BOBP/WP/88

The Shrimp Fry By-catch in West Bengal, India

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The Shrimp Fry By-catch in West Bengal

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Culture of tiger shrimp has gained momentum over the last decade in many parts of the world due to its high export value. It has become a major foreign exchange earner in India, where West Bengal is the largest culture centre. In West Bengal, the basic input of tiger shrimp fry is met from the wild, with a large number of the rural poor engaged in shrimp fry-catching and trading in the 24 Parganas (N and S) and Medinipur Districts. However, the destruction of by-catch captured during fry-collection has been causing concern.

This working paper, based on work done from October 1990 to September 1991. gives an overall picture of the shrimp fry by-catch by assessing quantitatively the seasonal and spatial variations in the species composition. By-catch is 64-99.4 percent of the total fry caught. The fry by-catch destroyed over a period of one year is estimated at 62 million - 2592 million. The study was carried out by the Central Institute of Brackishwater Aquaculture (CIBA) at its Research Centre in Kakdwip, West Bengal. It was sponsored by the Bay of Bengal Programme (BOBP) of the Food and AgricuLture Organization (FAO). Two field biologists were engaged by BOBP for sampling and data collection at three centres and the project was implemented under the supervision of CIBA scientists.

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The Bay of Bengal Programme (BOBP) is a multiagency regional fisheries programme which covers seven countries around the Bay of Bengal — Bangladesh, India, Indonesia, Malaysia, Maldives, Shri Lanka and Thailand. The Programme plays a catalytic and consultative role: it develops, demonstrates and promotes new technologies, methodologies and ideas to help improve the conditions of small-scale fisherfolk communities in member countries. The BOBP is sponsored by the governments of Denmark, Sweden and the United Kingdom, and also by UNDP (United Nations Development Programme). The main executing agency is the FAO (Food and Agriculture Organization of the United Nations).

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1. *INTRODUCTION*

Keeping pace with the Government of India and many other maritime Indian states, West Bengal intensified efforts during the Sixth Plan to develop coastal aquaculture, especially shrimp farming. Besides increasing production from the traditional systems, which cover an area of about 33.000 ha in 24 Parganas (North and South), schemes were also formulated and executed with assistance from the World Bank and other funding agencies. to bring more suitable areas under coastal aquaculture. Tiger shrimp *(Penacus monodon)* is the most preferred species for culture, as it commands excellent prices in the international market. At present, the source of tiger shrimp fry in West Bengal is only from the wild. The Hugli-Matla estuarine complex, which is a part of the world's most productive mangrove ecosystem, the Sundarbans. offers a rich collection ground.

To meet present requirements, professional fry-collectors venture deep into the reserve forests to collect shrimp fry. But demand for *P. monodon* fry will increase several-fold when more areas are brought under shrimp farming and cultural practices in the traditional *hheries* (pond farms) are upgraded/replaced by semi-intensive method of shrimp culture. The efforts of the fry-collectors will, then, have to become even more intensive.

It has been observed that during *P. monodon* fry-collection, the young of many species of finfish and other shellfish are destroyed, as this catch is not wanted in the market and is, therefore, not remunerative. This indiscriminate destruction, going on for nearly 15 years, may have an adverse effect on the estuarine ecology and fisheries.

Except for a few passing remarks, no information on shrimp fry by-catch is available. It was in this context that this study on shrimp fry by-catch was taken up during October 1990-September 1991 by the Kakdwip Research Centre of CIBA as a collaborative project between the Indian Council of Agricultural Research (ICAR) and the Bay of Bengal Programme (BOBP).

2. *OBJECTIVES*

The objectives of the study were to

- Make a qualitative and quantitative assessment of various organisms caught with the shrimp fry and of their time and spatial relationships;
- Assess the destruction of miscellaneous shrimp and fish fry captured as by-catch; and
- Observe and report on other ancillary activities connected with the collection and marketing of shrimp fry.

3. *ASSESSMENT OF SHRIMP FRY BY-CATCH*

3.1 *Definition*

In this investigation, the words 'fry by-catch' mean nontarget species caught with, and incidental to, the target species, *i.e. Penaeus monodon* post-larvae (PL).

3.2 *Methodology*

SELECTION OF CENTRES

Three centres in three different districts of West Bengal were selected for observations Although ihere are a number of fry-collection centres in the estuarine zone three representative centres were selected in the three river systems. The basis for the selection of the centres was where:

— The density of net operations is maximum, and

Variations in salinity in the three rivers are appreciable (see Appendix II. Table I).

The three sampling centres selected on this basis were:

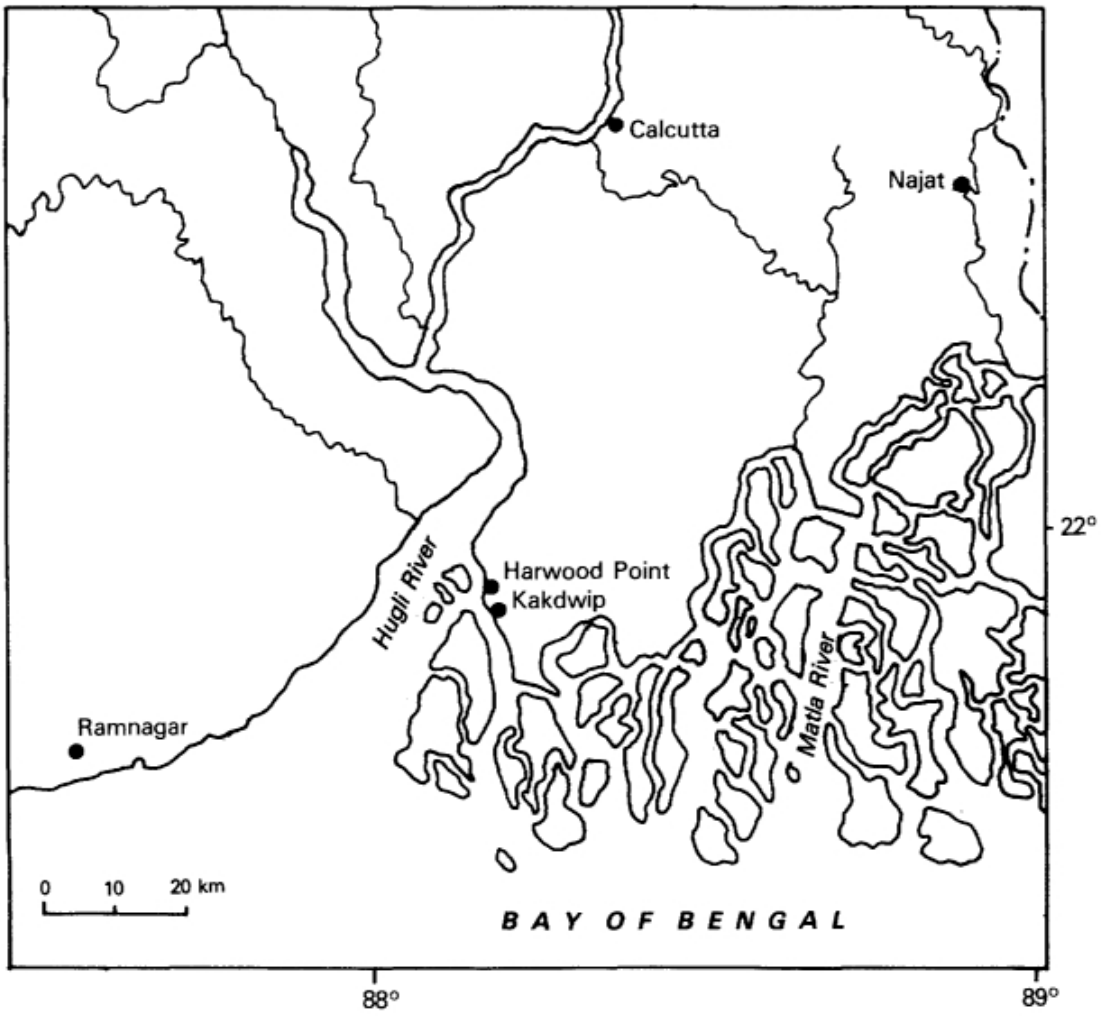
Harwood Point : 88" 11"E and 21"51" N. in South 24 Parganas District, on the river Hugli. 95 km from Calcutta by road.

Najat: 88" 50' F and 22" 27' N. in North 24 Parganas District on the tributary of the Bidyadhari. 91 km from Calcutta by road.

