CHAPTER -2

FISHERY

2.1. INTRODUCTION:

India has a significant marine fisheries sector that plays an important role in the country's economy and has been an important source of income and occupation and livelihood for not only the coastal communities but also for the millions of people inhabiting our country. In capture fishery besides fishes, shrimps are also very important both biologically and economically. The penaeid shrimps constitute the backbone of seafood export industry and are the major foreign exchange earner from fishery sector forming the source of livelihood for millions of peoples whose involve with fishery sector directly and indirectly.

Important penaeid shrimps that support commercial fisheries along the Indian waters

Scientific Name	Common Name
Fenneropenaeus indicus	Indian white prawn
Penaeus semisulcatus	Green tiger prawn
Penaeus monodon	Giant tiger prawn
Penaeus merguiensis	Banana prawn
Penaeus japonicus	Kuruma prawn
Penaeus penicillatus	Red-tail prawn
Metapenaeus dobsoni	Flower-tail prawn
Metapenaeus affinis	Jinga prawn
Metapenaeus kutchensis	Ginger shrimp
Metapenaeus monoceros	Speckled prawn
Metapenaeus brevicornis	Yellow prawn
Parapenaeopsis stylifera	Kiddi prawn

Parapenaeopsis hardwickii	Spear prawn
Parapenaeopsis sculptilis	Rainbow prawn
Parapenaeopsis maxillipedo	Torpedo prawn
Parapenaeopsis uncta	Uncta prawn
Trachypenaeus curvirostris	Rough prawn
Metapenaeopsis stridulans	Fiddler shrimp
Parapenaeus longipes	Flaming prawn
Solenocera crassicornis	Coastal mud prawn
Solenocera choprai	Coastal mud prawn

The coastal length of West Bengal is 158 km (Srinath et al., 2007). Here, marine fishing activity is an important source of income for coastal living people. There is enormous literature on the estuarine prawn fishery resources of West Bengal (Kunju, 1955; Rajyalakshmi, 1961, 1966; Rao, 1969; Gopalakrishnan, 1973; Gopalakrishnan and Rao, 1968; Gopalakrishnan et al., 1975; Thakur, 1975; Chakraborti et al., 1977; Basu and Pakrasi, 1979; Bhaumik et al., 1992; Bhowmik, 1993 and Sarkar and Bhattacharya, 2003). However, very little information is available on the marine prawn fisheries of Wet Bengal. There is limited information on the seasonal bag net fishery (Saigal et at., 1987) and on the prawn fishery of the large trawlers operating off the West Bengal coast (Rao, 1987, 1988, 2003 and Maheswarudu, 2013). As Digha being the main trawl landing centre along the northern Bay of Bengal and as, almost the entire *P. monodon* is caught in trawl nets, therefore, the trawl fishery of Digha is selected in the present study. There is no published information available till date on the trawl fishery of *P. monodon* from Digha coast of West Bengal, India. The present study aims to provide information on trawl fishery of *P. monodon* in coastal waters of Digha coast, India.

2.2. REVIEW OF LITERATURE:

West Bengal is the northern maritime state in the east coast of India. The state contributes on an average close to 3 lakh tones in the country's total marine fish production. The production is around 82% from the mechanized sector, while it is around 15% from the motorized sector and 3% from the non-motorized sector. During the major fishing season extending from July to February, multiday operations of trawlers and gillnetters are a regular phenomenon. The major contributors to the landings are the pelagic resources contributing on an average 60% followed by demersals contributing 27% and crustaceans contributing 13%, with negligible contribution from mollusks. Gill nets contribute the most, in both the mechanized (40%) and motorized sectors (10%), among all the different types of gears operated. Contribution of multiday trawl nets is around 23%. The middle of April to middle of June is the period of fishing ban for the mechanized fishery of West Bengal, where no trawlers operate. Therefore, in the month of May, trawl catch and effort is nil, and hence, this month has been excluded in the present study. The months from middle of June to middle of April contribute nearly 97% of the total landings, while the closed season contributes 3% (Ramani et al., 2010).

Maheswarudu et al. (2014) observed that penaeid prawns, on and average, contributed 9.8% to the annual marine fish landings along the east coast during 1991 – 2011 with their contribution varying from 5.5% - 13.8%. The contribution of east coast ranged from 17.4% to 41.2% during 1991 – 2011, with an average contribution of 29% to the country's total penaeid prawn catch. Average annual catch for the county was 86,969 t ranging from 33,131t in 1991 to 19,054 t in 2011. An overall increasing trend was observed during this 21 years period from 1991 – 2011. The average contribution of penaeid prawns in each state exhibited Tamil Nadu to contribute the highest (32%), followed by Andhra Pradesh (26%), West Bengal (22%), Odisha (19%), and Puducherry (1%). From West Bengal and Odisha, the highest catch was recorded in the year 2011, whereas from Andhra Pradesh it was in 2010

and from Tamil Nadu and Puducherry it was in 2009. The lowest catch from West Bengal, Odisha and Andhra Pradesh was observed in 1991 and in Tamil Nadu, it was in 2001 and from Puducherry, it was in 1997. The highest compounded annual growth rate during 1991 – 2011 was observed in West Bengal (0.211), followed by Odisha (0.192), Andhra Pradesh (0.056) and Tamil Nadu (0.033), whereas Puducherry showed negative compounded annual growth rate (-0.006). Maheswarudu et al. (2014) also reported that more than 90% of the penaeid prawns landed along the east coast was from trawl nets.

