

Original Research Article

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Fish Composition at Three Different Sites in Relation to Physico-chemical Characteristic of Yamuna River, India

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ABSTRACT

Keywords

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The present investigation was carried out to know the fish composition of Yamuna river at Delhi (B1), Mathura (B2) and Agra (B3). Monthly sampling from all the sampling sites was made for a period of 12 months (March 2019 – February 2020). A total of 45 fish species belonging to 8 orders and 16 families were recorded from three sampling sites during the study period in the Yamuna river. Mathura has highest number of fish diversity with 38 species and Delhi has recorded lowest fish biodiversity of 36 species. Order Cypriniformes has maximum number of species but family wise Siluriformes has recorded total of 7 family which indicates the dominance of cat fishes in Yamuna river. Physico-chemical parameters were found good for fishes in all sites except in Delhi where DO was on the lower side during some months. Diversion of water, discharge of domestic sewage and agricultural runoff were prominent among the disturbances that alter the habitat quality.

Introduction

River is simply defined as a dynamic body of water, which flows from higher ground elevation, like hills and mountains, towards lower levels, like the sea. Rivers are the most important fresh water resources used for domestic and irrigation purposes. The Yamuna River is one of north India's most polluted rivers, home to a rich diversity of flora and fauna and is the most significant water source. In Hindu mythology, it is considered as one of the most sacred rivers after the Ganges, and is one of the major

tributaries of the river Ganges. Total length of the Yamuna up to its point of confluence with the Ganges is around 1370 km.

Water resources need special interest for conservation, development and management for best and sustainable utilization. Given the increasing pressure on aquatic systems, documenting the available richness and establishing accurate estimates of the magnitude of biodiversity loss resulting from common human disturbances, such as land-use change and habitat loss, species invasions, and climate change is of particular importance

(Murphy and Romanuk, 2014). Although river water makes up only about 0.2 % of all the fresh water on earth, river play a very important role as vital carriers of water and nutrients to areas all around the earth.

In natural process, water pollution is mainly caused by the decomposition of vegetables, animals and weather products. Modifications in the water and habitat quality are mostly due to the forest removal, urbanization, embankments and diversions for irrigation and hydroelectric power stations May J.T. & Brown. L.R., (2002). In Anthropogenic process, water pollution is caused by industrial, agricultural, domestic, radioactive, mining sources, use of fertilizer & pesticides by human beings. In recent years, the growth of industry, technology, population and water use has increased the stress upon our water bodies. Municipal and industrial wastes, herbicides, pesticides and chemical fertilizers have entered the water bodies and degraded the water quality.

In general, most of the rivers in the country are facing similar situation, as a result there is sharp alterations in the physico-chemical parameters of the rivers, aquatic biota and fisheries in the down stream. Physico-chemical characteristics are important determinants reflecting the condition of freshwater fish assemblages. The river Yamuna is a critical example of habitat alterations due to massive anthropogenic activities.

The degree of pollution is generally assessed by studying physical and chemical characteristics of the water bodies Duran and Suicmez (2007). The targets of the present study were to archive the fish species in connection to physico-chemical qualities of water and propose proper management, protection and administration to river.

Materials and Methods

Sampling sites

The study was carried out for a period of twelve months from March 2019-February 2020. The basis for selection of sampling locations was the changeability within the river stretch considering the variations in the hydrological regimes, pollution and biodiversity characteristics. The 1000-km-long Yamuna River originates in the Himalayan mountains as a main tributary of the Ganges (Ganga) River. After descending through the Himalaya, the river passes through the capital city of India, Delhi, meanders through Agra and joins the Ganges River at Allahabad. One site from Union territory Delhi (B1) and two sites from districts of U.P. viz: Mathura (B2) and Agra (B3) were selected from Yamuna river which are presented in Figure 1.

Sampling and data analysis

The fishes were collected from the Yamuna river with the help of local fishermen during the year March 2019 to February 2020. The fishes were preserved in 10% formaldehyde solution for taxonomic analysis. Fish identification was done using standard literature by Day (1951), Talwar and Jhingran (1991) and Jayaram (2010).

