*J. Natn. Sci. Foundation Sri Lanka 2001 **29**(3&4): 107-115*

BY-CATCH MORTALITY DURING COLLECTION OF *PENAEUS MONODON* (FAB.) POST-LARVAE FROM THE RIVERS OF KHULNA, BANGLADESH

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(Received: 05 April 2000 ; accepted: 05 October 2001)

Abstract: The investigation was carried out in two river-estuaries of Khulna district from March 1998 to February 1999, to assess the abundance of black tiger shrimp (*Penaeus monodon*) post larvae (PL) and to quantify the damage to different aquatic organisms during collection of *P. monodon* PL. It was observed that about 384 larvae of other shrimp species, 208 fin-fish and 835 other macrozooplankton were destroyed during the collection of only one PL of *P. monodon*. During the experimental period 0.53 million man days/ year were estimated to be involved in shrimp fry collection and on average 59.0 million *P. monodon* PL were collected annually from the surveyed areas. The study implies that mass destruction of valuable aquatic organisms by shrimp seed collectors is a serious threat to bio-diversity and coastal ecosystem integrity.

Key words: Fin-fish, macrozooplankton, mass destruction, *Penaeus monodon*, shrimp

INTRODUCTION

Bangladesh has a number of marine shrimp species suitable for culture. Of these the black tiger shrimp (*Penaeus monodon*) locally known as "bagda chingri" is the most popular due to its high value in national and international markets. The wild post larvae (PL) of *P. monodon* are a major seed source for shrimp aquaculture in Bangladesh. Of late, hatchery produced PL partially fulfill the increasing demand of shrimp farmers but growth and survival of natural PL are much better than hatchery PL (Shrimp farmer's opinion).

Post larvae of "bagda chingri" enter rivers, canals and creeks of coastal areas and grow rapidly as a result of the enormous biological productivity in these coastal ecosystems.[10] High demand for *P. monodon* PL, low investment but high return have encouraged thousands of coastal girls, men and women of low income groups to be encouraged in shrimp fry collection. Drag net, push net and set bag net are generally used in tiger shrimp fry collection. After each haul, the whole catch is transferred to earthern or plastic bowls by splashing water on the net. The seed collectors themselves or their family members sort out and collect only the targeted *P. monodon* (PL) locally known as "bagda pona" and the rest comprising of other shrimp, macrozooplankton and fin-fish larvae are discarded and thrown on the dry shore.

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Earlier, some workers[1,7,9] conducted investigations on the abundance of *P. monodon* (PL), juveniles of penaeid shrimp but they could not clearly quantify the loss caused to valuable resources of other shrimp, zooplankton and fin-fish larvae while collecting PL of *P. monodon*. Mahmood[12] gave the first information on the quantum of damage to zooplankton and other aquatic organisms while catching "bagda" shrimp fry in the estuarine water of Bangladesh (Chakaria Sundarbans, Satkhira and Khepupara). This year round survey was carried out in the river-estuaries of Khulna district in Bangladesh to assess the abundance of *P. monodon* PL and to quantify the damage caused to different shrimp species, fin-fish larvae and macrozooplankton during collection of *P. monodon* (PL).

METHODS AND MATERIALS

Two different rivers, Koyra and Pasur under Koyra and Dacop thana of Khulna district were selected for the experimental area. Samples were taken from three different selected spots of each river from March 1998 to February 1999 (Fig. 1).

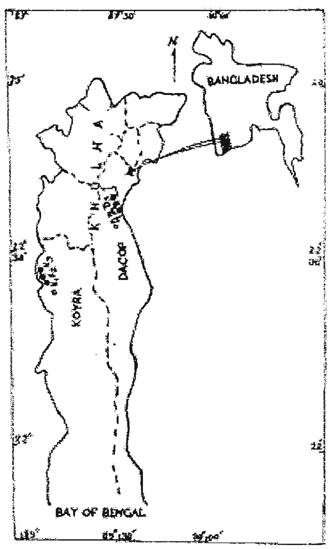

Figure 1: Map of Koyra and Dacop thana under Khulna district showing the location of the sampling stations (K_1,K_2,K_3,D_1,D_2 and D_3) (inset: map of Bangladesh).

Sampling was done at monthly intervals using a fine meshed (1.0 mm) nylon net with a split bamboo frame (1.6 m X 0.6 m). The net was manually operated in shallow water against the current. Each hauling time was about 10.0 minutes and considered as a unit of effort. Sampling was done twice a day during low and high tides. Samples were immediately stored in plastic pots after each haul and preserved in 5% buffered formalin solution. On return to the laboratory, the samples were segregated and penaeid shrimp larvae were identified upto species level following Muthu[14] and Motoh and Buri.[13] Macrozooplankton including other shrimp and fin-fishes were identified as major taxonomic groups following Fischer and Witchead[6], George[8] and Quddush and Shafi.[15] The total number of major taxa of other shrimp, fin-fish and macrozooplankton were determined and their abundance expressed as number of individuals per 10 minutes of haul and as a percentage. Different species of penaeid post-larvae were treated in the same manner and their percentage composition on the basis of total number of penaeid post-larvae was computed.

