

Ichthyoplankton Assemblages in the Hooghly Estuary, Sagar Island, Sundarbans, West Bengal, India

S. K. SASMAL AND A. CHOUDHURY

*S. D. Marine Biological Research Institute, Bamankhali
Sagar Island, 24 Pgs (S), West Bengal, India*

Abstract

An ichthyoplankton survey (in five sampling sectors in three stations) was conducted in Hooghly estuary in 2008 to assess abundance, distribution and seasonal occurrence of juveniles of estuarine fishes. The ichthyoplankton samples collected with plankton nets (mesh size 550—650 μm). The taxonomic composition of ichthyoplankton comprised 65 taxa with 27 genera, 38 species under 20 families. Maximum abundance of fish juvenile occurred during March to June (pre-monsoon season), minimum abundance during September to February (post-monsoon season). Species diversity was maximum during March to May and lowest during October to January. The most dominant families were Engraulidae (18.5%), Mugilidae (14.6%), Clupeidae (10.8%), Gobiidae (9.2%) and Cynoglossidae (7.4%). Ichthyoplankton samples from all three stations have similar species diversity indices ($H' = 0.56$ —1.19, mean 0.87) and evenness indices ($J' = 0.70$ —0.80, mean 0.75).

Key words : Ichthyoplankton, Taxonomic composition, Species diversity index, Evenness index.

Estuaries are known to be prime spawning and nursery areas for many important commercial and recreational fish species (1—4). Estuaries and coastal lagoons with shallow areas and habitats offer suitable food supply, shelter and eco-physiological conditions for eggs, embryos, larvae and juveniles of fish for development (5—6). West Bengal, a maritime state of the north eastern part of India, adjacent to Bangladesh, is indented at its southern part by numerous river openings. The Hooghly-Matla estuarine complex encompasses numerous large and small islands with mangrove vegetation supporting the world's most magnificent mangrove block—the Sundarbans (7—9). In general, two distinct groups of fish utilize estuaries : Those which are year around residents or migrate into the estuary to spawn, and those that spawn offshore but their eggs, larvae or juveniles enter into the system for nursing (10). There have been few ichthyoplankton surveys conducted in Hooghly estuary of Sundarbans region in the last few decades. Hooghly estuary is biologically most productive, taxonomically diverse and aesthetically celebrated ecosystem of the country (11, 12). The present paper deals with aspects of taxonomic composition, distribution, abundance of ichthyoplank-

ton, Shannon-Weaver species diversity index and evenness index.

Methods

The materials were collected during 2008 from each sampling station and were pooled together to make duplicate set of each sample for each station. The ichthyoplankton sample collected with a plankton net (mesh size 550—650 μm) from 30—35 m depth level. Samples were stored in 4% formaldehyde for identification. Five samples of ichthyoplankton were obtained at each of the three stations in the Hooghly estuary. Sagar Island is surrounded by the river Hooghly on the north-western side and river Mooriganga on the eastern side. The southern part faces the open sea—the Bay of Bengal. However, the station-1 (south Sagar) is located in the southernmost tip of Sagar Island, at the confluence of the Hooghly and Bay of Bengal and the station-2 (north Sagar) is located in the northern part of Sagar Island. The station-3 (Haldia) is located in the upper part of the Hooghly estuary at the confluence of Hooghly and Haldi river. Due to the small size of fish juveniles obtained with the help of plankton nets, some of the

Table 1. Composition and abundance (number of species) of ichthyoplankton on three sampling stations.