The water samples were collected monthly from all the sampling site for analysis of water quality parameters. Water temperature, dissolved oxygen, free CO₂, pH and electrical conductivity were measured at the sampling site.

A standard mercury thermometer (Borosil) was used to measure the water temperature. The pH of the water samples was measured with the help of portable 'HANNA' digital pH meter. Electronic conductivity was

measured by using a portable 'HANNA' digital conductivity meter. Dissolved oxygen and free CO₂ were measured according to procedure prescribed by (APHA, 2012). Statistical consideration should be a central element in the sampling design and in drawing conclusions. An important step is to standardize sampling and evaluation methods Skjoldal *et al.*, (2000).

Results and Discussion

The physico-chemical parameters affect aquatic environment and are supposed to be the limiting factors for the continued existence of aquatic life of flora and fauna (Chitmanat and Traichaiyaporn, 2010).

Dissolved oxygen

Dissolved oxygen (mg/l) in the Yamuna river at station B1 the minimum value was 2.1 in the month of June and maximum was observed 6.5 in month of January. The average value of 4.53 with SD \pm 1.58 was observed at site B1. At station B2 the minimum value was 3.4 in the month of April and maximum was 7.4 in the month of January. The average value of 5.4 with SD \pm 1.38 was observed at station B2. At station B3 the minimum value was 3.8 in the month of April and maximum was 7.3 in the month of January.

The average value of 5.62 with SD \pm 1.26 was observed at station B3 which are presented in Figure 6 and Table 3, 4&5. Khanna, D.R. and Bhutiani, R., (2003) also observed similar kind of trend in river Ganga at Haridwar. Dissolved oxygen is important and, in many cases, serves as a major lacking factor for regulating aquatic life. Babita, S. and Rao, S.N., (2015) reported maximum values of dissolved oxygen as 10.5 mg/l in the month of January and minimum 8 mg/l in August in Kosi river, Almora during his investigation.

Free carbon di-oxide

The free CO₂ (mg/l) in Yamuna river at station B1 the minimum value was 4.8 in the month of February and maximum was 15.3 in the month of June. The average value of 9.58 with SD \pm 3.35 was observed at site B1. At station B2 the minimum value was 5.5 in the month of December and maximum was 12.1 in the month of June. The average value of 8.32 with SD \pm 2.03 was observed at station B2. At station B3 the minimum value was 4.8 in the month of January and maximum was 11.2 in the month of June. The average value of 7.95 with SD \pm 2.08 was observed at station B3 which are presented in Figure 7 and Table 3, 4 & 5. A similar result of free CO₂ was reported by (Pramod Kumar *et al.*, 2014) from Kali River in Pithoragarh, Uttarakhand. According to Badola and Singh (1981), the maximum values of free CO₂ in rainy season in Alaknanda river was observed due to its utilization by negligible phytoplankton population and less availability of sunlight.

Water temperature

In the Yamuna river at station B1 the minimum value of water temperature (°C) was 18.8 in the month of January and maximum was observed 32 in month of June. The average value of 24.67 with SD \pm 4.10 was observed at site B1. At station B2 the minimum value was 20.3 in the month of January and maximum was 32.6 in the month of July. The average value of 26.67 with SD \pm 4.13 was observed at station B2. At station B3 the minimum value was 21.8 in the month of January and maximum was 32.8 in the month of May. The average value of 28.01 with SD \pm 3.40 was observed at station B3 which are presented in Figure 8 and Table 3, 4 & 5. The maximum temperature in river at all sampling sites was observed during monsoon season which is generally due to suspended particles as they absorb and scatter sunlight in water

column and lower in winter due to rarely rainfall & cold. The trend of water temperature found upward from winter season to summer season followed by downward from monsoon season onwards. Similar trend of water temperature was observed by Khanna *et al.*, (2012) in river Ganga at Haridwar.