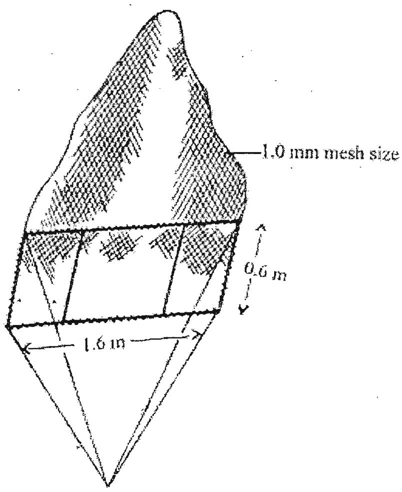

Figure 2: The net used in *Penaeus monodon* PL collection

Salinity of water was determined with the help of a hand refractometer (Atago, S/Mill, 0-100%). Temperature and pH of water were measured by an alcohol thermometer and a digital pH meter, respectively.

RESULTS AND DISCUSSION

The pH recorded from the different experimental sites indicated that the water of these places was mostly alkaline. The average values recorded were 7.4 to 8.5 and 6.5 to 8.0 in Koyra and Pasur rivers, respectively. Average monthly values for water temperature and salinity are presented in Fig. 3. There was little variation in water temperature compared to the wide fluctuation in monthly salinity that was observed at the experimental sites. The highest temperature (32.0°C) was observed in the Koyra and Pasur rivers in August and September respectively, and the lowest (21.0°C) in the Koyra river in January. Highest salinity of water was recorded in June at all the sites. Salinity dropped in Koyra river after June and it was zero ppt in the various seasons in Pasur river, probably due to monsoon effects, river run-off and land drainage. Salinity was found to increase gradually during post monsoon months.

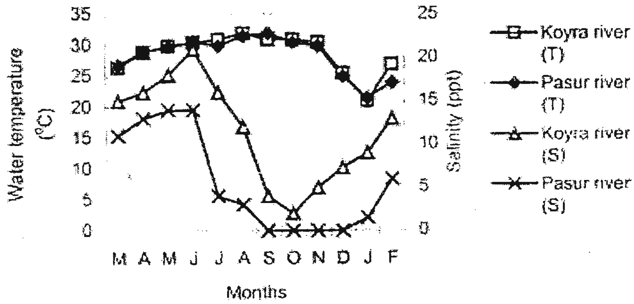

Figure 3: Monthly distribution of water temperature (T) and salinity (S) in the river of Koyra and Pasur under Khulna district, 1998-99.

Table 1: Catch composition (%) of *Penaeus monodon*, other shrimp species, fin-fishes and other macrozooplankton in the rivers of Khulna, 1998-99.

Major taxa	Mean No. haul^{-1}	Relative abundance (%)	Number of other species destroyed for each *P. monodon* PL collection
P. monodon PL	3.0±1.00 (2-4)	0.07	-
Other shrimp species	1137.5±350.50 (787-1488)	26.90	384
Fin-fish	616.5±207.50 (409-824)	14.58	208
Other macrozoo plankton	2473.0±458.00 (2015-2931)	58.45	835
Total	4231	100.00	1427

Monthly abundance (mean numbers/haul) of *P. monodon*, other shrimp, fin-fish and macrozooplankton is shown in fig. 4 and 5, for Koyra and Pasur river respectively. Data revealed that during the months of April to December *P. monodon* (PL) were absent in Koyra and Pasur when salinity was low. The larvae of *P. monodon* became available during January to March while salinity gradually increased. On the other hand, abundance of other shrimp species at all sites was found to increase during the months of July to December with the maximum number recorded in September and November at all sites. Therefore, fin-fish and other zooplankton were not abundant uniformly throughout the year.

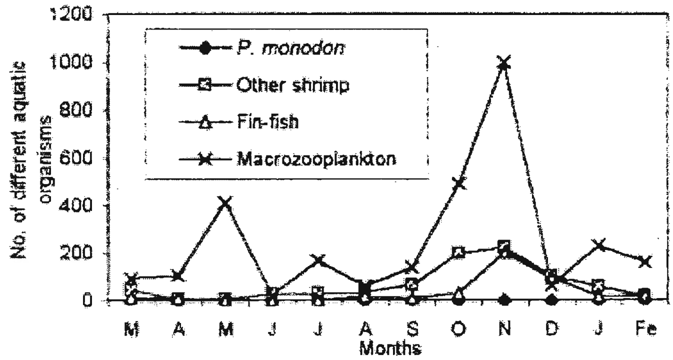

Figure 4: Monthly fluctuation of *Penaeus monodon*, other shrimp, fin-fish and macrozooplankton in the Koyra river of Khulna district during the study period, (1998-99).

