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Study on the Distribution of Fin Fish Juveniles in Few Selected Rivers of Indian Sundarbans

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Abstract: Regular sampling of juvenile fish fauna over 12 months (from March 2010- February 2011) in and adjacent creeks of three rivers in one of the largest mangrove area of the world, Indian Sundarbans, revealed a difference in the species distribution and diversity. Mangrove swamps often creates a complex ecosystems linked by biological and physical processes. A total of 92 types of juveniles of different finfish species were recorded along with their river wise distribution in three different seasons. Different diversity indices were analyzed as well as different statistical tests was performed to understand the pattern of distribution in three rivers (Hetania Doania, Muriganga and Saptamukhi) in premonsoon, monsoon and postmonsoon period.

Key words: Fish Fauna % Mangrove % Nursery % Diversity Indices % Statistical Tests

INTRODUCTION

Tropical mangroves of Australia have commonly been found to harbor high densities of juvenile fish [1-3] and make a large contribution to coastal fisheries productivity. The fish fauna of the Bangladesh Sundarban includes 53 pelagic and 124 demersal species [4, 5]. Of these, over 120 species have been recorded in commercial catches [6]. The Indian Sundarban supports a similar number of species (165 species) [7]. The fish diversity is directly related to the salinity gradients in different parts of the Sundarban. Understanding the degree of utilization of mangrove habitats by fish communities is important in aiding the development and implementation of effective resource management programs.

Several reasons have been proposed for the use of mangroves and seagrass beds by fish as juvenile habitats, including: (1) their function as a refuge from predation [8, 9], (2) the abundance of feeding resources [10, 11], (3) their ability to intercept planktonic fish larvae [8], (4) the reduced predator density [8] and (5) the turbidity decreasing the foraging efficiency of predators [9]. Vegetated areas (areas covered by mangrove trees), treeless mudflats and creeks are three main types of habitats of mangrove estuaries [12]. Mangrove estuaries vary greatly in levels of structural complexity among habitats. Different habitats within mangrove estuaries provide various levels of food and shelter for fish, which may influence the fauna assemblages across habitats [12, 13]. Gill net, trawl net and seine net are commonly used gears in mangrove-fish research [14-16]. However, well developed aerial roots of mangrove plants make it almost impractical to sample fish within vegetated areas of mangroves using these gears [15, 17]. While many investigators have argued that mangrove habitats may serve as important fish nurseries, most of their claims are not based on comparative studies [12, 18]. Until now, no study was investigated the heterogeneity of juvenile fish assemblages in different rivers in Indian Sundarbans because most studies were based on the adult fish diversity and the by catch problem.

The aims of the study were to (1) determine the juvenile fish diversity in the mangrove dominated estuary, (2) whether Sundarban mangrove habitat operates as

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nursery ground for juvenile fin fish species and (3) to describe seasonal variations in density and species composition of juvenile fish communities in mangrove mudflats. Fish communities in the different habitats of mangroves were compared on the basis of species richness, abundance and variation of juvenile fish species.

MATERIALS AND METHODS

Description of Study Area: These rivers are highly characterized by the difference of hydrological differences and the density and distribution of mangrove plant species. Mangrove forests were dominated by *Avicennia alba and Avicennia officinalis* followed by *Ceriops tagal* and *Brugeira gymnorhyza*.

The present study was conducted during March 2010- February 2011 in the three rivers of Indian Sundarbans Muriganga, Hetania, Doania and Saptamukhi Rivers were chosen for the study Muriganga River is a distributary channel of the River Hooghly originates due to bifurcation of Hooghly River passing through the Sagar Island in South 24 Parganas District in the Indian state of West Bengal. Saptamukhi River is a tidal estuarine river in and around the Sundarbans in South 24 Parganas District in the Indian state of West Bengal which originates near Sultanpur and flows between Kulpi and Mathurapur blocks. It has a connection with the Muriganga River through the Hetania Doania River.

It falls to the Bay of Bengal with a wide mouth after traversing about 80 kilometers. The fin fish juveniles were collected every fortnightly in different seasons (premonsoon, monsoon and postmoonsoon) from the rivers named Hetania Doania (Latti 21.763E- 21.737E and Longi 88.220N- 88.266N), Muriganga (Latti 21.842E - 21.652E and Longi 88.177N- 88.176N) and Saptamukhi (Latti 21.721E- 21.618E and Longi 88.281N- 88.374N).

Sampling Methods: Juvenile fin fishes were collected by using bag net, seine net, trawl net and trap net or mosquito net.

Fish Preservation and Identification: The collected samples were preserved in 2% formalin solution and were identified following by Talwar *et al*., Talwar & Kacker, Talwar & Jhingran and Fish Base [19- 21].

Statistical Software: Microsoft Excel, PAST and SPSS version 10.0 were used for statistical analysis.