pH

In the Yamuna river at station B1 the minimum value of pH was 7.3 in the month of July and maximum was observed 8.2 in month of January. The average value of 7.77 with SD ± 0.28 was observed at site B1. At

station B2 the minimum value was 7.6 in the month of March and maximum was 8.3 in the month of December. The average value of 7.96 with SD ± 0.21 was observed at station B2. At station B3 the minimum value was 7.5 in the month of June and maximum was 8.3 in the month of January. The average value of 7.85 with SD ± 0.23 was observed at station B3 which are presented in Figure 9 and Table 3, 4 & 5. Khanna *et al.*, (2007) in their study on Ganga river found higher values of pH during monsoon season which might be due to increase chemical load in the river and minimum in winter season. Similar results were made by Gautam *et al.*, (2015) in Subarnarekha River.

Table.1 Fish composition found in Yamuna river during the study period

Order	Family	Species
Clupeiformes	1. Clupeidae	1. Goniosalanx(Hamilton, 1822) 2. Gudusia(Hamilton, 1822)
	2. Pristigasteridae	1. Ilishamegaloptera(Swainson, 1839)
Cypriniformes	1. Cyprinidae	1. Cirrhinusreba(Hamilton, 1822) 2. Cyprinus carpio(Linnaeus, 1758) 3. Puntius sophore(Hamilton, 1822) 4. Salmophasiabacaila(Hamilton, 1822) 5. Amblypharyngodonmola(Hamilton, 1822) 6. Cabdiomorar(Hamilton, 1822) 7. Devariodevario(Hamilton, 1822) 8. Bariliusbarila(Hamilton, 1822) 9. Bariliusbendelisis(Hamilton, 1807) 10. Osteobramacotiacotia(Hamilton, 1822) 11. Labeoangra(Hamilton, 1822) 12. Rasbora daniconius(Hamilton, 1822) 13. Catlacatla(Hamilton, 1822) 14. Cirrhinusmrigala(Hamilton, 1822) 15. Labeobata (Hamilton, 1822) 16. Pethiaconchonus(Hamilton, 1822)
	2. Nemacheilidae	1. Acanthocobitisbotia(Hamilton, 1822)
Siluriformes	1. Bagridae	1. Speratasenghala(Hamilton, 1822) 2. Mystusvittatus(Bloch, 1794) 3. Mystustengra(Hamilton, 1822) 4. Mystuscavasius(Hamilton, 1822) 5. Sperataaor (Hamilton, 1822)

	2. Siluridae	1. Ompokbimaculatus(Bloch, 1794) 2. Ompokpabda (Hamilton, 1822)
	3. Claridae	1. Clariusgariepinus(Burchell, 1822)
	4. Sisoridae	1. Gagataenia(Hamilton, 1822) 2. Gogangraviridescens (Hamilton, 1822)
	5. Schilbeidae	1. Ailiacoila(Hamilton, 1822) 2. Clupisomagarua (Hamilton, 1822) 3. Eutropiichthysvacha (Hamilton, 1822) 4. Neotropiusatherinoides (Bloch, 1794)
	6. Heteropneustidae	1. Heteropneustesfossilis(Bloch, 1794)
	7. Pangasiidae	1. Pangasius pangasius(Hamilton, 1822)
Mugiliformes	1. Mugilidae	1. Rhinomugilcorsula(Hamilton, 1822) 2. Sicamugilcascasia(Hamilton, 1822)
Ophiocephaliformes	1. Channidae	1. Channa punctatus(Bloch, 1793) 2. Channastrata(Bloch, 1793) 3. Channamarulius(Hamilton, 1822)
Anabantiformes	1. Osphronemidae	1. Tricchogasterfaciata(Bloch &Schneider, 1801)
Perciformes	1. Ambassidae	1. Chanda nama(Hamilton, 1822) 2. Parambasisranga(Hamilton, 1822)
Cichliformes	1. Cichlidae	1. Oreochromis niloticus(Linnaeus, 1758)

