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Floral and Faunal Diversity in Yamuna River

Yamnotri – Allahabad

GRBMP : Ganga River Basin Management Plan

by

Indian Institutes of Technology

IIT Bombay | IIT Delhi | IIT Guwahati | IIT Kanpur | IIT Kharagpur | IIT Madras | IIT Roorkee

Preface

In exercise of the powers conferred by sub-sections (1) and (3) of Section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government has constituted National Ganga River Basin Authority (NGRBA) as a planning, financing, monitoring and coordinating authority for strengthening the collective efforts of the Central and State Government for effective abatement of pollution and conservation of the river Ganga. One of the important functions of the NGRBA is to prepare and implement a Ganga River Basin Management Plan (GRBMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin Management Plan (GRBMP) by the Ministry of Environment and Forests (MoEF), GOI, New Delhi. Memorandum of Agreement (MoA) has been signed between 7 IITs (Bombay, Delhi, Guwahati, Kanpur, Kharagpur, Madras and Roorkee) and MoEF for this purpose on July 6, 2010.

This report is one of the many reports prepared by IITs to describe the strategy, information, methodology, analysis and suggestions and recommendations in developing Ganga River Basin Management Plan (GRBMP). The overall Frame Work for documentation of GRB EMP and Indexing of Reports is presented on the inside cover page.

There are two aspects to the development of GRBMP. Dedicated people spent hours discussing concerns, issues and potential solutions to problems. This dedication leads to the preparation of reports that hope to articulate the outcome of the dialog in a way that is useful. Many people contributed to the preparation of this report directly or indirectly. This report is therefore truly a collective effort that reflects the cooperation of many, particularly those who are members of the IIT Team. Lists of persons who have contributed directly and those who have taken lead in preparing this report is given on the reverse side.

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1. Introduction

River Yamuna, the largest tributary (1376 km) of river Ganga, originates from Yamunotri glacier at Bandar Punch in the region of Simla (30° 58' N, 78° 27' E) at 6,387 m above mean sea-level (msl), in the lower Himalayas. It has a total catchment area of 3,425,848 km^2 (Moza and Mishra, 2003). After flowing through the Sivaliks, river Yamuna emerges on the plains near Tajewala at 370 m (msl). The river then flows south-west to southwards for 224 km to enter the National Capital Territory of Delhi at 215 m (msl). After meandering through Delhi for about 22 km to Okhla, the river continues southwards for 272 km to Agra (146 m msl) and then turns South-East until its confluence with the river Ganga at Allahabad (100 m msl) (Figure 1: Flow chart of the Yamuna river basin). All along its 1,170 km flow through the Gangetic plain, the average slope of the river bed decreases from about 0.56 m/km between Tajewala and Delhi to less than 20 cm/km between Delhi and Agra before becoming less than 5 cm/km thereafter (Gopal and Sah, 1993).

Based on the hydrological and ecological information river Yamuna can be differentiated into 5 sub stretches, as (CPCB, 2006):

a)	Himalayan stretch	From origin to Tajewala barrage (172 kms.)	(YR_1)
b)	Upper stretch	Tajewala barrage to Wazirabad barrage (224 kms.)	(YR_2)
c)	Delhi stretch	Wazirabad barrage to Okhla barrage (22 kms.)	(YR_3)
d)	Eutrophic stretch	Okhla barrage to Chambal confluence (490 kms.)	(YR_4)
e)	Diluted stretch	Chambal confluence to Ganga confluence (468 kms.)	(YR_5)

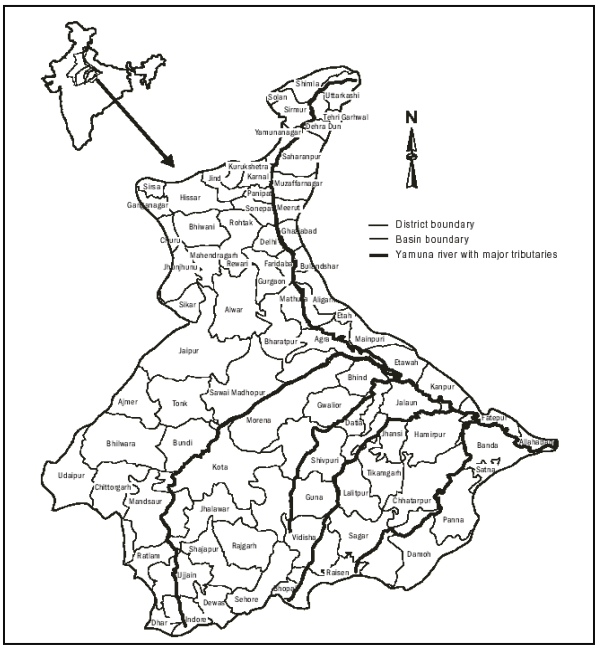

Figure 1: Yamuna river basin

2. Salient feature of Yamuna river

Several tributaries join it along its path, transforming it into a fourth-order river. Several major tributaries join river Yamuna in the Gangetic plain. Some of the important tributaries are river Hindon, Chambal, Sind, Betwa and Ken. The salient features of all the tributaries of river Yamuna are described in Table 1. The total catchment basin of the Yamuna river is 42.5% of the Ganga basin and 10.7% of the total geographical landmass of the country. River Chambal, well known for its deep ravines, is the largest of these tributaries, with a catchment area of 139,789 km^2 (40% of the Yamuna river basin).

Table 1: Tributaries of river Yamuna

	Tributaries					
Characteristics	**Hindon**	**Chambal**	**Sind**	**Betwa**	**Ken**	**Paisuni**
Position	Left bank tributary	Right bank tributary	Right bank tributary	Right bank tributary	Right bank tributary	Right bank tributary
Region of origin	Sivalik hills	North wards slope of the Vindhyan mountains in native state of Indore (M.P.)	North wards slope of the Vindhyan mountains originates at Hatoli (District Vidisha)	North wards slope of the Vindhyan mountains	North Western slope of the Vindhyan mountains in native state of Bhopal	Kaimur hills parts of the Vindhyan mountains
Length (km)	400	960	415	590	360	100
Width (m)	20-160	-	-	-	477	95
Depth (m)	-	1.4-9.2	-	2.7-9.4	2-10	1-15
Altitude (m)	-	-	-	-	193	140
River bed	Sand	Stony rapid, sand banks and gravel bars	-	Stones, Sand, Riffle and Pools; Pebbles and Cobble	Rocks, Stones, Sand	Stones, Sand, Mud
Benthic macrofauna	-	-	-	-	Insects, few mollsuca and annelida	Insects, few mollsuca and annelida

- Represented data not found **Gopal and Sah (1993); Dwivedi (2006)**

2.1. Physical conditions of the Yamuna river

The Himalayan part of the basin experiences very low winter temperatures and high rainfall (1,200 to > l,600 mm). In the plains, peak temperatures rise above 45°C during summer (late May-June), but during winter the temperature (average 2-9°C December-January) rarely drops below the freezing-point. The soils of the Yamuna basin vary considerably, as they have developed under different lithological, climatic, and pedogenetic conditions (Raychaudhury *et al.,* 1963). River bed of the upper Yamuna is primarily sandy in texture having sand in the range of 70.52-74.76%, silt in the range of 17.74-18.56% and clay in the range of 7.35-11.55%. Due to large variation in climate and soils, the natural vegetation is also highly variable in the Yamuna river basin.

2.2. Major abstraction of the Yamuna river

The river water is abstracted at different locations for multiple uses. At two places i.e. Hathnikund/ Tajewala and Okhla, the water abstraction is significant. The points of abstraction and addition in water of Yamuna river are shown in Figure 2.

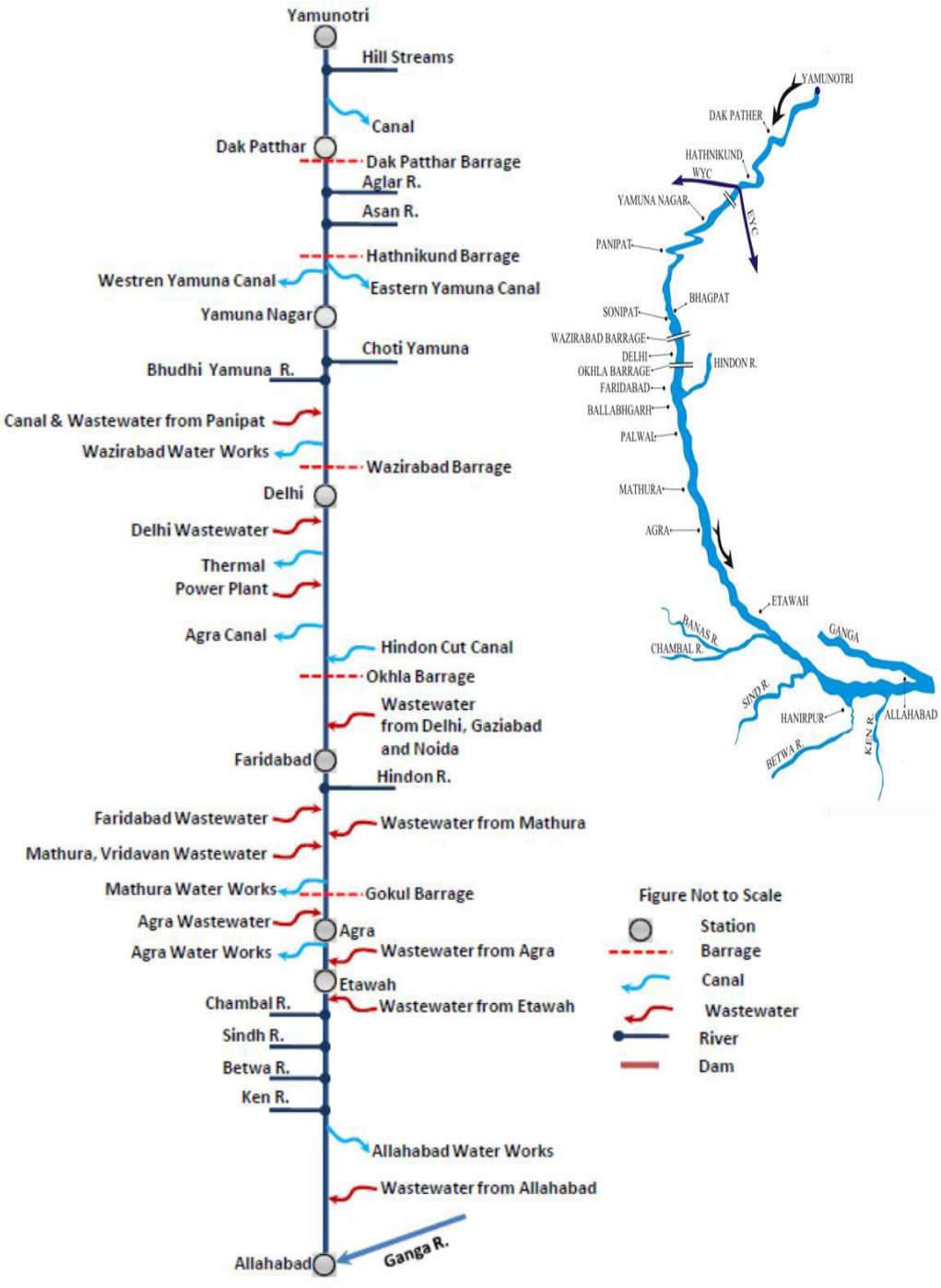

Figure 2: Points of water abstraction and additions in Yamuna river (CPCB, 2006)

3. Biological diversity of Yamuna river

Aquatic ecosystem harbours a variety of communities, which constitute the characteristics and functioning of the ecosystem in terms of maintaining production and food chain. Water qualities also strongly influence distribution and extent of biodiversity in Yamuna river. Planktonic and benthic communities determine processes, functions and attributes of aquatic ecosystem. These organisms were critically linked to changes in ambient environment and species present were either tolerant to the rigorous chemical milieu or had wide ecological amplitude. The average standing crop of total plankton in upper Yamuna was 308 u/l showing a gradual increase down the gradient. It being 273 u/l at Hathnikund, 289 u/l at Kalanour, 329 u/l at Badoli and 380 u/l at Sanoli (Moza and Mishra, 2003). The present report highlights characteristics features of community structure and diversity of phytoplankton, zooplankton, benthic communities and vertebrates of river Yamuna. The analysis of biodiversity present in Yamuna is based on data collected from secondary sources.