Family	Species	Common name	No. of species	Percent of total	Percent of family
Engraulidae	<i>Setipina phasa</i>	Anchovies	12	0.6	18.5
	<i>Setipina</i> sp.			0.4	
	<i>Coilia neglecta</i>			1.2	
	<i>Coilia ramcarati</i>			0.6	
	<i>Coilia</i> sp.			3.2	
	<i>Stolephorus bagenensis</i>			2.2	
	<i>Stolephorus malabaricus</i>			1.8	
	<i>Stolephorus</i> sp.			2.8	
	<i>Thryssa hamiltonii</i>			1.4	
	<i>Thryssa malabaricus</i>			1.3	
	<i>Thryssa</i> sp.			1.4	
	<i>Coilia raynaldi</i>			1.6	
Mugilidae	<i>Mugil cephalus</i>	Mulletts	8	3.6	14.6
	<i>Mugil</i> sp.			0.4	
	<i>Rhinomugil corsula</i>			1.3	
	<i>Rhinomugil</i> sp.			2.4	
	<i>Liza parsia</i>			1.6	
	<i>Liza tade</i>			2.2	
	<i>Liza microlepis</i>			2.3	
	<i>Liza subviridis</i>			0.8	
Clupeidae	<i>Sardinella gibbosa</i>	Sardines	7	0.6	10.8
	<i>Sardinella</i> sp.			0.6	
	<i>Ilisha elongata</i>			2.5	
	<i>Ilisha</i> sp.			1.2	
	<i>Tenualosa ilisha</i>			1.4	
	<i>Tenualosa toli</i>			2.2	
Gobiidae	<i>Boleophthalmus boddarti</i>	Gobies	6	2.6	9.2
	<i>Boleophthalmus viridis</i>			1.6	
	<i>Glossogobius</i> sp.			1.2	
	<i>Pseudopocryptas</i> sp.			0.8	
	<i>Stigmatogobius sadanundio</i>			1.6	
	<i>Stigmatogobius</i> sp.			1.4	
Sciaenidae	<i>Atrubucca nibe</i>	Croakers	2	1.6	3.0
	<i>Johnius belangeri</i>			1.4	
Ariidae	<i>Arius jella</i>	Sea catfish	1	1.5	1.5
Bothidae	<i>Pseudorhombus</i> sp.	Left eye flounders	1	1.5	1.5
Lutjanidae	<i>Lutjanus johni</i>	Snappers	2	1.4	3.0
	<i>Lutjanus malabaricus</i>			1.6	
Sillaginidae	<i>Sillaginopsis panijus</i>	Whitings	3	1.6	4.6
	<i>Sillaginopsis</i> sp.			1.2	
	<i>Sillago</i> sp.			1.5	
Cynoglossidae	<i>Paraplagusia bilineata</i>	Tongue-soles	4	2.8	7.4
	<i>Paraplagusia</i> sp.			3.0	
	<i>Cynoglossus lida</i>			0.2	
	<i>Cynoglossus</i> sp.			1.4	
Leiognathidae	<i>Leiognathus dura</i>	Pony fishes	2	1.5	3.0
	<i>Leiognathus</i> sp.			1.5	
Polynemidae	<i>Eleutheronema tetradactylum</i>	Thread fin	4	2.7	5.7
	<i>Eleutheronema</i> sp.			1.4	
	<i>Polynemus paradiseus</i>			0.6	
	<i>Polynemus</i> sp.			1.0	
Eleotrididae	<i>Odontamblyopus rubicandus</i>	Sleepers	2	1.6	3.0
	<i>Odontamblyopus</i> sp.			1.4	

Table 1. Continued.

Family	Species	Common name	No. of species	Percent of total	Percent family
Tetradontidae	<i>Gastrophysus lunaris</i>	Puffer fishes	2	1.3	3.0
	<i>Tetradon</i> sp.			1.7	
Hemiramphidae	<i>Hemiramphus</i> sp.	Halfbeaks	2	1.8	3.0
	<i>Zenarchopterus</i> sp.			1.2	
Syngnathidae	<i>Trachyrhamplis serratus</i>	Pipe fishes	1	1.5	1.5
Platycephalidae	<i>Platycephalus indicus</i>	Flatheads	2	1.2	3.0
	<i>Platycephalus</i> sp.			1.8	
Serranidae	<i>Epinephelus</i> sp.	Sea-basses	1	1.5	1.5
Ophichthidae	<i>Pisodonophis boro</i>	Snake-eels	1	1.5	1.5
Teraponidae	<i>Terapon jarbua</i>	Grunters	2	1.6	3.0
	<i>Terapon</i> sp.			1.4	

juveniles did not possess useful diagnostic characters and were not identified even at the family level. However, the identification of ichthyoplankton was done by expert member of the Zoological Survey of India, Kolkata.

Taxonomic composition, distribution and abundance of family of ichthyoplankton, Shannon-Weaver species diversity index and evenness index were studied. Species diversity was estimated using the Shannon-Weaver diversity index (H') using the equations given by Shannon-Weaver (13)

$$S \sum_{i=1}^S (N_i/N) \log_2 (N_i/N)$$

Where, S is the total no. of species; N is the total number of individuals; N_i is the no. of specimens in sample i.

Evenness index (J') was calculated using following equation given by Pielou (14).

$$J' = H' / \log_2 S.$$

Results and Discussion

Taxonomic Composition

In total, 65 taxa of which 27 genera, 38 species under 20 families were identified in three sampling stations of Hooghly estuary (Table 1). The number of juvenile per sampling ranged from 3.5 to 7.6 per 1,000 m³ water volume filtered (means 5.5 specimens/1,000 m³). The composition of the samples was represented

almost exclusively by juveniles of fin fish and shell fish. Maximum juvenile abundance occurred in during March to June (pre-monsoon season) in all sampling stations. Diversity of juvenile was greatest during March to May with the greatest number of species (65) being taken during April (Tables 1 and 2). The mean value of species diversity indices were 0.88, 1.19 and 0.56 in successive stations. The mean value of evenness indices were in 0.80, 0.77 and 0.70 in respective sampling stations (Table 2). However, species diversity index and evenness index were highest during May and lowest during September.

