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Floral and Faunal Diversity in Lower Ganga

Farakka to Gangasagar

GRB EMP : Ganga River Basin Environment Management Plan

by

Indian Institutes of Technology















IIT Bombay

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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: Environment Management Plan (GRB EMP).

A Consortium of 7 Indian Institute of Technology (IIT) has been given the responsibility of preparing Ganga River Basin Environment Management Plan (GRB EMP) 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: Environment Management Plan (GRB EMP). 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 GRB EMP. 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

The river Ganga comprises a lotic water series, which originates at Gaumukh and flows down to Gangasagar traversing a distance of 2525 km. During its course through eleven states, the river receives numerous tributaries (with characteristic quality, pollution load and biota) including Bhilangana, Alaknanda, Ram Ganga, Kali, Yamuna, Gomti, Ghagra, Gandak, and Kosi.

A thorough review of a large number of studies available in the form of student's project reports and theses, reports produced through sponsored, consultancy, investigatory and Environment Impact Assessment studies, published papers/articles in journals/ conference/ workshop/ symposia proceedings, books, news paper articles, etc. has led to collection of fragmented information on ecology and biodiversity in the Ganga Basin. The information is in different time domain and isolated stretches largely governed by the period of the study and the proximity of a river stretch/water body to the investigating institutions, organizations or individuals involved in the study. Due to lack of definitive bio-monitoring programme like river water quality monitoring programmes by the Central Pollution Control Boards, State Pollution Control Boards and National River Conservation Directorate, the analysis is based on extrapolation and interpolation of scattered, mostly qualitative data/information.

The entire stretch of the river Ganga (main stem) can be viewed into three segments:

- A. Upper Ganga ≈ 294 km Gaumukh to Haridwar
- B. Middle Ganga ≈ 1082 km Haridwar to Varanasi
- C. Lower Ganga ≈ 1134 km Varanasi to Ganga Sagar

(The Upper Ganga Segment for all practical purposes and studies carried out, starts at Gangotri as the terrain between Gaumukh to Gangotri is essentially devoid of biota due to hostile conditions)

These three segments not only differ in their geomorphology, ecology and rheology but are different in terms of issues that need to be addressed (refer report 001_GBP_IIT_GEN_DAT_01_Ver 1_Dec 2010). Considering this, floral and faunal diversity of the main stem of Ganga is reported in a series of four reports. This report covers the estuarine zone of lower Ganga stretch from Farakka to Gangasagar (LG-B). The lower Ganga comprises of a fresh water zone (Varanasi to Farakka) 701 km (LG-A) and estuarine zone (Farakka to Gangasagar) 286 km (LG-B). The LG-B zone spreads through a state viz. West Bengal.

Ganga is about 2525 km long and its basin is 861404 km², draining about one fourth area of the country. The river system covers cool upland streams and warm water stretches, including deltaic habitats. It has an annual runoff of about 493 km³ and carries approximately 616 x 10^6 tons of suspended solids to the Hooghly estuary. Downstream the river becomes wider and shallower. This is the "depositional zone" where conditions allow particles to sediment out to produce the typical lowland river forms.

River Ganga bifurcates near Farakka into a major offshoot Padma, which flows further eastwards to Bangladesh and a minor offshoot Bhagirathi which flows southwards to Bay of Bengal through deltaic region of west Bengal. Below the confluence of river jalangi with Bhagirathi, the river flows under the name of Hooghly, through Kolkata and Diamond Harbor and finally reaches its destination (Bay of Bengal). During the course of its 286 km run from Farakka to sea face, the Bhagirathi-Hooghly river system receives water from some of its tributaries and begin to spread into many small distributaries, forming the great Gangetic Delta. The tidal Hooghly estuary lies between the latitude 21°31'N and 23°30'N and longitude 87°45'E and 88°45'E and covers the districts of Nadia, Hooghly, North and South 24 Parganas, Howrah and Medinipur in West Bengal. In lower reaches it is joined by several tributaries like Ajay, Damodar, Roopnarayan and Haldi. Before meeting Bay of Bengal the estuary bifurcates near Sagar Island into main estuary Hooghly and river Muri Ganga which has got connection with river Thakuran and river Matlah, forming the Sundarban estuarine complex. The river Matlah flows in almost in the centre of the system. Since the river has lost its main freshwater connection, it has become practically a backwater for major part of the year. The estuarine complex which is a culmination of the interaction of land, sea and freshwater offers diverse specialized habitats such as mangroves, non-vegetated mudflats, intertidal zones, reclaimed areas etc.

The Hooghly-Matlah estuarine system is the largest among the estuaries of Indian coast and is characterized by mixing of freshwater and regular tidal influxes which create a steady gradient of marine to freshwater conditions. It extends for 300 km from North to South and 150 km from East to West. The entire estuarine system is estimated to be about 8029 km² and the total area of Sundarbans estuarine water is about 2340 km² (in India). The entire estuary is a tide dominated delta, which has a funnel shape. Tides facilitate transportation of sediments, replenishment of nutrients, flushing out of wastes and mixing of fresh and salt waters. The tides are semidiurnal with two high tides and two low tides in a day. The tides are unequal, varying in time and range depending on the location in the estuary. The estuary is characterised by strong tides with meso-macrotidal amplitude (5 to 7 m amplitude) during summer season from February to May and during pre-winter season, relatively weaker tides during the winter months. This corresponds to the rising of mean sea level at the Hooghly mouth in February, reaching a peak by September and falling down by winter months. The tides create an important intertidal zone, which harbour characteristic biota. Tides have strong influence on water quality parameters. In addition to tides, water movement is caused by surface and bottom currents. The latter carry plankton upstream and also maintain salinity gradients. Mean current velocities are between 108 and 117 cm s⁻¹ during low and high tide. The salt front rarely penetrates beyond Diamond Harbor, which is 80 km from the mouth of the Hooghly estuary. The circulation of water is important in maintaining populations of sessile and sedentary benthic organisms, majority of which have planktonic dispersal stages. Tides also help in transporting some of the euryhaline marine organisms from the sea to the estuary. The main river and its tributaries carry huge amount of sediments from the alluvial plains of northern India and also from Himalaya during monsoon which gets deposited throughout their course and their continuous upheavel from coastal areas through flood tides, keep the entire estuary very turbid. Coarser sand particles get deposited quickly in upper reaches of the riverine courses, the finer silt particles in the form of suspenoids, alongwith highly enriched detritus reach the deltaic region and settle gradually in the lower parts. This forms huge deltaic mudflats of Sundarbans.



Figure 1: The lower Ganga (LG-B) basin with zone I - zone IV

1.1. Climate

Climate in the region is characterized by the southwest monsoon (June-September), northeast monsoon or post-monsoon (October-January), and pre-monsoon (February-May); 70-80% of annual rainfall occurs during the summer monsoon (southwest monsoon), resulting in high river discharge (2952 and 11897 $m^3 s^{-1}$), which gradually diminishes to 900-1500 $m^3 s^{-1}$ during non-monsoonal months (Mukhopadhyay *et al.* 2006). Average air temperatures are 30.7±1.5°C in the pre-summer monsoon period and 21.5±4.6°C in the post-monsoon period.

The distributional pattern of both salinity and biota clearly demarcated the different stretches of the estuary. Stretch I and II with almost negligible or slight level of salinity is classified as freshwater and nearly freshwater zone. The wide fluctuation of salinity levels in Stretch III exhibited considerable alteration of the natural system of true estuarine gradient

zone. The constant high salinity levels and lesser fluctuations confirmed the almost marine nature of Stretch IV (Figure 1).

Stretch I (Zone I- Freshwater): Farakka to Nabadwip (24°48'13.79" N to 23°24'27.59"N, 87°55'58.99" E to 88°22'39.09" E)

The water temperature generally varies between $18.5-31.0^{\circ}$ C. The highest transparency values are found in this zone (~ 9.5-93.0 cm). The pH value varies between 7.3-8.8. Lowest salinity values were recorded from this zone (~ 0.02-0.06 g/l). Gross primary productivity ranges between $33.3-142.0 \text{ (mgC/m}^3/\text{hr})$.

The bottom sediment of this stretch consists approximately of equal amount of sand and silt.

Stretch II (Zone II- Nearly Freshwater): Nabadwip to Konnagar (23°24'27.59"N to 22°42'45.66"N, 88°22'39.09"E to 88°20'51"E)

The water temperature generally varies between 18.5-32.0°C. The transparency values found in this zone varies ~ 8.0-30.0 cm. The pH value varies between 7.4-8.4. Salinity values were less in this zone (~ 0.04-2.86 g/l). Gross primary productivity ranges between ~ 50.0-93.7 (mgC/m³/hr).

The bottom sediment of this stretch consists of sand, clay and silt with higher percentage of silt followed by sand.

Stretch III (Zone III- Estuarine): Konnagar to Diamond Harbour (22 42'45.66" N to 22 11'27.11" N, 88° 20' 51" E to 88°11'22.67"E)

The water temperature generally varies between $18.0-32.0^{\circ}$ C. This zone exhibits comparatively lower transparency values almost throughout the year. The pH value fluctuated around 8.1 ± 2.0 . Maximum variation in salinity values were observed in this zone (~ 0.07-18.98 g/l). Lowest gross primary productivity was between ~ $20 - 40 \text{ mgC/m}^3/\text{hr}$.

The bottom sediment is basically silty.

Stretch IV (Zone IV- Marine): Diamond Harbour to the mouth of the river covering whole Sundarbans. (22°11'27.11" N to 21°33'23.55"N, 88°11'22.67"E to 88°32'32.47"E)

The water temperature generally varies between $18.6-30.4^{\circ}$ C. This zone exhibits comparatively high transparency values almost throughout the year (~ 10.0 - 60.0 cm). The pH value fluctuated between 7.6 to 8.3. Maximum salinity was observed in this zone (~ 6.06-30.70 g/l). Gross primary productivity was found to be in between ~ 35.0-137.5 mgC/m³/hr). The bottom sediment of stretch IV is basically clayey with small amount of sand. Some sandy flats are also observed near the mouth of the estuary.

2. Biological profile of Lower Ganga Basin

The biodiversity of the lower Ganga Basin is largely controlled by freshwater flux, nutrient inputs and changing environmental condition like salinity, rainfall and temperature. Salinity

is the most important chemical factor which affects the diversity and abundance of the biota of this basin directly. Because of the different physiological adaptability of different species of animals and plants to salinity ranges, specific biotic communities colonize different stretch of the basin depending upon the prevailing level of salinity and the tolerance limits of individuals in the community.

Depending on the different groups of animals and plants found in the basin, the diversity can be differentiated between Phytoplankton, Zooplankton, Macrobenthos, Nekton, Macrofauna and Angiosperms (Figure 2).