Ramnagar 87" 34' E and 21" 41" N, in Medinipur District, on the Ramnagar Canal, 190 km by road from Calcutta.

The locations of the three centres are shown in Figure I.

Fig 1 : Map of Hugli estuarine system showing shrimp fry by-catch collection centres



Shootnet operated from shore

COLLECTION OF SAMPLES

Fortnightly samples were collected from commercial fry-collectors at both high and low tides during the spring tide period.

During this period *(4-5* days), shootnets were operated in large numbers. On an average, a shootnet was hauled in 16 times a day, each soaking being of 30 minutes' duration.

Catch samples were collected from five nets belonging to commercial fry-collectors at each sampling centre. But if the number of nets operated at a particular sampling centre was less than five, then the observation was limited to the number of nets actually operated.

Collections were made separately during full moon and new moon periods, at high tide and low tide. Being from riverine resources, the fry were generally a mixture of multispecies of fish and shrimp of commercial and noncommercial varieties. Samples by net were preserved in *5* per cent formalin and properly labelled for laboratory analysis. When the catch (catch/net/30 minutes) was low, the entire sample was taken, but if the catch was high, then a suitable subsample was analyzed and the total number was obtained by increasing it proportionately. Relevant information, *viz,* location, lunar phase, tide, type of gear used, duration of net operation, number of nets sampled, number of nets operated in the area, price of tiger shrimp fry, weather conditions, air and water temperature and ambient salinity were noted.

ANALYSIS OF SAMPLES

The entire sample was cleaned, sorted and segregated. The specimens were identified as far as possible to species level. The length of the specimens of different species was noted and the total number of each species was estimated for all the samples.

Estimated total catch of *P. monodon* and other species in the observation areas of different centres was obtained by using a raising factor of 80 (nets operated for eight hours a day, four hours during high and four hours during low tide, on five days during each lunar phase).

THE SPECIES OF FRY BY-CATCH

The information available on the occurrence of various species of by-catch in all three centres, *viz.* Harwood Point, Najat and Ramnagar, is more or less the same. The study reveals that the shrimp are represented by ten species belonging to three families. Megalopae of crab *(Varuna litterata)* were also recorded. The finfish were represented by 49 species belonging to 28 families. A list of species encountered in the survey is given in Appendix I.

4. TRADITIONAL FARMING

The history of brackishwater fish culture in the Indian state of West Bengal is more than a century old. The middle of the 19th Century saw the beginning of an improvised rearing technique in the lower reaches of Bengal, where there is a network of estuaries opening into the Bay of Bengal. The silt carried by these river systems formed mudflats and these mudflats were reclaimed for agricultural purpose by raising embankments. In the process, hundreds of acres of tidal swamps and salt marshes were cleared of jungle growth and enclosed with earthen dykes. Silt-laden high tide water was let in from time to time to raise the ground level sufficiently high for paddy cultivation. When the spring tide water was allowed in, innumerable brackishwater fish and shrimp fry also entered and grew to marketable size in 8-9 months' time. In course of time, the productive potential of naturally stocked shell/finfish fry attracted the attention of farmers, who found it to be more profitable than paddy cultivation. Thus, the traditional system of fisheries, locally known. as *bhasa badha,* originated. With the passage of time, more and more areas were brought under this traditional form of *bheri* culture.

The extent of brackishwater areas in the coastal districts of West Bengal at present is as follows:

	Brackishwater areas likely to be suitable			
District	*Private*	*Government*	*Other Govt/ waste* char *lands*	Total
North 24 Parganas	28,000	160	1620	29,780
South 24 Parganas	7900	1370	11,290	20,560
Medinipur	NA	2000	NA	2,000

Source. Ramaswamy, 1989.

Predators, like sea perch *(Lates calcarifer - bhekti), Eleutheronema tetradactylum (gurjeoli),* cat-fish, other perch etc., are a constant threat to the seed of the cultivated species. Some operators, therefore, prefer to let in flood tide water during December to June, when the seed in the spring tides are mainly those of the cultivated species and when the seed of predators are less.

From the late seventies, farmers have shown the greatest interest in *P. monodon* fry due to its high price.

Brackishwater fisheries are of two types. They are:

Perennial brackishwater fisheries : Perennial b*heries* exist mainly in the lower Sundarbans areas, which are unfit for agriculture due to their high saline content. These *bheries* are utilized only for brackishwater fish culture by letting in water almost year-round.

Seasonal brackishwater fisheries : These are situated in the upper Sundarbans areas. Here, the fields are utilized in the rainy season for one crop of *aman* paddy. After the harvest, the same area is used for fish culture by allowing in tidal brackishwater containing wild fry.

5. SHRIMP FRY COLLECTION

The gear described below are used by the commercial fry-collectors.

5.1 *Shootnet* (behundi jal)

The commonest gear for collection of *P. monodon* PL in West Bengal is the Medinipur type of shootnet (Basu & Pakrasi, 1979). This is a long, funnel-shaped bagnet set against the tidal current to filter seed from estuarine water. The size of the net is highly variable and there are various modifications, depending on the nature' of terrain and areas to be covered. The material used for the net is nylon monofilament of 1mm mesh. The *gamcha* (coarse cloth), which is used to collect carp fry, is no more used.

The general specifications of the net are : Width-40m-60m, Length-50m-75m and Height- l3m, with a tapering end 3m in diameter. Shrimp fry-collectors make a knot at the tail end of the shootnet. The contents from the tail end are periodically emptied into an aluminium utensil by untying the knot.

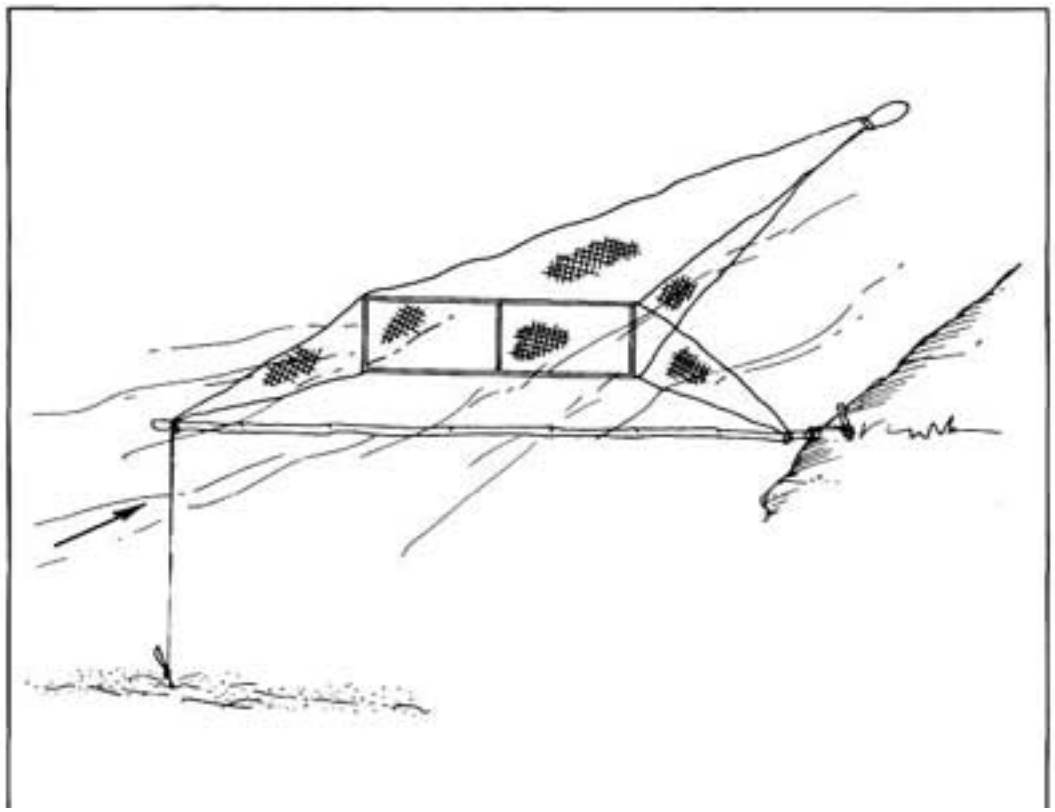
Behundi jal - *shootnet for shrimp fry collection in West Bengal - spreqd out for drying*

SHOOTNET OPERATION FROM SHORE

This simple method requires minimum manpower. At the beginning of high tide, a long bamboo is placed horizontally across the river by fixing one end to the shore while the other end projects over the water. The shootnet is placed against the current and is kept in position by means of a long nylon rope, one end of which is tied to the free end of the bamboo pole, while the other is tied to a small bamboo pin driven into the shore. The catches are emptied periodically (generally every 1/2 hour), depending on the catch rate. Two persons are required to handle such a net.