Table.2 Fish occurrence at different sampling sites during the study period

S.No.	Fish Species	B1	B2	B3
Family - Clupeidae				
1	Gonialosamanmina (Hamilton, 1822)	+	+	+
2	Gudusiachapra (Hamilton, 1822)	-	+	+
Family - Cyprinidae				
3	Cirrhinusreba (Hamilton, 1822)	+	+	+
4	Cyprinus carpio (Linnaeus, 1758)	+	+	+
5	Puntius sophore (Hamilton, 1822)	+	+	+
6	Salmophasiabacaila (Hamilton, 1822)	+	+	+
7	Amblypharyngodonmola (Hamilton, 1822)	-	+	-
8	Cabdiomorar (Hamilton, 1822)	+	+	+
9	Devariodevario (Hamilton, 1822)	+	-	-
10	Bariliusbarila (Hamilton, 1822)	+	+	-
11	Bariliusbendelisis (Hamilton, 1807)	+	-	+
12	Osteobramacotiacotia (Hamilton, 1822)	+	+	+
13	Labeoangra (Hamilton, 1822)	+	-	-
14	Rasbora daniconius (Hamilton, 1822)	+	-	+
15	Catlacatla (Hamilton, 1822)	-	+	+
16	Cirrhinusmrigala (Hamilton, 1822)	-	+	+
17	Labeobata (Hamilton, 1822)	+	+	+

18	Pethiaconchoni (Hamilton, 1822)	-	-	+
Family- Nemacheilidae				
19	Acanthocobitisbotia(Hamilton, 1822)	+	+	+
Family - Bagridae				
20	Sperataseenghala(Hamilton, 1822)	+	+	+
21	Mystusvittatus(Bloch, 1794)	+	+	+
22	Mystustengra(Hamilton, 1822)	+	+	+
23	Mystuscavasius(Hamilton, 1822)	+	+	+
24	Sperataaor (Hamilton, 1822)	+	+	+
Family- Siluridae				
25	Ompokbimaculatus(Bloch, 1794)	+	-	-
26	Ompokpabda (Hamilton, 1822)	+	-	-
Family- Mugilidae				
27	Rhinomugilcorsula (Hamilton, 1822)	+	+	+
28	Sicamugilcascasia (Hamilton, 1822)	+	+	+
Family- Claridae				
29	Clariusgariepinus (Burchell, 1822)	+	+	+
Family- Sisoridae				
30	Gagatacenia(Hamilton, 1822)	-	+	+
31	Gogangraviridescens (Hamilton, 1822)	+	+	-
Family- Schilbeidae				
32	Ailiacoila(Hamilton, 1822)	+	+	+
33	Clupisomagarua (Hamilton, 1822)	+	+	+
34	Eutropiichthysvacha (Hamilton, 1822)	+	+	+
35	Neotropiusatherinoides (Bloch, 1794)	-	+	+
Family- Heteropneustidae				
36	Heteropneustesfossilis(Bloch, 1794)	+	+	+
Family- Pangasiidae				
37	Pangasius pangasius (Hamilton, 1822)	+	+	+
Family- Channidae				
38	Channa punctatus (Bloch, 1793)	+	+	+
39	Channastriata (Bloch, 1793)	+	+	+
40	Channamarulius (Hamilton, 1822)	+	+	+
Family- Osphronemidae				
41	Trichogasterfaciata (Bloch &Schneider, 1801)	+	+	-
Family- Ambassidae				
42	Chanda nama(Hamilton, 1822)	+	+	+
43	Parambasisranga(Hamilton, 1822)	+	+	+
Family- Cichlidae				
44	Oreochromis niloticus(Linnaeus, 1758)	+	+	+
Family- Pristigasteridae				
45	Ilishamegaloptera(Swainson, 1839)	-	+	+
	Total	36	38	37

Table.3 Physico-chemical parameters observed at site-1

Months	Do	CO ₂	Temperature	Ph	Conductivity
March	3.6	9.8	24.5	7.7	349
April	2.8	12.4	26.5	7.6	368
May	2.2	14.2	29	7.5	396
June	2.1	15.3	32	7.4	425
July	4.2	10.7	28	7.3	482
August	4.4	11.2	26	7.9	512
September	5.2	8.9	25.5	8	529
October	5.4	8.8	24.6	7.8	456
November	6.1	7.2	22.4	8	405
December	6.3	6.3	19.6	8.1	341
January	6.5	5.4	18.8	8.2	269
February	5.6	4.8	19.1	7.8	308
Mean	4.533333	9.583333	24.66667	7.775	403.3333
SD	1.570948	3.354192	4.109265	0.283244	81.07722

