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THE BIOLOGY OF THE HOOGHLY-MATLAH ESTUARINE SYSTEM (WEST BENGAL, INDIA) WITH SPECIAL REFERENCE TO ITS FISHERIES

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ABSTRACT

The Hooghly-Matlah estuarine system, the major portion of which is characterised as a positive mixohaline estuary, is divided into five zones, each presenting different physico-chemical and biological conditions. The more important parameters which contribute to biological zonation in this estuarine system are temperature, salinity, turbidity and freshwater drainage. As regards the flora and fauna of the estuary, most of the data so far gathered are on the plankton and biology of commercially important fishes, salient features of which are presented and discussed. The biological characteristics of (i) the marine fishes which use the estuary as nursery ground, (ii) the species which migrate into the mouth of the estuary to form important local fisheries, and (iii) freshwater fishes which come into the estuary, are discussed. Prominent features of the fisheries potential of the estuarine system have also been given.

INTRODUCTION

IT is generally established that a combination of different fluctuating parameters are responsible for the nature and distribution of the flora and fauna in an estuary (Day, 1951 ; Caspers, 1967). Therefore, it is apparently necessary that each estuary or system is taken up as a separate entity for all biological investigations. On the Indian coast there are a number of estuaries of varying dimensions and of these, the Hooghly-Matlah Estuarine System (Fig. 1) covering a major portion of the Ganga-Brahmaputra delta is the largest (Pillay, 1967). This estuarine system exhibits great tidal fluctuations as well as *bores* in the Hooghly River between Hooghly Point and Triveni.

The deltaic area of this estuarine system in West Bengal State is estimated to be 3,100 sq. miles (Pillay, 1967). The main Hooghly Estuary is classified as a positive estuary in the mixohaline range (Pantulu, 1966), in which the tidal impact is observed up to about 295 kms from the sea. These characteristics, along with the large quantities of detritus washed into the waters, especially those of the lower regions, and the industrial pollutants, result in a wide range of biological conditions which are reflected in the nature and distribution of the flora and fauna. Most of the biological investigations conducted so far in this estuarine system are concerning plankton, fish and fisheries.

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Salinity and Temperature

The average values of surface water temperature in the different zones of the estuarine system for the last 5 years, are given in Table 1, from which it will be