Abundance of Family

Family Engraulidae. Juveniles of family Engraulidae (anchovies) was dominant in each sample and comprised 18.5% of all samples collected. This family was represented by 4 genera 8 species. The most abundant species of Engraulidae was *Stolephorus bagenensis* (3.2%), other species composition was less than 1.5% of total number (Table 1).

Family Mugilidae. The second most abundant family was Mugilidae (Mulletts) whose juveniles comprised 14.6% of the total collection. This family was represented by 3 genera and 5 species of which *Mugil cephalus* (3.6%) was found at all stations and was the most abundant among all species of this family. *Liza parsia* (2.4%), *Liza tade* (1.6%), *Liza microlepis* (2.2%), and *Liza subviridis* (2.3%), were present at almost all the stations (Table 1).

Family Clupeidae. The third abundant family Clupeidae (sardines) comprised 10.8% and repre-

Table 2. Monthly variation of Shannon-Weaver species diversity index and evenness index among different sampling stations.

Months	Station 1		Station 2		Station 3	
	Species diversity index	Evenness index	Species diversity index	Evenness index	Species diversity index	Evenness index
Jan 2008	1.36	0.84	1.24	0.87	0.46	0.77
Feb	1.12	0.86	1.14	0.85	0.46	0.76
Mar	1.30	0.78	1.23	0.86	0.54	0.58
Apr	1.65	0.82	1.65	0.87	0.64	0.64
May	1.74	0.84	1.68	0.91	0.82	0.68
Jun	1.54	1.97	1.71	0.94	0.72	0.83
Jul	1.24	0.72	1.59	0.82	0.64	0.72
Aug	0.94	0.62	1.27	0.63	0.50	0.65
Sep	0.84	0.52	0.51	0.55	0.62	0.71
Oct	1.56	0.61	0.84	0.60	0.52	0.68
Nov	1.43	0.64	0.76	0.64	0.45	0.69
Dec	1.32	0.83	0.68	0.73	0.46	0.74

sented by 3 genera and 4 species. The most abundant species was *Ilisha elongata* (2.5%) found at stations-1 and 2.

Family Gobiidae. The fourth abundant family was Gobiidae (Gobies), (9.2%) and represented by 2 genera and 4 species of which *Boleophthalmus boddarti* (2.6%), *Boleophthalmus viridis* (1.6%) and *Stigmatogobius sadanundio* (1.6%) were found at all the stations (Table 1).

Family Cynoglossidae. The fifth abundant family Cynoglossidae (Tongue-soles) comprised 7.4% of all samples collected and overall, 2 genera 2 species were identified. The most abundant species of Cynoglossidae were *Paraplagusia* sp. (3.0%), *Paraplagusia bilineata* (2.8%), *Cynoglossus lida* (0.2%), and *Cynoglossus* sp. (1.4%).

The ten families such as Sciaenidae (croakers), Sillaginidae (whittings), Lutjanidae (snappers), Leignathidae (pony fishes), Polynemidae (thread fin), Eleotrididae (sleepers), Tetradontidae (puffer fishes), Hemiramphidae (halfbeaks), Platycephalidae (flat heads) and Teraponidae (grunters) were represented by 2—4 species and were far less abundant. The five families such as Ariidae (sea catfish), Bothidae (left eye flounders), Syngnathidae (pipe fishes), Ophichthidae (snake-eels) and Serranidae (sea-basses) were represented by single species (Table 1). The most often occurring species were *Polynemus*

sp. *Sillago* sp., *Tenualosa toli*, *Tenualosa ilisha* and *Cynoglossus lida*.

Ichthyoplankton samples from all three stations have similar diversity indices ($H' = 0.56—1.19$, mean 0.87), and evenness indices ($J' = 7.07—0.809$, mean 0.75) (Table 2). Differences in species richness were small, with the exception of station 3 where only 17 species were recorded during investigation period.