The nets are operated in waist-to-chest-deep water. With the rise of the water level, the horizontal bamboo is adjusted and the net is soaked for further collections. This process is repeated till the tidal current becomes feeble and collections are no longer possible. Fixing the shootnet in reverse direction, fry can be collected during ebb tide, when the velocity of the water is sufficient to keep the net in position. This type of net operation is common at Harwood Point and a series of shootnets arc operated all along the shore line for collection of *P. monodon* fry. (Figure 2).

Fig. **2. Shootnet operation from shore**



SHOOTNET OPERATION FROM BOATS

Collection of post-larvae is also done in mid-stream using the same conical, *hehundi-type* shootnet from a boat. Before onset of high tide, the boat is taken to midstream and anchored. Two or three shootnets are tied to the boat using nylon ropes. As soon as high tide starts and the water current is sufficiently strong, the nets are placed in position side by side. The net mouths are kept wide apart and fully stretched. When there is good catch, the nets are lifted at intervals of 30 minutes and the contents emptied. No adjustment of the nets is necessary; attached as they are to the drifting boat, they automatically adjust to the rise or fall in water level. This type of collection is common in the open water of the Muriganga at Harwood Point (South 24 Parganas) and on the river Kalindi at Najat (North 24 Parganas). (Figure 3).

5.2 *Dragnet*

The net is used in the lower reaches of the Sundarbans for *P. monodon* fry collection (Singh. 1987). It is a rectangular net of length 3.0 m and width 1.5 rn, made of fine nylon net cloth (I mm mesh). All four ends of it are firmly stitched around a rectangular split bamboo frame (I .25 ni x 0.75 m). Both ends of the net arc attached to a long nylon rope and the net is operated in the shallow areas by one man holding both nylon ropes together and dragging the net from behind. (Figure 4).

Fig. 3. Shootnet operation from a boat

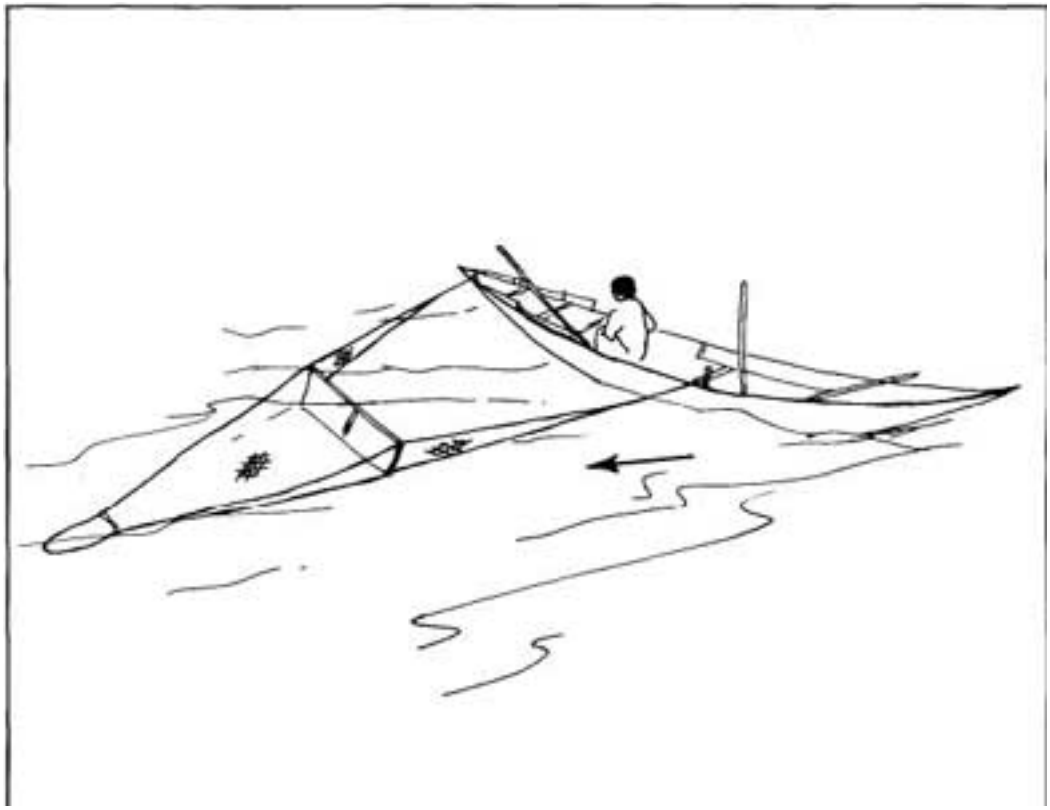
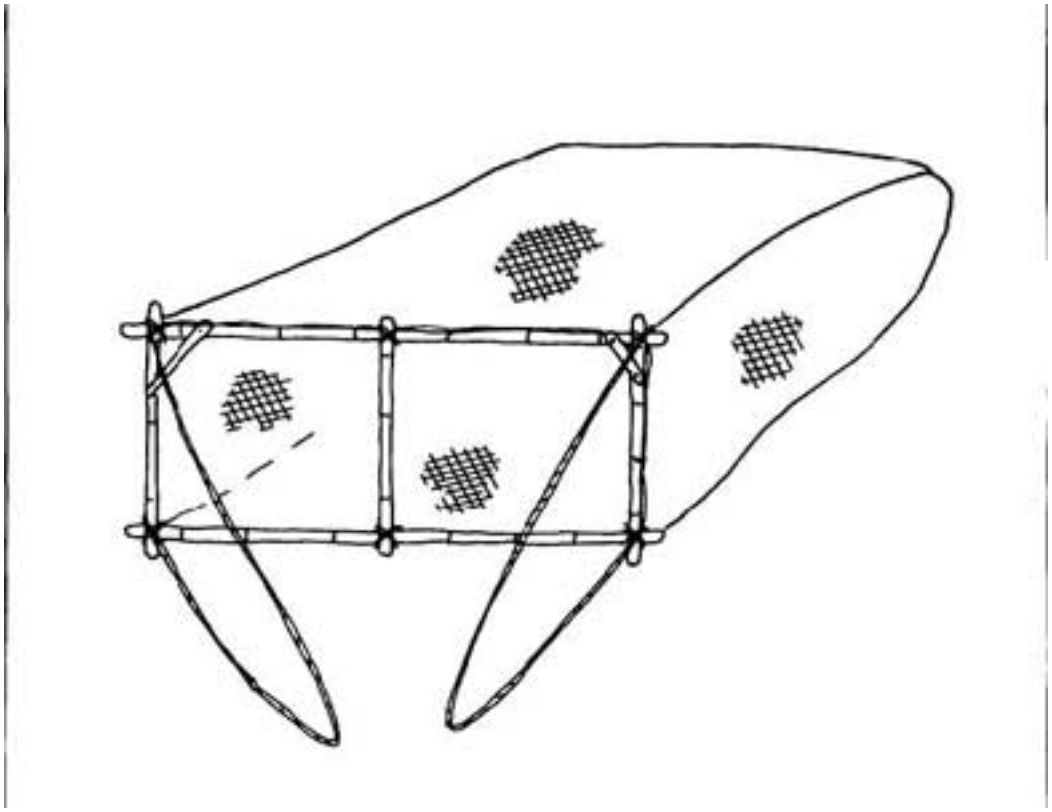