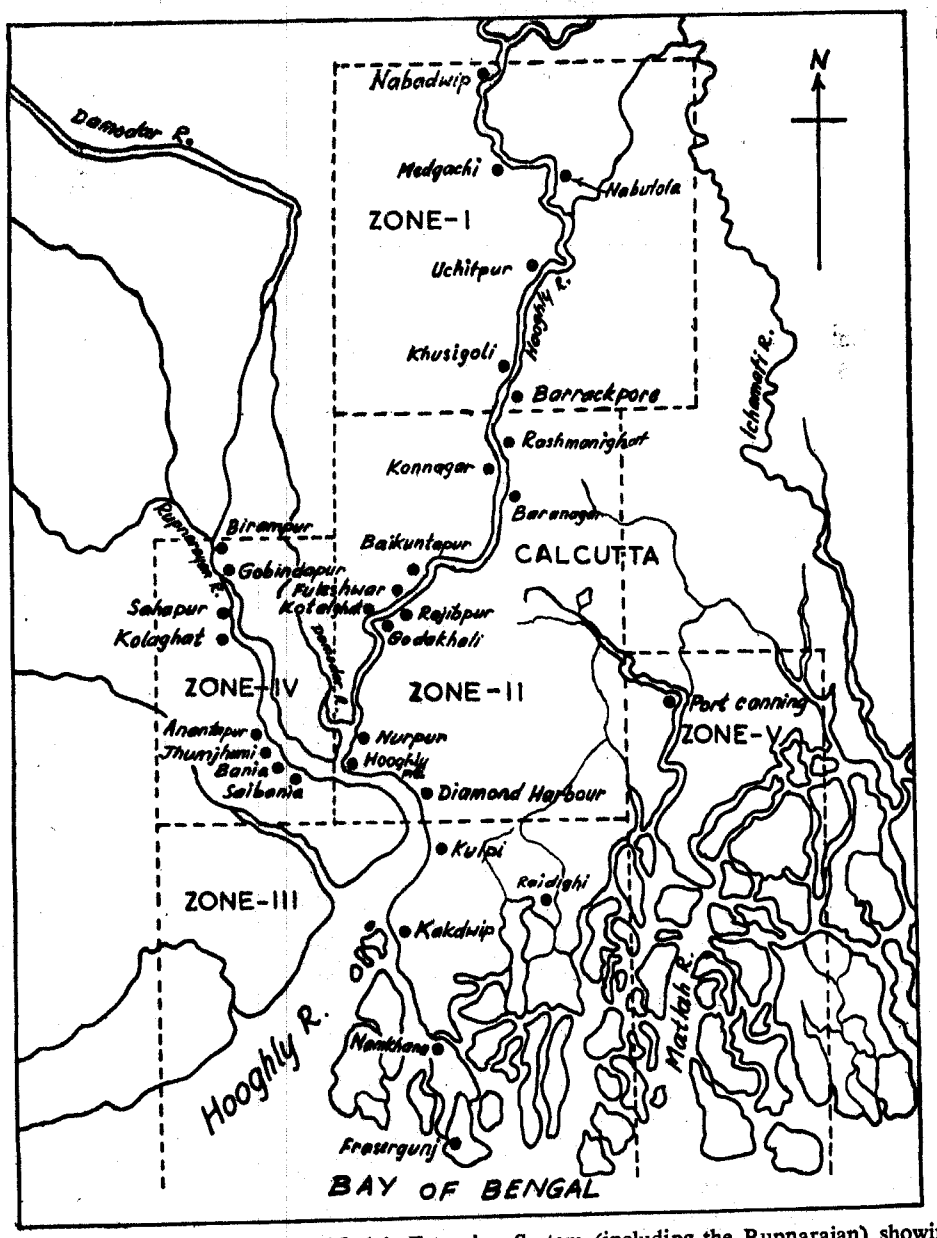

FIG. 1. Map of the Hooghly-Matlah Estuarine System (including the Rupnaraian) showing the Five Biological Zones.

seen that the minimum value observed is 17.7°C and maximum 33.68°C. In Table 2, the monthly average of surface water temperature for 2 selected years, namely 1964 and 1967 are given, so that the variation trends could be understood. From the data presented it will be seen that generally the water temperature is highest during May-June and September months. Bose (1956) found that there is no vertical thermal stratification in the Hooghly Estuary.

TABLE 1. *Average salinity and temperature (surface) in the different zones of the Hooghly-Matlah estuarine system (Average values for the last 5 years)*

Zone	Salinity ‰		Temperature °C.	
	min.	max.	min.	max.
Freshwater Zone (1)	Nil	Traces	21.8	31.8
Gradient Zone (2)	Traces	27.30	19.6	33.46
Marine Zone (3)	2.34	33.75	19.44	33.68
Rupnarain Zone (4)	Traces	15.87	17.7	33.0
Matlah Zone (5)	8.20	30.65	20.1	31.76

Traces=0.20‰.

The salinity variations are indicated in Tables 1 and 3. From Table 1 it will be seen that the variation in averages for the whole estuarine system is between ' Traces ' and 33.75‰. The monthly variations data (Table 3) for the different zones indicate that the higher values are generally reached during the period April to July. From the salinity pattern, 3 regimes viz., upper, middle and lower are quite evident in the Hooghly Estuary. In the case of Rupnarain and Matlah, the conditions are different in that while in the former, the averages generally range between ' Traces ' and 15.87‰, in the latter, the range is between 8.20 and 30.65‰. Carriker (1967) has chosen to divide typical estuaries into 5 approximate geographic divisions viz., River, Head, Upper Reaches, Middle Reaches, Lower Reaches and Mouth, but for the Hooghly estuary which is the biggest area in the estuarine system under study, demarcation into the 3 divisions mentioned above, appears to be more convenient.

BIOLOGICAL ZONATION

Taking into consideration the tidal regimes, salinity characteristics, temperature, turbidity and nature of fauna, the Hooghly-Matlah Estuarine System may be divided into the following 5 biological zones (Fig. 1).

(i) Freshwater zone of the Hooghly.

(ii) ' True estuarine ' zone of the Hooghly.

