing 10 families. Fish species like Anabas testudineus (Kabai/ Jalebi), Catla catla (Catla), Channa marulius (Padam saur), C. punctatus (Saurri/Gurrie), Cirrhinus mrigala (Nain/Mrigla), Eutropiichthys vacha (Bachuwa), Labeo bata (Bata), L. calbasu (Karaunt/Calbasu), L. rohita (Rohu), Mastacembelus armatus (Bam), Mystus seenghala (Tengan), Notopterus chitala (Chital/Moya), N. notopterus (Patra), Oxygaster bacaila (Chelhua), Rita rita (Rita), Wallago attu (Parhin/Lanchi) were common to most common while Chagunius chagunio, Channa gachua, Clarias batrachus, Cyprinus carpio, Heteropneustes fossilis, Hypopthalmicthys molitrix and Mystus tengra were rare and Barilius barna, Cirrhinus reba, Esomus danricus, Labeo gonius, Ompok bimaculatus and Puntius sarana were very rare during study period.

Fish growth and productivity is highly dependent on the physico-chemical characteristics of the water, and in the Yamuna, we observe that relationship to be true. Most of the parameters were found suitable for fish survival and reproductive multiplication. Thus, the limnological status of fishes in the Yamuna River at our study area was satisfactory during our study period.

In the meantime, the cpcb has listed out various safeguards for the future. It has stipulated that a minimum flow of water be maintained in the river through regular discharge instead of intermittent release. The board has issued directions to the up government to clean the riverbed and remove algae, which it suspects are playing a major role in do depletion at night. "The state government has also been asked to improve their sewage treatment facilities," says

Bharadwaj. Even as most government agencies seem out of their depth, it remains to be seen whether the itrc report -- which is awaited -- can shed light on the matter.

Effects on fish eggs; spawn and fry: Fish eggs are much more resistant than the adult fish. Toxicity thresholds for lead, zinc and nickel to be about 20, 40 and 2000 ppm respectively, values for higher than those found for about animal. Eggs would develop normally between pH 4 to 5 on the acid side and 8 to 9 on the alkaline side. In water more acid than pH 4.0, the eggs displayed exosmosis and collapsed, in water more alkaline than pH 9.0 there was endosmosis, the eggs swelled and yolk became white. The critical oxygen tensions are about 40 mm Hg for newly fertilized eggs and rises, as the embryo develops, to about 100 mg Hg (about 60% saturation) at the time of hatching. Trout and Salmon lay their eggs in gravel, through which water must percolate while the eggs batch and the fry live on the food from the egg yolk. Then the gravel must allow the fry to emerge. A suitable area must not accumulate silt and sand during the gravel life and it must not freeze or shift with floods. Oxygen shortage due to pollution in the water flowing through the gravel, an insufficient rate of water flow due to deposition of silt in the spawning beds, or a combination of both these adverse factors will hold up the development of fish eggs, delay hatching and proves fatal to the embryos.

Destruction of breeding & spawning grounds: For any nest, building fish or any fish in which the eggs attach to a particular substrate the nature of the substrate is important in successful spawning. Aquatic vegetation often provides the very substrate within which or on which eggs are laid and may protect eggs from wave action and erosion. Gravel bed is good for spawning. The role of nearby structure (gravel) of aquatic vegetation is less clear, but it doubtless makes nest defense from predator more effective. High level of turbidity caused by pollution often precludes the development of substantial littoral zone vegetation.

Effects on fishing and fishery products:

Fishing: Fishing gear and operations may be adversely affected by various kinds of pollutants. Over fertilization may cause fouling and clogging of nets, traps and other fishing gears by masses of macro algae or other plants and animals drifting in the water or using the materials as substratum. In the areas of oil exploitation nets are frequently clogged by crude oil and lumps of oily tar and catches have had to be discarded because of tainting. The numerous objects caught in the bottom trawls (from plastic containers to explosives) often interfere with fishing operations. Wrecked cars and other junk have hampered fishing particularly in the North sea and the Baltic by mechanical damage to nets and boats, and good fishing areas have been closed because of the danger from dumped military waste such as explosives, cyanide compounds, biological and chemical warfare agents and radio active wastes. Fishery products: A common reason for the discarding of catches and the discontinuance of fishing in certain areas is the tainting of the fish by unpleasant ordours and tastes caused by petroleum derivatives, even at concentrations significantly below lethal levels. Waste from refineries and discharges of petroleum from ships are causing increasing damage to fishing in this respect. 0.01-0.02 ppm concentration is sufficient to cause bad taste in rainbow trout, Japanese mackerel and some other species. Mullet, which is rich in body fat, is likely to acquire taint more readily than other fish species in the same environment. Colouring: Colouring has a similar effect to tainting on the fish's marketability that is a fish product with a modified colour is practically worthless. The "green Oyster" of Japan and Portugal, coloured by incorporated copper and zinc and "red herring" of Canada due to internal bleeding by elemental phosphorous are examples. There is evidence that pollution can cause morphological changes, teratogenic effects, skin ulcerations and other lesions, as well as various other diseases especially fungal in fish and shellfish. This has generally been associated with water is chronically contaminated by waste from industry or municipal sewage and sludge. In some countries fisheries product are eaten raw providing opportunity for human infection by pathogenic such as viruses, bacteria, and nematodes. Bacterial contamination from domestic sewage is a particular problem to the shellfish (e.g. oysters, mussels, cockles etc.) may be marketed, however, after appropriate treatment (sterilization, relaying or purification) which, when properly carried out, results in products safe for human consumption. Swordfish fishery has suffered economically because of rather high contamination of mercury found in this fish (M.R.L. for Hg 0.05 mg/kg body weight). In some cases, it has been observed that "blooms" of toxic species of plankton were related to the disposal of nutrients into the water, as by sewage pollution. The danger to consumers is evident and mass mortalities of fish and other organisms are frequent consequence. This has led to the temporary closure of certain fishing areas or to the prohibition of the sale of the product.