RESULTS

The total numbers of 92 juvenile fish species were recorded during our study period from three rivers of Indian Sundarban Biosphere Reserve (Table 1). The maximum varieties of estuarine juvenile fin fishes were recorded in Hetania Doania River during premonsoon, in Muriganga during monsoon and in

Table 1: List of juvenile fish species documented from the study sites of Sundarban mangroves with their distribution

Code No.	Scientific name	Local name	Order	Family	Pre Mon	Mon	Post Mon
sp1	*Herpodon nehereus*	Lote	Myctophiformes	Herpodontidae	H,M,S	H,M,	H,M,S
sp2	*Coilia reynaldi*	Jat Amude	Clupeiformes	Engraulidae	H,M,S	H,M,S	H,M,S
sp3	*Coilia neglecta*	Rupoli Amude	Clupeiformes	Engraulidae	H,M,S	M,S	S
sp 4	*Setipinna phansa*	Phansa	Clupeiformes	Engraulidae	M		H,S
sp 5	*Thryssa hamiltoni*	Ram phansa	Clupeiformes	Engraulidae	H,M,S		S
sp 6	*Setipinna taty*	Lal phansa	Clupeiformes	Engraulidae		H,M,S	S
sp 7	*Setipinna tenuifilis*	Sada phansa	Clupeiformes	Engraulidae	S	H	H,M,S
sp 8	*Corica soborna*	Nadi chuno	Clupeiformes	Clupeidae	H,M,S	H,M,S	H,M,S
sp 9	*Stolephorus commerson*	Gab chuno	Clupeiformes	Engraulidae	H,M,S	H,M,S	S
sp10	*Orygius melastigma*	Baishnab chuno	Cyprinodontiformes	Oryziidae	H		
sp11	*Escuslosa thoracata*	Mourala chuno	Clupeiformes	Clupeidae		H	S
sp12	*Gobiopterus chuno*	Amta chuno	Perciformes	Gobiidae	H		
sp13	*Otolithoides pama*	Jat Bhola	Perciformes	Sciaenidae	H,M,S	H,M,S	H,M,S
sp14	*Chrysochir aureus*	Madhu bhola	Perciformes	Sciaenidae	H,M,S	H,M,S	S
sp15	*Panna microdon*	Pote bhola	Perciformes	Sciaenidae	H,S		H,M,S
sp16	*Dasciaena albida*	Surungi bhola	Perciformes	Sciaenidae	H	M,S	H,S
sp17	*Upeneus mollucensis*	Rekha bhola	Perciformes	Mullidae	S	H,M	S
sp18	*Johnius coitor*	Kath bhola	Perciformes	Sciaenidae	H,S	H	H,S
sp19	*Lutjanus argenticulatus*	Lal bhola	Perciformes	Lutjanidae		M	
sp20	*Nibea saldado*	Karkat bhola	Perciformes	Sciaenidae			S
sp21	*Johnius gangeticus*	Bhola	Perciformes	Sciaenidae	S	M	S