TABLE 2. *Monthly surface water temperature (°C) variations, during 2 selected years, in the different zones of the Hooghly-Matlah Estuarine System*

Zone	Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	1963*	20.95	24.33	28.82	28.96	30.19	31.01	30.90	30.73	31.00	30.54	26.83	23.74
	1964*	21.78	23.33	28.66	30.17	31.51	30.89	30.89	32.50	30-12	—	—	—
2	1964	23.12	24.14	29.50	30.17	31.57	30.97	30.45	30.55	31.37	29.87	26.01	23.64
	1967	21.37	25.56	27.62	29.75	30.84	31.93	31.05	30.24	30.67	29.61	27.20	—
3	1964	22.96	24.56	29.31	29.80	31.98	31.89	29.71	30.26	30.19	29.62	25.55	23.49
	1967	21.75	24.49	27.38	29.77	30.62	32.09	30.32	28.49	31.12	29.21	26.45	—
4	1964	21.04	22.95	28.85	29.83	31.04	31.12	30.00	31.00	30.75	29.99	25.43	23.87
	1967	22.91	27.64	29.20	31.20	32.21	30.03	27.68	28.17	29.69	29.65	—	—
5	1964	22.25	24.02	28.10	29.57	30.45	30.35	28.80	29.22	29.10	28.65	26.05	22.50
	1967	20.15	23.50	27.07	29.20	30.50	30.85	30.20	29.02	29.85	29.52	26.00	—

— : Data not available ; *Subsequent years' data are not complete for this zone.

TABLE 3. *Monthly salinity (‰) variations, during 2 selected years, in the different zones of the Hooghly-Matlah Estuarine System*

Zone	Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1	1964	NIL-TRACES											
	1967	NIL-TRACES											
2	1964	3.60	4.54	7.93	12.33	15.35	17.77	0.39	Tr.	Tr.	0.31	1.72	3.23
	1967	2.20	8.58	12.11	14.29	18.87	22.19	9.62	0.33	Tr.	0.69	0.76	—
3	1964	16.57	22.02	25.68	31.06	32.52	32.10	13.22	7.04	5.96	7.70	12.84	17.00
	1967	19.39	22.70	25.88	27.94	27.81	32.19	32.77	15.48	4.97	10.57	12.50	—
4	1964	0.37	0.44	1.25	5.00	5.94	4.09	Tr.	Tr.	Tr.	Tr.	Tr.	Tr.
	1967	1.15	6.01	10.15	15.58	11.82	9.35	0.78	Tr.	Tr.	Tr.	Tr.	Tr.
5	1964	17.58	17.58	22.27	30.78	27.54	31.60	18.77	17.85	15.85	13.75	11.30	11.12
	1967	10.85	16.81	21.90	24.86	26.00	27.55	28.68	21.91	9.69	7.21	7.75	—

Tr.: Traces=0.20‰; —: Data not collected.

(iii) Marine zone of the Hooghly.

(iv) ' Estuarine ' zone of the Rupnarain.

(v) ' True estuarine and marine ' zone of the Matlah.

Generally three types of organisms are encountered in any estuarine system: (i) Freshwater organisms entering brackishwaters, (ii) Marine organisms entering brackishwaters, (iii) Organisms peculiar to particular estuaries, termed as ' resident ' species. In Table 4, a list of the important plankters observed, with their zonal distribution is given. Peak periods of occurrence of the groups are also indicated. Shetty *et al* (1961), who have studied in detail the plankton of this estuarine system, found that both the phytoplankton and zooplankton have a bimodal cycle, with one peak during June to August and the other during November to January/February. They also found an apparent direct relation between plankton production and commercial fish landings. Table 5 gives the list of fishes observed in the estuarine system, with the zones of their availability. The important prawns and their observed zonal distribution are presented in Table 6. Since most of the data collected on the fishes and prawns are based on commercial catches and the information available is more or less general, the periods of availability are not mentioned in these cases.