Ciguatera toxins and paralytic shellfish poisoning: Ciguatera toxins and paralytic shellfish poisoning are naturally occurring toxins. Ciguatera is the most common nonbacterial food poisoning disease associated with the consumption of fish primarily in tropical regions of the world, including Caribbean, Atlantic, Indian and Pacific Ocean regions and Middle Eastern and Australian areas. Ciguatera is considered a world health problem. Studies have shown that more than 20 toxins are responsible for ciguatera phenomenon. The primary toxin, ciguatera toxin, has been isolated from large carnivores, and in smaller amounts, in herbivores. This is due to the greater lipid solubility of ciguatera. Considerable circumstantial evidence has linked Gamberdicus toxicus and other dinoflagellates to the group of ciguatera toxins. Paralytic shellfish poisoning may occur because of ingestion by certain species of bivalves (e.g. mussels, calms, oysters) of planktonic poisonous dinoflagellates such as Gonyauflux. Murate et al. (1990) reported the structures of ciguatoxin from the morey eel (Gymnothorax javanicus) and has not yet been conclusively demonstrated that the toxin produced by the dinoflagellate is either identical to, or is a precursor to, ciguatoxin(s) accumulating in fish. However, research workers have suggested recently that the release of inorganic substances because of mining activities into the water of tropical regions in insular areas triggers off naturally occurring biotoxicity cycles such as “Ciguatera” and other fish poisoning. This makes the normally valuable food resource dangerous for human consumption and thereby instances of human death caused by such poisoning.

River Yamuna (Delhi-Agra): Out of the total quantity of water supplied in Delhi 20% covers consumptive use, the remaining 80% flows back into the river. River Yamuna at Delhi is daily contaminated by about 320000 kilo tones of nearly untreated city sewage in its 24 KM stretch. About 17 openings discharge waste in the Yamuna. The Najafgarh drain contains high quantity of DDT and chloral hydrate in its 15000 m3/day of industrial effluents. Out of these 6000 kg/day of fixed dissolved solids, 3000 kg/day of heavy metals, 300 kg/day ink and dye, 3800 kg/ day organics, 1800 kg/day oil and grease, 1000 kg/day acids, 700 kg/day alkali and 200 kg/day detergents. It also receives large volume of extremely hot water from the power generator plants situated on the bank of the river. The industries that causes pollution are printing, electroplating, soap manufacturer, food products, rubber, plastic, chemical, petroleum, fertilizer factories, synthetic material plants and drugs etc. Pollution of the Yamuna between Delhi and Agra has become a serious health hazard. The statement made by Prof. Arceivala that, “Agra may be drinking Delhi’s sewage”, is well documented by an analysis of river along its 195 monitoring stations downstream to Agra, which revealed increasing deterioration in its quality (Table 2). At Agra, Yamuna also receives the heavy load of city sewage and industrial effluents. Mathura oil refinery further deteriorated the quality of water of Yamuna. DDT factory waste brought to the river Yamuna through Najafgarh nallah was tested for toxicity to fish. The high concentrations of DDT and chloral hydrate coagulate the mucus of gills and opercular chamber of fishes under moderately acidic pH. Water quality deteriorates further in the downstream of Agra. Approximate dilution required for survival of fish in Yamuna at Delhi is 8000 times. In case the waste is neutralized then only 10-15 times dilution is required.