Figure 2: The Biodiversity of lower Ganga Basin (As per this study)

2.1. Phytoplankton

Phytoplankton communities are key to primary production and resulting flow of energy along the trophic levels. Phytoplankton is a good indicator of trophic states and every change in the environment affects this community. Many species of this community are very sensitive and respond to changes quickly (Manna *et al.* 2010). The most important elements for phytoplankton growth are nitrogen (N) and phosphorus (P). While the growth of phytoplankton cells in freshwater system is limited by P, growth in estuarine and marine environments is commonly N limited. Diurnal variations of phytoplankton and ancillary parameters follow the semi-diurnal tidal pattern. Abundance of phytoplankton was higher during high tide compared with low tide.

Various published reports on phytoplankton distribution in the lower Ganga basin (LG-B) provide only a patchy picture as they are usually based on short term surveys of small areas in the ecoregion. Compilation of various studies reveals a total of 641 algal species under

169 genera from lower Ganga basin (ZSI and WWF, 2011). From an inter-annual perspective, mean numerical abundance of phytoplankton was 3-fold higher in 2007 (Biswas *et al.* 2010) than 1990 (De *et al.* 1991) and 2000 (Biswas *et al.* 2004). Various species are found in all the stretches like *Aphanotheca microscopia, Calothrix bharadwajae, Chlorogloean fritschii, Gleocapsa crepidinum, G. pleurocapsoides, Microcystis bengalensis, M. elongata, Phormidium rotunda* and *Raphidiopsis curvata*.

The predominant species observed in the stretch IV during the monsoon included Coscinodiscus radiatus (17.11%), C. eccentricus (29.78%), C. lineatus (5.58%), and Rhizosolenia alata (3.9%) in 1990; Ceratium tripose (1.09%), Chaetoceros affinis (0.42%), C. eccentricus (14.22%), C. radiatus (14.75%), Pleurosigma elongatum (3.11%), Rhizosolenia alata (1.29%), R. styliformes (5.27%), and Skeletonema costatum (5.92%) in 2000; and Coscinodiscus radiatus (3.18%) and Skeletonema costatum (61.69%) in 2007. Sarkar (2010) reported for the first time, the occurrence of green benthic algae *Codium taitense* from the Indian Sundarbans. In general, Cyanophycean community with species of Oscillatoria, Lyngbya, Phormidium and Microcoleus occurs on bare mud flats and muddy soil between phanerogams. The pneumatophores of mangrove plants are covered with a number of blue green algae viz., species of Calothrix, Anabaena, Lyngbya, Hydrocoleum, along with some red algae viz., Caloglossa, Catenella and Bostrychia. Several epiphytic blue-green algae like Dermocarpa, Xenococcus, Chaemosiphon are also recorded. The planktonic blue green forms are dominated by species of Trichodesmium, Synechococcus, Apanothece, Gloeocapsa, Gloeothece, Merismopedia, Oscillatoria, Fohannesbaptistia and Microcystis. These planktonic species presumably contribute very much to primary production of the estuary. In partly reclaimed areas, the water-logged rice fields or brackishwater fish tanks are also colonised by a number of cyanophycean algal forms viz., species of Aulosira, Spirulina, Arthrospira, Gloeotrichia, Calothrix, Nostoc, Anabeana, Oscillatoria, Aphanocapsa, Myxosarcina, Crinalium, Polyclamydum, Lyngbya, Rhaphidiopsis and Microchaete etc., along with some salt tolerant green algae like Enteromorpha and Ulva. These forms provide a significant contribution to the soil fertility and nutrient balance in the wet land eco-system. Studies on the phytoplankton of the lower Ganga basin suggest that Cyanophyceae constitute the most important and dominant algae in freshwater, estuarine and marine habitats, whereas desmids and other green algae are important in freshwater and brackishwater habitats and the diatoms are found to prefer brakish and marine water zone.

A compendium of algal species stretch wise is given in Appendix I. Distribution of phytoplankton in different stretches is given in Figure 3. The presence and preponderance of important groups of algae stretch wise is given in Table 1.

Group	Number of taxa	Species in different stretches							
			II		IV				
Cyanophyceae	280	70	124	115	192				
Chlorophyceae	206	13	34	62	156				
Bacillariophyceae	115	0	0	86	105				
Dinophyceae	14	0	0	7	14				
Xanthophyceae	4	1	0	2	2				
Rhodophyceae	17	0	0	6	14				
Euglenophyceae	3	1	1	1	2				
Phaeophyceae	2	0	0	0	2				



The distribution of algae can be represented as:

Cyanophyceae (280 taxa) > Chlorophyceae (206 taxa) > Bacillariophyceae (115 taxa) > Rhodophyceae (17 taxa) > Dinophyceae (14 taxa) > Xanthophyceae (4 taxa) > Euglenophyceae (3 taxa) > Phaeophyceae (2 taxa)

The total data indicates that the dominant algae in lower Ganga is Cyanophyceae followed by Chlorophyceae. Bacillariophyceae are rare in fresh water zone but are represented by good numbers in the marine zone.

All the data tends to indicate that blue green algae dominates in the entire lower Ganga (LG-B).



Figure 3: Distribution of phytoplanktons in different stretches

A large number of plankton in the classes Cyanaophyceae, Chlorophyceae and Bacillariophyceae are specific to each stretch as depicted in the Table 2 below and in Figure 3.

Classes	I	II	III	IV
Cyanophyceae	10	19	18	59
Bacillariophyceae	-	-	11	30
Chlorophyceae	6	6	21	114
Dinophyceae	-	-	-	7
Rhodophyceae	-	-	3	11
Xanthophyceae	-	-	2	1
Phaeophyceae	-	-	-	2
Euglenophyceae	-	-	-	1
Total	16	25	55	225

 Table 2:
 Distribution of the algal taxa specific to the particular stretch

Most algae are found to show substratum preferences. The blue green algae are noted to prefer a soft, hydrophilic, biologically active mud, rich in organic matter; whereas, the green algae prefer a more consolidated type of soil rich in nutrients. Similarly, the red and brown algal groups seem to prefer hard consolidated soil in supra littoral zones or peripheral zones which are regularly inundated. Some common species are shown in Plate 1.



Plate 1: Common species of algae

The phytoplankton as a group have immense contribution towards the natural environment that they inhabit. They are most important contributors as the primary producer group, which sustains the total ecosystem at large and takes care of the diverse consumer groups. The most algal productions enter the food web through detrital pathways. Maity *et al.* (1987) have highlighted the importance of algalization in effectively altering the physicochemical status of soil, mainly increased salinity. The algae, as such, play important ecological role as pollution remediators, bio-fertilizers, bio-indicators and also associated in the process of soil reclamation.

2.2. Zooplankton

Most of the zooplankton studies are centered on Hooghly estuary. Studies on zooplankton communities from the upper stretches are very few. The zooplankton communities in lower Ganga basin are represented by members of Cnidaria, Rotifera, Chaetognatha, Copepod and larval forms of Decapods and Cyclopods. Along with phytoplankton, they also form a major part of the trophic states. A compendium of zooplankton is attached in Appendix II.

Cnidaria

Out of 25 species reported from lower Ganga basin, 22 species have been reported from stretch IV only like *Bougainvillia fulva, Obelia* sp., *Octaphialucium indicum, Liriope tetraphylla, Edwardsia jonesii*. While *Blackfordia virginica* and *Moerisia gangetica* have been observed only from stretch III and *Eirene menoni* has been reported both from Stretch III and IV citing the adaptability of the species to both marine and estuarine conditions. *Limnocnida indica* is the only species from stretch II. Cnidarians have been found to be totally absent from the true freshwater stretch i.e. Farakka to Nabadwip. The distribution of Cnidarian genera and species are shown in Figure 4.



Figure 4: Distribution of Cnidarians across different stretches

Chaetognatha

Chaetognaths, popularly known as Arrow worms or Glass worms form one of the important constituents of zooplankton which play an important role in the food cycle. Moreover, they act as good indicator organisms for the origin of water masses and their movement in the sea. Marine Chaetognaths have received more attention as most of the species inhabit in neritic and oceanic waters. Only some species under two genera, namely, *Sagitta* and *Krohnnitta* are reported from the Hooghly-Matlah estuary by Baidya and Choudhury (1984) and Sarkar *et al.* (1984; 1985). Out of the four species *Sagitta bedoti* is found in abundance followed by *Sagitta enflata*. Both these species along with *S. pulchra* are euryhaline species. *S. pulchra* can withstand high salinity (18-25%) and during low salinity periods their occurrence is noted near the mouth of Moori Ganga and Saptamukhi rivers near the Hooghly estuary and Jharkhali onwards in Matlah river. The common Chaetognatha are shown in Plate 2.



Plate 2: Common Chaetognaths of lower Ganga

Rotifera

The data reported for wheel animicules reveals the presence of 101 species under 29 genus and 16 families. The family Brachionidae (22 species), Colurellidae (14 species) and Lacanidae (41 species) constitute the large group. The genus *Brachionus, Lecane, Lapadale, Keratella* and *Filinia* are the most common. In the stretch IV *Asplancha* sp. and *Brachionus* sp. are mainly represented.

Copepoda

The importance of the copepods in the trophic dynamics is well known as they constitute nearly two third of the total zooplankton number and biomass throughout the year. They form the food of both larvae and adults of many commercially important fishes whose abundance in a particular area has been directly related to the availability of either a particular species or assemblage of few copepod species. The abundance of most of the species of Copepods is related to salinity. Pseudodiaptomidae and Acartiidae can tolerate wide range of salinity whereas; Diaptomids are generally intolerant to higher levels.

Copepods constitute more than 80% of the zooplankton population in these waters followed by Chaetognaths and Mysids. Copepod genera are mostly dominated by *Acartiella, Labidocera* and *Pseudodiaptomus* in the last stretch (WWF, 2011). Species like *Heliodiaptomus viduus* have been reported from all the stretches. *Microcyclops varicans, Paracyclops fimbriatus, Tropocyclops prascinus* and *Tropodiaptomus australis* have been observed exclusively in stretch III and *Phyllodiaptomus blanci* and *Neodiaaptomus schmackeri* have been reported from lower Ganga basin with the largest number reported from stretch IV. The common Copepods of lower Ganga (LG-B) are shown in Plate 3.



Plate 3: Common Copepods of lower Ganga (LG-B)

Cladocerans

Cladocerans along with copepods constitutes the important group of zooplankton. Cladocerans are represented by 53 species under 25 genera and 7 families. Cladocerans are conspicuous by their absence in the fresh water zone. Maximum species has been recorded in the eustarine zone and is represented by family Chydoridae genus *Alona, Kurzia, Ceriodaphnia, Daphnia* and *Simocephalus*. The stretch wise distribution of Cladocerans is 28 in Zone II; 46 in Zone III and 24 in Zone IV.