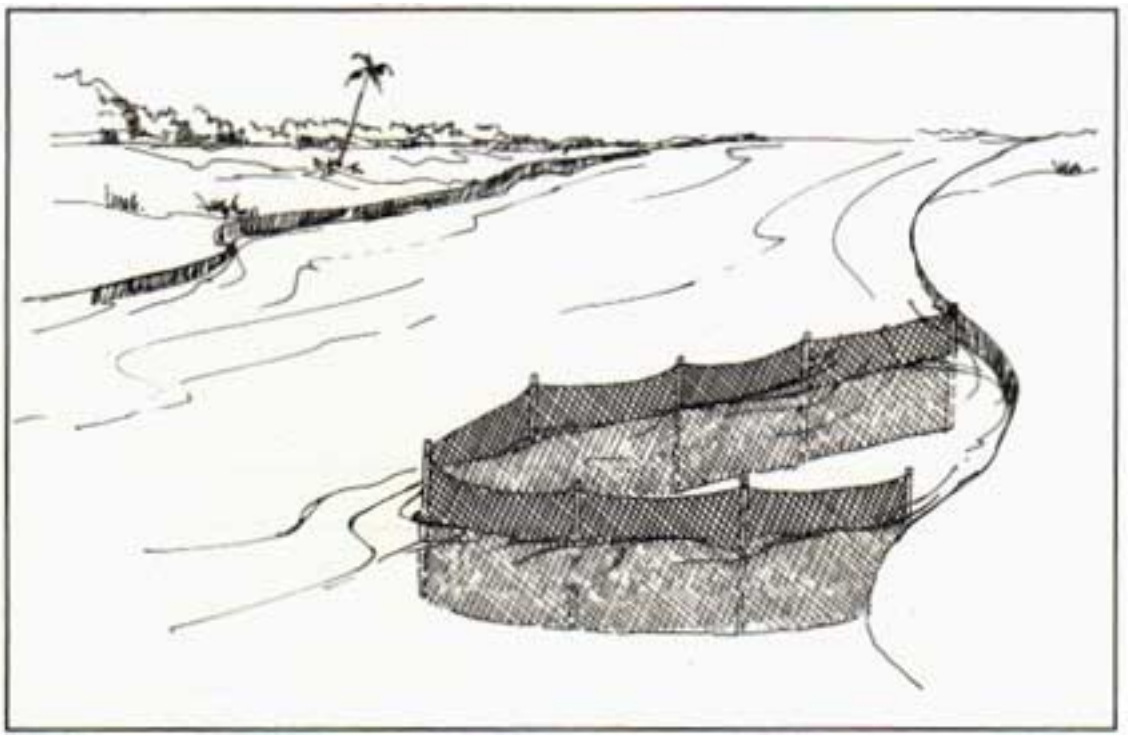
Fig. 4. Dragnet



5.3 Barrier nets

These are very long (100-300 m long and 2.0 - 3.0 m wide), narrow-meshed *(5-7* mm) nylon nets used to trap shrimp and mullet juveniles which enter the mangrove-covered tidal mudflats during spring tides (Figure *5).* The net, which remains in lowered position during the low tide, is raised during the turn of the tide with the help of strong bamboo poles. Various shellfish and finfish juveniles get trapped in the net as the tide recedes. Although this gear is quite effective in collecting the juvenile shrimp, large quantities of fish and shrimp fry which are not immediately collected get killed. A number of small pits are excavated and joined together by a narrow trench cut below the foot rope of the net to enable the trapped shrimp and fish fry to accumulate. The largest number of live *P. monodon* and finfish juveniles are recovered from these pits (Singh, 1988).

Fig. 5. Barrier net



5.4 *Craft*

Country boats of 5-6m length are commonly employed for collection of fry from midstream.

Country boat operating nets

5.5 *Collection method in tidal creeks and canals*

In tidal creeks/canals, PL are collected using a shootnet with two bamboo poles. One or two persons are required for each unit. The dimensions of the net depend on the width of canal. This method is popular in Ramnagar.

Just before the beginning of high tide, two bamboo poles are fixed some distance apart in the mud. Then, the conical-shaped shootnets are tied to the bamboo poles by means of rope. The free tail end of the net is allowed tQ drift against the current and gets stretched. The fry accumulated at this end are removed by opening the tail end, generally every 30 minutes.

In this method of collection, both bamboo poles are shifted towards shore with the gradual rise of water. The nets are accordingly adjusted. For low tide collections, a similar method is followed, but the net is fixed with the bamboo poles in the reverse direction. With the gradual fall of the water level, the bamboo poles are shifted towards the deeper zones and collection continued as long as the water current is adequate to keep the net in shape.

5.6 Identification and segregation of shrimp fry

The post-larvae of *P. monodon,* 10 mm and above, occur in the lower reaches of the Hugli estuary almost year round. At this stage, they are easily identifiable; each PL has a red streak along the entire ventral side of its abdomen. On closer look, 14-19 reddish brown chromatophores are visible on the ventral side of the 6th abdominal segment (Rajyalakshmi, 1989). The rapid, straight, swimming movement along the edge of the water and the tendency of the PL to cling toany object help in easy segregation.

Segregating shrimp fry and by-catch

Segregation is absolutely necessary for getting quality fry. The following methods are adopted by fry collectors to separate the tiger prawn fry and the juveniles of other species taken by the gear described above.

From barrier net collection : A few grass shoots/twigs are kept floating in each pit. The PL that stick to these shoots are periodically shaken into a *hundi* (aluminium container). Water from the collection pit is also scooped out from time to time with a white enamel dish and *P. monodon* segregated carefully with the help of a bivalve *(Lamellidens* sp.) shell. The fry thus collected are stored in an aluminium *hundi* containing river water. After the segregation is over, the rest of the organisms are left in the pit to perish in due course.

From shootnet collection made along the shore : The entire fry accumulated at the tail end of. the shootnets are removed periodically by untying the thread and emptying contents into large, wide-mouthed aluminium *hundis* containing water (Bhanot, 1978). A small pit (2'x 1') is dug on the bank, near the collection site, lined with a fine mesh nylon net to suit the size of the pit and the pit is then filled with river water. The entire collection from the shootnet, generally a mixture of prawn and fish fry, is emptied into the nylon net-lined pit. The fish fry, which are generally bigger in size, are collected with a small handnet and discarded in the mud.

From shootnet collections in midstream : The contents from the net are hauled into the boat and emptied into a large, wide-mouthed earthen vessel containing river water. The *P. monodon* are segregated in the same way as during the shore collection and what's left over in the earthen vessel is emptied periodically.

5.7 Seed calendar and abundance

Penaeus inonodon post-larvae are available throughout the year in the Muriganga estuary, with peaks during April-May and August-September. A 'Seed Calendar" for the Hugli-Matla estuarine system has been worked out (Bhanot, 1971; Gopalakrishnan *et al.,* 1975; Anon, 1978) and is presented in the table below

	Months of availability		
Rivers	*Hug/i*	*Matla*	*ichhamati*
Season	Feb-Oct	Jan-Mar June-Sep	May-July
Catch/net/hr (in nos.)	20-1766	10-165	29-130
Peak months	Feb-Apr. July	Mar, July	June
Catch/net/hr (during peak season, in nos.)	154-1766	55.165	60-130

The periods of availability and abundance of *P. monodon* fry in and around Kakdwip are

Months	January-December
Range of catch/net/hr (Nos.)	17 - 1152
Peak months	April-June and Sept - October
Range of catch/net/hr during peak season (Nos.)	501 - 1152. 199 - 283

The distribution pattern in the Muriganga estuary points to the fact that the peaks in April and May are related to a higher saline regime (18 - 19 ppt) with a rising temperature, 27.2°C to 30.2°C. In contrast, the peaks during September and October may be related to comparatively lower salinity, 3 - 6 ppt, with gradual lowering of temperature from 29°C to 27°C.

For additional data on *P. monodon* fry catch, see Appendix II, Tables 2. 3, 4.

6. *SEASONAL ABUNDANCE OF SHRIMP BY-CATCH*

From the details of the catch per net per day of the shrimp by-catch at each centre (see Appendix II, Tables 5, 6, 7), it can be seen that the catch of *Penacus penicillatus. Metapenaeus brevicornis, M. ensis, Aceres* sp., *Exopalaemon stvliferus, Stolephorus* sp. ***llisha*** sp., *Luuianus* sp., *Scatophagus argus,* sciaenids and gobids were highest at Ramnagar. This may be due to the fewer number of nets operated there, the proximity of the area to the sea and the consequent higher salinities.

At Harwood Point, *Rhinornugil corsula* and *Gohioides ruhicundus* were more abundant.

At Najat. *Liza parsia* and the megalopae of *Varuna litterata* were the highest catch.

The availability and peak periods of the main species of by-catch are as follows:

P. penicillatus : Available at Harwood Point during February-September, with peak catches in May. At Ramnagar it is caught during December-September with peak abundance in January and August. At Najat, it is a stray occurrence.