3.1. Phytoplankton

Phytoplanktons are the primary producers and constitute the first level in aquatic food chain for all aquatic animals. The density and diversity of phytoplankton and their association as biological indicators in the assessment of water quality or trophic status has been made by some workers (Chaturvedi *et al.,* 1999). Phytoplankton of river Yamuna was studied Sharma, 2000; Sankar, 2002; Atul, 2002; Nautiyal, 2004, but the studies conducted by them did not highlight the overall scenario of phytoplankton in the river from Yamunotri to Ganga confluence. The distribution of phytoplankton along the entire stretch of river Yamuna is shown in Appendix Ia and Figure 3.

The total number of algal taxa present in the entire stretch of river Yamuna is 220. The major contributors are Bacillariophyceae (56), Chlorophyceae (111), Myxophyceae (38) and Euglenophyceae (7). Chrysophyceae (1) and Xanthophyceae (3) are present in YR_4/ YR_5 and YR_3, respectively, while Dinophyceae (4) is present in YR_2, YR_3 and YR_4.

The dominant species of Bacillariophyceae in the Yamuna river are *Amphora* sp., *Navicula* sp., *Synedra* sp. and *Tabellaria* sp. Sarkar (2011) reported 10 prominent genera in YR_4 stretch as *Cyclotella*, *Gomphonema*, *Stauroneis*, *Nitzshia*, *Fragillaria*, *Syndra*, *Navicula*, *Melosira*, *Frustulia* and *Amphora*.

It is observed that the group Chlorophyceae represents the highest number of species. The maximum numbers of species are *Celastrum*, *Pediastrum*, *Pleurotaenium*, *Scenedesmus*, *Schroederia*, *Spirogyra* and *Ulothrix* genera. Sarkar (2011) also reported the dominance of 11 chlorophyceae genera namely *Eudorina, Chlamydomonas, Volvox, Zygnema, Closterium, Actinastrum, Pediastrum, Trachelomonas, Staurstrum, Scendesomus* and *Spirogyra* in the Agra (YR_4) stretch.

Myxophyceae was found chiefly at polluted sites. The population was largely composed of *Lyngbya* sp., *Merismopoedia* sp., *Oscillatoria* sp. and *Phormidium* sp. Sarkar (2011) reported the predominance of genus *Nostoc* in the year 2005-2007 in the YR_4 stretch. The two genera of Euglenophyceae, *Euglena* sp. and *Phacus* sp. are important in YR_3 and YR_4 stretch of river.

The causative factors for variation in phytoplankton in different stretch of Yamuna are not clearly understood. But a relationship could be established between free carbon dioxide and phytoplankton. However, Munawar (1970) suggested that Euglenophyceae prefer higher concentration of free carbon dioxide for their growth. This view favours the presence of free carbon dioxide at elevated level in the YR_3 stretch.

The other critical factor reflected the growth of phytoplankton in the ecosystem is dissolved oxygen. Dissolved oxygen (DO) ranged from 7.75-9.34 mg/l in YR_1 (Moza and Mishra, 2003) which is close to saturation level of oxygen in water. This indicated the low level of organic pollution in upper stretch of the river Yamuna, or the pollution landing is well within the carrying capacity of river. The DO was alarmingly low and it varied between 8.5-1.8 from Yamuna nagar to Delhi, due to the combined waste discharge from domestic and industrial sources. These values indicated the high organic pollution in the river Yamuna in the stretch between YR_2-YR_3. At Mathura, the river showed better condition (DO=8.6-4.8 mg/l) due to availability of diluting water added by the Mathura refineries, improving the self purification capacity of the river. At Agra the quality of water in the upper stretch of the river Yamuna exhibited buffering as a result of which only limited fluctuations were noticed. But Agra downstream (DO=0.5-3.2 mg/l) the continuous discharge adversely effected the self purification of water in the river Yamuna. At Firozabad (DO=3.7-4.8 mg/l) the condition of river was almost same as at Agra. The river showed great improvement in water quality downstream at Etawah due to the confluence of various tributaries (Figure 2) (Prakash and Panwar, 2005). There was a gradual improvement in water quality from Auria to Allahabad (DO=7.2-8.4 mg/l). Dissolved oxygen is directly dependent on the density of phytoplankton. Zafer (1964) attributed the higher percent of chlorophyceae to high value of dissolved oxygen. The composition of phytoplankton shifted from Bacillariophyceae dominated community at YR_1 (21) to Chlorophyceae at YR_3: Delhi (72) and Myxophyceae at YR_4: Mathura and Agra (23) and again Bacillariophyceae (23) between Mathura to Firozabad (YR_4).

It is generally believed that temperature is one of the most important factor in an aquatic ecosystem, but Hutchinson (1967) suggested that it was never a critical factor for considerable variation in the growth of phytoplankton. This appears to be more appropriate that in all habitats (YR_1-YR_5 stretch), high temperature (YR_3-YR_5 stretch) were found to be more conductive to the increase of phytoplankton. On the other hand, the low temperature (YR_1 stretch) also favoured the growth of certain phytoplankton as the minor peak was also observed in the same stretch.

Tabasum (2006) reported some phytoplankton indicator species based on the inter-relationships of population density with water quality. The indicator species decreased in the presence of high pollution load were *Rivularia* sp., *Oscillatoria priniceps*, *Mesotaenium endlicherianum* and *Tabellaria* sp. At the same time, indicator species increased in presence of high pollution load namely *Navicula viridula* and *Pleurogaster lunaris*.

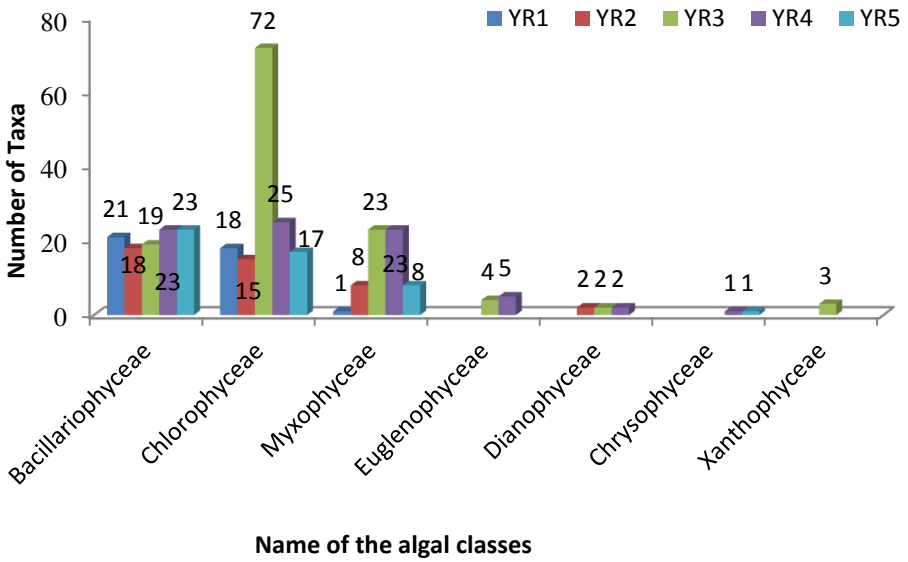

Figure 3: Distribution of phytoplanktonin river Yamuna (YR_1-YR_5)

3.2. Periphyton

Periphyton are benthic (attached) algae that grow attached to surfaces such as rocks or larger plants. Periphyton are primary producers and sensitive indicators of environmental change in lotic waters. Because periphyton are attached to the substrate, this assemblage integrates physical and chemical disturbances to the stream reach. The periphyton assemblage serves as a good biological indicator due to:

- ✓ A naturally high number of species
- ✓ A rapid response time to both exposure and recovery
- ✓ Identification to a species level by experienced biologists
- ✓ Ease of sampling, requiring few people
- ✓ Tolerance or sensitivity to specific changes in environmental condition are known for many species

Mishra and Singh (1968) were among the first to report on epiphytic algae on both natural and artificial substrates. Studies on periphyton are relatively few in river Yamuna, the only stretch having almost complete information is YR_3. The total number of algal taxa present in the entire stretch of river Yamuna is 396, mainly found in the 3 streches, YR_1 (72), YR_3 (227) and YR_5 (137).

Some reports revealed the presence of 12 taxa in YR_2 (Moza and Mishra, 2003) and 3 new taxa in YR_4 stretch (Tiwari and Chauhan, 2000). In case of periphyton the members of Bacillariophyceae were dominant over Chlorophyceae and Myxophyceae in the three stretches (YR_1, YR_2 and YR_5). Most common genera of Bacillariophyceae in the entire Yamuna stretch were *Achnanthes*, *Achnanthidium*, *Amphora*, *Caloneis*, *Cymbella*, *Cymbopleura*, *Gomphonema*, *Melosira*, *Navicula*, *Nitzschia*, *Pinnularia*, *Stauroneis*, *Surirella* and *Synedra*. According to Nautiyal (2004) the most dominant taxa of Yamuna basin were *Achnanthes linearis*, *A. microcephala*, *A. minutissima, Cymbella excisa* and *Gomphonema parvulum*. Moza and Mishra (2003) reported 6 dominant Bacillariophyceae genera of YR_2 stretch namely *Diatoma*, *Frustulia*, *Tabellaria*, *Cocconeis*, *Navicula* and *Synedra*.

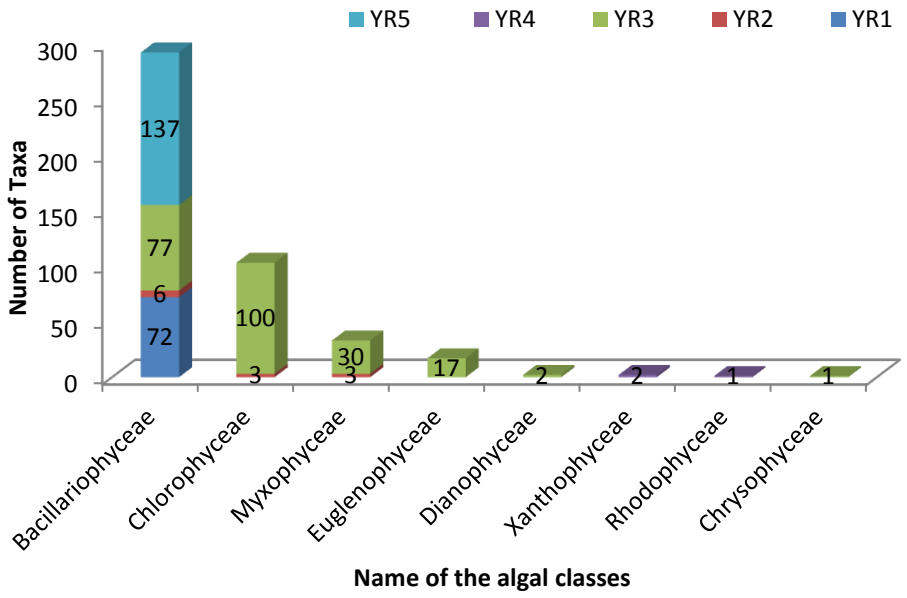

Figure 4: Distribution of periphytonin river Yamuna (YR_1-YR_5)

The Chlorophyceae and Myxophyceae algae mainly represented by *Closterium*, *Cosmarium*, *Pediastrum*, *Zygnema*, *Staurastrum*, *Syndesmus* and *Anabena*, *Merismopedia*, *Oscillatoria* and *Phormidium* in the YR_3 stretch. No relevant data available regarding the presence of periphyton except members of Bacillariophyceae in YR_5 stretch. Moza and Mishra (2003) reported 3 dominant genera of Chlorophyceae namely *Spirogyra*, *Trochschia* and *Cladophora* and 3 dominant genera of Myxophyceae namely *Oscillatoria*, *Sprilulina* and *Nostoc* in YR_2 stretch. The distribution of periphyton along the entire stretch of river Yamuna is given in Appendix Ib and depicted in Figure 4.