Table 1: Continue

Code No.	Scientific name	Local name	Order	Family	Pre Mon	Mon	Post Mon
sp22	*Lates calcarifer*	Bhetki	Perciformes	Centropomidae			S
sp23	*Gerres oyena*	Chand bhetki	Perciformes	Gerreidae	H	M	H,M,S
sp24	*Mugil cephalus*	Gol parse	Perciformes	Mugilidae	H,M,S	H,M,S	S
sp25	*Mugil parsia*	Chota parse	Perciformes	Mugilidae	H,M,S	H,M,S	M,S
sp26	*Liza macrolepis*	Bhuti parse	Perciformes	Mugilidae	M,S	M	S
sp27	*Mugil tade*	Bhangan	Perciformes	Mugilidae			S
sp28	*Rhinomugil korsula*	Domra	Perciformes	Mugilidae	H		
sp29	*Bregmaceros maccleandi*	Rule	Gadiformes	Bregmacerotidae	S,M		S
sp30	*Pseudapocryptes lanceolatus*	Guley	Perciformes	Gobiidae	H,M	H	
sp31	*Taenioides anguillaris*	Lal cheoa	Perciformes	Gobioididae	H,M,S	H,M,S	H,M,S
sp32	*Taenioides buchanani*	Kalo cheoa	Perciformes	Gobioididae	H	H,M	H,M,S
sp33	*Odontamblyopus rubicondus*	Sada cheoa	Perciformes	Gobioididae		M	S
sp34	*Anguilla bengalensis*	Kuche	Anguilliformes	Ophichthidae	H,S	H	
sp35	*Pisodonophis boro*	Sona bam	Anguilliformes		S		S
sp36	*Glossogobius guiris*	Bele	Perciformes	Gobiidae	H,M,S	H,M	H,S
sp37	*Platycephalus indicus*	Chota bele	Scorpaeniformes	Platycephalidae	H,S		S
sp38	*Bolepthalmus dussumieri*	Daku	Perciformes	Gobiidae	H	H,M	
sp39	*Periopthalmus weberi*	Menu 1	Perciformes	Gobiidae	H	H	M
sp40	*Periopthalmodon schlosseri*	Menu 2	Perciformes	Gobiidae	H	H	M
sp41	*Butis butis*	Bheto	Perciformes	Eleotridae	H,S	M	S
sp42	*Brachygobius nunas*	Kalo chhap bele	Perciformes	Gobiidae			S
sp43	*Stigmatogobius sadanandio*	Sabuj chhap bele	Perciformes	Gobiidae			S
sp44	*Sillaginopsis panijus*	Tul Bele	Perciformes	Sillaginidae			H,S
sp45	*Lepturacanthus pantului*	Fita	Perciformes	Trichuiridae	S	H	
sp46	*Trichiurus gangeticus*	Chhuri fita	Perciformes	Trichuiridae	S	H,M	S
sp47	*Polynemus paradiseus*	Topse	Perciformes	Polynemidae	H,M,S	M,S	S
sp48	*Eleutheronema tetradactylum*	Gurjali	Perciformes	Polynemidae	S		
sp49	*Lepturacanthus savla*	Sada fita	Perciformes	Trchuiridae			S
sp50	*Polydactylus indicus*	Shele	Perciformes	Polynemidae	H,S	S,M	M
sp51	*Ilisha elongata*	Rupsa	Clupeiformes	Clupeidae		H,M,S	
sp52	*Tenualosa ilisha*	Ilish	Clupeiformes	Clupeidae		M,S	S
sp53	*Hilsa toli*	Chandana Ilish	Clupeiformes	Clupeidae	H		
sp54	*Gadusia chapra*	Khaira	Clupeiformes	Clupeidae	H,M,S		S
sp55	*Cynoglossus cynoglossus*	Salfish	Pleuronectiformes	Soleidae	H,M	H	
sp56	*Paraplagusia bilineata*	Jat salfish	Pleuronectiformes	Soleidae	S		S
sp57	*Pseudorhombus javanicus*	Bhhut pata	Pleuronectiformes	Bothidae	H		S
sp58	*Cynoglossus lingua*	Pata macch	Pleuronectiformes	Soleidae			S
sp59	*Tetraodon cutcutia*	Tapa	Tetraodontiformes	Tetraodontidae	H,M,S		
sp60	*Gerriomorpha setifer*	Tekati	Perciformes	Gerreidae	H,M,S	H	S
sp61	*Leiognathus blochii*	Chanda baro nadi	Perciformes	Leiognathidae			S
sp62	*Pampus argenteus*	Pomfret	Perciformes	Stromateidae		M,S	
sp63	*Pampus chinensis*	Kalo pomfret	Perciformes	Stromateidae	H		
sp64	*Lutjanus johni*	Pankhai	Perciformes	Lutjanidae			S
sp65	*Elops machnata*	Lanka	Elopiformes	Elopidae		M	S
sp66	*Terapon jerbua*	Kath koi	Perciformes	Teraponidae	H	H,M	
sp67	*Scatophagus argus*	Paira Chanda	Perciformes	Scatophagidae	H,S	H,M,S	
sp68	*Gazza minuta*	Samudra baro chanda	Perciformes	Leiognathidae	H,S		
sp69	*Acanthopagrus latus*	Datne	Perciformes	Sparidae	H		H,S
sp70	*Strongylura strongylura*	Bak	Cyprinodintiformes	Belonidae	H	M	S
sp71	*Xenentodon cancila*	Bak	Cyprinodontiformes	Belonidae	S		
sp72	*Sardinella longiceps*	Sardin	Clupeiformes	Clupeidae		M,S	
sp73	*Rastrelliger canagurta*	Mackerel	Perciformes	Scombridae		H,M	
sp74	*Mystus bleekeri*	Nadi tengra	Siluriformes	Bagridae	H,M,S		S
sp75	*Aruis aruis*	Med kanta	Siluriformes	Ariidae	H,S		
sp76	*Arius thassinus*	Sul kanta	Siluriformes	Ariidae	H,M	H,M	
sp77	*Arius gagora*	Gagor kanta	Siluriformes	Ariidae	H		

Table 1: Continue

Code No.	Scientific name	Local name	Order	Family	Pre Mon	Mon	Post Mon
sp78	*Alepes jedaba*	Kane poka	Perciformes	Carangidae		H	
sp79	*Pellona ditchella*	Dhala	Clupeiformes	Clupeidae	S	M	
sp80	*Atropus atropus*	Taka	Perciformes	Carangidae		H,M	
sp81	*Leiognathus fasciatus*	Chhoto chanda	Perciformes	Leiognathidae		S	S
sp82	*Secutor ruconius*	Muk baka chanda	Perciformes	Leiognathidae		M	
sp83	*Leiognathus equulus*	Chanda	Perciformes	Leiognathidae	H,S	H	S
sp84	*Mystus gulio*	Nona Tengra	Siluriformes	Bagridae	H		
sp85	*Raconda russeliana*	Dhala chuno	Clupeiformes	Clupeidae		M,S	M,S
sp86	*Upeneus guttatus*	Sundari	Perciformes	Mullidae	H	H	
sp87	*Toxotes chatereus*	Goti Poa/Chuno	Perciformes	Toxotidae		M	
sp88	*Drepane punctata*	Baul pomfret	Perciformes	Drepanidae	H		
sp89	*Selar boops*	Aila	Perciformes	Carangidae			S
sp90	*Selar mate*	Khapkhapi	Perciformes	Carangidae			S
sp91	*Ophisopterus tadpore*	Pata dhala	Clupeiformes	Clupeidae		M	S
sp92	*Hilsa kelee*	Kokila	Clupeiformes	Clupeidae			S