2.3. Macrobenthos

Annelida

Annelids constitute one of the largest important macrobenthic fauna. The majority of annelids are benthic, only a few are pelagic. Benthic annelids prefer sandy or muddy substrata extending from the sea shore to the greatest depths of tidal zones; some are ever found in rocks and crevices. As many of these worms are sedentary in nature and very specific in terms of different environmental parameters, they are used as bio-indicators in environmental monitoring particularly in case of estuaries. Most of the annelids are very small in size, are in diet of many demersal fishes and considered as an important link in marine and estuarine food webs. The variety and abundance of species present can often be used as an indication of the cleanliness of the environment in which they live.

A total of 90 species under 66 genera have been reported of which 48 species of Polychaetes, 35 species of Oligochaetes and 7 species of Hirudinia are found. Stretch IV recorded highest number of species i.e. 60 number of species followed by 59 number of species in stretch III; 27 in stretch II and 19 in stretch I. Species like *Gattyana fauveli, Eteone barantollae, Ceratonereis burmensis, Dendroneries dayi, Marphysa mossambica* and *Pontodrilus bermudensis* have been reported exclusively from the Stretch IV. There is a high diversity of polychaete species towards the mouth of the estuary. The fluctuations of salinity in estuary compel the colonization of annelids with such severe problems that a decrease in species number with increased distance from the sea is almost a certainty. *Haemadipsa sylvestris, Hemiclepsis marginata, Lampito mauritti* among the Oligochaetes and Clitellates are freshwater forms reported mostly from stretch I and II. Species like *Eutyphoeus orientali,* has been observed in all the stretches. Distribution of Annelids across different stretches are shown in Figure 5.



Figure 5: Distribution of Annelids across different stretches

Arthropoda

The group Arthropoda is a major group under benthic fauna. It consists of Crustaceans, Spiders, Ticks, Mites and Insects. Spiders are among the oldest and most diverse groups of terrestrial organisms. They are the dominant predators of insects. Spiders are an integral part of diversity since they play important roles in ecosystems as predators and sources of food for other creatures. The mites especially the soil inhabiting forms are of great ecological importance. They constitute an integral part of ecosystem as pest, predator, and decomposer and an active constituent of nutrient cycling in the ecological system. Insect herbivores can cause changes in nutrient cycles and nutrient availability in soils: deposit significant quantities of fecal material onto litter and soil. Insects are important components of several biogeochemical cycles as well as mediators of energy transformation. They also play an important role in the carbon cycle by playing the role of decomposers. Insects are among the groups of organisms most likely to be affected by climate change because climate has a strong direct effect on their development, reproduction and survival.

A total of 476 species of Arthropods have been reported of which 240 species of Crustaceans, 33 species of Arachnids, 201 species of insects and 2 species of Merostomata (Gopal and Chauhan, 2006). The distribution of Arthropods excluding insects are shown in Figure 6. The common Arthropods of lower Ganga (LG-B) are shown in Plate 4. Appendix III provides a list of 115 taxa of Arthropods commonly found in lower Ganga.



Figure 6: The distribution of Arthropods excluding insects in lower Ganga basin



Plate 4: Some important Arthropods in lower Ganga

Mollusca

Molluscs are the largest group of animal kingdom after insecta, highly adaptive and occupy all possible habitats except aerial. Molluscs have an important role in the ecosystems by drawing a small amount of calcium from the environment and releasing more into it. The estuarine molluscs play important role in formation of organic detritus in the estuaries. Molluscs are characterized by low mobility, small populations, patchy and isolated distributions. They are very sensitive to environmental changes, hence, are used as effective bio-indicators. Recently 25 species in India (10 under Schedule I and 15 under Schedule IV) of molluscs have been included in Wildlife Protection Act, 1972. *Windowpane oyster, Placuna placenta* which is also found in Sundarbans is banned under Schedule IV. The macrobenthic molluscs can be broadly grouped under three categories (i) those living attached to stems, pneumatophores and leaves of living plants (arboreal) (ii) those living attached to or in the crevices of dykes, bricks, wooden pillars, jetties etc., and (iii) those living in the muddy substratum, either moving freely on it (epifauna) or burrowing into it (infauna). A few of the molluscan species may have overlapping habitats.

A total of 68 species have been reported from the lower Ganga basin. Distribution of Molluscs in different zones are given in Table 3. Stretch IV has the highest diversity with a total of 60 species, of which 32 species are Gastropods; Bivalves are represented by 22

species, Cephalopoda by 5 species and Scaphopoda by a single species. In stretch I no species of Gastropods and 4 species of Bivalves have been reported of which species like Lamellidens marginalis and Parreysia corrugata have wider distribution in all the stretches (Figure 7). No single species have been observed which is confined to stretch I. Species like Bellamya dissimilis, Bellamya crassa, Parreysia favidens and Thiara lineatus have been reported only from Stretch II. Species like Natica (Dostia) violacea, has shown truly estuarine characteristics and are confined to stretch III whereas rest of the species found in Stretch III have overlapping distribution in either stretch II or IV. Species like Amalda ampla, Assiminea beddomeana, A. woodmasoniana, Asthenotoma vertebrata, Cassidula nucleus, Cerithidea alata, Clithon reticularis, Cuspidaria chilkaensis, Iravadia ornate, Natica qualteriana, N. smithi, Olivancillaria qibbosa, Pitar alabastrum, Polinices didyma, Potamacmaea fluviatilis, Pseudanachis duclosiana, Stenothyra blanfordiana, Terebra tenera, Thais blanfordi, T. lacera, Tubiola microscopic, Umbonium vestiarum, Barnea candida, Corbicula gracilis, Glauconome sculpta, Laternula truncate, Mactra luzonica, Martesia fragilis, Novaculina gangetica, Nucula (Nucula) mitralis, Paphia malabrica, Parreysia (Radiatula) occata, Solen brevis, Sphenia perversa, Theora opalina, Trachycardium asiaticum, Loligo duvanceli, L. investigatoris, Octopus macropus, Sepia aculeate, Sepiella inermis and Dentalium octangulatum have been reported only in stretch IV. The common Molluscs of lower Ganga (LG-B) are shown in Plate 5.

	Table3: Distribution of Molluscs- Stretch wise in lower Ganga basin									
	Gastropoda		Biv	alvia	Scaph	opoda	Cepha	lopoda	Тс	otal
	Genus	Species	Genus	Species	Genus	Species	Genus	Species	Genus	Species
Stretch I	-	-	2	4	-	-	-	-	2	4
Stretch II	5	8	4	7	-	-	-	-	9	15
Stretch III	10	12	4	6	-	-	-	-	14	18

1

1

4



Telescopium telescopium

22

Lamellidens corrianus

49

5

60

Plate 5: Some common Gastropods

Stretch IV

25

32

19



Figure7: Distribution of Molluscs across different zones

Echinodermata

Echinoderms are exclusively marine inhabitants with little or no osmoregulatory mechanism and with only limited tolerance to narrow ranges of salinity variations. Hence their occurrence in truly estuarine, brackish water or freshwater stretches is very rare.

A total of 17 species under 15 genera have been observed only from stretch IV. 4 species of Asteroids like *Luidia hardwicki, Astropecten euryacanthus, A. indicus* and *Goniopecten* sp., 4 species of Ophiuroides like *Amphioplus (Lymanella)* sp., *Ophiactis delagoa, O. modesta, Ophiocnemis marmorata* and 4 species of Holothuroides (*Acaudina molpadioides, Synaptula recta, Labidoplax* sp., *Thorsonia investigatoris*) and 5 species of Echinoidea (*Laganum decagonale, Echinodiscus auritus, Chaetodiadema granulatum, Clypeaster rarispinus* and *Temnopleurus toreumaticus*) have been reported. No echinoderm data have been found from rest of the stretches. Appendix III provides a list of macrobenthos in lower Ganga.



Luidia hardwicki

Sea Urchin



2.4. Fishes

Towards the end of 18th century, it was freshwater zone in Kolkata and except *Hilsa* all other freshwater species were available in plenty. It was around 1943, considerable changes in the fish composition were noticed and in 1953 mainly brackishwater fishery extended upto Barrackpore. Subsequently the deltaic tidal plain which covered Nabadwip to Diamond Harbour, besides its usual flow was influenced by tidal waters. In the 60's the catch was fairly high. The composition in the upper stretch was *Tenualosa ilisha*, freshwater prawn species, *Harpodon nehereus* etc. while in the lower region besides the above; some more forms like *Polynemus indica, Tachysurus jella, Pama pama* were dominating in commercial scale. Miscellaneous group formed an important rank in the catch and their landing exceeded the *Hilsa* fishery. With the coming up of numerous irrigation projects on the Ganga and its tributaries, the fishery in the main river has considerably dwindled in recent years while in the Bhagirathi-Hooghly, with the additional release of water from Farakka the condition became more grave.

In stretch I, 25 species of fish belonging to 16 different families have been identified. Majority of them are carnivorous fishes. The commercially important fish species, Catla catla, Labeo rohita, Cirrhinus mrigala, Labeo calbasu etc, are getting depleted in this region. In stretch II i.e., Nabadwip to Konnagar, the main fish fauna available are: Catla catla, Labeo rohita, Puntius ticto, Wallago attu, Mystus vittatus, M. aor, Rita rita, Eitropiichthys vacha, Mastacembelus pancalus, Tenulosa ilisha, Boleophthalmus slaucus, Cirrhinus mrigala, Gudusia Chapra and Xenentodon cancila, besides Macrobrachium rosenberghii and Penaid prawns. The fish landing of Hilsa ilisha showed that the river stretch between Kalyani to Tribeni in stretch II is a good catchment area for *Hilsa*, along with other migrant species like Pama pama, Sillago panijius, migrating within the gradient and low saline stretch. In Stretch IV, 176 taxa of fishes have been reported from the report of Gopal and Chauhan (2006) and Das (1999) which categorise in 22 taxa of Chondrichthyes and 154 taxa of Osteichthyes. The species richness and abundance decrease with increasing distance from the mangrove forest. Some species were found in higher numbers in the mangroves and others are more abundant over mudflat habitats. Among the fishes found in this stretch, the highly priced Hilsa (Tenulosa ilisha), Bhetki (Lates calcarifer), Bhangon (Liza tade), and Mullets (Liza parsia) form a lucrative fishery of this region. A detailed report on "Hilsa - An assessment in lower Ganga river basin, India" is given in a seprate report. Hooghly-Matlah estuary is known for its faunastic richness. The icthyean fauna is represented by 156 species in 119 genera and 67 families (CIFRI-Ghosh, A. 2008) and 13 species of cartillaginous fishes (Chardrichthyes) in nine families. The common esturine fishes of lower Ganga (LG-B) are shown in Plate 7.