3.3. Zooplankton

Zooplankton are microscopic organisms which do not have the power of locomotion and move at the mercy of the water movements. Rotifers, Cladocerans, Copepods and Ostracods constitute the major groups of zooplankton. They occupy an intermediate position in the food web. Zooplankton mediatethe transfer of energy from lower to higher trophic level (Waters, 1977). Thus zooplankton represent an important link in aquatic food chain and contribute significantly to secondary production in fresh water ecosystem. Zooplankton also plays an important role as indicators of trophic condition in both cold temperate and tropical waters (Sharma, 1998).

In the entire stretch of Yamuna zooplanktons were represented by Protozoa, Rotifers, Crustacean, Molluscs, Nematodes, Annelids and Insects. The total number of zooplanktons taxa present in YR_2-YR_5 is 298. No reported literature was available showing the presence of zooplanktons in YR_1 stretch, this condition is almost similar to the Ganga river in which no zooplankton has been reported in UG_1 (Gangotri to Gangnani).

Zooplankton in the entire Yamuna stretch were represented by 38 orders and 1 subclass (Acari). In Yamuna river about 14 order of Protozoa, 4 order of Rotifers, 6 order of Crustacean, 1 order of Molluscs, 3 order of Nematodes, 3 order of Annelids and 7 order of Insects were reported. The details related to the name of the order and the numbers of taxa present in the respective order are depicted in Figure 5. The zooplankton community was represented by 14 order and 47 taxa at YR_2, 18 order and 196 taxa at YR_3, 18 order and 58 taxa at YR_4 and while members of 27 orders and 70 taxa were presented at YR_5.

Among the various groups of organisms, the Rotifer population was predominant in the YR_3-YR_5 stretch and represented by Philodinida, Bdelloida, Ploima and Eurotatoria. Rotifers are also essential food source for Indian Major Carps. The second most dominant group of organism was Protozoa in the same stretch. Protozoa mainly represented by the orders Ciliphora, Hypotrichida, Heterotrichida, Spirotricha, Armophorida, Bryometopida, Odontostomida, Peniculida, Hymenostomatida, Peritrichida, Suctorida, Testacea, Arcellinida and Amoebida. The third and fourth largest group of organisms in the same stretch was Arthropoda and Insecta, respectively. The distribution of zooplankton along the entire stretch of river Yamuna is shown in Appendix Ic and Figure 5 and 6.

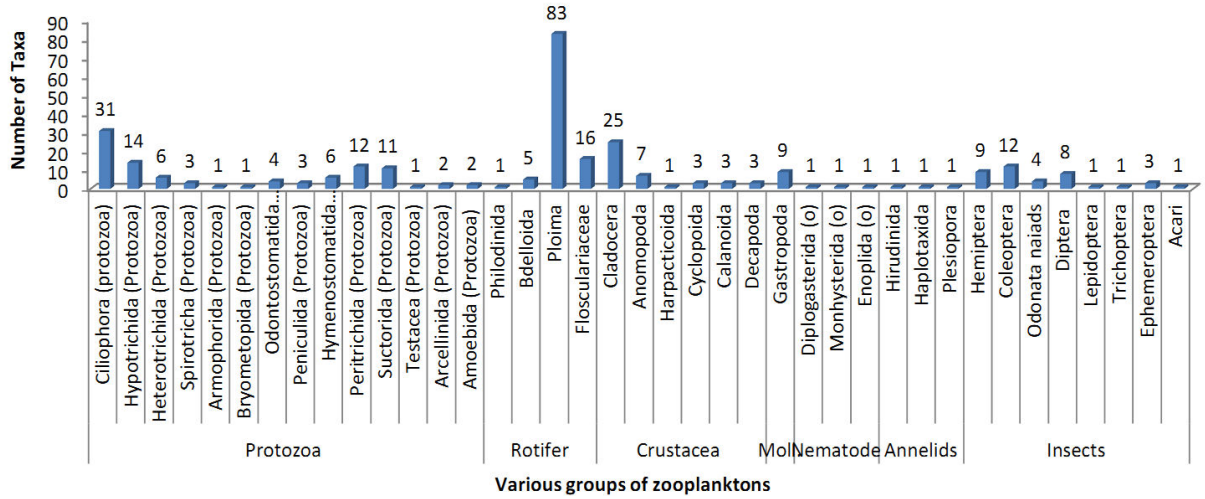

Figure 5: Distribution of various groups of zooplankton in Yamuna

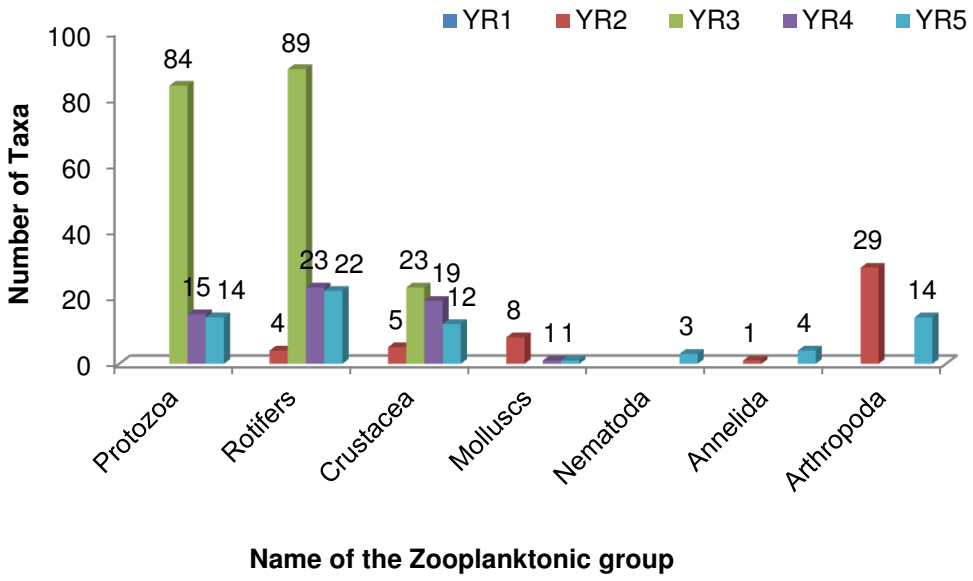

Figure 6: Distribution of zooplankton in Yamuna river (YR_1-YR_5)

3.4. Zoobenthos

It is widely accepted that benthic macroinvertebrates play a major role in the evaluation of environmental quality of aquatic ecosystems (Stewart *et al.,* 2000). They reflect the combined effects of various stresses influencing water quality in time and space (Timms, 2006). The abundance of benthic fauna mainly depends on physical and chemical properties of the substratum. Because of their extended residency period in specific habitats and presence or absence of particular benthic species in a particular environment these can be used as bio-indicators of specific environment and habitat conditions.

Zoobenthic population varied between 412-66 u/m^2. The maximum density of 412 u/m^2 at Hathnikund may be due to shallow clean water, stony bed and river soil having highest organic carbon and the minimum 66 u/m^2 at Karnal may be due to high sand and low clay percentage in texture. Diversity of zoobenthos at various sites in upper Yamuna showed that species confined to reference zone were *Nymphula*, *Ephemerella*, *Ephemera* and *Plea* sp. as such these classify as Saprophobic forms (non-tolerant species) in context of Yamuna basin (Moza and Mishra, 2003). Zoobenthos in the Yamuna river was represented by 3 orders of Arthropods, 9 orders of insecta, 2 classes of Molluscs, 4 classes/subclasses of Annelids and 1 order of Nematoda (Appendix-Id). The zoobenthic community was represented by 43 families of Insecta, 17 families of Mollusca, 9 families of Annelids and 1 family of Nematode. The data revealed the dominance of Insecta over Molluscs and Annelida in the YR_1 stretch. The class insecta in YR_1 stretch represented mainly by order Trichoptera (1), Hemiptera (2), Ephemeroptera (2), Coleoptera (3) and Diptera (2). In YR_2 stretch molluscs are clearly dominant over insecta and Annelida. Mollusca were represented by two major classes Gastropoda (7) and Bivalvia (2). YR_3 stretch showed the dominance of class Insecta over the other groups (Mollusca, Annelida and Crustacea). The class Insecta represented by 5 order and 24 families in this stretch. The same trend was followed by the next stretch YR_4 in which class Insecta (21 families) showed its dominance over Mollusca (15 families), Annelida (4 families) and Nematoda (1 family). The presence of crustacean was also recorded in YR_4 stretch. The data about the zoobenthos at YR_5 was not available. The distribution of zoobenthos along the entire stretch of river Yamuna is shown in Appendix Id and Figure 7.

The species composition of Yamuna (YR_4) at Vrindhavan range from fresh water indicator, *Baetis* (Chandler, 1970) to low pollution indicator, *Aelosoma* and leech (Barbhuyan and Khan, 1992) to organic pollutant indicators, *Chironomus, Tubifex* and *Cypris* (Krishnamoorthi and Sarkar, 1979; Moza, 1996), thereby showing that Yamuna at this site too is organically rich to some extent. Thus the YR_4 can be classified as mildly polluted or β-mesosaprobic and the benthic organisims present as saproxenic species, having wide range of organic pollution tolerance from low to high. The benthic population at Etawah was dominated by *Chironomus* and *Cypris* at different sites represents the nature of the stretch, polysaprobic and α-mesosaprobic. The decrease in benthic population after the confluence of Chambal (YR_5) showed the absence of organic pollutant and indicated comparatively clear zone (Moza and Kolekar, 2002).

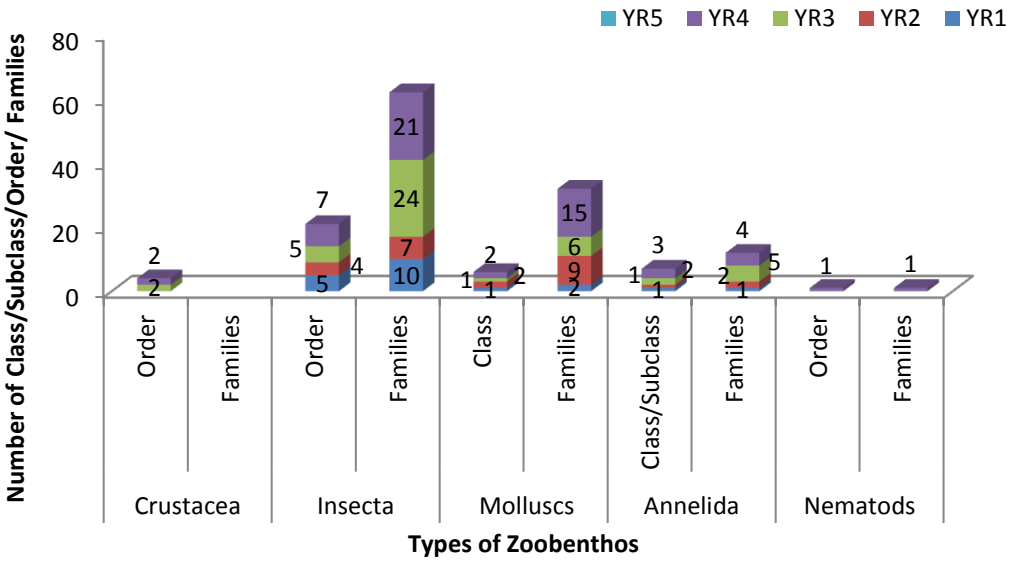

Figure 7: Distribution of zoobenthos in Yamuna river (YR_1-YR_5)

3.5. Fishes

The distribution and status of fish fauna of Yamuna river depicted is listed in Appendix Ie and shown as bar digram in Figure 8. Overall 139 species belonging to 78 genus and 33 families have been reported from Yamuna river. A total of 88 species belonging to 47 genus and 21 families has been recorded from YR_1, while in YR_2, 20 species belonging to 11 genus and 4 families has been reported. In YR_3 stretch 49 species belonging to 33 genus and 19 families has been reported. YR_4 and YR_5 stretch represented by 50 species, 35 genus, 19 families and 67 species, 51 genus, 23 families, respectively.