Table.4 Physico-chemical parameters observed at site-2

Months	Do	CO ₂	Temperature	Ph	Conductivity
March	4.6	8.2	26.6	7.6	672
April	3.4	10.1	28.2	7.8	702
May	4.2	9.2	31.3	7.7	764
June	3.8	12.1	31.5	7.9	789
July	4.8	9.6	32.6	8.1	834
August	5.2	9.1	28.4	7.9	902
September	4.8	9.8	27.2	8.2	958
October	5.9	7.9	26.8	7.9	934
November	7.2	6.7	24.6	8.1	848
December	7.4	5.5	21.2	8.3	714
January	7.1	5.6	20.3	8.2	628
February	6.4	6.1	21.4	7.9	656
Mean	5.4	8.325	26.675	7.966667	783.4167
SD	1.374442	2.039664	4.135462	0.214617	112.2517

Table.5 Physico-chemical parameters observed at site-3

Months	Do	CO ₂	Temperature	Ph	Conductivity
March	4.4	9.2	28.1	7.8	1136
April	3.8	10.8	29.5	7.7	1168
May	4.6	8.4	32.8	7.9	1198
June	4.1	11.2	31.6	8.1	1206
July	5	9.5	29	8	1238
August	5.6	8.1	30.2	7.7	1285
September	5.4	8.4	31	8.1	1326
October	6.4	7.8	28	8	1284
November	6.9	6.2	26.4	8.1	1137
December	7.2	5.9	24	7.9	1065
January	7.3	4.8	21.8	8.2	1098
February	6.8	5.2	23.8	8.1	1128
Mean	5.625	7.958333	28.01667	7.966667	1189.083
SD	1.262843	2.085647	3.407701	0.166969	81.52686