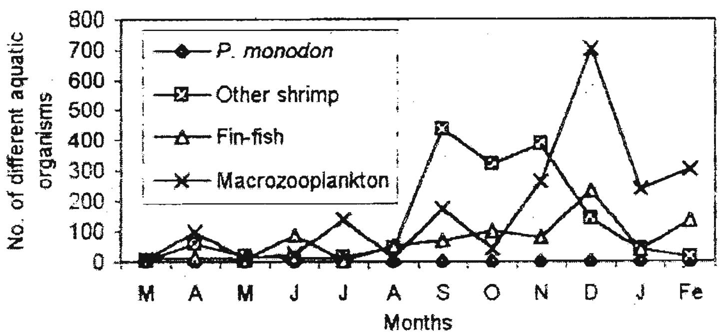

Figure 5: Monthly fluctuation of *Penaeus monodon*, other shrimp, fin-fish and macrozooplankton in the Pasur river of Khulna district during the study period, (1998-99).

Post-larvae of *P. monodon* were found to be only a very small fraction of the total annual catch composition being 0.09 and 0.05 % in Koyra and Pasur river, respectively. Juveniles of other shrimp species (*Penaeus indicus, Metapenaeus monoceros, Metapenaeus brevicornis, Palaemon styliferus, Macrobrachium rosenbergii, Macrobrachium villosimanus, Macrobrachium dyanus, Macrobrachium dolichodactylus* and *Macrobrachium rude,* etc.) made up 19.06 % in Koyra river and 34.36 % in Pasur river. Larvae of fin-fish species (*Liza parsia, Liza tade, Rhinomugil corsula, Lates calcarifer, Setipina phasa, Hilsa ilisha, Pangasius pangasius, Glossogobius* spp, *Puntius* spp and *Mystus* spp. etc) made up 9.90 and 19.03 % of the total catch in Koyra and Pasur river, respectively. Macrozooplankton (*Acetes* sp, Mysids, Isopods, Copepods, Alima and Crab larvae etc) were available at a higher density of 70.95 and 46.56 % in Koyra and Pasur river, respectively. Mahmood[12] reported that zooplankton was in higher density in Chakaria Sundarbans (98.30%)

Table 2: Monthly abundance (numbers/ haul^{-1}) of *Penaeus monodon*, other shrimp seed, fin-fish and other macrozooplankton in the rivers of Khulna district, 1998-99.

Major groups	Months M	A	M	J	J	A	S	O	N	D	J	F	Mean total	%
Koyra river														
P. monodon	1±0.58	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	1.0±0.00	1.7±0.-33	4	0.09
	(0-2)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(1.0-1.0)	(1.0-2.0)		
Other shrimp	40±2.89	4±0.58	4±1.15	25±7.64	30±10.58	32±4.16	62±7.57	196±14.0	220±43.59	102±9.17	56±17.47	16±1.15	787	19.06
	(35-45)	(3-5)	(2-6)	(15-40)	(14-50)	(26-40)	(50-76)	(170-218)	(140-290)	(90-120)	(32-90)	(14-18)		
Fin-fish	12±2.08	10±4.73	1±0.00	1±0.58	2.33±0.33	16±1.53	10±2.65	30±5.13	201±41.88	93±25±24	16±2.08	20±3.61	409	9.90
	(9-16)	(3-19)	(1-1)	(0-2)	(2-3)	(13-18)	(6-15)	(23-40)	130-275)	(52-139)	(12-19)	(15-27)		
Other macro-	90±10.58	105±10.69	412±60.37	21±2.08	166±36.94	60±8.14	136±25.51	492±79.12	1000±152.37	62±8.89	229±57.71	158±32.35	2931	70.95
zooplankton	(70-106)	(84-119)	(325-528)	(17-24)	(98-225)	(45-73)	(88-175)	(353-627)	(745-1272)	(45-75)	(135-334)	(96-205)		
Mean total	143	119	417	47	198	108	208	718	1418	257	302	196	4131	100.0
Pasur river														
P. monodon	1±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	0.0±0.00	1.33±0.33	0.0±0.00	2	0.05
	(1-1)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(0.0-0.0)	(1-2)	(0.0-0.0)		
Other shrimp	5±1.73	56±12.12	17±2.65	12±2.08	14±2.65	44±3.79	436±41.02	322±39.31	386±32.36	141±32.39	40±7.23	15±2.65	1488	34.36
	(2-8)	(35-77)	(13-22)	(8-15)	(9-18)	(38-51)	(358-497)	(256-392)	(326-437)	(83-195)	(28-53)	(11-20)		
Fin-fish	7±1.73	16±2.65	7±2.65	86±10.69	4±2.08	50±8.14	68±11.53	102±26.96	80±23.12	231±59.77	38±7.37	135±22.94	824	19.03
	(4-10)	(11-20)	(3-12)	(68-105)	(1-8)	(37-65)	(46-85)	(58-151)	(41-121)	(126-333)	(27-52)	(93-172)		
Other macro-	6±1.73	97±22.52	12±2.08	25±6.43	136±34.08	16±3.79	174±29.21	42±6..08	264±57.45	704±114.84	238±62.52	301±41.68	2015	46.56
zooplankton	(3-9)	(58-136)	(9-16)	(13-35)	(78-196)	(9-22)	(116-209)	(32-53)	(155-350)	(495-891)	(123-338)	(232-376)		
Mean total	19	169	37	123	154	110	678	466	730	1076	317	451	4330	100.0