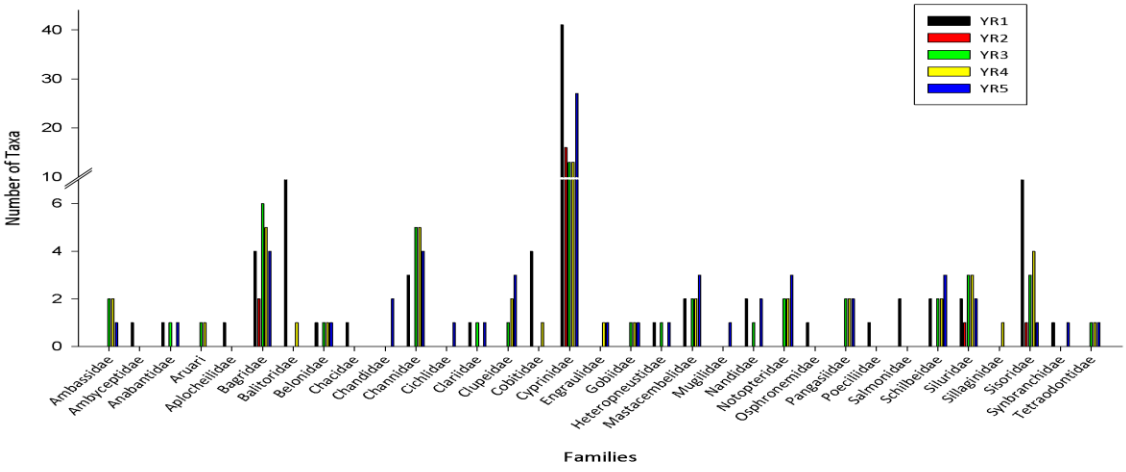

Figure 8: Distribution of fishes in Yamuna river (YR_1-YR_5)

Moza and Mishra (2001) recorded high share of others (57.42%), *Cyprinus carpio* (5.20%), *Aorichthys aor* and *A. seenghala* (7.31%) and *W. attu* (6.92%) compared with small proportions of *L. rohita*, *C. catla*, *C. mrigala* and *L. calbasu* (1.72%, 0.52%, 1.96%, and 2.37%, respectively) in the upper stretch of Yamuna. *T. putitora* was present in small proportions 3.11%.

The upper stretch of river Yamuna (YR_1-YR_2) contains fish biomass of 22.98 t per year ranging from 6.31 t at Yamuna nagar to high of 15.54 t at Panipat though a low of 1.13 t at Karnal. The overall fish population from Yamunanagar to Panipat shows dominance of miscellaneous groups (70.71%) while Cat fishes forming 14.23%; IMC 6.64%; common carps 5.20% and Mahseer 3.11% of the total population (Figure 9) (Moza and Mishra, 2001). Exotic carps like *Ctenopharyngodon idella* (0.04%) and *Aristichthys nobilis* (0.07%) were negligible. Among the miscellaneous minor carps form sizeable group representing 11.69% of total population while as a group "others" contain assorted fishes being represented by *Chela* sp., Murrels, *Notopterus*, *Bagarius* sp. etc. (Moza and Mishra, 2001). In the Yamuna at Kulal (Poonta Sahib) the composition differed, *Tor* spp. (52.78%), *L. calbasu* (36.11%), *L. dero* (5.55%) and miscellaneous groups (4.17%).

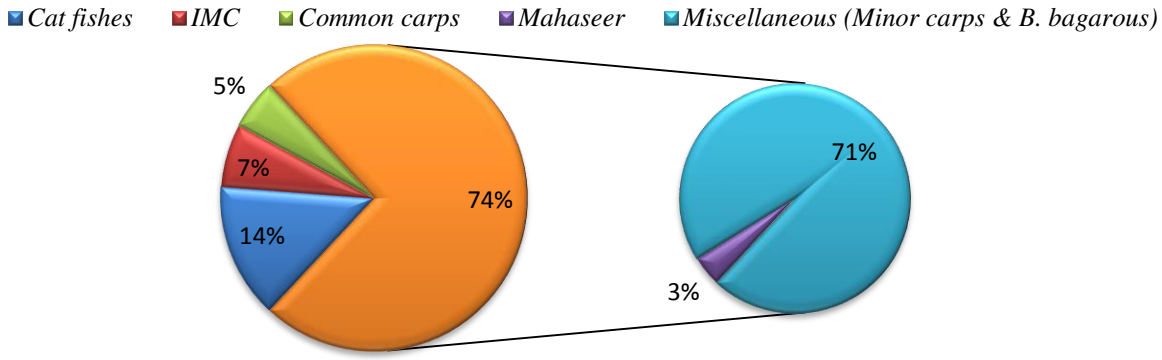

Figure 9: Status of fish population in Yamuna river (YR_2)

In the western Yamuna canal, scenario of the catch was different, *Cyprinus carpio* was dominated (17.95%), other fish accounted for 18.23% while *Aarichthys* spp. and *T. putitora* contributed small proportions, 9.88% and 9.67%. *C. catla*, *L. rohita, C. mrigala* and *L. calbasu* contributed small proportions, 0.31%, 1.82%, 3.45% and 3.08%, respectively. Thus in the river other and cat fish contributed 70.71% and 14.23%, while in the canal exotic carps and cat fishes accounted for 18.42% and 16.23%.

The main cause of low production in upper region of Yamuna may be mainly due to:

i. Water abstraction ii. Siltation of river bed

The average yield in the river Yamuna between Delhi and Etawah stretch (YR_3-YR_4) with Agra as a focal point decreased from 100.76 t (1989) to 46.83 t (1993), with an average of 64.16 t. IMC except *L. calbasu* (8.2 to 13.64%) was on decline, showed *C. mrigala* (7.81%), *L. rohita* (5.89%)

and *C. catla* (2.20%). Catfishes increased especially *Mystus* sp. (31.5%) and *W. attu* (18.0%). Miscellaneous fishes (21.14%) were also present in this stretch. Common carps were also established in the system and forms 0.16% of the population (Figure 10) (Mishra and Moza, 1997).

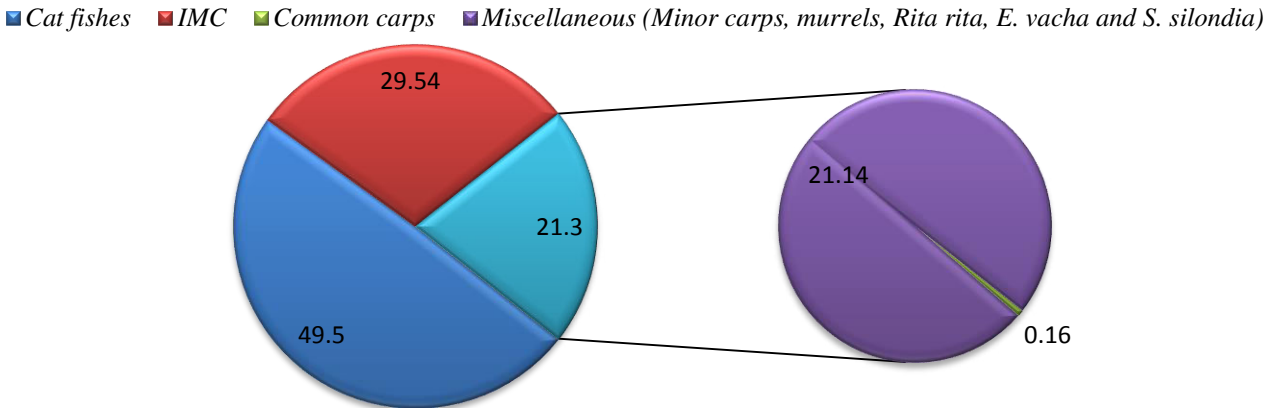

Figure 10: Status of fish population in Yamuna river (YR_3-YR_4)

The *L. rohita*, *C. catla* and *C. mrigala* contributed small proportions in the Yamuna river (Delhi to Etawah), showed dominance of large size cat fishes (≈49.26%) followed by major carps (≈28.54%).

The presence of exotic carp *C. carpio* in the Yamuna along with small share of other exotic carp formed 17.8% of the total landing at Allahabad (Anon, 2003). It account for 4.5% of the landing at Panipat in Haryana (Moza and Mishra, 2001), located before Delhi and much upstream of Allahabad. After common carp, the miscellaneous and cat fishes are emerging as a major fishery in Yamuna (Anon, 2002; 2003). Singh *et al.* (1998) found that *S. aor* and *S. seenghala* were dominant sp. (45.2%) compared with miscellaneous (28.2%) and *L. calbasu* (14.6%) in the Yamuna at Allahabad (Figure 11). Grover and Gupta (1977) reported 58 fish taxa in river Yamuna at Chilla.

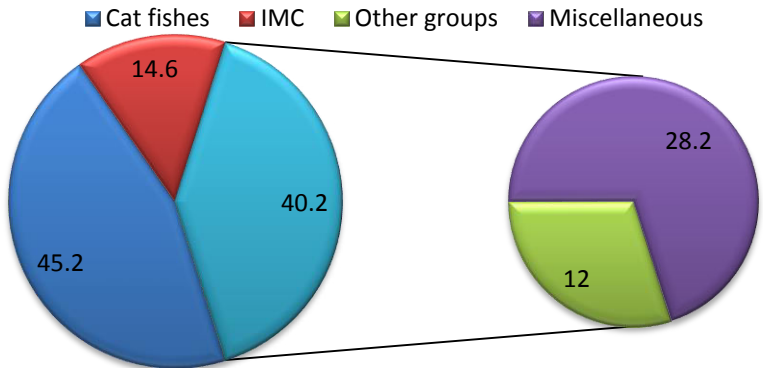

Figure 11: Status of fish population in Yamuna river (YR_5)

3.6. Higher vertebrates

Among the important higher vertebrates reported in Yamuna river are dolphin *Platanista gangetica gangetica*, Gharial (*Gavialis gangeticus*), turtles, *Lissemys punchata, Chitra indica, Aspideretes gangeticus* and three species of *Kachuga, K. kuchuga, K. tentoria* and *K. dhongoka*.

In the Yamuna river from confluence of Chambal to Hamirpur (350 km) 60 dolphins has been reported by WWF (2010) and by Sinha *et al*. (2010). In the major tributaries of Yamuna river; in Chambal (Pali to Barhi) 89; in Ken (from confluence of Yamuna at Chilla to Sindhan Kala village) 08; in Betwa (from confluence of Yamuna at Hamirpur to Orai) 06; in Sind (from confluence with the Yamuna) 05 number of dolphins have been reported (Sinha, 2000).

In case of Gharial (*Gavialis gangeticus*) Chambal river holds the largest population with an upper estimate of 306 adults animals (Converse, 2009). The other small population of Gharial is in Ken river.

Tiwari (2003) reported six species of turtles in the Yamuna at Etawah. Three species belongs to one genera and one family of hard shell turtle and other 3 species belonging to 3 other genera and one family of soft shell turtle. The six reported turtles are *Kachuga tentoria* (Indian tent turtle), *K. kuchuga* (Painted roofed turtle), *K. dhongoka* (Three stripped roofed turtle), *Lissemys punchata* (Indian flap-shell turtle), *Aspideretes gangeticus* (Indian soft-shell turtle) and *Chitra indica* (Narrow headed soft-shell turtle). Out of all reported turtles *K. tentoria* is the most common turtle found in Yamuna river. *K. dhongoka* was reported in Yamuna river at Bateswar (U.P.). Occurrence of *K. dhongoka* in Chambal was reported by Rao (1990). Moll (1987) reported *Kachuga tentoria*, *K.* t. *flariventor* and *K.* t. *circumdata* in Hindon river, Yamuna river at Gaziabad and Etawah. Rao (1995) also reported *Aspideretes gangeticus* in Chambal and Yamuna river.