Plate 7: Common fishes of estuarine region

The catch of purely marine forms and typically neritic species, such as *Liza parsia* among mullets, *Eleuthheronema tetradactylum* among polynemids, *Coilia* sp. among Anchovies, *Tenulosa toli* and *Ilisha elongata* among Clupeids and *Harpodon nehereus* and *Trichiurus* sp. among other groups, have shown a sharp decline or total absence in the upper estuary during the post-Farakka period. A few purely freshwater species (*Rita rita, Wallago attu, Mystus aor, Ailia coilia, Catla catla, Labeo rohita,* and *Labeo bata*) have made their appearance in the estuary and contributed notably to community structure. But these species are not reported in zone I. A significant decline in the availability of certain non-commercially important estuarine and marine species (*Chanos chanos* and *Plotosus* sp. etc.) was also observed. A list of 172 and 13 fishes in the lower Ganga is given in Appendices IV and V, respectively.

2.5. Higher Vertebrates

The higher aqatic vertebrates of Hooghly-Matlah estuary is represented by turtles, crocodiles, mammals, dolphin and porpoises. The turtle population is represented by *Batagur baska, Petochelys bibrone* and *Chelonia mydas* (endangered species) and marine turtles olive ridley turtle *Lepidochelys olivacea* and green turtle *Chelonia mydas, logger head Caretta caretta* and *Eretmochelys palustris*. Among other reptiles *Crocodylus palustris* (now extinct) and estuarine crocodile, *Crocodylus olivaceae* (in small numbers) have been reported. Among mammals dolphin and porpoise *Neophocaena phocaenoides* have been recorded. A list of higher vertebrates of lower Ganga is given in Appendix VI.

2.6. Angiosperms

More than 1175 plant species in 680 genera under 154 families has been identified by Naskar (1993) in the lower Ganga basin. 301 species are Moncotyledons under 149 genera and 30 families and 874 species of Dicotyledons under 531 genera and 124 families have been identified. The most dominant families having high number of species are Poaceae (128), Cyperaceae (62), Euphorbiaceae (47), Compositae (64), Papillionaceae (88), Malvaceae (31), Caesalpiniaceae (30), Rubiaceae (27), Convulvulaceae (26), and Acanthaceae (27) etc. A total of 296 species under 158 genera of aquatic, semi-aquatic and moist loving plants have been observed in lower Ganga basin. Some of the aquatic, indigenous plants species are: *Ranunculus sceleratus, Bergia capensis, Oxalis latifolia, Neptunia natans, Aldrovanda vesiculosa, Myriophyllum indicum, Rotala indica, Ipomoea carnea* etc. and some of the semi-aquatic plants are: *Pentapetes phoenicea, Hydrocera triflora, Ammannia baccifera, Ludwigia perennis* etc. Detailed distribution of Angiosperms has been included in the report on riparian vegetation. The report on mangroves give details of Sunderbans. The distribution of Angiosperms in lower Ganga are shown in Figure 8.



Figure 8: Distribution of angiosperms in lower Ganga

2.7. Scenario analysis

The Sundarbans has experienced a balanced growth of flora and fauna in association with the fresh water flow from the upper stream Ganges at the north and the salty water inflow from the Bay of Bengal at the southern border. But the balance is being threatened due to decreasing freshwater flow from upstream as a result of increasing siltation and unplanned construction of embankments along the river banks. As the salinity of the Sundarbans increases from west to east, density of vegetation growth and canopy closure decreases from east to west. Height and growth of different species in the Sundarbans are related with the salinity. Salinity in the Sundarbans is highly dependent on the volume of freshwater coming from the upstream. The variation is subject to the nature of tide in the area. Annual pattern of salinity changes inside the Sundarbans is also related with the changes of freshwater flow from upstream rivers.

Estuarine regions along riverine systems are highly influenced by freshwater discharge and marine water inflow where plankton abundance and species composition are characterized by a high degree of spatial and temporal variability. A variety of ecological processes regulate phytoplankton assemblages and abundances in natural systems. The Bhagirathi–Hooghly estuary is an important coastal region in the Indian subcontinentwhere the river Ganges (referred as Bhagirathi-Hooghly) gradually confluences with the Bay of Bengal. Due to the vastness of the area and theproximity of the Bay of Bengal, mixing is pronounced, based upon which the study area can be categorized as riverine, estuarine, and coastal stretches. Significant works on the nutrient and hydrobiological dynamics from this estuary are not very common. The analysis of environmental variables and plankton population from the surface waters of the study area indicates that a regular and recurrent pattern of variation in species assemblage was present with low inter annual variability.

The increased flushing of freshwater from the Farakka Barrage to Bhagirathi river and consequently river Hooghly has naturally resulted in major changes in the ecology and chemistry of this estuary. Concurrently, significant structural changes in fishery resources and fishing pattern has also emerged. The ecological changes due to opening of the Farakka

Barrage are reflected in the community composition of freshwater, marine and euryhaline forms of plankton.

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Appendix I

Species	I	Ш	ш	IV
Cyanophyceae				
Anabaena aginicola		+		+
A. ambigua		+		+
A. anomana	+			+
A. cercinalis		+		+
A. doliolum	+	+		+
A. fertilissima				+
A. fuellebornii		+	+	+
A. gelatinicola	+			+
A. iyengarii				+
A. hannae		+		
A. naviculoides			+	+
A. orientalis	+	+		
A. olzii				
A. oryzea		+		+
A. oscillarioides		+	+	+
A. sphaerica		+		+
A. spiroides				+
A. totulosa				+
A. utermohlii		+		
A. vaginicola forma				
fertilissima				+
A. variabilis				<u> </u>
Anabaenopsis arnoldii		+		+
banaresensis	+	+		+
A. biformis	+	+		+
A. grevillei		+		+
A. koorders		+	+	
A. littoralis		+	+	
A. montana	+		+	
A. pulchra	+		+	+
A. roeseana		+		+
A. thermalis	+		+	+
A. virescens				+
Aphanothece bullosa			+	
A. castagnei			+	

Distribution of phytoplankton in the lower stretch of Ganga river from Farakka to Gangasagar.

A. microscopia	+	+	+	+
A. naegelii	+		+	
A. pallida		+	+	+
A. stagnina		+	+	
Arthosporia gomotiana		+	+	+
A. jenneri		+		+
A. massartii		+		+
Arthrospira platensis				+
Aulosira aeniamatica	+	+		
A. fertilissima		+	+	+
A. fritschii				+
A. implexa	+			+
A prolifica	+			+
A pseudodarmosa				+
Calothrix bharadwaiae	+	+	+	+
C braunii	+	+	+	
C brevissima		+	+	
C. castellii		•		+
C. contarenii		_	_	
C. contarenni		T	- -	т
C. fusca				· -
C. glosci	т 		-	т
C. grioser	- T	-		
C. membrunuceu		т	-	
C. purietinu	+			+
C. thermans Camptylonemorpsis		+	+	+
lahorensis				+
Chamaesiphon				
curvatus		+	+	+
Chlorogloean fritschii	+	+	+	+
Chroococcus cohaerens		+	+	
C. minutes			+	+
C. pallidus			+	
Crinalium magnum	+	+		
cyiinarospermum alatosporium		+		+
C. cuvatum		†		+
C. dorvphorum		+		-
C indicum	+	+		+
	Т	Γ	I	

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C. licheniforme		+		+
C. majus			+	
C. michailoukoense			+	
C. muscicola			+	+
C. sphaerica		+		
C. stagnale		+		
Dermocarpa sp.		+	+	+
D. hemisphaerica				+
D. leibleiniae				+
D. sphaerica				+
Fischerella muscicola			+	+
Gloeocapsa aeruginosa				+
G. calcarea			+	+
G. crepidinum	+	+	+	+
G. decortican	+		+	
G. kuetzingiana			+	+
G. luteo-fusca	+			+
G. montana	+			+
G. pleurocapsoides	+	+	+	+
G. polydermatica	+			+
G. punctata				+
G. rupestris		+	+	+
Gleothece maxima	+			+
G. membranacea	+	+		+
G. rupestris		+	+	+
G. samoensis		+	+	+
Gloeotrichia echinulata		+	+	+
G. intermedia				+
G. natans	+			
G. raciborskii			+	+
G. pisum				
Hapalosiphon				
		+		
Homeothrix juliana	+		+	+
Hydrocoleum sp.				
H. lyngbyaceum			+	+
Johannesbaptistia sp.				
Katagnymene pelagica	+			
coerulae			+	
L. aestuarii		+		
L. agerheimii forma				
lacerata			+	

L. allorgei				+
L. birgei				+
L. ceylanica				+
L. confervoides	+			+
L. cryptovaginata			+	+
L. gracilis				+
L. hieronymusii				+
L. lachneri				+
L. largerheimii			+	
L. laxespiralis		+		+
L. lutea		+		+
L. magnifia		+		+
L. major				+
L. majuscula		+	+	+
L. martensiana			+	+
L. mesotricha				+
L. perelegems			+	+
L. rubida		+		
L. semiplana				+
L. sordida				+
L. spiralis	+	+		
L. pirulinoides	+	+		
L. stagnina	+	+		
Mastigocladus				
Mariamanadir. an		+	+	
Merismopedia sp.		+		+
			+	+
M. glauca		+		
Microchaete	+	+	+	
loktakensis			+	+
M. tenera		+	+	+
M. uberrima	+	+		+
Microcoleus sp.		+		
M. chthonoplastes	+			+
M. lacustris		+		
M. paludosus	+			
M. subtorulosus			+	+
M. vaginatus			+	
Microcystis aeruginosa			+	+
M. bengalensis	+	+	+	+
M. elongata	+	+	+	+

M. littoralis+++M. marginata+-+M. marginata+++M. pseudofilamentose-++M. pulvereaM. robusta+++M. viridis+Myxosarcina-++Spectabilis+++Nostoc calcicola-++N. comminutum-++N. depressum+++N. depressum+++N. hatei+++N. hatei+++N. hatei+++N. labatus+N. muscorum-++N. paludosum+++N. spongiaeforme-++N. spongiaeforme-++O. acuminata+++O. acuminata+++O. anguina+++O. animalis+++O. corallinae+++O. cordilinae+++O. cordilinae+++O. cordilinae+++O. cordilinae+++O. cordilinae+++O. cordilinae+++O. cordilinae+++ <tr <td="">+O. cordilinae</tr>	M. flos-aquae		+	+	+
M. marginata+I+M. pseudofilamentose++M. pulvereaIIM. robusta++M. viridisIIM. viridisI+M. viridisI+Myxosarcina++Spectabilis++Nostoc calcicolaI+N. comminutumIIN. commune++N. depressum++N. ellipsosporum++N. hatei++N. hatei++N. hatei++N. labatus+IN. nuscorumIIN. psicinale++N. psongiaeformeI+N. lobata+ID. acuminata++D. amphigranulata++D. annae++D. chilybea++D. chilybea++D. corollinae++D. corollinae	M. littoralis	+	+		+
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Oscillatoria acuta + - O. acuminata + + O. amaena + + O. amphigranulata + + O. amphigranulata + + O. amphigranulata + + O. amphibia + + O. anguina + + O. animalis + + O. animalis + + O. breis + + O. chalybea + + O. chilkensis + + O. corallinae + + O. cortiana + + O. cortiana + +	N. lobata			+	
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D. curviceps + +	O. cortiana				+
	O. curviceps		+		+