Only juvenile of 20 families were collected on three sampling stations of Hooghly estuary. The number of juvenile at different stations vary in different seasons of a year. However, the family Engraulidae was quantitatively dominant (18.5%, total no. of species 12). The most frequent and abundant species were *Boleophthalmus boddarti*, *Lutjanus johni*, *Stolephorus bagenensis*, *Thryssa hamiltonii*, *Mugil cephalus*, *Liza parsia* and *Liza tade*. The analysis of ichthyoplankton data from the Hooghly estuary in the Sundarbans reveals high species richness and a high degree of faunal similarity between samples separated by a long distance. To simplify the discussion, only species names will be mentioned, implying that reference is made to early life stage of this species. Recent studies indicate that pelagic ecosystems of the Sundarbans can contain significantly more species than thought.

The occurrence of early life history stages of different species of fish in Hooghly estuary suggests that this estuary is an important spawning and nursery grounds for several species of fish. The most highly impacted regions of the estuary in stations-3 (upper part of Hooghly estuary) showed the greatest decline in ichthyoplankton diversity. The station-1 showed maximum abundance and taxonomic composition of ichthyoplankton than stations 2 and 3. Station-1 showed greatest diversity and station-3 showed lowest diversity of ichthyoplankton.

References

1. Mc. Hugh J. L. 1985. The estuarine ecosystem integrated. Foreword. Pages 9—16 in A. Yanez Arancibia, editor. Fish community ecology in estuarine and coastal lagoons : Towards an ecosystem integration. Universidad Nacional Autonoma de Mexico PAUL-ICML. Editorial Universitaria. Mexico.
2. Powles H., F. Auger and G. J. Fitzgrald. 1984. Near-shore ichthyoplankton of a north temperature estuary. Can. J. Fish. and Aquat. Sci. 41 : 1653—1663.
3. Day J. W. J. R. L., A. Deegan, J. G. Gosselink, A. Jr.

- Yanezarancibia, G. P. Soberon-Chavez and P. Sanchez-Gil. 1985. Relationships among primary productivity, fisheries yield, and physical characteristics of the Gulf of Mexico estuaries. *Estuaries* 8 : 3A.
4. Yeomans L. V. 2000. Seasonal variation of ichthyoplankton in a western Caribbean Bay system. *Environ. Biol. Fish.* 58 : 379—392.
 5. Sasmal S. K., A. Kaviraj, A. Choudhury and A. Mitra. 1998. Community structure of ichthyoplankton in the coastal zone of West Bengal, India. *J. Riv. Res.* 25 : 80—83.
 6. Slavik O. and L. Bartos. 2001. Spatial distribution and temporal variance of fish communities in the channelized and regulated Vltava river (central Europe). *Env. Biol. Fish.* 61 : 47—55.
 7. Mitra A., S. K. Sasmal, A. Choudhury, S. Mitra and D. P. Bhattacharyya. 1999. Ichthyoplankton richness around Sagar Island, West Bengal, India. *J. Inland Fish. Soc. India* 31 : 38—42.
 8. Trivedi S., A. Mitra, A. Choudhury, A. Gupta, B. Singh and A. Choudhury. 1994. A case study on the loss of bio-diversity during prawn seed collection from the Hugli estuary, India. *Proc. Nat. Conv. on Env. of India. Challenges for the 21st Century*, IPHE. India.
 9. Aich A., A. Mitra, S. Niyogi, A. Mishra, B. Singh and A. Choudhury. 1996. Seasonal biodiversity of ichthyoplankton in relation to dissolved trace metal, salinity and nutrients around Sagar Island, West Bengal, India. Pages 121—124 in C. S. P. Iyer, editor. *Advances in environmental science*. Educ. Publ. and Distr., New Delhi, India.
 10. Boehlert G. W. and B. C. Mundy. 1988. Roles of behavioral and physical factors in larval and juvenile fish recruitment to estuarine nursery areas. *Am. Fish. Soc. Symp.* 3 : 51—67.
 11. Choudhury R., A. Mitra, S. Mitra, S. K. Sasmal and D. P. Bhattacharyya. 1999. Zinc, copper and lead content in sea water and salt marsh grass from north east coast of Bay of Bengal. *J. Inland Fish. Soc. India* 31 : 18—21.
 12. Sasmal S. K., A. Choudhury and A. Kaviraj. 2000. Inter-relationship between diversity of finfish juveniles and mangroves in Sagar Island, West Bengal, India. *Nat. Conf. on application of biotechnology in marine and estuarine environment*. Science City, 18—19 Nov 2000, Calcutta, India.
 13. Shannon C. E. and W. Weaver. 1963. The mathematical theory of communication. *Univ. Illinois, Urbana*. pp. 117—125.
 14. Pielou E. C. 1966. The measurement of diversity in different types of biological collections. *J. Theor. Biol.* 13 : 131—144.