M. brevicornis : Available froni December/January to September, with peak abundance at Najat in September, at Harwood Point in February and May, and at Ramnagar in April, June. September and December.

M. ensis : This species is available during December-September at Ramnagar, for eight months during that period at Harwood Point and for four months at Najat. The peak period for collection at Najat is June, at Harwood Point May and August and at Ramnagar February, April and August.

Acetes sp. : Available round the year. with peak catches in January, May and June at Najat and Ramnagar and in March and November at Harwood Point.

Exopalaemon styliferus : Available over a major part of the year (except May-July) at Ramnagar and throughout the year at the other two stations, with peak catches recorded in September and December at Ramnagar and Harwood Point and in January and August at Najat.

Palaemon sp. : Recorded only during August-September at Najat and during March-September at Ramnagar, with peaks in March, July and September at Ramnagar, and in September at Najat. Not recorded at Harwood Point. *Nernatopalaernon tenuipes* is included in this species.

Macrobrachium rude Available during February-April/May and September-December, with peaks in September at Najat, in February and December at Harwood Point and in December at Ramnagar.

Varuna litterata Megalopae of this species virtually choke the collection gear in certain months, but are found throughout the year at all three centres, with the peaks recorded during February-April. August/September and November/December. They are more abundant at Najat.

Stolephorus sp. : Available for nearly ten months in the year, with peak catches in March, June and September at Ramnagar, in November at Harwood Point and in September and December at Najat.

Hilsa spp. : Stray occurrences in Najat and Ramnagar. but available during February-May and in November at Harwood Point, with peaks in February and November. *Hilsa ilisha* and *Hilsa toli* are included in this genus.

ilisha elongata : Stray occurrences in Najat and Harwood Point. Available at Ramnagar during December-June with peaks in January and April.

Liza parsia : Peaks during April/May and again during November-January.

Liza tade : Only stray catches in the shootnets at Najat in March.

Mugil spp. : Only stray catches recorded. *Mugil cephalus* and *Valamugil cunnesius* are included.

Rhinomugil corsula Available throughout the period of study at Harwood Point, but seen only during January-March and in August at Najat. Stray occurrences at Ramnagar in December. January and July are peak months at Harwood Point. coinciding with salinity levels of 8-10 ppt. Perhaps the high salinity at Ramnagar accounts for this species not being found there.

Lutfanus spp. Available for ten months at Harwood Point with peaks in February and June. Found at Ramnagar during December-July, with peaks in December and June. Only strays at Najat. *L. johni* and another unidentified species were recorded in this genus.

Scatophagus argus Available at Harwood Point during March-September and again in November, with peaks in June and November. Seen during April-September at Ramnagar, with peak catches in April and September.

Sciaenids : Available during February-March and again from June to September at Najat, with peaks in March, June and September. Available throughout the year at Harwood Point with peaks during March-June. Recorded throughout the year at Ramnagar with peaks in March and June. *Pama parna* and *Johnjus coitor* were included in this genus.

Gobioides rubicundus This commercially important species, referred to as *gulay maach* in Bengali. is available almost throughout the year, with peaks in January and April at Najat, in March and June at Harwood Point and in February, July and September at Ramnagar.

Other Gobids Available throughout the year with a peak in April at Najat. Peaks in January, July and November at Harwood Point and peaks in March. May and August at Ramnagar. *Glossogohius giuris* and *Gohius sadanundio* are included in this genus.

Others:Of the 49 species of finfish and 11 crustaceans listed in Appendix I, one species of penaeid prawn *(Parapenaeopsis sculptilis)* and 32 species of finfish are included in this category.

6. 1 *The species ratio and percentage contribution*

The ratio between the total estimated catch of *Penaeus monodon* and others at Harwood Point, Najat and Ramnagar were 1: 1.78, 1:65.6 and 1: 156.6 respectively. The percentage contribution of *Penaeus monodon* and others at the three centres is as follows

Centre,v	*Percentage contribution*	
	P.monodon	*Others*
Harwood Point	36.0	64.0
Najat	1.5	98.5
Ramnagar	0.6	99.4

It is clear that by-catch is maximum at Ramnagar and least at Harwood Point. The fewer number of nets operated at Ramnagar might be the reason for this.

7. THE FRY TRADE

Fry of *P. monodon* are brought in open containers (aluminium */iundis)* to an assembling centre or they are sold at the collection spot to middlemen ready to lift the stock. At assembling centres! markets, traders collect the fry and stock them in dugout earthen pits (4'x2'x2). The number of pits is increased depending upon the supply of fry. Representatives of *bheri* owners come to the assembling centres to purchase fry. After examining the fry and negotiating the price. the fry are transported to the far off *bheries* and other impoundments.

Najat in North 24 Parganas is considered the biggest tiger shrimp fry (wild-caught) market in the country. Large quantities of *bagda (P. nionodon)* fry are assembled from various collection spots in the Sundarhans. The collections arrive there by motorized boat.

After a regular shrimp fry trade was established (Verghese *et al*.. 1988). thousands of persons belonging to the fisherfolk and agricultural communities have found gainful employment in fry collection and trade. And their number is increasing. The Central Inland Capture Fisheries Research

Hundi *loads of shrimp fry caught in boat operations*

Shrimp fry on plates for sale

Hundi *loads of shrimp fry being taken by truck for stocking in* bheries

Institute, Barrackpore. recently conducted a survey of fry-collectors in South 24 Parganas. The study, confined to a 40 km stretch in the Kulpi area, revealed that there were about 5000 fry-collectors in 21 villages on this stretch operating 7000 nets. On an average they collect about 2500 *P. monodon* fry a day (8 hours), which is about 28 per cent of the mixed fry catch.

Another survey, in South 24 Parganas, conducted by Directorate of Fisheries, West Bengal Government, has reported on the 'Brackishwater Prawn Seed Resource' (January to July. 1991) in the blocks of Diamond Harbour, Kakdwip, Namkhana, Kulpi, Kultali, Canning and Sagar (Anon, 1991). Due to resource constraints, the Basanti, Gosaba and Patharpratima blocks could not be covered. This survey revealed that fry collectors belonging to 3025 families in the seven blocks were engaged in this profession and annually collected 429.1 millions of *P. monodon* fry, 78.3 million of these during the lean season. Of these families, more than half had a per capita annual income of between Rs. 401 and Rs. 1200. About 500 families earned less than Rs. 400 and 954 families had annual incomes exceeding Rs. 1200.

8. *DISCUSSION*

The observations on the seasonal abundance of the shrimp fry by-catch show that each species has an extended season of availability with several peaks of abundance. The centre-wise distribution of seed indicates that the catch by numbers per net per day is high in Ramnagar compared to other centres, perhaps due to the fewer nets operated and its proximity to the sea.

The greater abundance of certain species, like *Rhinomugil corsula,* at Harwood Point appears to be due to the fact that the salinity range in monsoon and post-monsoon months is within 1.0 to 9.6 ppt.

The reduced catch per unit of effort at Najat, which was observed in the present study, is due to the fact that a larger number of nets are operated here to meet the high demand of the nearby *hheries.*

Seed collection activities are much more pronounced in North 24 Parganas, as about 90 per cent of the *bheries* are located in that area. The total number of shrimp fry-collectors in both districts may be more than 50,000. The percentage contribution of *P. monodon* was 1.50, 36.00 and 0.60 respectively at Najat, Harwood Point and Ramnagar; the remaining shell and finfish juveniles were killed in the process. Das (1987) reported large-scale destruction of prawn and fish fry in the Hugli-Matla estuarine system. Verghese *et at.,* (1988) reported 25,000-100,000 post-larvae of *M. monoceros* occurring in the shootnet collections in the Muriganga estuary per net per hour. Our own data suggest that for every *P. monodon* fry caught, the total number of other species caught is as high as 190.87 at Ramnagar.

The impact of wanton killing of various shrimp fry can be observed from the fact that out of 10754.9 **t** of fish landings from the Hugli-Matla estuary during 1970-71 (pre-Farakka period), shrimp contributed 1975 t, forming 14.4 per Cent (Datta, et *al.,* 1973) of the landings. Although the total fish landings from the Hugli-Matla estuary has increased considerably during the recent past (Anon, 1988-89, 1989-90), the percentage contribution of shrimp has declined to 8.1 per cent in 1989-90. This increase in total fish landings has been attributed to the significant increase in fishing effort, especially *Hilsa* gear. Along with the increased craft, the introduction of modern synthetic gear employed for catching *Hilsa ilisha* and other fish during the winter fishery is a plausible reason for the increased catches.