4. Conclusions

i. The water quality of the Yamuna river under study has confirmed that the pollution load of up stream of Yamuna river (YR_1) is less as compared to down stream (YR_3 and YR_4).

ii. The water characteristics considered for the study indicate that the river water in YR_3 stretch is highly polluted and can not serve as a good habitat for many aquatic animals including endangered species.

iii. The poor quality trend continues downstream Delhi with values of DO fluctuating upto Majhawali and also downstream Agra. However, the values improved at Auraiya.

iv. In stretch YR_1 (from origin to Tajewala barrage), the biotic community is very less explored, attributed to very low temperature. However, phytoplankton, periphyton, zoobenthos and fishes are presented. In the YR_1, Bacillariophyceae are more than Chlorophyceae and Myxophyceae in both forms (phytoplankton and periphyton).

v. The stretch YR_1 are facing more pressure on fish resources due to high frequency of unscientific fishing methods, which completely disturb the population of fish and pollute the river water quality (Badola and Singh, 1977; Nautiyal and Lal, 1994; Uniyal *et al.,* 2006).

vi. At Yamuna nagar (YR_2) reduction of Bacillariophyceae and presence of rotifers, crustacean, molluscs, annelids and other arthopoda indicating the presence of organic pollution.

vii. In Delhi stretch (YR_3) the plankton comprised of 6 algal classes (Bacillariophyceae, Chlorophyceae, Myxophyceae, Euglenophyceae, Dianophyceae and Chrysophyceae). Chlorophyceae is more than other classes in this stretch. Chlorophyceae and Myxophyceae are higher in the Delhi stretch due to the combined sewage and industrial effluents, as compare to the YR_1 stretch, the clearest zone of the river.

viii. Apearence of number of Cladocerans and Rotifers in form of zooplankton and zoobenthos in YR_3 stretch also reflected high load of organic contaminants.

ix. In the river stretch affected by Mathura oil refinery waste, the Bacillariophyceae population has been found thriving well, showing the oil refinery effluent making the river water more suitable for the development of Bacillariophyceae population (Prakash and Panwar, 2005). In this stretch water condition in the river improve in comparision to the Delhi stretch (YR_3). The condition with respect to Bacillariophyceae population is same afterwords Mathura stretch.

x. At Etawah the composition of benthic population represented the heavy dose of organic population. Moza and Kolekar (2002) reported the benthic population dominated by *Chironomus* sp. (indicator of polysaprobic zone) and *Cypris* sp. (indicator of organic pollution).

xi. After the confluence of Chambal river (YR_5) the Yamuna is comperatively clean (Anon, 1991). The plaktonic population also reflected the same showing the dominance of Bacillariophyceae over other algal classes.

xii. The status of fishery showed considerable changes from upstream to downstream. The number of IMC showed incline 7.0% in YR_2 to 29.54% in YR_3-YR_4 and 14.6% in YR_5. Whereas Catfishes population enhanced from 14% in YR_2 to 49.5% in YR_3-YR_4 and 45.2% in YR_5. The number of minor carps showed decline from 71% (YR_2)-21.14% (YR_3-YR_4). All these changes in fishery composition point might be due to ecodegradation of the river Yamuna.

xiii. The total amount of annual water use in Yamuna basin from all the sources is approximately 44 bilion cubic meters out of which as much as 42.2 billion cubic meter *i.e.* 96% is used for irrigation alone (CPCB, 1982), leaving very little water in the river apart for its own beneficial uses for pollution dilution and assimilation (Mishra and Moza, 1997).

xiv. To keep the river living and useful it is necessary to take some conservation work early and to maintain the minimum amount of water which is necessary for biodiversity point of view and for self purification of the river.

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Appendix-I: Distribution of all aquatic organisms in the Yamuna River from Yamunotri to Ganga confluence

Ia. Distribution of phytoplankton in the Yamuna river from Yamunotri to Ganga confluence

Bacillariophyceae	**YR_1**	**YR_2**	**YR_3**	**YR_4**	**YR_5**	**Bacillariophyceae**	**YR_1**	**YR_2**	**YR_3**	**YR_4**	**YR_5**
Achnanthes sp.	+	+				*Nedium* sp.					+
Actinella sp.			+			*Nitzschia* sp.	+	+		+	+
Amphora sp.		+		+	+	*N. sigmoidea*			+		
A. acutiuscula	+					*Pinnularia* sp.				+	+
A. bangrainii	+					*Pleurosigma* sp.				+	+
Amphicampa sp.			+			*Rhaphoneis* sp.					+
Amphipleura sp.			+	+	+	*Rhapolodia* sp.				+	
Anomoeoneis sp.					+	*R. gibba*			+		
Asterionella sp.				+	+	*Rhizosolenia* sp.					+
Caloneis sp.		+				*Stauroneis* sp.		+			
Campylodiscus cribrosus			+			*Stephanodiscus* sp.				+	+
Ceratoneis sp.			+			*Surirella* sp.	+				+
C. arcus			+			*Synedra* sp.		+		+	+
Cocconeis sp.	+	+				*S. acus*	+				
Coscinodiscus sp.				+	+	*S. capitata*			+		
Cyclotella sp.	+	+	+	+	+	*S. miniscula*	+				
Cylindrotheca gracilis			+			*S. tabulata*	+				
Cymbella sp.		+		+	+	*S. ulna*	+		+	+	
Denticula sp.			+			*Tabellaria* sp.	+	+		+	+
Diatoma sp.	+	+		+	+	*T. binalis*	+				
D. ellipitica			+			*T. fenestrata*			+		
Eutonia sp.	+			+		Chlorophyceae					
Fragillaria sp.	+	+		+	+	*Actinastrum* sp.		+		+	
F. capucina	+					*A. fluvialitte*			+		
Frustulia sp.	+	+		+		*Ankistrodesmus* sp.		+		+	+
Gomphonema sp.		+		+	+	*A. falcatus*			+	+	
Gyrosigma sp.		+		+	+	*Arthrodesmus convergens*			+		
G. kutzingii			+			*Batryococcus* sp.		+			
Meridion sp.		+				*B. sudeticus*			+		
M. circulare			+			*Binuclearia sudeticus*			+		
Melosira sp.	+	+		+	+	*Celastrum* sp.		+			
M. varians			+			*C. elegans*			+		
Navicula sp.	+	+		+	+	*C. incrassate*			+		
N. viridula			+			*C. pisiformis*			+		
N. cryptocephalon	+					*Chaetophora incrassate*			+		

Chlorophyceae	YR_1	YR_2	YR_3	YR_4	YR_5
C. pisiformis			+		
Chara zeylanica	+				
Characium sp.		+			
Chlamydomonas sp.				+	+
Chlorella sp.				+	+
C. vulgaris				+	
Chlorococcum sp.			+	+	
C. humicola					
Chlorococcus sp.				+	
Cladophora sp.	+	+		+	+
C. glomerata	+		+		
Closteriopsis sp.		+			
C. longissima			+		
Colelastrum chodati			+		
C. microporum			+		
Coleochaete sp.			+		
Cosmarium sp.	+	+			
Cystodinium sp.		+			
Dactylococcum sp.			+		
Desmidium sp.				+	
Dichotomosiphon tuberosus	+				
Dimorphococcus sp.					+
Echinosphaerella sp.			+		
Elakatothrix viridis			+		
Enteromorpha intestinalis			+		
Eudorina sp.				+	+
E. elegans			+		
Genicularia sp.			+		
Golenkinia radiata			+		
Hormidium subtile			+		
Hydrodictyon sp.			+	+	+
H. reticulatum			+	+	
Hyalotheca dissiliens			+		
Kirchneriella sp.		+			
Mesotaenium sp.					+
M. endlicherianum			+		
Microspora flocossa	+		+		
Mougeotia willeana	+		+		

Chlorophyceae	YR_1	YR_2	YR_3	YR_4	YR_5
Netrium sp.					+
N. lamellosa			+		
Oedogonium crassum			+		
O. solataria			+		
Ophioceticum sp.				+	
Ophiocytium cochleare			+		
O. parvulum			+		
Oocystis solitaria			+		
Pandorina sp.			+		+
Pediastrum sp.		+		+	+
P. boryanum			+		
P. duplex			+		
P. simplex				+	
P. tetras				+	
Protococcus sp.				+	
Pleurogaster lunaris			+		
Pleurotaenium coronatum			+		
P. ehrenbergii			+		
P. trabecula			+		
Protosiphon sp.			+		
Rhizoclonium heiroglyphicum			+		
Schroederia sp.			+		
S. opoliensis			+		
S. quadricauda			+		
S. thomassoni			+		
Selenastrum sp.				+	
Scenedesmus sp.			+	+	+
S. quadricauda				+	
Sphaeroplea annulina			+		
Sphaerocystis sp.			+		
Spirogyra sp.	+	+		+	+
S. bichromatophora	+				
S. crassa			+		
S. communis	+		+		
S. ellipsospora			+		
S. narcissiana			+		
S. pratensis			+		
S. rectangularis			+		

Chlorophyceae	**YR_1**	**YR_2**	**YR_3**	**YR_4**	**YR_5**
Spirotaenia sp.					+
Staurastrum sp.	+	+		+	
Stigeoclonium longicollum			+		
S. pachydermum			+		
S. tenue			+		
Tetraspora sp.	+				
Tetrastrum sp.			+		+
T. crassa			+		
Tribonema bombycinum	+				
Trochiscia sp.	+	+			
T. vestitus			+		
Ulothrix sp.	+	+		+	
U. aequalis			+		
U. cylindricum			+		
U. subtilissima			+		
U. variabilis	+		+		
U. zonata	+		+		
Volvox sp.					+
V. tertius			+		
Voucheria terrestris	+				
Zygnema sp.			+	+	+
Z. insigne			+		
Myxophyceae					
Agmenellum sp.				+	+
Anabaena sp.				+	+
A. aequalis			+		
Ancystis sp.				+	+
Aphanocapsa sp.			+		
A. delicatissima			+		
Aphanothecea sp.				+	
Coelosphaerium sp.		+		+	
Gleocapsa sp.				+	
Gomphospaeria sp.		+		+	+
Lyngbya sp.			+	+	+
L. contorta			+		
L. major			+		
Merismopoedia sp.		+		+	
M. glauca			+	+	

Myxophyceae	**YR_1**	**YR_2**	**YR_3**	**YR_4**	**YR_5**
M. punctata			+	+	
Microcystis sp.		+	+	+	
M. aeruginosa			+	+	
Nostoc sp.		+	+	+	+
Oscillatoria sp.	+	+		+	+
O. chlorina			+	+	
O. limosa			+	+	
O. prolifica			+		
O. princeps			+		
O. subbrevis				+	
O. splendida			+		
O. tenuis			+	+	
O. willei					
Phormidium sp.		+		+	
P. favosum			+		
P. uncinatum			+		
Polycystis sp.				+	
Rivularia sp.				+	+
R. haemititis			+		
Spirulina sp.		+		+	
S. major			+		
S. muscorum			+		
Tolypothrix sp.			+		
Euglenophyceae					
Euglena sp.				+	
E. acus			+	+	
E. viridis			+	+	
Peranema trichophorum			+		
Phacus sp.				+	
P. caudatus				+	
P. triqueter			+		
Dianophyceae					
Ceratium sp.		+		+	
C. hirundinella			+		
Peridinum sp.		+		+	
Gloeodinium quadridens			+		
Chrysophyceae					
Dinobryon sp.				+	+

Xanthophyceae	**YR_1**	**YR_2**	**YR_3**	**YR_4**	**YR_5**	*O. parvulum*			+		
Ophiocytium cochleare			+			*Pleurogaster lunaris*			+		