Fig.1 Sampling sites on Yamuna river

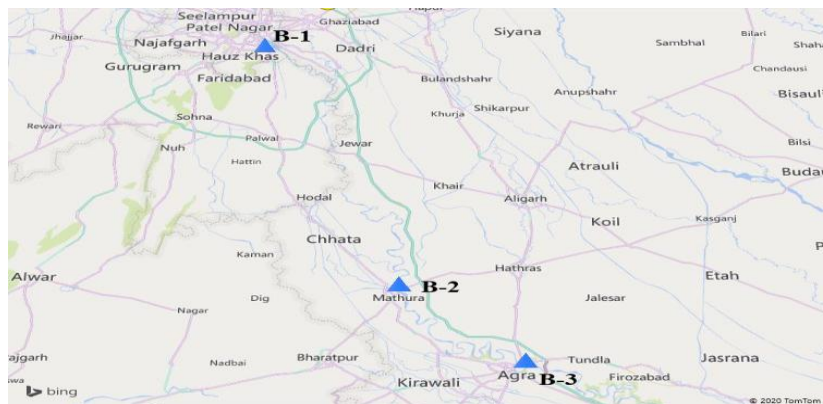


Fig.2 Fish composition in Yamuna river

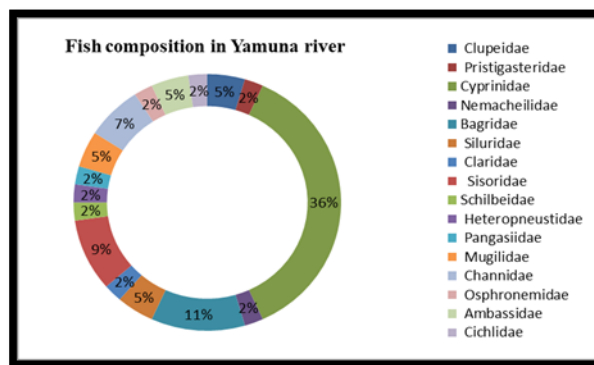


Fig.3 Fish composition at site B1

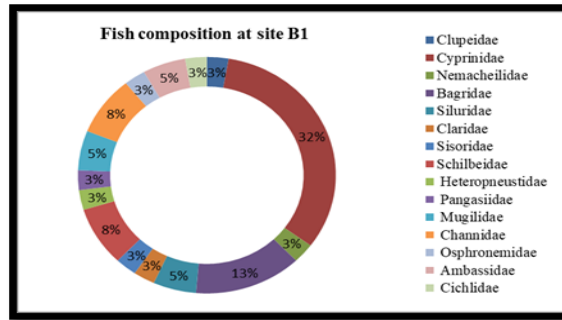


Fig.4 Fish composition at site B2

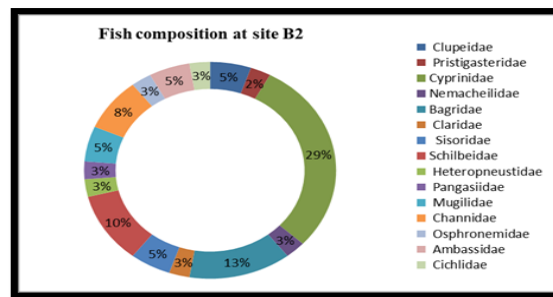


Fig.5 Fish composition at site B3

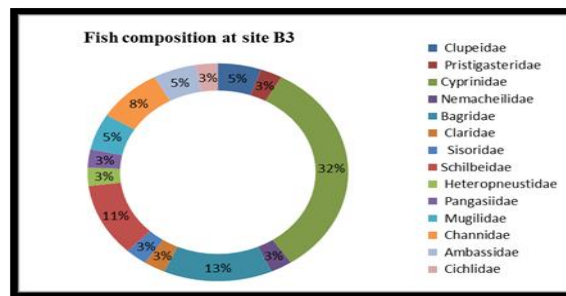


Fig.6 Monthly variation in Dissolved oxygen

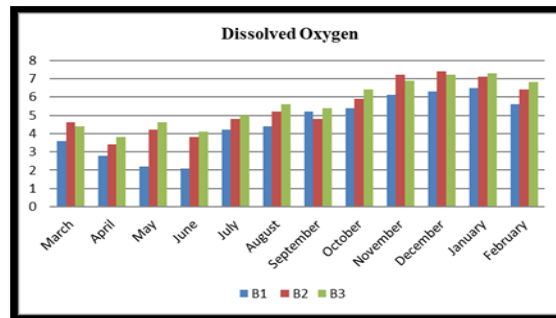


Fig.7 Monthly variation in Free Carbon di-oxide

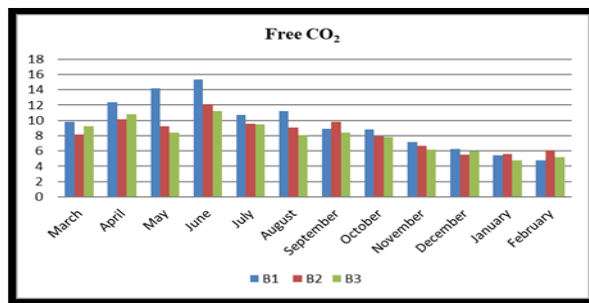


Fig.8 Monthly variation in Water temperature

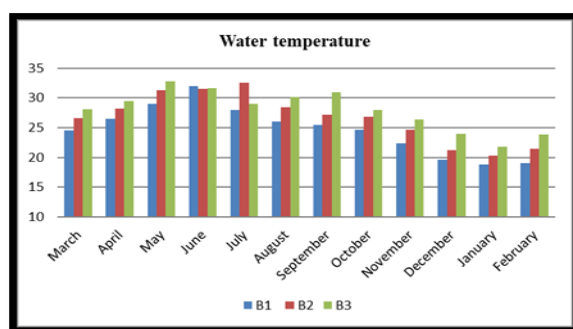


Fig.9 Monthly variation in pH

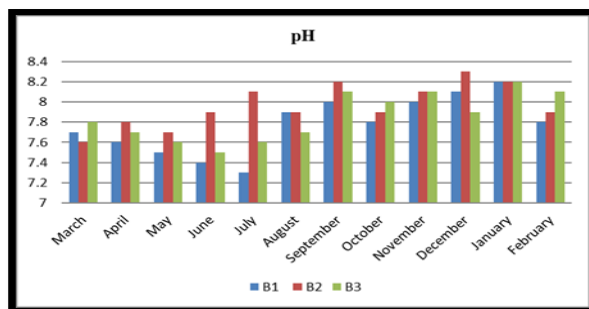
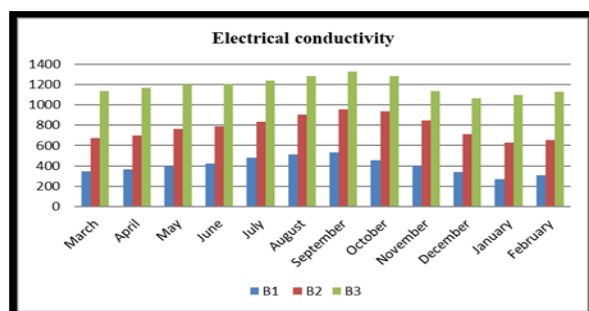


Fig.10 Monthly variation in Electrical conductivity



Electrical conductivity

The electrical conductivity ($\mu\text{S}/\text{cm}$) in Yamuna river at station B1 the minimum value was 269 in the month of January and maximum was 529 in the month of September. The average value of 403.33 with $\text{SD} \pm 81.07$ was observed at site B1. At station B2 the minimum value was 628 in the month of January and maximum was 958 in the month of September. The average value of 783.41 with $\text{SD} \pm 112.25$ was observed at station B2. At station B3 the minimum value was 1065 in the month of December and maximum was 1326 in the month of September. The average value of 1189.08 with $\text{SD} \pm 81.52$ was observed at station B3 which are presented in Figure 10 and Table 3, 4 & 5. Singh *et al.*, (2006) and Khanna *et al.*, (2005) also noted similar trend of conductivity in river Ganga at Bulandshahar and river Panvdhoi at Saharanpur respectively. Higher values during monsoon season may be due to large number of salts, silts and greater ionic concentration inlet flow carried by river (Jha and Barat, 2003).