9. CONCLUSION

The study points out clearly the magnitude of destruction of the shrimp fry by-catch. It was estimated to be almost 407 million in Najat, 62 million in Harwood Point and 2592 million in Ramnagar.

The fry by-catch comprises a wide variety of fish and shrimp species of commercial importance. They include:

Shellfish

Penaeidae *(Metapenaeua brevicornis, Metapenaeus ensis, Parapenaeopsis sculptilis. Penaeus penicillatus)*

Sergestidae *(Acetes indicus)*

Palaemonidae *(Exopalaemon styliferus, Macrobrachiurn rude, Macrobrachium* sp.)

Finfish

Clupeidae *(Hilsa ilisha, Hilsa to/i)*

Engraulidae *(Stolephorus* sp.)

Mugilidae *(Liza parsia, Liza lade. Rhinomugil corsula)*

Lutjanidae *(Lutjanus* sp.)

Sciaenidae *(Parna pama, Johnius coitor)*

Gobiidae *(Glossogohius giuris, Gohioides ruhicundus)*

Excepting the sergestid, *Acetes* sp., and the engraulid, *Stolephorus* sp.. all the species of shrimp fry by-catch have a good and ready market as fresh fish. Although *Acetes* sp. and *Stolephorus* sp. are not preferred as edible fresh fish, they have considerable commercial value in dried form, as they are a major component in fishmeal manufacture.

The enormous quantity of shrimp fry by-catch destroyed constitutes fry of both economic and uneconomic varieties. Among the uneconomic varieties of shellfish caught commonly as fry by-catch are crustaceans, *Nematopalaemon tenuipes* and the larvae of *Varuna litterata.* The uneconomic finfish landed are *Haplochi/us panchax, Plotossus canius, Anguilla* sp., *Ambassis* sp., *Equula ruconius, Gohius sadanundio, Cynoglossus* sp. and *Arochiron* sp.

In practice. a shootnet collects more hatchlings and early fry of fish and post-larvae of shrimp, which have a major role to play in the food chain of predatory fish. So elimination of fry in the fry by-catch is not only detrimental to the predators thriving on them, but it also creates an ecological imbalance.

The large quantities of fry by-catch discarded by the fry- collectors is because

Its value is insignificant, relative to that of *Penaeus ,nonodon.*

— No fry trade of commercially important fish and shrimp (other than tiger shrimp) exists.

The fry-collectors lack education: and

The poorer fry-collectors receive advances from the traders/agents only for tiger shrimp fry-collection, which is the only organized fry trade in West Bengal.

10. *RECOMMENDATIONS*

Any attempt at radically changing the behavioral pattern of the rural communities associated with the fry trade, with particular reference to fry-collectors, can only be accomplished effectively through the concerted effort of the various departments concerned. These efforts should be directed at

Educating the fry-collectors:

— Establishing a fry bank;

— Reducing stocking density of *Penaeus monodon* fry in *hheries;*

— Using hatchery fry as stocking material; and

— Transporting tiger shrimp fry under oxygen packing.

10. | *Educating the fry collectors.*

Collectors, agents, traders etc., who are involved in the tiger shrimp fry trade, should be motivated and guided by Government extension agencies to put back the rest of the fry in the collection spot in live condition after segregation of tiger shrimp fry.

Audio-visuals, radio talks, pamphlets and other devices should be used to educate fry-collectors on the severe damage that can be caused to the ecology and fisheries in the estuaries. The Department of Fisheries, West Bengal, has already made a beginning in this direction by imparting training to 1800 fry-collectors in the three districts under study.

10.2 *Establishing a fry bank*

The establishment of fry banks would enable seasons of poor demand and low prices to be tided over and seed to be made available to *hheries* at competitive prices during seasons of high demand.

10.3 *Reducing stocking density of* Penaeus monodon *fry in* bheries

Current practices of improved traditional farming in West Bengal have farmers stocking fry at a very high rate (50,000-60,000/ha). This is much higher in comparison to other Asian countries, where it is usually 3000-5000/ha. The production range in the other culture systems range from 100 to 500 kg/ha/yr., which is about what the West Bengal culture system produces. The large scale stocking In *bheries* without proper scientific management, entails large losses of tiger shrimp fry through high mortality. Reduced stocking density in the *hheries* can help conserve this resource.

10.4 *Using hatchery fry as stocking material*

Some efforts have already been made by the Department of Fisheries, to establish a tiger shrimp fry hatchery. Once the hatchery comes into operation, it will cater to the needs of traditional farmers and reduce the exploitation of the natural resource.

10.5 Transporting tiger shrimp *fry under oxygen packing*

Fry is at present transported in open containers, resulting in poor survival of fry, as they are under stress during the long journeys. The development of an oxygen-packing technique for fry will reduce the mortality rate to a great extent.

10.6 *Supplementary recommendations*

The impact of the large-scale destruction of shrimp fry by-catch in the estuarine fisheries merits further investigation, It is necessary to study the impact of exploitation on the natural population and on the recruitment pattern of the capture fishery resources, in the context that the current level of fishing effort has rendered a decline in shrimp catch. It is therefore recommended that a sampling programme be initiated to collect data on population parameters for selected species of commercial importance occurring in the shrinip fry by-catch.

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APPENDIX I

List of species encountered in seed collection net

I. CRUSTACEANS

1. Crab: *Varuna litterata* (Megalopa larvae)

Family : Penaeidae

2. *Metapenaeus brevicornis* (H. Milne Edwards)
3. *M. ensis*(de Haan)
4. *Parapenaeopsis sculpt//is* (Helter)
5. *Penaeus (Fenneropenaeus) penicillatus* (Alcock)
6. *Penaeus monodon* (Fabricius)

Family : Sergestidae

7. *Acetes* sp.

Family : Palaemonidae

8. *Exopa/aemon styliferus* (H. Milne Edwards)
9. *Macrobrachium rude* (Heller)
10. *Macrobrachium* sp.
11. *Nematopalaemon tenuipes* (Henderson)

II. FINFISH

Family : Clupeidae

12. *Hilsa ilisha* (Hamilton-Buchanan)
13. *H. toli* (Valenciennes)
14. *Ilisha elongata* (Bennett)
15. *Rac onda russeliana* (Gray)

Family : Engraulidae

16. *Stolephorus* sp.
17. *Coilia du.csumieri* (Valenciennes)
18. *C. ramcarati* (Hamilton-Buchanan)
19. *Engraulus taty* (Valenciennes)
20. *E. telara* (Hamilton-Buchanan)

Family : Elopidae

21 *Elops saurus*

Family : Cyprinidae

22. *Puntius ticto* (Hamilton-Buchanan)

Family : Cyprinodontidae

23. *Haplochilus panchax* (Hamilton-Buchanan)

Family : Ophiocephalidae

24. *Channa punetata* (Russel)

Family : Plotosidae

25. *Plotosus canius* (Hamilton-Buchanan)

Family : Harpadontidae

26. *Harpodon nehereus* (Hamilton-Buchanan)

Family : Ariidae

27. *Arius* sp.

Family : Anguillidae

28. *Anguilla* sp.

Family : Muraenesocidae

29. *Muraenesox* sp.

Family : Hemiramphidae

30. *Hemirhamphus gaimardi* (Valenciennes)
31. *H. huffonis* (Cuvier and Valenciennes)

Family : Mugilidae

32. *Liza parsia* (Hamilton-Buchanan)
33. *L. tade* (Forskal)
34. *Mugi! cephalus* (Linnaeus)
35. *Valamugil cunnesius* (Valenciennes)
36. *Rhinomugil corsula* (Hamilton-Buchanan)

Family : Polynemidae

37. *Eleutheronema tetradactylum* (Shaw)
38. *Polynemus indicus* (Shaw)
39. *P. sextarius* (Bloch & Schneider)

Family : Ambassidae

40. *Ambassis nama* (Hamilton-Buchanan)
41. *A. ranga* (Hamilton-Buchanan)

Family : Latidae

42. *Lates calcarifer* (Bloch)

Family : Theraponidae

43. *Therapon jarhua* (Forskal)

Family : Sillaginidae

44. *Silago sihama* (forskal)

Family : Leiognathidae

45. *Equula ruconius* (Hamilton-Buchanan)

Family : Lutjanidae

46. *Lutjanus johni* (Bloch)
47. *Lutjanus* sp.