Table 2: Different diversity indices in different rivers in three different seasons

	Hetania Doania			Muriganga			Saptamukhi		
Index	Pre Mon	Mon	Post Mon	Pre Mon	Mon	Post Mon	Pre Mon	Mon	Post Mon
Dominance_D	0.165	0.167	0.121	0.275	0.092	0.128	0.115	0.241	0.098
Simpson_1-D	0.835	0.833	0.879	0.725	0.908	0.872	0.885	0.759	0.902
Shannon_H	2.25	2.34	2.33	1.86	2.74	2.29	2.43	1.92	2.29
Evenness_e^H/S	0.197	0.313	0.686	0.293	0.417	0.756	0.291	0.38	0.395

Table 3: List of juvenile finfish species with their level of correlations with other species

Code number of the sp	Scientific names	Code numbers of correlated sp (significant level 0.05)	Code numbers of highly correlated sp (significant level 0.01)
1	*Herpodon nehereus*	54,57,83	5,25,37,60,74
2	*Coilia reynaldi*	45,34	83
3	*Coilia neglecta*	5,13,25,74	26,29,54
4	*Setipinna phansa*	44,36, (50,67)	-
5	*Thryssa hamiltoni*	3,9,24,29,68,75	1,25,37,54,59,60,74
6	*Setipinna taty*	51,62	52
7	*Setipinna tenuifilis*	-	(47)
8	*Corica soborna*	9,13,24,67,68,75	-
9	*Stolephorus commerson*	5,8,13,14,25,37,68,74,75,83	24,41
10	*Orygius melastigma*	-	12,53,63,77,84,88
11	*Escuslosa thoracata*	17,20,22,27,42,43,45,49,58,61,64,89,90,92	-
12	*Gobiopterus chuno*	-	10,28,53,63
13	*Otolithoides pama*	3,8,9,41,68,75	24
14	*Chrysochir aureus*	6,9,21,24,33,52,65,70,91	-
15	*Panna microdon*	23,37,41,44,57,(51)	69
16	*Dasciaena albida*	-	52,62
17	*Upeneus mollucensis*	11,21,26,35	45,46,56
18	*Johnius coitor*	44,69	-
19	*Lutjanus argenticulatus*	62,73,79,80,91	82
20	*Nibea saldado*	11,33,44,56,57,65,81	22,27,42,43,49,58,61,64,89,90,92
21	*Johnius gangeticus*	14,17,41,46,79	26,33,65,91
22	*Lates calcarifer*	11,33,44,56,57,65,81	20,27,42,43,49,58,61,89,90,92
23	*Gerres oyena*	15,33,41,57	22,64,70
24	*Mugil cephalus*	5,8,14,25,41,68,75	9,13
25	*Mugil parsia*	3,9,24,37,59,68,75,83	1,5,54,60,74
26	*Liza macrolepis*	3,17,35,46,54	29,56
27	*Mugil tade*	33,44,56,57,65,81	20,22,42,43,49,58,61,64,89,90,92