Agrawal (2002); Kaur (1996); Kumar (1999); Moza and Mishra (2003); Rauthan (2009); Tabasum (2006); Verma (1999)

Ib. Distribution of periphyton in the Yamuna River from Yamunotri to Ganga confluence

	YR1	YR2	YR3	YR4	YR5
Bacillariophyceae					
Achnanthes crenulata	+				
A. marginulata	+				
A. minutissima	+		+		+
A. sphacelata	+				
Achnanthidium biasolettianum	+				
A. conspicua	+				
A. exigua	+				+
A. petersenii	+				
A. subhudsonis	+				
Adlafia miniscula	+				+
A. muscora	+				
Amphora sp.					+
A. aequalis					+
A. inariensis					+
A. libyaca					+
A. montana	+				
A. normanii					+
A. ovalis			+		
A. pediculus	+				+
A. twentiana					+
A. veneta	+				+
Atteya sp.			+		
Aulcoseira granulata					+
Brachysira sp.					+
B. vitrea					+
Caloneis sp.	+				+
C. bacillum					+
C. beccariana					+
C. silicula					+
Cocconeis sp.					+
C. pediculus	+		+		
C. placentula			+		
Craticula ambigua					+
C. buderi					+
C. citrus					+
C. minusculoides					+
Cyclotella comta			+		

	YR1	YR2	YR3	YR4	YR5
C. kuetzingiana			+		
C. meneghiniana	+		+		
C. ocellata			+		
C. pseudostelligera					+
Cymbella sp.					+
C. aequalis			+		
C. australica					+
C. cymbiformis					+
C. diversa					+
C. excisa	+				+
C. kolbei					+
C. cancettuliformis					+
C. metzeltinii	+				
C. nova.zeelandiana					+
C. parva					+
C. pervarians					+
C. prostrata			+		
C. tropica	+				+
C. turgidula	+				+
C. tumida	+		+		+
C. ventricosa			+		
C. vulgata	+				+
Cymbopleura angustata					+
C. citrus					+
C. falaisensis					+
C. lapponica					+
C. rupicola					+
C. microcephala					+
C. varna					+
Cymatopleura sp.					+
C. elliptica			+		
C. solea			+		
Delicata sparsistriata					+
Denticula sp.					+
D. kuetzingii					+
D. tenuis			+		
Diadesmis sp.					+
D. confervacea					+

	YR1	YR2	YR3	YR4	YR5
Diatoma sp.		+			
D. hiemale			+		
Diatoma mesodon					+
D. minus					+
Diploneis sp.					+
D. oblongella					+
D. smithii					+
D. subovalis					+
Encyonema sp.					+
E. leei	+				
E. minutum	+				+
E. silesiacum	+				+
Epithemia ocellata			+		
E. pseudopectinalis					+
E. turgida			+		
E. zebra			+		
Eunotia pectinalis			+		
E. sudelica					+
Fallacia pygmea					+
Fragillaria sp.					+
F. capucina			+		
F. crotonensis			+		+
F. virescens			+		
Frustulia sp.		+			+
F. rhomboides			+		
F. vulgaris			+		
Gesslaria decussis					+
Gomphonema sp.					+
G. acuminatum			+		
G. angustatum	+		+		+
G. clevei	+				+
G. constrictum			+		
G. gracile	+				+
G. lagenula	+				
G. lanceolata	+				
G. olivacum			+		
G. parvulum	+		+		+
Gomphoneis minutum	+				+
Gomphocymbelopsis ancyli					+
Gyrosigma eximum			+		

	YR1	YR2	YR3	YR4	YR5
G. kutzingee			+		
G. scalproides					+
Hantzschia amphioxys			+		
Hippodonta ruthnielseniae	+				
Luticola mutica	+				+
L. saxophila					+
Melosira sp.	+				
M. crenulata			+		
M. granulata			+		
M. italica			+		
M. juergensii			+		
M. tenuissima			+		
M. varians	+		+		
Mougeotia sp.			+		
M. calcarea			+		
M. robusta			+		
M. sphaerocarpa			+		
M. tumidula			+		
Navicula sp.		+			
N. alineae	+				
N. angusta					+
N. antonii	+				+
N. broetzii	+				
N. capitatoradiata	+				+
N. cataracta-rheni	+				+
N. caterva	+				+
N. cincta					+
N. confervaceae			+		
N. cryptocephala	+		+		+
N. cryptotenella	+				+
N. cryptotenelloides					+
N. cryptofallax					+
N. cuspidate			+		
N. dicephala			+		
N. erifuga					+
N. exigua			+		
N. exilis	+				+
N. germainii					+
N. minima	+				
N. notha	+				+

	YR1	YR2	YR3	YR4	YR5
N. phylleptosoma					+
N. radiosa			+		
N. reichardtiana	+				+
N. radiosafallax					+
N. rostellata	+				+
N. rynchocephala			+		
N. schorteri					+
N. simplex			+		
N. stagnorum	+				+
N. subrhynchacephala					+
N. symmetrica					+
N. trivialis					+
N. veneta					+
N. viridula	+		+		+
N. viridulacalcis					+
Nedium sp.					+
N. productum			+		
Nitzschia acuta	+				
N. acicularis					+
N. amphibia	+				
N. capitellata					+
N. closterium			+		
N. communis					+
N. debilis					+
N. denticula	+				
N. dissipata	+				+
N. fonticola	+				
N. frustulum	+				
N. ganderheimensis					+
N. hantzchiana					+
N. hungarica			+		+
N. intermedia					+
N. linearis	+				
N. obtuse					+
N. ovalis	+				
N. palea	+		+		+
N. punctata					+
N. sinuata					+
N. tenuis	+				+
N. tripunctata	+				

	YR1	YR2	YR3	YR4	YR5
N. vitabunda	+				
N. walterecki	+				
Pinnularia sp.					+
P. cardinalis			+		
P. gibba			+		
P. interrupta			+		
P. maior			+		
P. nobilis			+		
P. trauenbergiana					+
Placoneis elegans					+
Planothidium lanceolatum	+				+
Reimeria sinuata	+				
R. uniseriata	+				
Rhizosolenia gibba			+		
Sellaphora hostedtii					+
S. mutatoides					+
S. pupula					+
Stauroneis acuta			+		
S. anceps	+		+		+
S. phoenicenteron			+		
S. phyllodes			+		
S. pinnata	+				+
S. producta			+		
Surirella sp.					+
S. apiculata					+
S. aungusta	+		+		+
S. didyma			+		
S. linearis			+		+
S. minuta					+
S. ovalis			+		
S. robusta			+		
S. splendida					+
Synedra sp.		+			
S. acus			+		
S. amphicephela					+
S. capitata			+		
S. dorsiventralis					+
S. rumpens					+
S. ulna	+		+		+
Tabellaria sp.		+			

	YR1	YR2	YR3	YR4	YR5
Chlorophyceae					
Achinestrum hantzschii			+		
Ankistrodesmus falcatus			+		
Binuclearia tetrana			+		
Bulbochaete giganta			+		
B. nana			+		
Chlamydomonas globosa			+		
C. variabilis			+		
Cladophora sp.		+			
Closterium acerosum			+		
C. acutum			+		
C. braunii			+		
C. dianae			+		
C. ehrenbergii			+		
C. gracile			+		
C. lanceolatum			+		
C. leiblenii			+		
C. lunula			+		
C. moniliferum			+		
C. parvulum			+		
C. strigosum			+		
C. turgidum			+		
C. venus			+		
Colelastrum microporum			+		
C. reticulatum			+		
Cosmarium botrytis			+		
C. constrictum			+		
C. depressum			+		
C. formosulum			+		
C. granatum			+		
C. moniliforme			+		
C. nitidulum			+		
C. protractum			+		
C. quadrum			+		
C. sexangulare			+		
C. speciosum			+		
C. subcrenatum			+		
C. subimpressulum			+		
C. supraspeciosum			+		
Crucigenia tetrapeda			+		

	YR1	YR2	YR3	YR4	YR5
Errerella bornhemiensis			+		
Euastrum gemmatum			+		
E. oblongum			+		
E. pulchellum			+		
Eudorina elegans			+		
Gonium formosum			+		
G. pectorale			+		
Hydrodictyon sp.			+		
H. reticulatum			+		
Hormidium sp.			+		
Micrasterias americana			+		
Micractinium pusillum			+		
Microspora quadrata			+		
Oedogonium cardiacum			+		
Oocystis punchatostriatum			+		
O. vulgare					
Pandorina sp.			+		
P. morum			+		
Pediastrum boryanum			+		
P. duplex			+		
P. integrum			+		
P. simplex			+		
P. tetras			+		
Pleurotaenium coronatum			+		
P. ehrenbergii			+		
P. rabecula			+		
Spirogyra sp.		+			
S. communis			+		
S. rectangularis			+		
S. silvicola			+		
S. setiformis			+		
Staurastrum chaetoceros			+		
S. crenatum			+		
S. gracile			+		
S. margaritaceum			+		
S. oxyacanthum			+		
S. punctulatum			+		
Stigeoclonium sp.			+		
S. tenue			+		

	YR1	YR2	YR3	YR4	YR5
Syndesmus abundans			+		
S. acuminatus			+		
S. arcuatus			+		
S. armatus			+		
S. bicellularis			+		
S. brasiliensis			+		
S. dactylococcoids			+		
S. dimorphus			+		
S. ecornis			+		
S. nanus			+		
S. opoliensis			+		
Tetraedron caudatum			+		
T. gracile			+		
T. muticum			+		
Tetrastrum sp.			+		
Treubaria crassipina			+		
Trochiscia sp.		+			
T. reticularis			+		
Ulothrix aequalis			+		
U. zonata			+		
Volvox globator			+		
V. spermatosphaera			+		
Wislouchiella plantonica			+		
Zygnema cylindricum			+		
Z. insigne			+		
Z. pectinatum			+		
Myxophyceae					
Anabena circularis			+		
A. flos-aquae			+		
A. spiroides			+		
A. variablis			+		
Aphanocapsa sp.			+		
Aphanizomenon flos-aquae			+		
Cylindrospermum majus			+		
Lyngbya aeruginea coerulea			+		
L. birgei			+		
Merismopedia convulata			+		
M. glauca			+		
M. tenuissima			+		

	YR1	YR2	YR3	YR4	YR5
Microcystis sp.			+		
Nodularia harveyana			+		
Nostoc sp.		+			
N. ellipsosporum			+		
N. muscorum			+		
Oscillatoria sp.		+			
O. aghordhii			+		
O. chlorina			+		
O. curviceps			+		
O. formosa			+		
O. limosa			+		
O. tenuis			+		
Phormidium foveolarum			+		
P. incrustatum			+		
P. inudatum			+		
P. tenue			+		
Schizothrix purpurascens			+		
Spirulina sp.		+			
Spirulina major			+		
S. nordstedtii			+		
Symploca muscorum			+		
Euglenophyceae					
Anisonema ovale			+		
Euglena acus			+		
E. acutissima			+		
E. gracilis			+		
E. oblonga			+		
E. sanguinea			+		
E. spirogyra			+		
E. spiroides			+		
E. viridis			+		
Lepocinclis ovum			+		
Mallomonas caudata			+		
Phacus longicauda			+		
P. pleuronectes			+		
P. pyrum			+		
P. torta			+		
P. triqueter			+		
Trachelomonas hispida			+		
Dianophyceae					

	YR1	YR2	YR3	YR4	YR5
Ceratium hirundinella			+		
Gloeodinium quadridens			+		
Chrysophyceae					
Dinobryon cylindricum			+		

Xanthophyceae					
Mischococcus confervicola				+	
Ophiocytium variable				+	
Rhodophyceae					
Compsopogan coeruleus				+	

Kaur (1996); Verma (2008)

Ic. Distribution of zooplankton in the Yamuna river from Yamunotri to Ganga confluence