TABLE 4. *Important plankters and their distribution in the Hooghly-Matlah Estuarine System*

Organisms	Zones	Peak periods of occurrence of the groups
Diatoms		
1. *Synedra ulna*	1, 2, 3, 4	June, July and August: minor peak
2. *Coscinodiscus granii*	All	
3. *Coscinodiscus* spp.	All	
4. *Surirella* sp.	1, 2, 4	
5. *Melosira granulata*	All	
6. *Melosira* spp.	3, 4, 5	
7. *Nitzschia* sp.	All	
8. *Navicula* spp.	1, 2, 4	
9. *Pleurosigma* spp.	All	Dec., Jan. and Feb.: major peak
10. *Asterionella japonica*	1, 2, 3	
11. *Stephanodiscus* sp.	1, 2, 4	
12. *Cyclotella* spp.	1, 2, 4	
13. *Chaetoceros* spp.	2, 3, 4, 5	
14. *Diplonics* sp.	2, 3, 4	
15. *Biddulphia mobiliensis*	2, 3, 4, 5	
16. *Biddulphia sinensis*	3, 4, 5	
17. *Planktoniella sol*	2, 3, 4, 5	
18. *Lithodesmium* spp.	2, 3, 4, 5	
19. *Thalaniothrix* sp.	2, 3, 4, 5	
20. *Ditylum brightweelii*	2, 3, 4, 5	
21. *Hemidiscus hardmaniannus*	2, 3, 5	
22. *Hemiaulus sinensis*	2, 3, 5	
23. *Skelitonema costatum*	2, 3, 4, 5	
24. *Rhizosolenia* sp.	2, 3, 5	
25. *Triceratium* sp.	2, 3, 5	
26. *Bacteriastrum* spp.	3, 5	
27. *Coscinosira* sp.	All	
28. *Fragilaria* sp.	1, 2, 5	

Organisms	Zones	Peak periods of occurrence of the groups
Green Algae		
1. *Pediastrum simplex*	1, 2	July, August, December and Jan.: minor and major peaks
2. *Pediastrum* spp.	1, 2, 4	
3. *Spirogyra* spp.	All	
4. *Mongeotia* sp.	1, 2	
5. *Eudorina elegans*	1, 2	
6. *Tribonema* sp.	1, 3, 4	
7. *Closterium* sp.	1, 2, 3, 5	
8. *Cosmarium* sp.	1	
9. *Scenadesmus* sp.	1, 2, 4	
10. *Zygnema* sp.	1	
11. *Pandorina morum*	1, 2, 4	
12. *Chlorella* sp.	1, 2	
13. *Volvox* sp.	1, 2	
14. *Borgia planktonica*	All	
Bluegreen Algae		
1. *Microcystis* spp.	1, 2, 4	August, Sep. and Dec./ January in zones 1, 2, 5.
2. *Oscillatoria* spp.	All	
3. *Phormidium* sp.	1, 2, 3, 5	Aug. Sep. and June/ July in zone 3 (very few);
4. *Nostoc* spp.	All	Oct., Nov. and March in zone 4
5. *Anabaena* spp.	All	
6. *Aphanizomenon* sp.	1, 2, 4	
7. *Lyngbya* sp.	All	
8. *Trichodesmium* sp.	2, 3, 4, 5	
Flagellates		
1. *Euglena* spp.	1, 2, 3	July, Aug. and Sep. in zones 1, 2, 5.
2. *Ceratium hirundinella*	All	
3. *C. tripos*	2, 3, 5	Sep., Oct. and Nov. in zones 3 and 4.
4. *Phacus* sp.	All	
5. *Peridinium* spp.	All	
6. *Noctiluca miliaris*	2, 3, 4, 5	
7. *Trachelomonas* sp.	1, 4	
Protozoa		
1. *Difflugia* spp.	All	July, August and Sep. in zones 1, 2, 5.
2. *Arcella* spp.	All	
3. *Vorticella* sp.	1, 2, 4, 5	Sep., Oct. and Nov. in zones 3 and 4.
4. *Centropyxis* sp.	3, 2, 5	
5. *Tintinnidium* sp.	3, 5	
Rotifera		
1. *Brachionus* spp.	1, 2, 4, 5	July, Aug., Sep. and Nov./December in zones 1 and 5.
2. *Keratella* spp.	1, 2, 4	
3. *Filinia* spp.	1, 2	
4. *Asplanchna* sp.	1, 5	January, February and October, November in zones 2, 3, 4.
5. *Ploesoma* sp.	4, 2	
6. *Notholca* sp.	3	
Copepoda		
1. *Diaptomus* sp.	1, 2, 3, 4	Aug., Sep., Dec., Jan. and Feb. in zones 1, 2, 5.
2. *Pseudodiaptomus* spp.	All	
3. *Cyclops* sp.	1, 4, 5	
4. *Microsetella* sp.	2, 3, 5	June, July, Oct., Nov. and Dec. in zones 3 and 4.
5. *Acartiella* spp.	2, 4	
6. *Paracalanus* sp.	3, 4, 5	
Cladocera		
1. *Bosmina* sp.	1, 2	July, August, Dec., Jan. and February in zones 1 and 2. Sep., Oct., Nov and Dec. in zones 3, 4, 5.
2. *Bosminopris* sp.	1, 2, 3	
3. *Ceriodaphnia* sp.	1, 2, 4	
4. *Daphnia* sp.	1, 2	
5. *Moina* sp.	1, 2	
6. *Diaphanosoma* sp.	2	
Miscellaneous		
1. *Mesopodopsis orientalis*		
2. *Sagitta* spp.		
3. *Isopods*		