Threats to river Yamuna

The major threats affecting the ecological integrity of River Yamuna identified during the investigation have been

(i) Alteration of the habitat of fish: The alteration of flow of river Yamuna has changed the habitat characteristics for fish and other aquatic organism. The disruption of the longitudinal and lateral connectivity of the river by diversion of the river water for power generation, irrigation and drinking water purposes at various places all along its length from the barrages at Dakpatthar, Asan, Hathnikund, Wazirabad, ITO bridge, and Okhla has altered the flow characteristics.

(ii) Pollution of water: The Ganga basin in general and the Yamuna basin in particular has a large proportion of the population concentrated in large urban centres, most of which do not have any sewerage and those with sewerage system do not have yet adequate capacity to treat domestic wastewaters. Therefore, enormous amounts ofuntreated or partly treated sewage are directly discharged in the river Yamuna in the urban centres along with industrial effluents and agrochemical pollutants (CPCB, 2005). As a result the water quality has deteriorated in these segments of the river. Since 1985, the Government has implemented the Ganga Action Plan to provide for interception and treatment of sewage in major cities along the River Ganga. This was later extended to many cities and smaller towns along River Yamuna (under the Yamuna Action Plan) and other rivers in the Ganga basin (CPCB, 2005). Under present situation the river is not

serving as an optimum habitat for fish.

(iii) Siltation and degradation of wetlands: All the segments of river Yamuna have been subjected to siltation, encroachment of river beds and the flood plains. This has resulted in a change in land use pattern hindering the ecological functions of the wetlands in the Yamuna basin.

(iv) Introduction of Exotic Species: Alteration of the habitat structure in river Yamuna has provided a favourable environment for the exotic species Cyprinus carpio, Oreochromis niloticus, Clarius gariepinus to colonise the river since 2003 resulting in decline of the valuable Indian major carps.

Conclusion

The management strategies for the fisheries of river Yamuna need to be viewed holistically. While maintaining sustainable production from the river it needs to be ensured that the maximum number of fisherfolk, traders and other support personnel make a reasonable living from the fish resource. The strategies advocated for effective management and conservation of fisheries in the river are summarised below: Conservation efforts in the Yamuna basin necessitates a national approach to check deforestation in the Himalayan stretch of the river coupled with massive afforestation programme even along the plains to halt the soil erosion.

Commercial exploitation of Yamuna bed for extraction of stones/pebbles in upper segment of the river at Hathnikund, Doddopur, Tajewallah should not be allowed in order to preserve the breeding grounds and food web of the prized Mahseer fishery. Programmes aimed at restoring the quality of river water and abating pollution, should evolve viable standards for various parameters, stretch-wise and to ensure that the standards are strictly adhered to by the agencies concerned, viz. industries, municipalities etc. There is also a need for direct monitoring of the ecosystem by the enforcing agency.

The indentified sanctuary areas between the two states i.e. Haryana and U.P. should not be leased. Strict imposition of mesh size along with fish size needs to be pursued earnestly by the concerned department. One major concern demanding the attention of policy makers is the question of water allocations for maintaining ecological services. The collective management of

rivers should ensure that interests of all its users including the fishers are protected in a sustained way. Traditionally, the rivers are managed as common property resource. These have multiple uses for riparian area population. The residents of these areas cannot be excluded from its use, as they have the rights and duties in common property regime.

The most serious chronic effect of increased acidity in surface waters appears to be interference with the fish' reproductive cycle. Calcium levels in the female fish may be lowered to the point where she cannot produce eggs or the eggs fail to pass from the ovaries or if fertilized, the eggs and/or larvae develop abnormally (EPA, 1980).

Extreme pH can kill adult fish and invertebrate life directly and can also damage developing juvenile fish. It will strip a fish of its slime coat and high pH level 'chaps' the skin of fish because of its alkalinity. When the pH becomes highly alkaline (e.g. 9.6), the effects on fish may include: death, damage to outer surfaces like gills, eyes, and skin and an inability to dispose of metabolic wastes. High pH may also increase the toxicity of other substances. For example, the toxicity of ammonia is ten times more severe at a pH of 8 than it is at pH 7. It is directly toxic to aquatic life when it appears in alkaline conditions.

Assessment of total dissolved solids (TDS) represents an integrated measure of the concentrations of common ions (e.g., sodium, potassium, calcium, magnesium, chloride, sulfate, and bicarbonate). Correlation between increasing TDS and toxicity is not always caused by same ions and therefore is not the best predictor of toxicity of effluent. Dissolve oxygen is critical for aquatic life and also controls chemical processes. DO is important to aquatic life for several reasons, most of them need to breathe and many of the microbes need to perform their

decomposition function. DO enters the water from the air and from aquatic plant photosynthesis. Chemical oxygen demand (COD) is used as a measure of oxygen requirement of a sample that is susceptible to oxidation by strong chemical oxidant.

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