	YR_1	YR_2	YR_3	YR_4	YR_5
Ciliophora					
Acineria incurvata			+		
Actinobolina sp.			+		+
Amphibothrella sp.			+		
Amphileptus sp.			+		
Askenasia sp.			+		
Chaenea sp.			+		
Carchesium sp.				+	+
Chilodonella uncinata			+		
C. cucullus			+		
Coleps hirtus			+		
C. elongates			+		
Didinium nasutum			+		
Dileptus binucleatus			+		
Enchelyodon sp.			+		
Enchelys sp.			+		
Glaucoma sp.					+
Holophrya sp			+		
Homalozoon vermiculare			+		
Lacrymaria olor			+		
L. elegans			+		
Litonotus fasciola			+		
Loxophyllum sp.			+		
Mesodinium sp.			+		
Paradileptus sp.			+		
Prorodon teres			+		
Pseudoprorodon sp.			+		
Spathidium depressum			+		
S. spathula			+		
Trachelium ovum			+		
Trachellophylum sp.			+		
Trichopelma sp.				+	+
Hypotrichida					
Aspidisca costata			+		
A. turrita			+		
Euplotes sp.			+		
E. patella			+		
Gastrostyla steinii			+		

	YR_1	YR_2	YR_3	YR_4	YR_5
Holosticha sp.			+		
Oxytricha sp.			+		
Paraurostyla sp.			+		
Steinia sp.			+		
Strongylidium crassa			+		
Stylonychia sp.			+		
Uroleptus sp.			+		
Urosoma sp.			+		
Urostyla sp.			+		
Heterotrichida					
Blepharisma coeruleum			+		
B. lateritium			+		
Bursaria truncatella			+		
Stentor muelleri			+		
S. polymorphus			+		
S. roeselli			+		
Spirotricha					
Metopus sp.			+	+	+
Spirostomum sp.				+	+
S. ambiguum			+		
S. minus					
S. teres					
Armophorida					
Caenomorpha medusala			+		
Bryometopida					
Bryometopus sp.			+		
Odontostomatida					
Halteria grandinella			+		
H. cirrifera			+		
Saprodinium dentatum			+		
Strombidium viridae			+		
Peniculida					
Paramecium sp.				+	+
P. aurelia			+		
P. caudatum			+	+	
Hymenostomatida					
Cinetochilum margaritaceum			+		
Colpidium colpoda			+		

	YR_1	YR_2	YR_3	YR_4	YR_5
C. cucullus			+		
Frontonia leucas			+		
Glaucoma sp.			+	+	
Tetrahymena pyriformis			+		
Peritrichida					
Astylozoon faurei			+		
Carchesium sp.				+	
C. polypinum			+		
Epistylis sp.				+	+
E. plicatilis			+		
E. rotans			+		
Opisthonecta sp.			+		
Vorticella sp.				+	+
V. campanula			+		
V. convallaria			+		
V. similis			+		
Vaginicola crystalline			+		
Suctorida					
Acineta sp.			+		
Cothurnia trabeculae			+		
Discophrya sp.			+		
Metacineta sp.			+		
Podophrya fixa			+		
Pyxicola carteria			+		
Rhabdostyla sp.			+		
Scyphidia hyaline			+		
Sphaerophrya magna			+		
Thuricola folliculata			+		
Tokophrya fallax			+		
Testacea					
Arcella sp.				+	+
Arcellinida					
Diffugia sp.				+	+
Nebela sp.				+	+
Amoebida					
Amoeba sp.				+	+
Entamoeba histolytica				+	+
Rotifers					
Philodinida					
Habrotrocha sp.			+		

	YR_1	YR_2	YR_3	YR_4	YR_5
Bdelloida					
Philodina citrina			+		
Rotaria sp.				+	+
Rotaria macroceros			+		
R. neptunia			+	+	
R. ratatoria			+		
Ploima					
Anuraeopsis fissa			+		
Ascomorpha saltans			+		
Asplanchna sp.				+	+
A. brightwellii				+	
A. herricki			+		
A. intermedia			+	+	+
A. priodonta			+		
A. sieboldi			+		
Brachionus sp.		+		+	+
B. angularis			+	+	+
B. bidentata			+		
B. budapestinensis			+		
B. caudatus			+	+	+
B. calyciflorus			+	+	+
B. diversicornis			+		
B. falcatus			+	+	+
B. forficula			+	+	+
B. leydigii			+		
B. patulus			+		
B. plicatilis			+	+	+
B. quadridentatus			+	+	
B. rubens			+	+	
B. urceolaris			+		
Cephalodella exigua			+		
C. forficula			+		
C. gibba			+		
C. mucronata			+		
Chromogaster ovalis			+		
Colurella obtuse			+		
Dicranophorus forcipatus			+		
Dipleuchlanis propatula			+		
Encentrum longipes			+		
Epiphanes brachionus			+		

	YR_1	YR_2	YR_3	YR_4	YR_5
E. clavulata			+		
E. senta			+		
Euchlanis sp.					+
E. dilatata			+		
E. macrura			+		
E. triquetra			+		
Hurringia sp.			+		
Keratella sp.		+		+	+
K. cochlearis			+	+	+
K. quadrata			+	+	+
K. tropica			+	+	+
K. procurva			+		
K. serrulata				+	+
K. valga				+	+
Lecane leontia			+		
L. nana			+		
L. ohioensis			+		
L. bulla			+		
L. furcata			+		
L. lunaris			+		
L. obtusa			+		
L. pyriformis			+		
L. quadridentata			+		
Lepadella sp.					+
L. ovalis			+		
L. patella			+		
Manfredium eudactylotum			+		
Monommata sp.			+		
Monostyla sp.		+			
Mytilina mucronata			+		
M. ventralis			+		
Nothalca sp.		+			
Notommata copeus			+		
Polyarthra sp.				+	+
Polyarthra euryptera			+		
P. longiremis			+		
P. multi appendiculata				+	
Pompholyx sulcata			+		
Proales decipiens			+		
Resticula sp.			+		

	YR_1	YR_2	YR_3	YR_4	YR_5
Scaridium longicauda			+		
Squatinella mutica			+		
S. pectinata			+		
S. stylata			+		
Trichocerca sp.					+
T. cylindrical			+		
Trichocerca longiseta			+		
T. similis			+		
Trichotria tetractis			+		
Wulfertia sp.			+		
Floscullariaceae					
Conochilus dossuarius			+		
C. arboreus			+		
Filinia sp.				+	
F. longiseta			+		+
F. opaliensis			+		
F. terminalis			+		
Floscularia conifera			+		
Hexarthra sp.					+
H. intermedia			+		
H. mira			+		
H. oxyuris			+		
Horaella brehmi			+		
Limnios melicerta			+		
Pompholyx sulcata			+		
Ptygura stephanion			+		
Testudinella patina			+		
Crustacea					
Cladocera					
Alona sp.				+	+
A. pulchella			+		
A. rectangula			+		
Alonella exigua			+		
Bosmina sp.		+		+	+
B. longirostris			+	+	
Bosminopsis deitersi			+		
Chydorus sp.				+	+
C. sphaericus			+		
C. parvus			+		
C. ventricosus			+		

	YR_1	YR_2	YR_3	YR_4	YR_5
Daphnia sp.		+		+	+
D. carinata			+		
D. lumholtzi			+		
D. pulux			+		
Danhevedia crassa			+		
Macrothrix rosea			+		
M. spinosa			+		
Moinodaphnia sp.				+	
M. maclaeyi			+		
Prinocypris sp.					+
Anomopoda					
Camptocercus rectirostris			+		
Ceriodaphnia sp.				+	+
C. cornuta			+		
C. reticulata			+		
Moina sp.				+	
M. brachiata			+	+	
Scapholebris kingi			+		
Harpacticoida					
Canthocamptus sp.				+	+
Cyclopoida					
Cyclops sp.		+		+	+
Cypris sp.				+	+
Nauplii sp.		+			
Calanoida					
Diaptomus sp.				+	+
Cladocera					
Sida sp.				+	
S. crystallina			+		
Simocephalus sp.				+	+
S.serrulatus			+		
Calanoida					
Acartia sp.				+	
Pseudodiaptomus annandalei				+	
Decapoda					
Palaemon sp.				+	
Shrimps		+	+	+	
Plaemon sp.					+
Gastropoda					
Bostrycapulus aculeatus				+	+

	YR_1	YR_2	YR_3	YR_4	YR_5
Carbicula sp.		+			
Lymnaea sp.		+			
Gyraulus sp.		+			
Melanies stritella		+			
Physa sp.		+			
Planorbis sp.		+			
Valvata sp.		+			
Viviparus bengalensis		+			
Nematoda					
Diplogasterida					
Diplogasteroides sp.					+
Monhysterida					
Trilobus sp.					+
Enoplida					
Prismatolaimus sp.					+
Annelida					
Chaetogaster sp.					+
Hirudinida					
Leeches		+			
Haplotaxida					
Aeolosoma sp.					+
Plesiopora					
Nais andina					+
Pristina sp.					+
Insects and other larvae					
Hemiptera					
Belostoma sp.		+			
Corixa sp.					+
Corixa heiroglyphica		+			
Diplonynchus annulatum		+			
Gerris sp.		+			+
Laccotrophes robustus		+			
Limnometra micronecta		+			
Plea sp.		+			
Notonecta sp.		+			+
Coleoptera					
Berosus indicus		+			
Cybistus sp.		+			
Dytiscus sp.					+
Eretes sp.		+			

	YR_1	YR_2	YR_3	YR_4	YR_5
Gyrinus sp.					+
Halipus sp.		+			
Hydrophilus sp.		+			+
Laccpphilus sp.		+			
Ranatra sp.					+
Ranatra filiformis		+			
Regimbartea attenutta		+			
Rhantaticus sp.		+			
Odonata naiads					
Epicordulia sp.		+			
Enallogoma sp.		+			
Gomphidae nymphs		+			
Plecoptera nymphs					+
Diptera					
Chironomus larvea		+			+
Culex nymphs & larvae		+			
Culicidae larvae					+
Dixa pupa		+			
Elliptera sp.		+			
Ephydra larvae					+
Tanypus larvae					+
Tipula larvae					+
Lepidoptera					
Nymphula larvae		+			
Trichoptera					
Caddis fly larvae		+			
Ephemeroptera					
Ephemeridae nymphs					+
Ephemerella nymphs		+			
Baetis nymphs		+			
Acari					
Water mite		+			

Agrawal (2002); Kaur (1996); Kumar (1999a); Kumar (1999b); Moza and Mishra (2003); Sucarcha (1994); Tabasum (2006); Verma (1999)

Id. Distribution of zoobenthos in the Yamuna river from Yamunotri to Ganga confluence

	Genus	YR_1	YR_2	YR_3	YR_4	YR_5
Ostracods				+		
	***Cypris* sp.**				+	
Conchostraca				+		
Decapoda	***Palaemon* sp.**				+	
Trichoptera				+		
Hydropsychidae	***Hydropsyche* sp.**	+				
Hemiptera						
Aphididae				+		
Belostomatidae				+		
	***Belostoma* sp.**				+	
Corixidae	***Corixa* sp.**				+	
Gerridae	***Gerris* sp.**	+	+		+	
Mesoveliidae				+		
Nepidae	***Lacotrephes* sp.**				+	
	***Nepa* sp.**				+	
Notonectidae	***Notonecta* sp.**				+	
Pleidae				+		
	***Plea* sp.**	+	+		+	
Odonata						
Coenagrionidae				+		
Gomphidae						
	***Gomphus* sp.**		+		+	
	***Macrogomphus* sp.**				+	
	***Dromogomphus*sp.**				+	
Libellulidae				+		
Lepidoptera						
Pyralidae				+		
Orthoptera						
Gryllotalpidae	***Gryllotalpa* sp.**				+	
Ephemeroptera						
Baetidae	***Baetis* (nymphs)**	+			+	
Ephemeridae	***Ephemera* sp.**	+				
Ephemerellidae					+	
Coleoptera						
Belostomatidae	***Laccotrephes* sp.**		+			
Chrysomelidae				+		