Table 3: Continue

Code number of the sp	Scientific names	Code numbers of correlated sp (significant level 0.05)	Code numbers of highly correlated sp (significant level 0.01)
28	*Rhinomugil korsula*	10,12,77	53,63,84,88
29	*Bregmaceros maccleandi*	5,35,56	3,26,54
30	*Pseudapocryptes lanceolatus*	34,38,40,66	55,86
31	*Taenioides anguillaris*	-	-
32	*Taenioides buchanani*	-	-
33	*Odontamblyopus rubicondus*	14,20,22,23,27,41,42,43,49,58,61,64,70,89,90,92	21,65,91
34	*Anguilla bengalensis*	2,30,38,40,66,67,68,75	83,86
35	*Pisodonophis boro*	17,26,29,37,48,71	46,54,56
36	*Glossogobius guiris*	4,(50)	-
37	*Platycephalus indicus*	9,15,25,35,41,54,56,69,70	1,5,57,60,74
38	*Bolepthalmus dussumieri*	30,34,40,67	66,86
39	*Periopthalmus weberi*	-	40,86
40	*Periopthalmodon schlosseri*	34,38,66	39,86
41	*Butis butis*	13,14,23,24,33,37,57,65,91	9,70
42	*Brachygobius nunas*	11,33,56,57,65,81	20,22,27,43,49,58,61,64,89,90,92
43	*Stigmatogobius sadanandio*	11,33,44,56,57,65,81	20,22,27,42,49,58,61,64,89,90,92
44	*Sillaginopsis panijus*	4,15,18,20,22,27,42,43,49,58,61,64,69,89,90,92	-
45	*Lepturacanthus pantului*	2,11,46,78	17,83
46	*Trichiurus gangeticus*	21,26,45,56	17,35
47	*Polynemus paradiseus*	-	7
48	*Eleutheronema tetradactylum*	35,68,75	71
49	*Lepturacanthus savla*	11,33,44,56,57,65,81	20,22,27,42,43,58,61,64,89,90,92
50	*Polydactylus indicus*	(4,36)	-
51	*Ilisha elongata*	6,62	73,80
52	*Tenualosa ilisha*	14,16,81	6,62
53	*Hilsa toli*		10,12,28,63,77,84,88
54	*Gadusia chapra*	1,26,37,56,59,60	3,5,25,29,35,74
55	*Cynoglossus cynoglossus*	-	30,86
56	*Paraplagusia bilineata*	20,22,27,29,37,42,43,46,49,54,58,60,61,64,89,90,92	17,26,35
57	*Pseudorhombus javanicus*	1,15,20,22,23,27,41,42,43,58,60,61,64,89,90,92	37,69,70
58	*Cynoglossus lingua*	11,33,56,57,65,81	20,22,27,42,43,49,61,64,89,90,92
59	*Tetraodon cutcutia*	25,54,75	5
60	*Gerriomorpha setifer*	25,56,57,83	1,5,37
61	*Leiognathus blochii*	11,33,44,56,57,65,81	20,22,27,42,43,49,58,64,89,90,92
62	*Pampus argenteus*	6,16,19,51,82	2,52
63	*Pampus chinensis*	-	10,12,28,53,77,84,88
64	*Lutjanus johni*	11,33,44,56,57,65,81	20,22,27,42,43,49,58,61,89,90,92
65	*Elops machnata*	14,20,22,23,27,41,42,43,49,58,61,64,70,89,90,92	21,33,91
66	*Terapon jerbua*	30,34,40,67	38,86
67	*Scatophagus argus*	8,34,38,66,86,(4)	-
68	*Gazza minuta*	5,8,9,13,24,25,34,48,59,71,74,83	75
69	*Acanthopagrus latus*	18,23,37,44,70	15,57
70	*Strongylura strongylura*	14,33,37,65,69,91	23,41,57
71	*Xenentodon cancila*	35,68,75	48
72	*Sardinella longiceps*	-	-
73	*Rastrelliger canagurta*	19,82	51,80
74	*Mystus bleekeri*	3,9,68,75	1,5,25,37,54,59,60
75	*Aruis aruis*	5,8,9,13,24,25,34,48,59,71,74,83	68
76	*Arius thassinus*	-	-
77	*Arius gagora*	-	10,12,28,53,63,84,88
78	*Alepes jedaba*	45	-
79	*Pellona ditchella*	19,21,82	-
80	*Atropus atropus*	19,82	51,73
81	*Leiognathus fasciatus*	20,22,27,42,43,49,52,58,64,89,92	-
82	*Secutor ruconius*	61,62,73,79,80,91	19

Table 3: Continue

Code number of the sp	Scientific names	Code numbers of correlated sp (significant level 0.05)	Code numbers of highly correlated sp (significant level 0.01)
83	*Leiognathus equulus*	1,9,25,60,68,75	2,34,45
84	*Mystus gulio*	-	10,12,28,53,63,77,88
85	*Raconda russeliana*	-	
86	*Upeneus guttatus*	67	30,34,38,39,40,55,66
87	*Toxotes chatereus*	-	
88	*Drepane punctata*	-	10,12,28,53,63,77,84
89	*Selar boops*	11,33,44,56,57,65,81	20,22,27,42,43,49,58,61,64,92
90	*Selar mate*	11,33,44,56,57,65,81	20,22,27,42,43,49,58,61,89,92
91	*Ophisopterus tadpore*	14,19,41,70,82	21,33,64,65
92	*Hilsa kelee*	11,33,44,56,57,65,81	20,22,27,42,43,49,58,61,64,89,90

*(Result)indicates negative correlation

Table 4: Duncan test result of sp5 for different seasons

	N	Subset for alpha = .05	
SEASON		1	2
2	3	.22	
3	3	.90	.90
1	3		2.22
Sig.		.292	.064

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000. *(Season 1=Premonsoon, Season 2=Monsoon, Season 3=Postmonsoon)

Table 5: Duncan test result of sp6 for different seasons

	N	Subset for alpha = .05	
SEASON		1	2
1	3	.22	
3	3	1.75	1.75
2	3		9.18
Sig.		.679	.079

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 6: Duncan test result of sp51 for different seasons

	N	Subset for alpha = .05	
SEASON		1	2
1	3	.22	
3	3	.22	
2	3		2.67
Sig.		1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 7: Duncan test result of sp 59 for different seasons

	N	Subset for alpha = .05		
SEASON		1	2	3
2	3	.22		
3	3		.22	
1	3			1.02
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 8: Duncan test result of SP 72 for different seasons

	N	Subset for alpha = .05		
SEASON		1	2	3
1	3	.22		
2	3		.22	
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 9: Duncan test result of sp74 for different seasons

	N	Subset for alpha = .05	
SEASON		1	2
2	3	.22	
3	3		.63
1	3		2.70
Sig.		.616	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 10: Duncan test result of SP 76 for different seasons

	N	Subset for alpha = .05		
SEASON		1	2	3
1	3	.22		
2	3		.22	
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 11: Duncan test result of sp 85 for different seasons