Fish biodiversity of Yamuna river

Overall 45 fish species belonging to 8 orders and 16 family were recorded from Yamuna river from all sites during the study period. Cyprinidae were the most predominant order (36%) followed by Bagridae (11%), Sisoridae (9%), Channidae (7%), Clupeidae, Siluridae, Muglidae and Ambassidae each with (5%), Pristigasteridae, Nemacheilidae, Claridae, Schilbeidae, Heteropneustidae, Pangasiidae, Osphronemidae and Cichlidae with (2%) each. At site B1 a total of 36 fish species were recorded belonging to 8 order and 15 family. Cyprinidae were the most dominant with (32%) followed by Bagridae (13%), Schilbeidae and Channidae (8%), Sisoridae, Muglidae and Ambassidae (5%), Clupeidae, Nemacheilidae, Claridae, Sisoridae,

Heteropneustidae, Pangasiidae, Osphronemidae, and Cichlidae (3%). At site B2 a total of 38 species were recorded belonging to 8 order and 15 family. Cyprinidae were the most dominant with (29%) followed by Bagridae (13%), Schilbeidae (10%), Channidae (8%), Clupeidae, Sisoridae, Muglidae and Ambassidae (5%), Nemacheilidae, Claridae, Heteropneustidae, Pangasiidae, Osphronemidae, and Cichlidae (3%), Pristigasteridae (2%). At site B3 a total of 37 species were recorded belonging to 8 order and 14 family. Cyprinidae were the most dominant with (32%) followed by Bagridae (13%), Schilbeidae (11%), Channidae (8%), Clupeidae, Muglidae and Ambassidae (5%), Pristigasteridae, Nemacheilidae, Claridae, Sisoridae, Heteropneustidae, Pangasiidae, and Cichlidae (3%) which are presented in Figure 2-5 and table 1 & 2.