Bottom Biota

Preliminary observations only have been made on the bottom biota of this estuarine system. In view of the great turbulance caused by tidal currents and bore tides, and large scale discharge of industrial pollutants into the waters of the Hooghly, benthic organisms are not ordinarily encountered in appreciable quantities. From studies so far made, the following organisms have been found to constitute the bottom biota :

(1) Chironomids (larvae and adults).
(2) Gastropods (empty shells ; some with animals).
(3) Tribifex worms.
(4) Insect larvae.
(5) Megalopa larvae.
(6) Fish larvae (mainly gobids).
(7) Small prawns.

All present in the freshwater and 'true estuarine' zones, but only in few numbers.

(8) Mats of filamentous algae (mainly *Spirogyra* sp. and *Oscillatoria* sp.).

In the freshwater zones only.

In this connection it may be mentioned that Kemp (1917), while describing the bottom fauna of Matlah river, has indicated that although only few species were encountered, the individuals were rather in abundance. In the Hooghly Estuary, as is seen from the data presented above, the species as well as number of individuals are found to be meagre, which condition may be attributed to the greater tidal turbulence and effects of industrial pollution.

Biological Effects of Industrial Pollutants

About 215 industrial establishments on both sides of the Hooghly, which have factories producing jute, textiles, pulp and paper, tannery, chemicals, food, brewery, yeast, paints, cycle rims, tyres etc. discharge their wastes directly or indirectly into the river waters. Detailed studies on the effects of these pollutants on the fisheries of the estuary are under way (Ray and Gopalakrishnan, 1969) and information gathered so far tend to show that mass mortality of fish eggs and larvae takes place at and near the discharge points. Similarly, the plankton is also adversely affected. Evidences gathered indicate that pollution is likely to be one of the factors responsible for the decline of hilsa catches in the estuary. The biological equilibrium of the estuary is also adversely affected and the primary productivity has been found to be low.

Turbidity

The waters in this estuarine system are generally very turbid. The values are highest in monsoon seasons due to suspended clay and silt, lower in post-monsoon months and again higher during the summer months.

Fisheries

In common with the other major estuaries of the country, the fishery exploitation of the Hooghly-Matlah Estuarine System is not balanced. This is evident

from the fact that about 70 to 80% of the total fish catches from the estuarine system come from the marine zone (commonly known as Sunderbans); and of these 75 to 80% are obtained during a period of 3 months during the winter season, when weather conditions permit normal commercial fishing activities. The important commercial fishes consist of hilsa and other clupeids, Bombay duck, prawns, mullets, catfishes, bhetki (*Lates calcarifer*), thread fins and jew fishes. In the upper stretches, large quantities of palaemonid prawns are caught regularly. Estimated fish catches from the 5 zones during 2 recent years are (in tonnes):

Zone	1967	1968
1	771	753
2	356	309
3	5,813	4,222
4	754	898
5	145	109

The total fish landings from the entire estuarine system, as estimated during recent years (in tonnes) are: 1963-64—6,412; 1964-65—10,413; 1965-66—6,516; 1966-67—6,766; 1967-68—8,805; and 1968-69—8,275.