	N	Subset for alpha = .05		
SEASON		1	2	3
1	3	.22		
2	3		.22	
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 12: Duncan test result of SP 87 for different seasons

	N	Subset for alpha = .05		
SEASON		1	2	3
1	3	.22		
2	3		.22	
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 13: Duncan test result of sp18 for different rivers

	N	Subset for alpha = .05	
RIVER		1	2
2	3	.22	
3	3	1.47	1.47
1	3		3.05
Sig.		.203	.121

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000. *(River 1=Hetania Doania, River 2= Muriganga, River 3= Saptamukhi)

Table 14: Duncan test result of sp72 for different rivers

	N	Subset for alpha = .05		
RIVER		1	2	3
1	3	.22		
2	3		.22	
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 15: Duncan test result of sp76 for different rivers

		Subset for alpha = .05		
RIVER	N	1	2	3
1	3	.22		
2	3	.22		
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 16: Duncan test result of sp85 for different rivers

		Subset for alpha = .05		
RIVER	N	1	2	3
1	3	.22		
2	3		.22	
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed. Uses Harmonic Mean Sample Size = 3.000.

Table 17: Duncan test result of sp87 for different rivers

		Subset for alpha = .05		
RIVER	N	1	2	3
1	3	.22		
2	3		.22	
3	3			.22
Sig.		1.000	1.000	1.000

Means for groups in homogeneous subsets are displayed.
Uses Harmonic Mean Sample Size = 3.000.

Table 18: Species whose ANOVA shows significance level (0.05) of variation during study period

Code no	Scientific Name	Season wise variation (p value)	River wise variation (p value)
SP 5	*Thryssa hamiltoni*	0.036	-
SP 51	*Ilisha elongata*	0.006	-
SP 74	*Mystus bleekeri*	0.036	-
Sp 18	*Johnius coitor*	-	0.048

Saptamukhi River during postmonsoon season (Fig. 1). It was also found that the Order Perciformes emerge as most dominant groups among these diverse juvenile fish community (Fig. 2).The dominating taxonomic family among juvenile fin fishes were found to be Clupeidae, Gobiidae, Engraulidae and Sciaenidae respectively (Fig. 3). Table 2 represents various diversity indices like index of Dominance, Simpson index, Shannon H index and Evenness index of all the three rivers in the three different seasons. Table 3 shows the significant correlation about the abundance among the various juveniles of fin fishes. Table 4 to Table 12 show significant Duncan test result of different juvenile fin fish species for different seasons, whereas significant Duncan test results of different juvenile finfish species for different rivers are shown from Table 13 to Table 17. Species whose ANOVA shows significant level (0.05) of variation during study period are enlisted in Table 18, where sp5, sp51 and sp74 varied seasonally, while sp18 varied among the rivers.

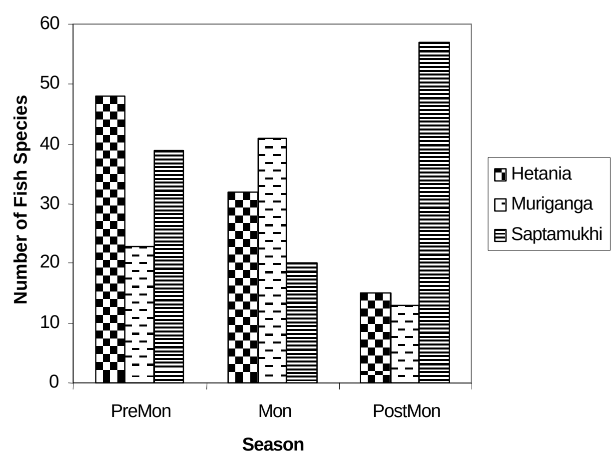

Fig. 1: Juvenile fish diversity in three rivers in three different seasons

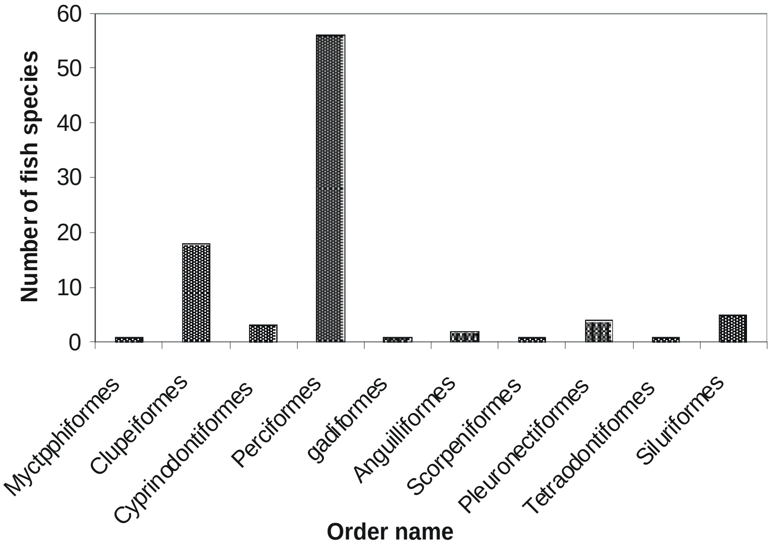

Fig. 2: Diversity of order of different juvenile fish species of the three sampling rivers