Order Siluriformes which includes families Bagridae, Sisoridae, Siluridae, Claridae, Schilbeidae, Heteropneustidae, Pangasiidae belong to catfishes has recorded maximum 7 number of families which indicates the dominance of catfishes with 16 species *Sperata seenghala*, *Mystus vittatus*, *Mystus tengra*, *Mystus cavasius*, *Sperataaor*, *Ompok bimaculatus*, *Ompok pabda*, *Clarius gariepinus*, *Gagata cenia*, *Gogangra viridescens*, *Ailia coila*, *Clupisoma garua*, *Eutropiichthys vacha*, *Neotropius atherinoides*, *Heteropneus tesfossilis* and *Pangasius pangasius*. Order Cypriniformes include families Cyprinidae and Nemacheilidae has recorded 16 species *Cirrhinus reba*, *Cyprinus carpio*, *Puntius sophore*, *Salmophasia bacaila*, *Amblypharyn godonmola*, *Cabdiomorar*, *Devario devario*, *Barilius barila*, *Barilius bendelisis*, *Osteobrama cotiacotia*, *Labeo angra*, *Rasbora daniconius*, *Catlacatla*, *Cirrhinus mrigala*, *Labeo bata*, and *Pethiacon chonius*. Order Clupeiformes includes families

Clupeidae and Pristigasteridae has recorded 3 species *Gonialosa manmina*, *Gudusia chapra* and *Ilishamegaloptera*. Order Mugiliformes include family Mugilidae has recorded 2 species *Rhinomugil corsula* and *Sicamugil cascasia*. Order Ophiocephaliformes includes family Channidae has recorded 3 species *Channa punctatus*, *Channa striata* and *Channam arulius*. Order Anabantiformes includes family Osphronemidae has recorded 1 species *Tricthogaster fasciata*. Order Perciformes includes family Ambassidae has recorded 2 species *Chanda nama* and *Parambassis ranga*. Order Cichliformes includes family Cichlidae has recorded 1 species *Oreochromis niloticus* which are presented in Figure 2-5 and table 1 & 2.

The abiotic factors such as current velocity, temperature and substrate can determine the distribution and abundance of individual species (Rahel & Hubert 1991). Physico-chemical parameters of water at the three sampling stations markedly differ, this seem to be caused by variation in amount and duration of rainfall. The relative abundance and diversities of its component functional groups fluctuate in predictable cycles with the alternating hydrological regimes of the river. Greatest diversity in Cypriniformes and siluriformes has been reported by Johal and Rawal (2005) in Western Himalayan Hill stream. Jha *et al.*, (2004) studied the fish fauna of Mahananda reservoir, Near Siliguri Town and Identified 49 Species of Fish. Bharat *et al.*, (2005) reported 21 species of fishes from Darjeeling uplands. The river Yamuna has faced extreme degradation of water quality and scarcity of fresh water (Babu *et al.*, 2013), which caused silt loading river bed, algal choking, extermination of sensitive native fish species and invasion of exotic fishes. The altered flow regime, river habitats and physico-chemical parameters turned adverse to the sensitive native fishes including IMC and large catfishes. As a

result, the vacant habitats have been occupied by hardy exotic fishes. Studies on other Asian rivers have also found the more or less similar patterns (De Silva *et al.*, 2007). Seasonal differentiation evident in higher number of species and individuals caught during wet months of the study period, agree with results of Welcome (1985), for floodplain rivers. Relatively higher fish densities and species richness values in the middle and lower river reaches, were probably because being mainly forest flood plains, as explained by Leigh (1990), these reaches offer a wide habitat heterogeneity that leads to a large number of potential ecological niches of fish species.

It has been concluded from the above study that the fishes of River Yamuna totally depend upon the physico-chemical parameters. The need is to protect the existing indigenous fish stock species and prevent polluting the rivers by industrial and domestic sewage, beside this we have to control the non-point pollution sources for better management of rivers so the water may remain suitable for their living.

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