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O. imguu	Ŧ			
0. jasorvensis				+
<u>O. Ilmosa</u>			+	+
O. margaritifera			+	+
O. mougeotii				+
O. nigroviridis			+	+
O. obscura	+	<u> </u>		+
O. okeni			+	+
O. princeps				+
O. proboscidea			+	+
O. prolifica			+	
O. proteus	+	+		+
O. rooi	+			+
O. scanta				+
O. schultzii		+	+	
O. simplicissima			+	+
O. splendida			+	+
O. subbrevis			+	
O. tenuis		+		
O. terebriformis				+
Phormidium				
angustissimum				+
P. ambiguum		+		+
P. anomala			+	
P. bohneri			+	
P. corium	+		+	+
P. faosum		+		+
P. fragile	+	+	+	
P. jadinianum	+	+	+	
P. laminosum		+	+	+
P. molle	+	+		+
P. papyraceum		+	+	
P. purpurascens				+
P. retzii				+
P. rotanda	+	+	+	+
P. staanina		1		+
P. tenue	1	+		+
P ulderianum	+		+	+
Plectonema	† -	-	<u> </u>	<u> </u>
nostocorum	+	+		
P. notatum				+

O. earlei

<u>Report Code</u>	027_6	BP_IIT	_ENB_	DAT_	04_	Ver_	Jun 2	012

P. tomasinianum				+
Porphyrosiphon				
nostarisii	+			
Pseudanabaena sp.		+		+
P. schidlei				+
Raphidiopsis curvata	+	+	+	+
R. indica				
Schizothrix arenaria				+
S. calcicola		+	+	
S. friesii				+
S. lacutris		+	+	+
S. lamyii		+		+
S. muelleri	+			
S. penicillata		+		+
S. rubella	+			+
S. tamyl	+			
S. telephoroides				+
Scvtonema bohneri		+		
S. burmanicum				+
S. caldarium		+		+
S ciricinnatum				+
S. coactile		+		
S. fermuii		<u> </u>	+	+
S. fritschii		+		
S auvanense		+		
S. hofmanni		+		+
<u>S</u> iavanicum		· ·	+	
S. Jentohasis		+	_	
S. reptobusis		-	т	
S. myocinous				+
S. scimilar		+		+
S. simplex		+		
S. stuposum				+
S. tolypothricholdes		+		
labyrinthiformis		+		
S. major		+		+
S. meneghiniana				+
S. princeps			+	+
S. subalsa			+	+
S. subtilissima				+
Stichosiphon			1	
sansibaricus				+
Stigonema hormoides	+			

S. ocellatum			+	
Symploca muralis				+
Synechocystis aquatitis			+	+
Trichodesmium				
erytthraeum		+		
T. thiebauti	+		+	+
Wollea bharadwajae			+	
Xenococcus acervatus				+
X. chaetomorphae	+			+
X. cladophorae				+
Bacillariophyceae		1		
Achnanthes			.	
			+	+
A. minutissima			+	+
Amphiprora sp.			+	+
Amphora sp.			+	+
A. veneta				+
Anomoeoneis exilis				+
Asterionella formosa			+	
A. japonica			+	+
Asteromphalus flabollatus				
Bacillaria paradova				- -
Bacteriastrum				+
cosmosum				+
B. delicatulum				+
B. hyalinum			+	+
B. varians			+	+
Biddulphia heteroceros			+	+
B. longicruris			+	+
B. mobiliensis			+	+
B. pulchella			+	+
B. sinensis			+	+
Caloneis				
madraspatensis			+	+
Campylodiscus clypeus			+	+
Chaetoceros anheurckii			+	+
C. curvisetus			+	+
C. diversus			+	+
C. eibenii				+
C. flexuosus				+
C. indicus			+	+
C. laciniosus				+
C. lorenzianus			+	+
			•	

C. peruvianus		+	+
C. subsecundus		+	+
C. tenuissimus		+	+
Climacodium			
frauenfeldianum		+	+
elongata		+	+
Cocconeis placentula.		+	+
Corethron hystrix		+	+
C. inerme		+	+
Coscinodiscus			
asteromphalus		+	+
C. concinnus			+
C. eccentricus			+
C. gigas			+
C. granii			+
C. jonesianus		+	+
C. oculusiridis			+
C. perforatus			+
Cyclotella sp.		+	+
C. glomerata			+
C. striata			+
Cymbella chandolensis		+	+
C. ehrenbergii			+
Diatoma vulgare		+	+
Diploneis robustus			+
Ditylum brightwelli		+	+
D. sol		+	+
Eucampia balaustium		+	+
E. cornuta		+	+
E. zodiacus		+	+
Eunotia sp.		+	+
Fragilaria canica		+	+
F. vaucheriae		+	+
Frustulia sp.		+	+
Gomphonema			
sphaerophorum		+	+
Gyrosigma acuminatum		+	
G. alticum		+	+
Hemiaulus sp.		+	+
Hemidiscus cuneiformis		+	+
Isthmia enervis		+	+
Lauderia annulata		+	+

Leptocylindrus danicus	+	+
Lithodesmium		
undulatum	+	+
Melosira moniliformis		+
M. sol		+
M. sulcata		+
Navicula cryptocephala	+	
N. radiosa	+	+
N. similis	+	+
N. stauroptera	+	
N. viridis	+	
Nitzschia acicularis	+	+
N. closterium	+	+
N eriata	+	
N linearis	+	+
N. Iongissima	_	
N. obtusa	Ŧ	+
N. oblusu		+
N. pelagica	+	+
N. scalaris	+	
N. sigma	+	+
N. sublinearis	+	+
Paralia sp.	+	+
Pinnularia viridis		+
<i>Planktoniella</i> sp.	+	+
P. sol		+
Pleurosigma		
angulatum		+
P. elongatum	+	+
		-
P. normanii	+	+
P. normanii Rhizosolenia alata	+++	+ +
P. normanii Rhizosolenia alata R. imbricata	+ + +	+ + +
P. normanii Rhizosolenia alata R. imbricata R. robusta	+ + + +	+ + + +
P. normanii Rhizosolenia alata R. imbricata R. robusta R. setigera	+ + + + +	+ + + + +
P. normanii Rhizosolenia alata R. imbricata R. robusta R. setigera R. stolterfothii	+ + + + +	+ + + +
P. normanii Rhizosolenia alata R. imbricata R. robusta R. setigera R. stolterfothii Rhopalodia gibba	+ + + + + + + + +	+ + + + + +
P. normanii Rhizosolenia alata R. imbricata R. robusta R. setigera R. stolterfothii Rhopalodia gibba Skeletonema costatum	+ + + + + + + + + +	+ + + + +
P. normanii Rhizosolenia alata R. imbricata R. robusta R. setigera R. stolterfothii Rhopalodia gibba Skeletonema costatum Stauroneis	· + + + + + + + + + + + + + + + + + + +	+ + + + + +
P. normanii Rhizosolenia alata R. imbricata R. robusta R. setigera R. stolterfothii Rhopalodia gibba Skeletonema costatum Stauroneis phoenicenteron	· + + + + + + + + + + + + + + + + + + +	+ + + + + +
P. normaniiRhizosolenia alataR. imbricataR. robustaR. setigeraR. stolterfothiiRhopalodia gibbaSkeletonema costatumStauroneisphoenicenteronStephanopyxispalmeriana	· + + + + + + + + + + + + + + + + + + +	+ + + + + + + +
P. normanii Rhizosolenia alata R. imbricata R. robusta R. setigera R. stolterfothii Rhopalodia gibba Skeletonema costatum Stauroneis phoenicenteron Stephanopyxis palmeriana S. turris	· + + + + + + + + + + + + + + + + + + +	+ + + + + + + + + +
P. normaniiRhizosolenia alataR. imbricataR. robustaR. robustaR. setigeraR. stolterfothiiRhopalodia gibbaSkeletonema costatumStauroneisphoenicenteronStephanopyxispalmerianaS. turrisSurirella eximia	· + + + + + + + + + + + + + + + + + + +	+ + + + + + + + + + + +
P. normaniiRhizosolenia alataR. imbricataR. robustaR. robustaR. setigeraR. stolterfothiiRhopalodia gibbaSkeletonema costatumStauroneisphoenicenteronStephanopyxispalmerianaS. turrisSurirella eximiaSynedra ulna	· + + + + + + + + + + + + + + + + + + +	+ + + + + + + + + + + +

				1
Thalassiosira sp.			+	+
Thalassiosirs			Ι.	
			+	+
frauenfeldii			+	+
T. ongissima			+	+
Thalassionema				
nitzschioides			+	+
Triceratium elengans			+	+
T. favus				+
Tropidoneis elegans			+	+
Chlorophyceae			-	
<i>Bambusina</i> sp.				+
B. brebissonii				+
Boodleopsis				
sundarbanensis				+
Chaetomorpha aerea				+
C. brachygona				+
C. gracilis				+
Chara andalurensis	+			
C. braunii	+			
C. coralina				
C. erythrogyna			+	
C. fibrosa			+	
C. flaccidus			+	
C. globularis			+	+
C. hydropitys				+
C. setosa			+	
C. socotrensis			+	
C. zeylanica			+	+
Chlorella marina				+
C. salina				+
C. vulgaris				+
Cladophora echinus				+
Cladophorella				
sundarbanensis				+
Closterium abrupum		+		+
C. acerosum				+
C. acutum				+
C. baillyanum				+
C. calosporum	1	1	1	+
C. cynthia		+		+
C. ehvenberaii	+			
C. enus		+		
0. 01103	1	1	1	

	i i	1	1	l
C. lanceolatum				+
C. libellula				+
C. lineatum				+
C. moniliferum				+
C. moniliformis	+			+
C. parvulum				+
C. ralfsii				+
C. rectimarginatum		+		+
C. striolatum				+
C. ulna				+
Cosmarium amoenum	+			+
C. angulatum forma				
majoris				+
C. auriculatum	+			+
C. bipunctatum				+
C. connatum				+
C. cuneatum				+
C. ceylanicum				+
C. cyclicum				+
C. cylanicum				+
C. decoratum				+
C. depressum				+
C. formosulum				+
C. freemanii				+
C. geminatum		+		+
C. granatum		+		+
C. laeve		+		+
C. lundellii		+		+
C. margispinatum		+		+
C. obsolatum			+	
C. paucigranulatum				+
C. perforatum				+
C. phaseolus		+		
C. planogranatum				+
C. platydesminum				+
C. pseudoconnatum			+	+
C. pseudoretusum			+	
C. pseudopyramidatum				
Jorma minor				+
C. punctulatum			+	
C. quadrum				+
C. regenlii				+