Family : Sciaenidae

48. *Pama pama* (Hamilton-Buchanan)
49. *Johnius coibor* (Hamilton-Buchanan)

Family : Mullidae

50. *Upeneus (Upeneus) vittatus* (Lacepede)

Family,: Scatophagidae

51. *Scatophagus argus* (Linnaeus)

Family : Trichiuridae

52. *Lepturacanthus savala* (Cuvier)
53. *Trichiurus* sp.

Family : Gobiidae

54. *Glossogobius giurus*
55. *Gobius sadanundio*
56. *Gobioides rubicundus*

Family : Rhynchobdeluidae

57. *Mastacembelus* sp.

Family : Platycephalidae

58. *Platycephalus* sp.

Family : Cynoglossidae

59. *Cynoglossus* sp.

Family : Tetraodontidae

60. *Arothron* sp.

APPENDIX II

Table 1 Physico-chemical parameters (average) at different centres

Centres	*Oct. 90*	*Not'*	*Dec.*	*Jan. 91*	*Feb.*	*Mar,*	*Apr.*	*Ma)'*	*Jun.*	*Jul.*	*Aug.*	*Sep.*
NAJAT												
Air Temp. (C)	29.00	22.50	23.70	19.60	21.50	28.10	32.20	30.60	30.70	31,90	31.60	28.20
Waler Temp. (C)	28.00	26.20	23.70	20.90	21.00	26.70	31.20	30.30	30.00	30.70	30.60	28.50
Salinity (ppt)	Trace	7.00	9.00	7.30	6.00	12.00	16.10	18.80	19.00	11.80	6.50	3.00
HARWOOD POINT												
Air Temp. (C)	30.00	*25.60*	23.00	18.40	24.80	28.60	29.60	31.00	29.80	29.50	31.50	30.30
Water Temp. (C)	28.00	26.20	22.50	19.70	23.40	28.10	29.60	29.20	29.70	30.00	30.60	30.20
Salinity (ppt)	Trace	5.00	9.60	6.60	6.80	9.80	13.20	13.50	12.80	8.70	5.20	**1.00**
RAMNAGAR												
Air Temp. (C)	No observation made		22.10	18.00	25.10	29.00	32.00	31.50	30.10	31.00	30.80	30.00
Water Temp. (C)	-do-		22.30	18.30	23.90	27.70	30.60	30.80	29.30	29.90	30.20	30.00
Salinity (ppt)	-do-		20.50	17.30	21.90	24.20	30.10	30.30	19.40	17.00	2.20	**4.40**

Table 2 : Total fish and shrimp landings (t) from the Hugli-Matla estuary before and after tiger shrimp fry trade

	Before	*After*					
	1970-71	1984-85	1985-86	1986-87	1987-88	*1988.89*	*1989*
Total	10755	26043	26437	19798	31147	41321	33140
Shrimp	1575	2323	1892	2564	1787	3452	2670
% Contribution	14.6	8.9	7.2	12.9	5.7	8.2	8.1

Table 3 : Production of *P. monodon* fry (million) and average price (Rs/thousand fry) at different centres

Centres	*Nov. 90*	*Dec.*	*Jan. 91*	*Feb.*	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sep.*
NAJAT											
Number		0.005	0.155	0.037	1,467	1.065	0.411	1.496	0.018	1.432	0.042
Price	NA	120.00	45.00	70.00	234.00	158.00	110.00	65.00	43.00	30.00	10.00
HAR WOOD POINT											
Number	0.143	0.742	0.900	1.539	2.277	3.233	1.994	16.274	5.343	2.172	0.012
Price	57.00	60.00	33.00	150.00	190.00	170.00	53.00	48.00	29.00	22.00	NA
RAMNAGAR											
Number		0.220	0.384	0.078	0,152	1.335	2.521	11.248	0.266	0.200	1.235
Price	NA	50.00	50.00	123.00	112.00	90.00	43.00	35.00	27.00	11.00	10.00

NA: Not available

Table 4. Total catch of *P. monodon* fry and other species by fry-collectors at three different centres

	Nov. 90	*Dec.*	*Jan. 91*	*Feb.*	*Mar.*	*Apr.*	*May.*	*Jun.*	*Jul.*	*Aug.*	*Sept.*	*Total*	*% of total catch*
NAJAT													
Nets operated (no.)	2.00	2.00	78.00	17.00	513.00	399.00	105.00	272.00	565.00	805.00	12.00		
Nets observed (no.)	2.00	2.00	23.00	10.00	30.00	36.00	15.00	13.00	18.00	20.00	8.00		
P. monodon catch (obs. no.)	-	70.00	559.00	275.00	719.00	1031.00	671.00	920.00	184.00	502.00	354.00		
P. monodon catch (Est. '000s)	-	5.60	154.76	37.40	1467.00	1064.60	411.80	1496.30	18.00	1432.30	42.50	6130.26	1.50
Others (Est. million)	.008	0.15	17.20	1,40	64.80	137.30	1.40	29.10	45.40	109.90	0.69	407.34	98.50
HARWOOD POINT													
Total No. of nets operated	39.00	207.00	282.00	466.00	915.00	1031.00	489.00	946.00	329.00	154.00	11.00		
No. of nets observed	27.00	38.00	30,00	29.00	34.00	43.00	23.00	29.00	15.00	15.00	10.00		
P. monodon catch (Obs. no.)	1455.00	1460.00	797.00	1089.00	1066.00	1643.00	1117.00	5020.00	3348.00	1731.00	346.00		
P. monodon (Est. '000s)	143.24	742.96	899.98	1539.42	2276,80	3233.13	1994.20	16274.14	5342.69	2172.48	12.05	34631.09	36
Others (Est. millions)	1,94	2.09	2.50	6.06	13.98	12.54	1.36	11.46	6.36	3.19	0.07	61.55	64
RAMNAGAR													
Total No. of nets operated	-	51.00	49.00	93.00	98.00	225.00	146.00	391.00	36.00	11.00	11.00		
No. of nets observed	-	91.00	17.00	25.00	22.00	23.00	24.00	18.00	13.00	11.00	11.00		
P. monodon catch (Obs. no.)	-	1017.00	1570.00	311.00	448.00	1478.00	4154.00	6514.00	976.00	1950.00	15438.00		
P. monodon (Est. '000s)	-	219.79	384.43	77.51	151.92	1334.50	2520.62	11248.47	265.96	200.16	1235.04	17638.40	0.60
Others (Est. millions)	-	5.58	14.38	19.88	3.97	2453.16	21.61	46.78	2.93	13.73	9.86	2591.88	99.40

- Other catch include miscellaneous shrimp and fish, crab and *Acetes* sp.

Table 5: Species-wise seasonal abundance (catch/net/day) of shrimp fry by-catch at Harwood Point (No. x **100)**

Species	*(size range mm*)*	*1990* *Nov.*	*Dec.*	*1991* *Jan.*	*Feb.*	*Mar.*	*Apt'.*	*Ma)'*	*Jun.*	*Jul.*	*Aug.*	*Sep.*
CRUSTACEANS												
Penaeus penicil/atus	(18-45)	-	-	-	0.16	0.18	-	0.41	-	0.32	-	0.23
Metapenaeus brevicornis	(24-28)	0.54	-	0.41	1.18	0.05	0.52	0.99	-	0.53	0.63	0.87
M. ens/s	(20-28)	-	-	-	0.13	0.41	0.48	0.8	0.24	0.12	0.3	0.04
Acetes sp.	(15-25)	886.96	48.45	18.39	21.28	23.47	7.06	1.4	1.59	4.99	.09	47.64
Exopalaemon styliferus	(13-21)	0.25	1.65	0.85	1.23	0.45	0.16	0.08	0.13	1.65	.25	2.5
Macrobrachium rude	(20-25)	0.12	0.76	-	0.45	-	0.01	-	-	-	-	0.02
Varuna litterata		69.03	29.76	40.24	107.97	73.73	112.82	12.6	939.36	120.1	36.08	3.86
FISH												
Stolephorus sp.	(23-37)	6.72	2.73	-	2.54	1.25	1.48	0.06	0.12	0.35	1.67	4.14
Hilsa sp.	(18-40)	2.85	-	-	0.46	0.083	0.01	0.24	-	-	-	-
Ilisha sp.	(30-51)	0.45	-	-	-	-	-	0.32	-	1.17	-	-
Liza parsta	(20-84)	0.44	-	4.55	2.11	0.84	0.9	0.25	0.65	-	-	-
Liza spp.	(10-30)	0.05	-	-	-	-	-	-	-	-	0.39	-
.Rhinomugil corsula	(16-40)	0.50	-	7.56	0.17	0.03	-	0.07	-	2.3!	0.25	-
Lutjanus sp.	(16-28)		1.25	1.68	3.88	1.15	0.5!	0.79	1.37	-	0.08	0.2!
Scatophagus argus	(15-28)	0.23	-	-	-	0.1	0.16	-	0.24	0.16	0.15	0.11
Sciaenids	(13-30)	0.03	0.54	-	0.7	0.87	0.75	0.12	1.93	0.82	1.71	0.08
G. rubicundus	(16-138)	-	0.49	2.92	0.67	48.09	3.57	1.22	1.59	0.13	0.36	-
Gobids	(10-40)	19.65	1.42	8.01	5.57	3.93	0.83	3.82	3.39	3.7	2.4	1.36
Others		6.24	2.91	-	-	-	-	-	-	-	-	