The most priced fish of the Hooghly Estuary is the Indian shad, *Hilsa ilisha*, the fishery of which has shown great fluctuations and drastic decline in recent years (Gopalakrishnan, 1969). In view of its importance, the biology of this fish has been the subject of investigations by many workers (Pillay and Rosa, Jr., 1963).

TABLE 5. *Fishes and their observed distribution in the Hooghly-Matlah Estuarine System*

Species	Zones	Species	Zones
Clupeidae		*Coilia dussumieri* (Cuvier and Valenciennes)	1, 2, 3
Gadusia chapra (Hamilton)	1	*Coilia reynaldi* (Cuvier and Valenciennes)	1, 2, 3
Hilsa ilisha (Hamilton)	1, 2, 3		
Hilsa toli (Cuvier and Valenciennes)	3	**Chirocentridae**	
Corica soborua (Hamilton)	1	*Chirocentrus dorab* (Forskål)	3
Ilisha elongata (Bennett)	1, 2, 3		
Ilisha motius (Hamilton)	1, 2, 3	**Notopteridae**	
Ilisha indica (Swainson)	1, 2, 3	*Notopterus notopterus* (Pallas)	1
Raconda russeliana Gray	3	*Notopterus chitala* (Hamilton)	1
Gonialosa manmina (Hamilton)	1		
Pellona ditchela (Cuvier and Valenciennes)	2	**Synodidae**	
		Harpodon nehereus (Hamilton)	2, 3
Engraulidae			
Anchoviella indica (van Hasselt)	2, 3	**Siroridae**	
Anchoviella tri (Bleeker)	2, 3	*Gagata cenia* (Hamilton)	
Anchoviella commersoni (Lacépède)	2, 3		
Thrissocles hamiltoni (Gray)	2, 3	**Cyprinidae**	
Thrissocles purava (Hamilton)	2, 3	*Catla catla* (Hamilton)	1
Setipinna phasa (Hamilton)	1, 2, 3	*Esomus danrica* (Hamilton)	1
Setipinna taty (Cuvier and Valenciennes)	2, 3	*Rasbora daniconius* (Hamilton)	1
Coilia ramcarati (Hamilton)	1, 2, 3	*Amblypharyngodon mola* (Hamilton)	1
Coilia borneensis Bleeker	1, 2, 3	*Puntius conchonius* (Hamilton)	1

Species	Zones
Puntius sarana (Hamilton)	1
Puntius sophore (Hamilton)	1
Puntius ticto (Hamilton)	1
Puntius gelius (Günther)	1
Cirrhinus mrigala (Hamilton)	1
Cirrhinus reba (Hamilton)	1
Labeo bata (Hamilton)	1
Labeo calbasu (Hamilton)	1
Labeo rohita (Hamilton)	1
Oxygaster bacaila (Hamilton)	1
Osteobrama cotio (Hamilton)	1
Ophisthopterus tardoore (Cuvier)	1
Amblypharyngodon mola (Hamilton)	1
Ariidae	
Osteogeneiosus militaris (Linnaeus)	1, 2, 3
Tachysurus jella (Day)	1, 2, 3
Tachysurus nenga (Hamilton)	2, 3
Tachysurus sona (Hamilton)	1, 2, 3
Tachysurus gagora (Hamilton)	1, 2
Plotosidae	
Plotosus canius Hamilton	1, 2, 3
Siluridae	
Ompok bimaculatus (Bloch)	1
Wallago attu (Bloch and Schneider)	1
Saccobranchidae	
Heteropneustes fossilis (Bloch)	1
Bagridae	
Rita rita (Hamilton)	1
Mystus aor (Hamilton)	1, 2
Mystus gulio (Hamilton)	1, 2, 3
Mystus vittatus (Bloch)	2, 3
Mystus seenghala (Sykes)	1, 2
Schilbeidae	
Eutropichthys vacha (Hamilton)	1
Pangasius pangasius (Hamilton)	1, 2, 3
Clupisoma garua (Hamilton)	1, 2
Ailia coilia (Hamilton)	1
Silonia silondia (Hamilton)	1, 2
Clupisoma atherinoides (Günther)	1, 2
Anguillidae	
Anguilla bengalensis (Gray and Hardw.)	1
Ophichthyidae	
Pirodonophis boro (Hamilton)	1
Belonidae	
Xenentodon cancila (Hamilton)	1
Hemiramphidae	
Hemiramphus gaimardi (Valenciennes)	1
Cyprinodontidae	
Oryzias melastignus (McClelland)	1
Aplocheilus panchax (Hamilton)	1