C. speciosissimum		+	
C. speciosum			+
C. striolatum			+
C. subauriculatum			+
C. subtumidum			+
Desmidium coarctatum			+
D. grevilli		+	+
D. swarrzii			+
D. waetzii		+	
Dictyosphaerium			
pulchellum Enteromorpha			+
clathrata			+
E. compressa		+	+
E. intestinalis			+
E. prolifera		+	+
Euastrum			
acanthophorum			+
E. ansatum			+
E. coralloides			+
E. didelta			+
E. dubium		+	
E. elegans			+
E. gnathophorum			+
E. horikawae			+
E. longicolla			+
E. serratum			+
E. sinuosum			+
E. spinulosum	+		+
E. subhexalobum			+
Eudorina sp.			+
Franceia dorescheri			+
Gonatozygon sp.	+		
Heterosiphonia sp.			+
H. dendroidea			+
Hyalotheca dissiliens			+
Lola capillaries			+
L. implexa			+
L. tortuosa			+
Micrasterias alata			+
M. foliacea			+
M. mahabuleahwarensis			+
-			

M. rotata				+
Netrium digitus	+			+
Nitella acuminata				+
N. furcata			+	
N. gracillis			+	
N. hyaline	+		+	
N. mucronata			+	
N. polycarpa	+			+
N. tuberculata		+		+
Oedogonium				
undulatum				+
Onychonema leave				+
Pediastrum boryanum				+
P. uplex				+
P. simplex				+
P. tetras		+		
Phyllobium dimorphum				+
coroniferum				+
P. ehrenbergii		+	+	
P. eugeneum				+
P. irregulare				+
P. kayei				+
P. lagerheimii forma				
minor				+
P. nodosum			+	+
P. ovatum				+
P. subcoronulatum		+		
P. rabecula				+
P. trabecula				+
Radiococcus sp.				+
Rhizoclonium sp.			+	+
R. grande				+
R. hookeri				+
R. riparium			+	+
Scenedesmus bijuga				+
S. quadricauda				+
Sphaeroplea soleirolli				+
Spirogyra bellis		+	+	<u> </u>
S. brunna	+			<u> </u>
S. condensala		+	+	<u> </u>
S. corrugata		+	+	<u> </u>
S. crenulata		+	+	

S. daedalea		+	+	
S. dubia				+
S. elliptica		+	+	
S. farlowii		+	+	
S. gujaratensis	+	+		+
S. hunanensis		+	+	
S. irregularis				+
S. juergensii				+
S. kundaensis		+	+	
S. maxima			+	+
S. minor		+	+	
S. neglecta			+	
S. nitida			+	
S. porticalis		+	+	
S. rhizobrachialis		+	+	
S. setiformis		+	+	
S. ternata				+
Spirotaenia				
condensata				+
Spondylosium sp.				+
S. nitens			+	
S. planum				+
Staurastrum bellum		+	+	+
S. corniculatum				+
S. gladiosum				+
S. indentatum Jorma minus				+
S. longispinum			+	+
S. saltans				+
S. wildemanii				+
Stigeoclonium				
aestivale			+	+
S. curvirostrum		+		+
S. farclum			+	+
S. fasciculore			+	+
S. flagellifera			+	+
S. geraldii			+	+
S. indicum			+	+
S. longipilum			+	+
S. pachydermum			+	+
S. penicillatum		+		
S. pusillum			+	+
S. tenue			+	+

Tetradinium sp.			+	+
Triplastrum				
abbreviatum				+
T. simplex				+
Triploceras gracile				+
Ulothrix ariablis	+			
U. fimbriata	+			
U. munaliformis		+	+	
U. zonata			+	
<i>Ulva</i> sp.			+	+
U. fasciata				+
U. lactuca				+
U. lobata			+	+
U. patengensis				+
Uronema confervicola				+
Zygnema kiangsiense			+	
Z. majus			+	
Z. pectinatum			+	
Dinonhyceae	1	I		
Ceratium extensum			+	+
C furca			- -	
C. Juicu				+
C. inflatum			+	+
				+
C. teres				+
C. tripos			+	+
C. trichoceros				+
Dinophysis caudata			+	+
Noctiluca sp.			+	+
Peridinium brevipes				+
Protoperiainium crassines				+
P denressum			+	+
P ovatum				+
Pyrophacus				· · ·
horologicum				+
Xanthophyceae				
Trbonema				
bomybcinum	-	-	+	
Vaucheria sp.	 		+	
V. prescotti	<u> </u>	<u> </u>		+
V. sessilis	+			+
Rhodophyceae	1	1	1	
Bostrychia radicans				+

B. tenella		+
Caloglossa adnata	+	+
C. leprieurii		+
Catenella impudica		+
C. nipae	+	+
C. repens		+
Ceramium elegans	+	+
C. gracillimum	+	
Compsopogon lividus	+	
C. coeruleus	+	
Gelidium pusillum		+
Gelidiella acerosa		+

Polysiphonia denudata				+
P. mollis				+
Porphyra sp.				+
Pterosiphonia pinnata				+
Euglenophyceae				
Euglena viridis	+	+		
Phacus pleuronectes				+
P. triqueter			+	+
Phaeophyceae				
Colpomenia sinuosa				+
Dictyota ceylanica				+

Appendix II

Distribution of zooplankton in the lower stretch of Ganga River from Farakka to Gangasagar
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Species	I	П	ш	IV
Cnidarians				
Acromitus flagellatus				+
A. rabanchatu				+
Aequorea pensilis				+
Blackfordia virginica			+	
Bougainvillia fulva				+
Cassiopea andromeda				+
Diadumene schilleriana				+
Edwardsia tinctrix				+
E. jonesii				+
Eirene ceylonensis				+
E. menoni			+	+
Limnocnida indica		+		
Liriope tetraphylla				+
Moerisia gangetica			+	
Netrostoma typhlodendrium				+
Nevadne glauca				+
Obelia sp.				+
Paracondylactis indica				+
Pelocoetes exul				+
P. minima				+
Phytocoeteopsis ramunnii				+
Phytocoetes gangeticus				+
Pseudodiaptomus tollingerae				+
Tamoya gargantua				+
Versuriga anadyomene				+
Copepoda				
Family: Acartidae	-	-		
Acartia chilkaensis			+	
A. plumose			+	
Acartiella keralensis				+
A. major				+
A. minor				+
A. sewelli				+
A. tortanifoprmis				+
Family: Diaptomidae				
Heliodiaptomus cinctus	+	+		

H. contortus		+	+	+
H. viduus	+	+	+	+
Neodiaaptomus madrasensis		+		+
N. schmackeri	+			
Pseudochydorus globosus			+	
Tropodiaptomus australis			+	
Family: Pontellidae				
Labidocera acuta				+
L. pavo				+
Family: Cyclopidae				
Mesocyclops leukarti	+		+	+
Microcyclops varicans			+	
Paracyclops fimbriatus			+	
Phyllodiaptomus blanci	+			
Tropocyclops prascinus			+	
Family: Pseudodiaptomidae				
Pseudodiaptomus annandalei			+	
P. aurivilli				+
P. binghami				+
P. lobipes				+
P. tollingerae				+
Cladocera				
Family: Chydoridae	ī			-
Alona affinis		+	+	+
A. costata			+	
A. davidi				+
A. intermedia		+	+	
A. kurua		+		+
A. kwangsiensis			+	
A. monacantha			+	
A. pulchella		+		+
A. quandrangularis				+
A. rectangular				+
A. verrucosa		+	+	
Alonella excisa		+	+	
Dunhevedia crassa			+	
D. serrata		+	+	

	_	-		
Graptoleberis testudinaria			+	
Guernella raphaelis			+	
Kurzia latissima			+	+
K. longirostris		+	+	+
Leydigia acanthocercoides			+	
Notoalona globulosa		+	+	+
Oxyurella singalensis		+	+	+
Pleuroxus denticulatus			+	+
P. similes			+	+
Family: Bosminidae				
Bosmiopsis deitersi		+	+	
Family: Daphnidae				•
Ceriodaphnia cornuta		+	+	+
C. barroisi		+	+	+
C. eurynotus		+	+	
C. faviformis		1	+	
C. pubescens			+	
C. reticulata			+	
C. sphaericus			+	+
C. ventricus		+	+	
Daphnia carinata			+	+
D. lumholtzi		+	+	+
D. similis			+	
Scapholeberis kingi		+	+	
Simocephalus exspinosus		+	+	+
S. latirostris		+	+	
S. vetulus		+	+	+
Family: Sididae				•
Diaphanosoma brachyurum		+	+	
D. excisum		+	+	+
D. sarsi			+	
Latonopsis australis		+	+	
Pseudosida bidentata			+	+
Family: Ilyocryptidae			-	-
Ilyocryptus spinifer		+	+	
Family: Macrothridae	•			
Eschinisca triserialis		+	+	+

Grimaldina brazzai Macrothrix goeldii M. spinosa		+	
Macrothrix goeldii M. spinosa			
M. spinosa		+	
	+	+	
Family: Moinidae			
Moina micrura	+	+	+
M. weismanni	+		
Moinodaphnia macleayi		+	
Other Crustaceans			
Conchoecete alcocki			+
C. artificious			+
Dorippe dorspes			+
D. facchino			+
D. fachhinovar alcocki			+
Euryalona orientalis			+
M. dentipes			+
M. indica			+
M. intermedia			+
Metopograpsus maculates			+
M. messar			+
Pachygrapsus propinquus			+
Ptychognathus dentatus			+
P. onyx			+
Pyxidognathus fluviatilis			+
Susarma bidens			+
S. edwardsi			+
S. intermedia			+
S. kraussi			+
S. longipes			+
S. quadrata			+
S. smithi			+
S. taenialatum			+
S. tetragona			+