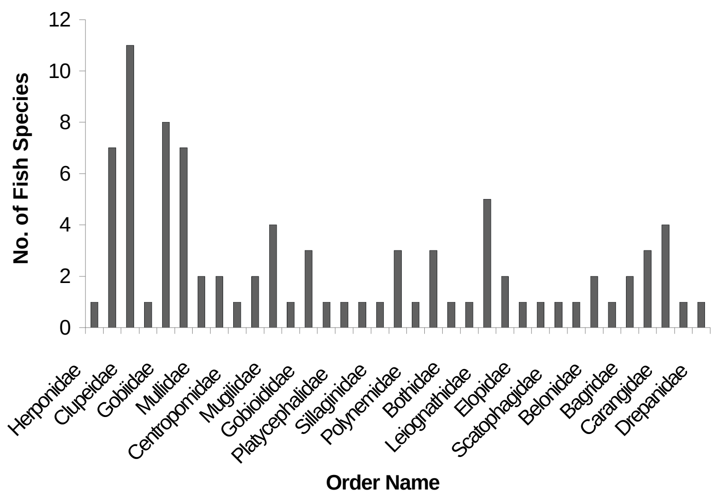

Fig. 3: Diversity of juvenile finfish family in the three rivers

DISCUSSION

Estuaries are highly variable coastal ecosystem where marine and freshwater meets. As such, estuaries retain some characteristics of both marine and freshwater environments, but also each estuary has unique properties of its own. Some of them are common to all estuaries of the world, but others are determined by local conditions. In spite of the low volume they represent in the hydrosphere, estuarine-lagoon complexes play an important role, often essential, in the life histories of many marine species, including fishes. These coastal ecosystems represent nursery areas for larval stages of fishes, where abundant food supply and shelter ensure high survival for early stages. Fish communities in estuaries exhibit a variety of origins. Many marine species move into the estuaries to breed and use them as a nursery for young fish; other species use estuary as migratory route to rich the rivers from the sea, or vice versa and only few species are estuarine throughout their life cycle [22]. Juveniles of *Herpodon nehereus* (sp 1), *Coilia reynaldi* (sp 2), *Corica soborna* (sp 8), *Otolithoides pama* (sp 13) and *Taenoides anguillaris* (sp 31) were recorded in the three rivers in all three seasons' i.e. premonsoon, monsoon and postmonsoon. In premonsoon the total of 48 juvenile fin fish species were recorded from Hetania Doania River, out of which 18 fish species were only found from this river, whereas from Saptamukhi River out of 39 species of juveniles, 10 species were recorded only from here. In Muriganga River the total of 23 juvenile species were recorded during pre monsoon season, out of which one juvenile species, *Setipinna phansa* (sp 4) was unique to it. In monsoon the total of 32 juvenile fin fish species were recorded from Hetania Doania River, out of which 12 fish species were only found from this river, whereas from Muriganga river out of 41 juveniles of fin fishes, 12 species were recorded only from Muriganga River. In Saptamukhi River the total of 20 juvenile species were recorded during monsoon season, out of which one juvenile species, *Leiognathus fasciatus* (sp 81) was unique to it. The post monsoon results show a drastic difference from other seasons. In postmonsoon season 15 juvenile species were collected from Hetania Doania River out of which none was unique to it. But in Muriganga River 13 juvenile species were collected out of which 3 species were found only from this river. Majestically out of 57 recorded juvenile species 40 species of juveniles were only found in Saptamukhi River in post monsoon season and these 40 species of juvenile fin fishes were not recorded from other two rivers during postmonsoon season. The banks and the creeks of River Saptamukhi entirely surrounded by diversified true and associated mangrove plants. For small fish arriving at the estuary as post larvae, the most important pressures governing habitat selection and/or differential survival among habitats are the risk of predation and the availability of food, both of which relate to the nature of physical structure. Mangrove forests provide structure at an intermediate scale in which capture of invertebrate food prey by juvenile fish species appears optimal and risk from piscivorous predators is reduced [23]. These above facts cumulatively support the highest record of juveniles of fin fish species in River Saptamukhi especially in post monsoon period.

In Hetania Doania River both the dominance index and Simpson index indicate relative lesser dominance by single juvenile fin fish species. The juvenile fish community was most evenly distributed in post monsoon period in this river whereas the Shannon index was relatively same throughout the year.