Species	Zones
Mugilidae	
Rhinomugil corsula (Hamilton)	1, 2, 3
Mugil cunnesius Valenciennes	2, 3
Mugil parsia (Hamilton)	2, 3
Mugil tade (Forskål)	2, 3
Polynemidae	
Eleutheronema tetradactylum (Shaw)	2, 3
Polydactylus indicus (Shaw)	2, 3
Polynemus paradiseus (Linnaeus)	1, 2, 3
Ophicephalidae (Channidae)	
Channa punctatus (Bloch)	1
Channa gachua (Hamilton)	1
Amphipnoidae	
Amphipnous cuchia (Hamilton)	1
Latidae	
Lates calcarifer (Bloch)	2, 3
Ambassidae	
Ambassis nama (Hamilton)	1
Ambassis ranga (Hamilton)	1
Ambassis baculis (Hamilton)	1
Theraponidae	
Therapon jarbua (Forskål)	3
Sillaginidae	
Sillago sihama (Forskål)	2, 3
Sillago panijus (Hamilton)	2, 3
Carangidae	
Caranx carangus (Bloch)	2
Lutianidae	
Lutianus argentimaculatus (Forskål)	3
Lutianus johnii (Bloch)	3
Leiognathidae	
Leiognathus equula (Forskål)	1
Gerridae	
Gerres oyena (Forskål)	3
Pomadasyidae	
Pomadasys hasta (Bloch)	3
Sciaenidae	
Pseudosiaena coibor (Hamilton)	2, 3
Johnius belangeri (Cuvier)	2, 3
Johnius osseus (Day)	2, 3
Sciaena vogleri (Bleeker)	2, 3
Sciaenoides biauritus (Cantor)	2, 3
Otolithus maculatus (Cuvier)	2, 3
Sciaena sinuata Day	2, 3
Sciaena glauca (Day)	2, 3
Sciaena albida (Cuvier and Valenciennes)	2, 3
Pseudosciaena soldado (Lacépède)	2, 3
Johnius sina (Cuvier)	2, 3
Pama pama (Hamilton)	1, 2, 3

Species	Zones	Species	Zones
Scatophagidae		*Glossogobius elegans* (Kuhl and Hars)	2
Scatophagus argus (Linnaeus)	3	*Glossogobius giuris* (Hamilton)	1, 2, 3
		Apocryptes bato (Hamilton)	1
Nandidae		*Pseudapocryptes lanceolatus* (Bloch and Schneider)	1
Nandus nandus (Hamilton)	1	*Eleotris fusca* Günther	1
		Goboides rubicundus (Bleeker)	2, 3
Kurtidae			
Kurtus sp.	3	**Platycephalidae**	
		Platycephalus insidiator (Forskål)	1
Trichiuridae		*Thysanophrys indicus* (Linnaeus)	1
Trichiurus savala Cuvier	2, 3		
Trichiurus pantului Gupta	2, 3	**Soleidae**	
Trichiurus muticus Gray	2, 3	*Brachirus pan* (Hamilton)	1
Trichiurus intermedius Gray	2, 3		
Trichiurus gangeticus Gupta	2, 3	**Cynoglossidae**	
		Cynoglossus lingua (Hamilton)	2, 3
Stromatoidae		*Cynoglossus cynoglossus* (Hamilton)	2, 3
Pampus argenteus (Euphrasen)	3		
		Mastocembelidae	
Gobiidae		*Mastocembelus armatus* (Lacépède)	1
Boleophthalmus boddaerti (Pallas)	1	*Macrognathus aculeatum* (Bloch)	1
Periophthalmus cantonensis pearsi Eggert	1		
Periophthalmus schlosseri (Bleeker)	1	**Tetrodontidae**	
Gobiopterus chuno (Hamilton)	1	*Monotretus cutculia* (Hamilton)	2, 3
Brachygobius nunus (Hamilton)	1		

TABLE 6. *Important prawns and their observed distribution in the Hooghly-Matlah Estuarine System*