List of rotifers in lower Ganga basin

Brachionidae	L. (Lepadella) quadricarinata	C. catellina
Anuraeopsis coelata	L. (Lepadella) rhomboids	C. forficula
A. fissa	L. (Lepadella) rhomboidula	C. gibba
Brachionus angularis	L. (Lepadella) triptera	C. mucronata
B. bidentatus	L. (Lepadella) triprojectus	Scaridium longicaudu
B. budapestinensis	L. (Heterolepadella) aspicora	Trichocerca (Trichocerca) rattus
B. calyciflorus	L. (Heterolepadella) eherenbergi	T. (Trichocerca) elongata
B. caudatus	L. (Heterolepadella) heterostyla	T. (Trichocerca) pasilla
B. diversicornis	Lacanidae	T.(Diurella) weberi
B. forficula	Lecane (Lcane) aculeata	Asplanchnidae
B. mirabilis	L. (Lcane) arcula	Asplanchna brightwelli
B. plicatilis	L. (Lcane) bifastigata	A. priodonata
B. pteridinoides	L. (Lcane) crepida	Dicranophoridae
B. quadridentatus	L. (Lcane) flexilis	Dicranophorus forcipatus
B. rubens	L. (Lcane) hornemanni	D. lutkeni
B. sessilis	L. (Lcane) lateralis	Gastrophoridae
B. urceolaris	L. (Lcane) leontina	Ascomorpha ovalis
Keratella cochlearis	L. (Lcane) ludwigi	Synchaetidae
K. lenzi	L. (Lcane) luna	Polyarthra valgaris
K. procurva	L. (Lcane) nana	Conochilidae
K. quadrata	L. (Lcane) ohioensis	Conochilus natans
K. tropica	L. (Lcane) papuana	Hexarthridae
Platyias quadricornis	L. (Lcane) ungulata	Hexarthra mira
Euchilanidae	L. (Lcane) vasishti	Testudinellidae
Beauchampiella sp.	L. (Hemimonostyla) inopinata	Pompholyx sulcata
Dipleuchlanis propatula	L. (Hemimonostyla) sympoda	Testudinella emarginula
Euchlanis dilatata	L. (Hemimonostyla) syngenes	Filinidae
E. oropha	L. (Monostyla) bulla	Filinia longiseta
Ttripleuchanis plicata	L. (Monostyla) closterocera	F. opoliensis
Mytilinidae	L. (Monostyla) decipiens	F. pejleri
Mytilina ventralis	L. (Monostyla) furcata	F. terminalis
Trichotridae	L. (Monostyla) hamata	Trochosphaeridae
Trichotria tetractis	L. (Monostyla) lunaris	Horaella brehmi
Macrochaetus sericus	L. (Monostyla) pawlowskii	Philodinidae
Colurellidae	L. (Monostyla) pyriformis	Rotaria neptunia
Colurella uncinata	L. (Monostyla) quadridentata	*All the above mentioned taxa are
Lepadella (Lepadella) acuminata	L. (Monostyla) sinuata	Kharagpur, Kolkata, N 24 Pgs , Hooghly
L. (Lepadella) aspida	L. (Monostyla) stenroosi	
L. (Lepadella) imbricata	L. (Monostyla) thalera	
L. (Lepadella) ovalis	L. (Monostyla) unguitata	
L.(Lepadella) patella	Cephalodella auriculata	

Appendix III

Distribution of macrobenthos in the lower stretch of Ganga River from Farakka to Gangasagar

	Т	II	Ш	IV
Arthropoda		•		
Achaearanea durgae		+		
Aculops abutiloni				+
Anilocra laticauda				+
Aphis fabae	+	+	+	
A. gossypi		+		+
Araneus dehaanii		+	+	
A. excelsus		+		
Arctosa himalayensis			+	
A. indicus			+	
Argiope catenulata		+	+	+
A. latia			+	
Artema atlanta	+	+	+	
Bomis bengalensis			+	
B. kolkataensis			+	
Calappa lophos				+
C. pustulosa				+
Catantops erubescens				+
Cheiracanthium insigne			+	
C. mysorensis				+
C. trivialis		+	+	
Cirolana parva		+		+
Clubiona drassodes			+	+
C. filicata		+	+	+
C. ludhianaensis		+	+	
Conchoecete alcocki				+
Crossopriza lyoni	+	+	+	+
Cyclosa confraga		+		
Cymothoa indica				+
Cyrtophora cicatrosa	+	+	+	+
Diplatys brindlei				+
Dorippe dorsipes				+
D. facchino	1	1		+
Euborellia stali	1	1	+	+
Euophrys	1	+	+	
chiriatapuensis		_		<u> </u>
Exosphaeroma parva	<u> </u>	<u> </u>		+
Forcipula indica		<u> </u>	+	+
Gasteracantha kuhli			+	

	-	-	-	
G. mammosa			+	
Geocoris ochropterus	+			
Gerenia bengalensis				+
Hersilia savignyi	+	+	+	+
Heteropoda		+	+	+
sexpunctata				
Hippasa partita			+	
Hysteroneura setariae			+	
Labidura riparia			+	
Larinia phthisica		+	+	
Leucauge decorata	+	+	+	
L. tessellata				+
Lutica bengalensis			+	
Lycosa choudhuryi				+
L. kempi			+	
Lyssomanes			+	
andamanensis				
L. bengalensis			+	+
L. santinagarensis			+	
Marpisa bengalensis			+	+
M. calcuttaensis			+	
M. decorata			+	+
Matuta lunaris				+
M. planipes				+
Melanaphis sacchari	+			
Mesambria dubia	+	+	+	+
Metisolabis caudelli	+	+		
Myrmarachne			+	+
orientalis				
Nala nepalensis			+	
Neoscona excelsus				+
N. molemensis				+
N. mukerjei		+	+	+
N. poonaensis	+	+	+	
Nephila kuhlii			+	
N. maculata			+	
Nerocila madrasensis				+
N. phaeopleura				+
N. serra				+
N. sundaica				+
Nysius ceylonicus	+	+	+	+
	-			

Oecobius putus			+	
Oedignatha		+	+	
scrobiculata				
Oligonychus biharensis			+	+
O. coffeae		+		
O. indicus	+			+
O. magniferous	+		+	+
Oxyopes ratnae	+	+	+	+
O. shweta		+	+	
Pachygrontha	+	+		+
bipunctata				
Paraconophyma scabra		+	+	+
Paradiplatys gladiator				+
Parawixia dehaani				+
Pardosa birmanica	+	+	+	
P. burasantiensis		+	+	
P. sumatrana		+	+	
Paromius pallidus			+	+
Phidippus bengalensis		+	+	
P. indicus	+	+	+	+
P. pateli	+	+	+	+
Plexippus paykulli	+		+	+
Poekilocerus pictus		+	+	+
Pseudopachybrachius		+	+	+
guttus				
Pyrgomorpna conica		+		+
Rhene indicus			+	
R. khandalaensis		+		
R. pantharae		+		
Salticus ranjitus	+	+	+	+
Scalopidia spinosipes				+
Schizotetranychus	+	+		
cajani Sautodos propingua				
Scytodes propinqua			+	+
Simalio biswasi			+	
Singa chota			+	
Spariolenus tigris				
Sphaeroma triste				+
Sphingius paltaensis			+	
Stegodyphus	+		+	+
Tagasta indica	+	+		<u> </u>
Toxontera odinae		<u> </u>	+	<u> </u>
			- -	
uloborus danolius	+		+	+

Zygeilla melanocrania		+	+	+		
Molluscs						
Gastropoda						
Amalda ampla				+		
Andita umpia				-		
perspectiva			+	+		
Assiminea				+		
beddomeana						
A. woodmasoniana				+		
Asthenotoma				+		
vertebrata						
Bellamya bengalensis		+		+		
B. crassa		+				
B. dissimilis		+				
Brotia costula		+	+			
Cassidula nucleus				+		
Cerithidea alata				+		
Clithon reticularis				+		
Columbella ducolosiana			+	+		
Iravadia ornata				+		
Larina burmana			+	+		
Natica gualteriana				+		
N. smithi				+		
N. tigrina			+	+		
N. violacea			+			
Olivancillaria gibbosa				+		
Pila globosa		+		+		
Polinices didyma				+		
Potamacmaea				+		
fluviatilis						
Pseudanachis duclosiana				+		
P. sulculosa			+	+		
Septaria caerulescens		+	+	+		
S. lineata		+	+	+		
Stenothyra				+		
blanfordiana						
S. deltae			+	+		
Telescopium			+	+		
telescopium			<u> </u>	<u> </u>		
				+		
i nais blanfordi				+		
T. lacera				+		
Thiara lineatus		+				

·	T	1	T	r
T. scabra			+	+
Tubiola microscopica				+
Umbonium vestiarium				+
Pelycepoda				
Barnea candida				+
Corbicula bensoni		+		+
C. gracilis				+
C. striatella			+	+
Cuspidaria chilkaensis				+
Gafrarium pectinatum		+		+
Glauconome sculpta				+
Lamellidens corrianus	+	+	+	
L. marginalis	+	+	+	+
Laternula truncata				+
Mactra luzonica				+
Martesia fragilis	1	1	1	+
Meretrix meretrix			+	+
Novaculina gangetica				+
Nucula mitralis				+
Paphia malabarica				+
Parreysia caerulea	+	+	+	
P. corrugata	+	+	+	+
P. favidens		+		
P. occata				+
Pitar alabastrum				+
Solen brevis				+
Sphenia perversa				+
Theora opalina				+
Trachycardium				+
asiaticum				
Cephalopoda	-	-	1	
Loligo duvanceli				+
L. investigatoris				+
Octopus macropus				+
Sepia aculeata				+
Sepiella inermis				+
Scaphopoda				T
Dentalium		1		+
	1	1		
Polychestse				
Parantolla soulata				
<i>Βυταπτοπα Sculpta</i>			+	

Capitella capitata			+
Ceratonereis burmensis			+
Chloeia parva		+	+
Dendronereides		+	+
gangetica			<u> </u>
D. neteropoda	 +	+	+
Denaronereis arborifera			+
D. aestuarina			+
D. dayi			+
Diopatra neapolitana			+
Eteone barantollae			+
Eunice aphroditois			+
Ganganereis sootai			+
Gattyana fauvele			+
Glycera alba			+
G. lancadive			+
Hesione splendida			+
Heteromastus similis			+
Hyalinoecia tubicola			+
Isolda pulchella			+
Laonome indica			+
Lumbrineris			+
heteropoda			
Lycastonereis indica		+	+
Lysidice collaris			+
L. natalensis			+
Marphysa sp.			+
M. mossambica			+
Mastobranchus indicus		+	+
Minuspio cirrifera			+
Namalycastis fauveli	+	+	+
N. indica	+	+	+
N. meraukensis			+
Neanthes		+	+
chingrighattensis			
N. chcoghuthu		+	Ŧ
N. meggitti		-	
N. IIIEYYILLI	+	+	+
Owerniu jusijormis			+
Perimereis cavijrons			+
P. cultrijera			+
Prierusa bengalensis			+