In Muriganga River the best Shannon index value was recorded in monsoon time which is also supported by the value of Simpson index and the situation was in turn reflected from index of Dominance by showing lesser dominance than postmonsoon and pre monsoon respectively. In Saptamukhi River the members of fin fish juvenile community were most evenly distributed during postmonsoon season. In this season we also found the lowest value of Dominance index which was again reflected from Simpson index. Lowest Shannon value during monsoon period in this river generally indicates low species diversity of juveniles of fin fishes on that season. The outbreak of rain and the changes in the environment act as a definite stimulant to spawning even in species, which are the continuous breeder [24]. Status of aquatic stocks of water resources depending on type and environment condition, are changed during different time periods [25]. According to their abundance and availability many of the juvenile of fin fish shows correlation with the juveniles of other species. Negative correlation ship in respect to abundance and availability in found among *Setipinna phansa* (sp4) with *Scatophagus argus* (sp67) and *Polydactylus indicus* (sp50); *Setipinna tenuifilis* (sp7) with *Polynemus paradiseus* (sp47); *Panna microdon* (sp15) with *Ilisha elongata* (sp51); *Glosogobius guiris* (sp36) with *Polydactylus indicus* (sp50).

When we did the Duncan test maximum species shows no variations in the mean values both seasonally or river wise study. But while studying sp5 (*Thryssa hamiltoni*) it was found that Season 1 (Pre-monsoon) resulted significantly higher mean than season 3 (Post monsoon) and season 2 (Monsoon). But season 2 and season 3 are resulting homogeneous means. While studying sp6 (*Setipinna taty*) it was found that Season 2 (Monsoon) resulted significantly higher mean than season 3(Post monsoon) and season 1(Pre-monsoon). But season 1 and season 3 are resulting homogeneous means. While studying sp51 (*Ilisha elongata*) it was found that Season 2 (Monsoon) resulted significantly higher mean than season 3(Post monsoon) and season 1(Pre-monsoon). But season 1 and season 3 are resulting homogeneous means. While studying sp59 (*Tetraodon cutcutia*) it was found that, season 1(Pre Monsoon) resulted highest mean, which is significantly higher than both season 2 (Monsoon) and season 3 (Post monsoon). Again Season 3 has resulted significantly higher mean than season 2. While studying sp72 (*Sardinella longiceps*) it was found that, season 3 (post Monsoon) resulted highest mean, which is significantly higher than both season 2 (Monsoon) and season 1 (Pre-monsoon). Again season 2 has resulted significantly higher mean than season 1 while studying sp74 (*Mystus bleekeri*) it was found that Season 1 (Pre-monsoon) resulted significantly higher mean than season 3 (Post monsoon) and season 2 (Monsoon). But season 2 and season 3 are resulting homogeneous means. While studying sp76

(*Arius thassinus*) it was found that, season 3 (post Monsoon) resulted highest mean, which is significantly higher than both season 2 (Monsoon) and season 1(Pre-monsoon). Again Season 2 has resulted significantly higher mean than season 1. While studying sp85 (*Raconda russeliana*) it was found that, season 3 (post Monsoon) resulted highest mean, which is significantly higher than both season 2 (Monsoon) and season 1(Pre-monsoon). Again Season 2 has resulted significantly higher mean than season 1. While studying sp 87 (*Toxotes chatereus*) it was found that, season 3 (post Monsoon) resulted highest mean, which is significantly higher than both season 2 (Monsoon) and season 1(Pre-monsoon). Again Season 2 has resulted significantly higher mean than season 1. Again in river wise study using Duncan test we found few variations in mean values. While studying sp18 (*Johnius coitor*) it was found that River 1 (Hetania-Doania) resulted significantly higher mean than river 3 (Saptamukhi) and river 2 (Muriganga). But river 2 and river 3 are resulting homogeneous means. While studying sp72 (*Sardinella longiceps*) it was found that, river 3 (Saptamukhi) resulted highest mean, which is significantly higher than both river 2 (Muriganga) and river 1 (Hetania-Doania). Again river 2 has resulted significantly higher mean than river 1.While studying sp76 (*Arius thassinus*) it was found that, river 3(Saptamukhi) resulted highest mean, which is significantly higher than both river 2 (Muriganga) and river 1 (Hetania-Doania). Again river 2 has resulted significantly higher mean than river 1.While studying sp85 (*Raconda russeliana*) it was found that, river 3 (Saptamukhi) resulted highest mean, which is significantly higher than both river 2 (Muriganga) and river 1 (Hetania-Doania). Again river 2 has resulted significantly higher mean than river 1 While studying sp87 (*Toxotes chatereus*) it was found that, river 3 (Saptamukhi) resulted highest mean, which is significantly higher than both river 2 (Muriganga) and river 1(Hetania-Doania). Again river 2 has resulted significantly higher mean than river 1. Thus, it has been found that during Duncan test analysis sp72, sp76, sp85 and sp87 show both seasonal and river wise variation. sp5, sp51, sp74 and sp 18 (river wise) varied significantly in test of ANOVA which are again shows variation during Duncan test analysis. Salinity is one of the prime factors, which influence the abundance and distribution of the environment which in turn is influenced by freshwater inflow and prevailing air temperature [24]. This makes variation in distribution and diversity of juvenile fin fishes.

CONCLUSION

From the above study it can be concluded that mangrove based estuary of Sundarban Biosphere Reserve harbours a great diversity of juveniles of fin fishes. More or less in all seasons we have recorded a good number of juveniles of various species from our studied area. Depending on the availability and abundance of juveniles of different fish species we can make an order of descending pattern in three studied rivers, i.e. Saptamukhi > Hetania Doania > Muriganga.

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