Macrozooplankton were: Acetes, mysids, isopods, copepods, alima and crab larvae etc.

followed by Satkhira (97.72%) and Khepupara (97.53%). Moreover, other shrimp and fin-fishes accounted for only about 2% of the zooplankton community and shrimp (*P. monodon*) post-larva alone contributed a very small quantity to the total annual catch (0.7% in Chakaria and Khepupara; 1.2% in Satkhira).

The catch composition and the extent of damage caused to macrozooplankton and other aquatic organisms as a result of harvesting wild *P. monodon* PL have been presented in Table 1. *P. monodon* PL contributed 0.07 %, other shrimp species 26.90 %, fin-fishes 14.58 % and other macrozooplankton 58.45 %. Higher numbers of other shrimp species and fin-fish larvae were found in Pasur river than in Koyra river. But number of *P. monodon* PL was lower in Pasur river compared to Koyra river. The results obtained revealed that capture of one live *P. monodon* PL contributed to the killing of 384 other shrimp species, 208 fin-fishes and 835 other macrozooplankton. According to Mahmood[12] for catching a single *P. monodon* PL, 14 other shrimp spp, 21 fin-fishes and 1631 zooplankton were destroyed in the Chakaria Sundarbans, Satkhira and Khepupara estuaries. The difference in capture of zooplankton population in the present study might be due to difference in mesh size of the collection net. Mahmood[12] used a rectangular nylon net with smaller mesh size (0.5 mm). The mesh size of the net used in the present study was 1.0 mm which is similar to that used by shrimp seed collectors. Thus, smaller zooplanktons would escape through the large mesh (1.0 mm) used in the present study. BFRI[3] reported that one *P. monodon* fry was collected at the cost of 292 larvae of other shrimp species, fin-fish and macrozooplankton in the Khulna region in 1996. The tremendous loss of different aquatic organisms was also reported by BOBP[4] and Khan et al.[11]

The relation of different water quality parameters such as water temperature, pH and salinity to the abundance of *P. monodon* (PL) had been statistically analyzed. Multiple regression analysis was employed for this purpose. The co-efficient of multiple regression, R^2 as determined was 0.404. The calculated value (4.52) of F with (3. 20) degree of freedom (df) at 5% level of significance was found to be greater than the tabulated value (3.10) of F with the same df. SO, R^2 value was significant at 5% level. The value of R^2 indicated that 40% of the total variation in the abundance of *P. monodon* (PL) was explained by the independent variables (water quality parameters).

Observation on the number of seed collectors/ km, length of the river, number of boats and hours of engagement reveals that 0.53 million man days/ year were involved in shrimp seed collection activities in Khulna district. Funegaard[7] stated that about 20,000 to 25,000 people were engaged in shrimp fry collection in Satkhira district while according to Chowdhury[5] about 75,000 fry collectors were found in Satkhira district alone. It was recorded that about 59.0 million *P. monodon* PL were collected in the water of Khulna estuaries in 1998-99. Accordingly, it was estimated that 84,193 million of other shrimp species, fin-fishes and macrozooplankton were destroyed annually by the shrimp seed collectors in the Khulna estuaries. The severe impact of shrimp seed collection activities reduced the availability of *P. monodon* from 2000 shrimp fry net^{-1} $day,^{-1}$ to 200 fry net^{-1} day^{1} in Satkhira district.[2] The findings of the above studies and the present study indicate that the natural stocks of shrimp fry and other valuable aquatic organisms are being drastically reduced due to over fishing. Therefore, to conserve the environment, biodiversity as well as natural productivity of the estuarine environment, necessary measures should be taken urgently to stop such indiscriminate destruction during *P. monodon* PL collection.

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