Polydora kempi				+
P. normalis				+
Prionospio cirrifera				+
Pseudopolydora kempi				+
Sabellaria pectinata				+
Spio bengalensis				+
Sternaspis scutata				+
Talehsapia annandalei				+
Oligocheata				L
Aelosoma bengalensis			+	
Allonais inaequalis		+	+	
A. paraauavensis	+		+	
Aulodrilus remex	+			
Branchiodrilus		+		
hortensis				
B. semperi		+	+	+
Branchiura sowerbyi	+	+		
Chaetogaster langi			+	
Dero cooperi	+	+		+
D. dorsalis	+	+	+	
Dichogaster bolaui			+	
D. modiglianii		+	+	
Drawida nepalensis		+	+	
Eutyphoeus	+	+	+	
incommodus				
E. nicholsoni	+	+	+	
E. orientalis	+	+	+	+
E. waltoni			+	
Lampito mauritti	+	+	+	+
Lennogaster pusillus			+	
Limnodrilus	+	+	+	
hoffmeisteri Matanhira planata			-	
M. posthuma	-	т	т	
Nais barbata	<u> </u>			+
			+	
N. SIMPLEX			+	+
Octocnaetona beatrix	+	+	+	+
U. compta	 	+		
Pellogaster bengalensis		+		
Perionyx excavatus	+	+	+	+
Polypheretima				+

elongata				
Pontodrilus				+
bermudensis				
Priatina aequiseta			+	
P. sperberae		+		
Slavina appendiculata			+	
Stylarias fossularis	+		+	
Tubifex tubifex	+			
Hirudinia				
Glossiphonia weberi	+	+	+	+
Haemadipsa sylvestris	+	+	+	+
Helobdella nociva			+	+
Hemiclepsis marginata	+	+		
Hirudinaria manillenses	+	+		
Ozobranchus shipleyi			+	
Pontobdella aculeata				+
Echinodermata				
Acaudina molpadioides				+
Amphioplus sp.				+
Astropecten				+
euryacanthus				
A. indicus				+
Chaetodiadema				+
granulatum				
Clypeaster rarispinus				+
Echinodiscus auritus				+
Goniopecten sp.				+
Labidoplax sp.				+
Laganum decagonale				+
Luidia hardwicki				+
Ophiactis delagoa				+
O. modesta				+
Ophiocnemis				+
marmorata				<u> </u>
Synaptula recta				+
Temnopleurus				+
toreumaticus Thorsonia				
investigatoris				+
ecstigatoris				L

Appendix IV

Distribution of fishes in the lower stretch of Ganga River from Farakka to Gangasagar

Anguillidae
Anguilla hengalensis*
Onhighthdag
Psidodonopins boro
Notopteridae
Notopterus notopterus*
N. chitala*
Clupeidae
Andontostaoma manmina
A. chacunda
Corica soborna
Gadusia chapra*
Gonealosa manmina*
Hilsa kelee
Sardinella melanura
Tenualosa ilisha*
Chirocentridae
Chirocentrus dorab
Pristigasteridae
Ilisha feligera
I. megaloptera
Raconda russeliana
Engraulidae
Coilia dussumiere
C. ramcorti
C. reynalidy
Setipinna phasa*
S. taty
S. brevifilis
Stolephorus indicus
Thryssa purava
Cyprinidae
Amblypharyngodon mola*
Catla catla*
Cirrhina mrigala*
C. reba*
Dani devario*
D. dangila
Esomus danricus*
Labeo bata*
L. calbasu*
L. rohita*
Puntius conchonius*
P. sarana sarana*
P. sophore*
P. ticto*
Rasbora daniconius*
Salmostoma bacaila*
Cobitidae

Botia lohochata*
B. dario*
Lepidocephalus guntea*
Bagridae
Mystus vittatus*
M. cavasius
M. gulio*
Rita rita*
Sperata aor*
S. seenghala*
Schilbeidae
Aila coila*
Clupisoma garua*
Eutropiichthys vacha*
Silonia silondia*
Pangasidae
Pangasius pangasius*
Siluridae
Ompak bimaculatus*
O. pabo*
O. pabda*
Wallaga attu*
Sissoridae
Bagarius bagarius*
Gagata cenia*
Clariidae
Clarius batrachus*
Heteropneustidae
Heteropneustis fossalis*
Aridae
Arius arius
A agora
A lella
A saaar
A. song
Batrachocephalus mino
Osteogeneiosus militaris
Harpadontidae
Harpadon nehereus
Synodontidae
Squrida tumbil
Brogmoscratidos
Centropomidae
Lates calcarifer*
Ambassidae
Ambasis baculis
A. commersoni
Pseudombasis ranga*

P lala*
Leiognathidae
Leiognathus equulus
Gazza minuta
Secutor ruconis
S. insidiator
Gerridae
Gerres filamentosa
G. ovena
Gerreomorpha setifer
Lutjanidae
Lutjanus johni
L. argenti maculates
Nandidae
Nandus nandus*
Badidae
Badis badis*
Anabantidae
Anabastes testudineus*
Osphronemidae
Colisa fasciatus*
C. lalius
Scatophagidae
Scatophagus argus
Polynemidae
Eleutheronema
tetradactylum
Polynemus paradiseus*
Uranoscopidae
Uranoscopus congnatus
Gobiidae
Apocryptes bato
Brachygobius nunus
Boleopthalmus dussumieri
Glossogobius giuris*
Gobiopterus chuno
Pseudapocryptes lanceolatus
Periopthalmodon schlosseri
Stigmatogobius sadanundio
Gobiodidae
Bathygobius orbicularis
Odontamblyopus rubicundus
Taenioides anguillaris
I. cirraatus
Eleotrididae
Eleotris fusca
Sillaginidae
Sillago sithama
Sillaainopsis paneius

Carangidae
Carangoides malabaricus
Caranx carangus
Megalaspis cordyla
Parastromateidae
Parastromateus niger
Stromateidae
Pompus argenteus
Ephippididae
Drepene punctata
Mullidae
Parupeneus indicus
Upeneus vittatus
U. Sulphureus
Teraponidae
Terapon jarbua
Terapon theraps
Trituridae
Triturus haumala
T. savala
Sciaenidae
Johnius coitor
J. gangeticus
Pama pama*
Otolithoides biauritus
Lobotidae
Lobotes surinamensis
Haemulidae
Pomadasys maculatus
P. argenteus
Sparidae
Acanthopagrus latus
Cichlidae
Oreochromis nloticus
Mugilidae
Liza parsia
L. tade
L. macrolepis
Mugil cephalus
Rhinomugil corsula*
Sciamugil cascasia*
Valamugil cunnesieus
Mastacembelidae
Mastacembelus armatus*
M. pancalus
Macrognatus aculeatus*
M. puncalus
Tetradontidae
Tetradon cutcutia*
Triacanthidae
Triacanthus brevirostris

Hemirasmphidae
Hyporhampus limbatus
Belonidae
Xentendon cancila*
Strongylura strongylura
Oryziidae
Oryzias melastegma
Aplocheilidae
Aplocheilius panchax
Syngnathidae
Microphis cuncalus
Dactylopteridae
Dactylopterus orientalis
Channidae
Chanda nama*
Channa marulius*
C. orientalis*
C. punctatus*
C. striatus*
Symbranchidae
Monopterus cuchia
Cyanoglossidae
Cyanoglossus arel
C. cyanoglossus
C. lingua
Soleidae
Euryglossa orientalis
Synaptura albomaculata
Scorpaenidae
Pterois russellii
Synancellidae
Minous coccineus
Platycephalidae
Platycephalus indicus
Batrachoidae
Batrichthys grunnies
Plotosidae
Plotosus canius
Kurtidae
Kurtus indicus
Muraenidae
Lycodontis tile
Megalopidae
Megalops cyprinoides
Trichiuridae

Appendix V

Families	Species
Carcharhinidae	Aetobatus narinari
Carcharhinidae	Carcharhinus limbatus
Carcharhinidae	Glyphis gangeticus
Dasyatidae	Dasyatis bleekeri
Dasyatidae	D. marginata
Dasyatidae	D. stephen
Dasyatidae	D. uarnak
Dasyatidae	D. zugei
Hemiscylliidae	Chiloscyllium griseum
Pristidae	Pristis microdon
Rhinobatidae	Rhinobatos annandalei
Sparidae	Eusphyra blochii
Stegostomalidae	Stegostoma fasciatum

Distribution of carlillngineous fishes (Class- Chondrichthyes) in the Hooghly Estuary

Status : Sch.-II, App.-I, Vulnerable

Status : Sch.-I, App.-I

Schedule I, App-I, Endangered

Appendix VI

Distribution of higher vertebrates in the lower stretch of Ganga River from Farakka to Gangasagar

Dolphin
 Distribution: Hooghly (Shrirampore; But occurrence in recent time is very doubtful)
 Family: Delphinidae

1. Orcaella brevirostris (Gray)Status : Sch.-I, App.-IICommon Name: Irrawaddy DolphinDistribution: South 24 Pgs (Bay of Bengal)

2. Sousa chinensis (Osbeck)Status : Sch.-II, App.-ICommon Name: Plumbeous DolphinDistribution: South 24 Pgs.

Stenella attenuata (Gray)
 Status : Sch.-II
 Common Name: Malay Dolphin
 Distribution: South 24 Pgs (Sunderban; Only report of sighting in 1891 by W.T. Blandford)

Family: Phocoenide

4. Neophocaena phocaenoides (Cuvier)

Common Name: Black Finless Porpoise *Distribution*: South 24 Pgs (Sunderban)

Family: Platanistidae

5. Platanista gangetica (Roxburgh)

Common Name: Gangetic Dolphin *Distribution*: Hooghly, Nadia (Mayapur)

ii. Gharial and Turtles

1. Gavialis gangeticus (Gmelin) Common name: Gharial Distribution: Nadia (Ranaghat)

Family: Crocodylidae

2. Crocodylus porosus SchneiderSchedule I, App-I, EndangeredCommon name: Estuarine/Saltwater crocodileDistribution: North 24 pgs (Bhagabatpur), South 24 Pgs (Sunderban).

Order:	Testudines
Family:	Chelonidae

3. Chelonia mydas Linnaeus

Schedule I, App-I, Endangered

Common name: Green sea turtle Distribution: Sunderban (South 24 Pgs)

- 4. Eretmochelys imbricata Linnaeus Common name: Hawksbill or tortoise shell sea turtle Distribution: Sunderban (South 24 pgs) with rare occurrence.
- Lepidochelys olivacea (Eschscholtz) Schedule I, App-I, Endangered Common name: Pacific Ridley Turtle Distribution: Medinipur (Digha), South 24 Pgs (Sunderban).

Family: Emydidae

- Batagur baska (Gray) Common name: River terrapin Distribution: South 24 Pgs (Sunderban)
- 7. Geoclemys hamiltonii (Gray)Schedule I, App-ICommon name: Spotted pond turtleDistribution: South 24 Pgs (Hooghly river).
- 8. Geomyda indopeninsularis Distribution: Jalpaiguri (Gorumara).
- Kachuga kachuga Common name: Red crowned roof turtle Distribution: Koch Bihar (Baneswar), Kolkata (Golf green)
- 10. Kachuga tecta (Gray) Common name: Indian tent turtle Distribution: North 24 pgs. (Palta), South 24 Pgs (Sunderban), Kolkata, Haora (Botanical garden) and Jalpaiguri (Gorumara).

wned roof turtle (Baneswar), Kolkata (Golf green) Schedule I, App-I, Vulnerable tent turtle