Species	Zones	Species	Zones
Penaeidae		*Macrobrachium kempi* (Tiwari)	1
Penaeus indicus H. Milne-Edwards	2, 3, 4, 5	*Macrobrachium rosenbergii* (de Man)	1, 2, 4
Penaeus monodon Fabricius	3, 4	*Macrobrachium malcolmsonii* (H. Milne-Edwards)	1, 2, 4
Penaeus semisulcatus (de Man)	3, 5	*Macrobrachium lamarrei* (H. Milne-Edwards)	1, 2
Penaeus canaliculatus Oliver	3, 5	*Macrobrachium scabriculum* (Heller)	1, 2, 4
Penaeus longipes Alcock	3, 5	*Macrobrachium rude* (Heller)	1, 2, 3, 4
Metapenaeus brevicornis (H. Milne-Edwards)	All	*Macrobrachium mirabile* (Kemp)	1, 2, 3, 4
Metapenaeus monoceros (Fabricius)	All	*Macrobrachium villosimanus* Tiwari	1, 2, 3, 4
Metapenaeus affinis (H. Milne-Edwards)	3, 5	*Leptocarpus fluminicola* (Kemp)	1, 2, 4
Metapenaeus lysianassa (de Man)	3, 5	*Palaemon styliferus* H. Milne-Edwards	2, 3, 4, 5
Parapenaeopsis sculptilis (Heller)	2, 3, 4, 5	*Palaemon tenuipes* (Henderson)	2, 3, 5
Parapenaeopsis stylifera var *coromandelica* (Alcock)	3, 5		
		Atyidae	
Sergestidae		*Caridina nilotica* var *bengalensis* de Man	1
Acetes indicus H. Milne-Edwards	2, 3, 4, 5	*Caridina propinqua* de Man	1
Palaemonidae		**Hippolytidae**	
Macrobrachium dayanum (Henderson)	1	*Hippolysmata ensirostris* Kemp	3, 5
Macrobrachium australe (Guerin-Menville)	1	*Saron marmoratus* (Oliver)	5

From the biological investigations conducted on the major commercially important fishes of the estuarine system, it is seen that 3 groups may be distinguished among them, viz., (i) the marine fishes which use the estuary as nursing ground, (ii) the species wich migrate into the mouth of the estuary to form important local fisheries, and (iii) freshwater fishes which come into the estuary.

In the first group, hilsa occupies a predominent position. There are 2 runs of the fish up the estuary during each year, one in the monsoon and the other in the winter, to the spawning grounds which are located in the upper reaches of the Hooghly and also in the Rupnarain.

Pama pama also migrates up the estuary for both genetic and tropic reasons and concentrate in the upper zone. Other species which may be indicated in this group are *Mystus gulio* which migrate to the ' true estuarine ' and freshwater zones for spawning and *Osteogeniosus militaris*, which moves up for spawning in the ' true estuarine zone '.

Among the marine species which move into the mouth of estuaries of this system to form fisheries of importance, may be mentioned *Harpodon nehereus, Mugil parsia, M. tade, Trichiurus savala, T. pantulai, Setipinna phasa, S. taty, Sillago panijus, Coilia* spp., *Raconda russeliana, Hilsa toli, Anchoviella* sp., and penaeid prawns.

Some of the palaemonid prawns are examples of freshwater species moving into the estuary proper to form important fisheries. *Macrobrachium dayanum* and *Caridina* spp. are freshwater forms (Rao, 1969). The species of importance which abound in the upper zones and sometimes move into the gradient zone are *Macrobrachium mirabile, M. rude, M. villosimanus, M. malcolmsonii* and *M. rosenbergii.*

It is significant to note that none of the commercially important species of fishes (or prawns) are true residents of this estuarine system. The marine zone of this estuarine system is the most productive and this is evident from the zonal distribution of organisms, especially fish fauna. The fisheries resources of the Hooghly-Matlah Estuarine System are closely related to the fisheries of the adjacent inshore area of West Bengal (Gopalakrishnan, 1968). Taking an overall view, we are still a long way off in understanding fully the complex biological characteristics and variations in this great estuarine system. However, the biological richness of the estuary has been shown and further work leading to greater and fuller exploitation of its potential resources will be well worthwhile.

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