* Size range is same for other centres also

Table 6 : Species-wise seasonal abundance (catch/net/day) of the shrimp by-catch at Najat (No. x 100)

	1990		1991								
	Not'	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*Ma)'*	*Jun.*	*Jul.*	*Aug.*	*Sep.*
CRUSTACEANS											
Penaeus penicil/atus	-	-	37.00	0.28	-	-	-	-	-	0.19	-
Metapenaeus brevicornis	-	-	0.05	0.23	0.21	0.18	1.11	0.55	2.25	10,80	14.40
M. ensis	-	-	-	-	-	-	1.43	1.91	0.81	0.75	-
Acetes sp.	36.51	7.20	286.65	778.45	1463.95	242.49	129.05	2752.50	755.39	70.35	4.00
Exopalaemon styliferus	0.40	-	6.35	1.88	2.99	1.62	2.29	2.05	1.57	32.32	18.40
Palaemon spp.	-	-	-	-	-	-	-	-	-	0.64	1.00
Macrobrachium rude	-	-	-	0.12	-	-	0.09	0.32	0.49	0.37	2.50
Varuna litterata	0.40	38.40	18.10	11.31	2758.39	708.50	-	63.04	265.52	3396.08	453.20
FISH											
Stolephorus sp.	-	74.80	7.80	0.35	2,32	1.72	2.15	2.79	0.76	5.40	33.50
Hilsa spp.	-	-	0.60	0.57	-	-	-	0.32	-	-	-
Ilisha sp.	-	-	0.18	-	0.58	-	-	-	-	-	-
Liza parsia	-	-	33.20	11.94	0.63	0.47	7.70	6.30	-	-	
Liza tade (15-30)	-	-	-	-	41,32	-	-	0.10	-	0.07	-
Rhinomugil corsula	-	-	0.60	-	0.29	-	-	-	-	0.16	-
Luijanus sp.	-	-	0.40	-	-	-	-	0.64	-	0.30	-
Scatophagus argus	-	-	-	-	-	-	-	-	-	0.04	1.00
Sciaenids	-	-	-	1.41	3.66	-	-	11.78	-	0.66	41.53
G. *ruhicundus*	-	-	6.91	2.33	16.88	37.26	7.84	1.20	0.54	0.44	3.60
Gobids	-	5.60	1.27	-	9.89	25.72	2.52	1.32	0.93	6.52	0.40
Others	0.80	23.60	29.28	8.42	9.27	5.28	10.36	15.53	0.39	0.58	0.60

Table 7 : Species-wise seasonal abundance (catch/net/day) of the shrimp fry by-catch at Ramnagar (No. x 100)

	Dec. 1990	Jan.	Feb.	Mar.	Apr.	1991 May	Jun.	Jul.	Aug.	Sep.
CRUSTACEANS										
Penaeus penicillatus	0.29	27.00	4.85	0.52	3.17	5.33	11.26	-	1722.47	10.04
Metapenaeus brevicornis	6.67	2.13	6.49	4.21	47.91	38.75	175.80	2.60	173.31	238.14
M. ensis	7.69	-	13.78	39.94	8797.88	38.09	2.38	28.38	210,97	96.54
Acetes sp.	883.31	2765.35	1544,79	156.87	439.87	931.82	384.66	-	7.20	-
Exopa/aemon stvliferus	11.81	8.68	3.55	1.49	0.25	-	-	-	104.72	1304.40
Palaemon spp.	-	-	-	60.75	1.15	0.42	11.12	35.71	0.07	1056.30
Macrobrachium rude	3.73	0.25	0.12	-	-	-	-	-	-	0.70
Varuna litterata	6.87	16.28	1.92	0.39	50.90	-	19.41	40.44	1768.00	2402.20
FISH										
Stolephorus sp.	0.30	0.51	10.43	30.77	16.90	16.11	425.85	-	31.56	105.25
Hilsa spp.	-	0.33	-	-	4.88	-	-	-	-	-
ilisha sp.	12.18	15.23	0.09	-	23.19	7.67	0.75	-	-	-
Li:a parsia	1.75	8.29	4.73	0.73	2.46	0.59	0.55	-	-	-
Liza spp.	-	-	-	-	-	-	16.33	-	-	1.49
M. cephalus	-	-	-	-	-	2.67	-	-	-	-
Rhinomugil corsula	0.94	0.33	-	-	-	-	-	-	-	
Lutjanus sp.	2.77	2.33	1.51	2.18	5.23	3.73	6.61	0.009	-	-
Scatophagus argus	-	-	-	-	1.31	0.04	0.78	-	0.22	0.40
Sciaenids	-	-	-	-	-	-	5.54	3.11	147.12	34.30
G. *rubicundus*	0.46	0.29	1.31	0.12	1.82	2.39	0.79	8.67	-	76.22
Gobids	2.80	0.85	17.92	12.54	1.69	9.42	3.07	30.18	215.49	18.48
Others	25.95	50.39	14.29	39.67	157.18	0.34	6.54	0.31	3.71	19.98

PUBLICATIONS OF THE BAY OF BENGAL PROGRAMME (BOBP)

The BOBP brings out the following types of publications:

Reports (BOBP/REP/...) which descnbe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and subprojects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/...) which are progress reports that discuss the findings of ongoing work.

Manuals and Guides (BOBP/MAG/...) which are instructional documents for specific audiences.

Information Documents (BOBP/INF/...) which are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters *(Bay of Bengal News)* which are issued quarterly and which contain illustrated articles and features in nontechnical style on BOBP work and related subjects.

Other publications which include books and other miscellaneous reports.

Those marked with an asterisk (*) are out of stock but photocopies can be supplied.

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33. *Nonformal Primary Education for Children of Marine Fisherfolk in Orissa. India.* U. Tietze, N. Ray. (Madras, 1987.)

34. *The Coastal Set Bagnet Fishery of Bangladesh Fishing Trials and investigations.* S. E. Akerman. (Madras, 1986.)

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37. *High-Opening Bottom Trawling in Tamil Nadu, Gujarat and Orissa, India : A Summary of Effort and Impact.* (Madras, 1987.)

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39. *investigations on the Mackerel and Scad Resources of the Malacca Straits.* (Colombo, 1987.)

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59. *Report on Development of' Canoes in Shri Lanka. G* Pajot, *O* Gulbrandsen. **(Madras,** 1993.)

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50. *Experiences with a Manually Operated Net-Braiding Machine in Bangladesh.* B.C. Gillgren, A. Kashem. (Madras, 1986.)

51. Hauling Devices for Beachlanding Craft. A. Overa. PA. Hemminghyth. (Madras, 1986.)

52. *Experimental Culture of Seaweeds* (Gracilaria sp.) *in Penang. Malaysia.* (Based on a repon by M. Doty and J. Fisher). (Madras, 1987.)

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1. *Helping Fisherfolk to Help Themselves : A Study in People's Participation,* (Madras, 1990.).
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NOTE: Apart from these publications, the BOBP has.brought out several folders, leaflets, posters etc., as part of its extension activities. These include Post-Harvest Fisheries folders in English and in some South Indian languages, on anchovy drying, insulated fish boxes, fish containers, ice boxes, the use of ice etc. Several unpublished reports connected with BOBP's activities over the years are also available in its Library.

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