	Genus	YR_1	YR_2	YR_3	YR_4	YR_5
Curculionidae				+		
	***Bagous* sp.**	+				
Dytiscidae	***Cybister* sp.**			+		
	***Rhantaticus* sp.**				+	
	***Laccophilus* sp.**				+	
	***Hyphoporus* sp.**				+	
Elmidae	***Stenelmis***			+		
Gyrinidae	***Gyrinus* sp.**				+	
Haliplidae	***Haliplus* sp.**	+				
Hydrophilidae	***Hydrophilus* sp.**			+	+	
	***Berosus* sp. (larvae)**		+		+	
Psephenidae	***Psephenus* sp.**	+				
Staphylinidae				+		
Diptera						
Anthomyiidae				+		
Ceratopogonidae				+		
	***Culicoides* sp.**				+	
	***Probezzia* sp.**				+	
Chaoboridae	***Chaoborus* sp.**				+	
Chironomidae				+		
	***Chironomus* sp.**	+	+		+	
	***Tanipus* sp.**				+	
Culicidae				+	+	
Cylindrotomidae	***Triogma* sp.**	+				
Dixidae	***Dixa* sp.**		+		+	
Dolichopodidae				+		
Ephydridae	**Ephydra larvae**				+	
Muscidae	**House fly larvae**				+	
Psychodidae				+	+	
	***Psychoda* sp.**				+	
Stratiomyidae				+		
Syrphidae				+		
Tabanidae				+		
Tendipedidae				+		
Tipulidae				+		
	***Tipula* sp.**				+	
Plecoptera					+	
Gastropoda						

	Genus	YR_1	YR_2	YR_3	YR_4	YR_5
Ariophantidae	***Macrochlamys* sp.**		+		+	
Bithyniidae				+		
	***Bithynia* sp.**				+	
Hydrobiidae				+		
	***Amnicola* sp.**				+	
Lymnaeidae	***Lymnaea* sp.**	+	+	+	+	
Melaniidae				+		
Pachychilidae	***Faunus ater***				+	
Physidae	***Physa* sp.**		+		+	
Planorbidae				+		
	***Gyraulus* sp.**				+	
	***Planorbis* sp.**	+	+			
Pleuroceridae	***Pleurocera* sp.**				+	
Pomatiasidae	***Cyclotopsis* sp.**				+	
Subulinidae	***Glessula* sp.**		+			
Thiaridae	***Melania tuberculata***				+	
	M. straitella		+			
Valvatidae	***Valvata* sp.**				+	
Viviparidae				+		
	***Vivipara* sp.**				+	
	V. bengalensis		+		+	
	***Campeloma* sp.**				+	
Bivalvia						
Unionidae	***Lemillidens* sp.**		+		+	
	***Unio* sp.**				+	
Sphaeriidae	***Spaerium* sp.**				+	
Corbiculidae	***Corbicula straitella***				+	
	C. regularis		+			
Annelida						
Hirudinea				+	+	
Erpobdellidae				+		
Glossiphoniidae				+		
Oligochaeta				+		
Aeolosomatidae	***Aelosoma* sp.**		+		+	
Branchiurinae	***Branchiura* sp.**				+	
Lumbricidae				+		
Lumbriculidae				+		
Naididae	***Nais* sp.**				+	

	Genus	YR_1	YR_2	YR_3	YR_4	YR_5
	N. andina				+	
	***Tubifex* sp.**				+	
	***Dero* sp.**				+	
	***Chaetogastor* sp.**				+	
	***Lemnodrilus* sp.**				+	
	***Pristina* sp.**				+	
	***Tubifex* sp.**				+	
	Tubifex tubifex	+	+			
Tubificidae				+		
Clitellata						
Lumbricidae	***Lumbricus* sp.**				+	
Nematods						
Diplogasteridae	**Diplogasteroids**				+	

Kaur (1996); Moza and Mishra (2003); Moza and Kolekar (2002)

Ie. Distribution of nektons in the Yamuna River from Yamunotri to Ganga confluence

Species	Families	YR_1	YR_2	YR_3	YR_4	YR_5
Ailia coila	**Schilbeidae**					+
Ambasis name	**Ambassidae**			+	+	
A. ranga	**Ambassidae**			+	+	
Amblyceps mangois	**Ambyceptidae**	+				
Amblypharyngodon mola	**Cyprinidae**					+
Anabas testudineus	**Anabantidae**			+		
Aplocheilus panchax	**Aplocheilidae**	+				
Aspidoparia jaya	**Cyprinidae**	+				
A. morar	**Cyprinidae**	+				+
Badis badis	**Nandidae**	+				+
Bagarius bagarius	**Sisoridae**	+	+	+	+	+
B. yarrelli	**Sisoridae**	+				
Barilius barna	**Cyprinidae**	+				+
B. bendelensis	**Cyprinidae**	+				
B. bola	**Cyprinidae**					+
B. dimorphicus	**Cyprinidae**	+				
B. pectorilus	**Cyprinidae**	+				
B. vagra	**Cyprinidae**	+				
Botia dario	**Cobitidae**				+	
B. rostrata	**Cobitidae**	+				
Carassius carassius	**Cyprinidae**	+				
Catla catla	**Cyprinidae**	+	+	+	+	+
Chaca chaca	**Chacidae**	+				
Chagunius chagunio	**Cyprinidae**	+				+
Chanda nama	**Chandidae**					+
C. ranga	**Chandidae**					+
Channa sp.	**Channidae**			+	+	
C. gachua	**Channidae**	+		+	+	+
C. marulius	**Channidae**			+	+	+
C. punctatus	**Channidae**	+		+	+	+
C. striatus	**Channidae**			+	+	+
Chela atpar	**Cyprinidae**					+
Chitala chitala	**Notopteridae**					+
Cirrhinus mrigala	**Cyprinidae**	+	+	+	+	+
C. reba	**Cyprinidae**	+	+	+	+	+
Clarias batrachus	**Clariidae**	+		+		+
Clupisoma garua	**Schilbeidae**			+	+	+
C. montana	**Schilbeidae**	+				
Colisa fasciata	**Anabantidae**	+				+
Crossocheilus latius latius	**Cyprinidae**	+				+
Ctenopharyngodon idellus	**Cyprinidae**	+	+			
Cyprinus carpio	**Cyprinidae**	+	+	+	+	+
C. specularis	**Cyprinidae**	+				
Danio devario	**Cyprinidae**	+				
D. rerio	**Cyprinidae**	+				
Esomus danricus	**Cyprinidae**	+				+
Eutropiichthys vacha	**Schilbeidae**			+	+	+
Gagata cenia	**Sisoridae**				+	
Gambusia affinis	**Poeciliidae**	+				
Garra gotyla gotyla	**Cyprinidae**	+				
G. lamta	**Cyprinidae**	+				

Species	Families	YR_1	YR_2	YR_3	YR_4	YR_5
Glossogobius giuris	**Gobiidae**			+	+	+
Glyptothorax cavia	**Sisoridae**	+				
G. dakapathari	**Sisoridae**	+				
G. garhwali	**Sisoridae**	+				
G. horai	**Sisoridae**	+				
G. pectinopterus	**Sisoridae**	+				
G. telchitta	**Sisoridae**			+	+	
Goniolosa manmina	**Clupeidae**					+
Gudusia chapra	**Clupeidae**			+	+	+
Heteropneustes fossilis	**Heteropneustidae**	+		+		+
Hypophthalmichthys molitrix	**Cyprinidae**		+	+	+	
H. nobilis	**Cyprinidae**		+			
Ilisha motius	**Clupeidae**					+
Labeo bata	**Cyprinidae**		+	+	+	+
L. boggut	**Cyprinidae**					+
L. calbasu	**Cyprinidae**	+	+	+	+	+
L. dero	**Cyprinidae**	+	+			
L. dyocheilus	**Cyprinidae**	+	+			
L. fimbriatus	**Cyprinidae**					+
L. gonius	**Cyprinidae**		+			+
L. rohita	**Cyprinidae**	+	+	+	+	+
Lepidocephalus annandalei	**Cobitidae**	+				
L. caudofurcatus	**Cobitidae**	+				
L. guntea	**Cobitidae**	+				
Macrognathus aculeatus	**Mastacembelidae**					+
Mastacembelus armatus	**Mastacembelidae**	+		+	+	+
M. pancalus	**Mastacembelidae**	+		+	+	+
Monopterus cuchia	**Synbranchidae**	+				+
Mystus bleekeri	**Bagridae**	+				
M. cavasius	**Bagridae**			+	+	
M. tengara	**Bagridae**			+		+
M. vittatus	**Bagridae**	+		+	+	
Mugil carsula	**Aruari**			+	+	
Nandus nandus	**Nandidae**	+		+		+
Nemacheilus botia	**Balitoridae**	+			+	
N. corica	**Balitoridae**	+				
N. doonensis	**Balitoridae**	+				
N. gangeticus	**Balitoridae**	+				
N. montanus	**Balitoridae**	+				
N. punjabensis	**Balitoridae**	+				
N. rupicola	**Balitoridae**	+				
N. submontanous	**Balitoridae**	+				
Notopterus chitala	**Notopteridae**			+	+	+
N. notopterus	**Notopteridae**			+	+	+
Ompok bimaculatus	**Siluridae**			+	+	+
O. pabda	**Siluridae**	+		+	+	
Ophiocephalus punctatus	**Channidae**	+				
O. mossambicus	**Cichlidae**					+
Osphronemus goramy	**Osphronemidae**	+				
Osteobrama cotio cotio	**Cyprinidae**					+
Oxygaster bacaila	**Cyprinidae**			+	+	+
Pangasius pangasius	**Pangasiidae**			+	+	+

Species	Families	YR_1	YR_2	YR_3	YR_4	YR_5
Parambassis ranga	**Ambassidae**					+
Porliuciosoma daniconius	**Cyprinidae**	+				
Pseudecheneis sulcatus	**Sisoridae**	+				
Pseudeutropius atherinoides	**Schilbeidae**	+				
Puntius carletoni	**Cyprinidae**	+				
P. chelynoides	**Cyprinidae**	+				
P. chola	**Cyprinidae**	+				+
P. conchonius	**Cyprinidae**	+				
P. sarana sarana	**Cyprinidae**	+		+	+	+
P. sophore	**Cyprinidae**	+		+	+	+
P. ticto ticto	**Cyprinidae**	+		+	+	+
Raiamas bola	**Cyprinidae**	+				
Rasbora daniconius	**Cyprinidae**	+		+	+	+
Rhinomugil corsula	**Mugilidae**					+
Rita rita	**Bagridae**			+	+	+
Salmo gairdneri gairdneri	**Salmonidae**	+				
S. trutta fario	**Salmonidae**	+				
Salmostoma bacaila	**Cyprinidae**					+
Sciaena coitor	**Cyprinidae**					+
Setipinna phasa	**Engraulidae**				+	+
Schizothorax progastus	**Cyprinidae**	+				
S. richardsonii	**Cyprinidae**	+	+			
Sillaginopsis panijus	**Sillaginidae**				+	
Silonia silondia	**Pangasiidae**			+	+	+
Sisor rabdophorus	**Sisoridae**			+	+	
Sperata aor	**Bagridae**	+	+	+	+	+
S. seenghala	**Bagridae**	+	+	+	+	+
Tenulosa ilisha	**Clupeidae**				+	
Tetraodon cutcutia	**Tetraodontidae**			+	+	+
Tor sp.	**Cyprinidae**		+			
T. chelynodies	**Cyprinidae**	+				
T. chilinoides	**Cyprinidae**	+				
T. putitora	**Cyprinidae**	+	+			
T. tor	**Cyprinidae**	+				
Wallago attu	**Siluridae**	+	+	+	+	+
Xenentodon cancila	**Belonidae**	+		+	+	+

Grover and Gupta (1977); Mishra and Moza (1997); Mishra and Moza (1998); Mishra and Moza (2001); Moza and Mishra (2001); Uniyal (2009); Uniyal and Mehta (2007)