Species composition of penaeid prawn along the east coast during 1991 – 2011 was computed by Maheswarudu et al. (2014) from the landings at Paradeep, Visakhapatnam, Kakinada, Chennai, Mandapam and Tuticorin fishing harbours / landing centers. Around 19 species supported regular fishery from the 23 species recorded. *Metapenaeus dobsoni* with 21.4% contribution dominated the catches, followed by *M. monoceros* (3.2%), *Metapenaeopsis spp* (9.4%), *Penaeus semisulcatus* (9.2), *Fenneropenaeus indicus* (7.5%), *Parpenaeopsis mxilipedo* (4.3%), *Trachypenaeus spp* (4.2%), *Solenocera spp* (4.1%), *Parapenaeopsis stylifera* (4%), *P. hardwickii* (3.7%), *M. affinis* (3.1%), *M. moyebi* (2.5%), *M. lysianssa* (1.7%), *P. monodon* (1.6%), *M. brevicornis* (1.6%) and *Parapenaeus longipes*. A regular fishery was observed from 1993 onwards for *M. brevicornis*. From 1993 onwards, the contribution of *P. stylifera, P. hardwickii, Solenocera spp, P. longipes* and *M. moyebi* has increased significantly. For *P. monodon,* the catch tripled in 1994, after which it was more or less stable. Similar trend has been observed for *F. indicus, M. dobsoni, M. monoceros* and *P. maxillipedo,* whose landings gradually increased up to 1994 and henceforth it has been steady.

About 11 species supports the fishery in West Bengal. The dominant species was *P. hardwickii* (24.1%), followed by *M. dobsoni* (18.5%), *P. stylifera* (11.7%), *M. lysianassa* (10.4%), *Solenocera spp* (7.9%) and *M. monoceros* (6.6%). Landings were low for

commercial species like *P. monodon, F. indicus* and *P. merguiensis*. Panikkar and Menon (1956) from the marine catches off the coasts of India recorded 10 to 11 inches (25.4 to 27.9 cm) as the largest sizes of *P. monodon*. Shaikhamahmud and Tembe (1960), from the catches of Mumbai, observed *P. monodon* of size ranging from 10 to 15 cm. *P. monodon* is caught in small numbers throughout the season in the Kerala backwater fishery. Similarly in the Gautami estuary, though catch is recorded in all the months, intense fishery is from November to early January (Subrahmanyam, 1965). In Philippines, the 'sugpo` fry season starts from May and ends by October. *P. monodon* constitute the commercial catches from August to October off Mumbai. Srivatsa (1953) estimated that 10% of the Gulf of Kutch prawn fishery is constituted by *P. monodon*. Subrahmanyam (1966), from the Gautami estuary during 1960-1961, estimated the catches to be 500 tonnes with an average catch rate of 2.1 kg/day/net. *P. monodon* is caught in small quantities by stake nets, cast nets and dip nets along the southwest coast of India. Domantay (1956) described several nets and contraptions made of cotton twine and bamboo poles from the mangrove swamps in Philippines for the capture of *P. monodon*.

2.3. MATERIALS AND METHODS

Data on catch and effort expended in trawls for *P. monodon* were obtained for the period from January 2011 to December 2013. The monthly and annual estimates of catch and effort were made following the Multistage Stratified Random Sampling Technique devised by Fishery Resource Assessment Division of Central Marine Fisheries Research Institute, India. In this, the stratification is over space and time. A sampling unit is considered to be a boat-net combination. Based on the information on the number of units that have gone for fishing, the number of units to be sampled is determined. One calendar month is recognized as the stratification over time. Landing centre days are the primary stage sampling units and the space-time stratum is a zone and a calendar month. If in a zone, there are 20 landing centers,

there will be 20 x 30 = 600 landing centre days in that zone for that month (of 30 days). A month is divided into 3 groups each of 10 days for observation purpose. A day is selected at random from the first five days of a month after which the next 5 consecutive days are automatically selected. Two consecutive days are formed from these three clusters. For example, in a given month, for a given zone, from the five days if 4 is the date (day) selected at random then the clusters formed are 4, 5; 6, 7 and 8, 9 in the first ten day group. The clusters are systematically selected with an interval of 10 days for the remaining ten day groups. Therefore in the above situation, in the remaining groups, the clusters of observation days are 14, 15; 16, 17; 18, 19; 24, 25; 26, 27 and 28, 29. There will be 9 clusters of two days each in a month normally. Nine centers are selected with replacement and allotted to the 9 cluster days as described earlier based on the total number of landing centers in the given zone. Therefore 9 landing centre days are observed in a month. In a centre, the observation is made from 1200 hrs to 1800 hrs on the first day and from 0600 hrs to 1200 hrs on the second day. For the intervening period of these two days, from 1800 hrs of the first day of observation to 0600 hrs of the 2^{nd} day of observation of a landing centre-day, the data are collected by enquiry and the landing is termed as 'night landing'. The landings for one (landing centre day) day (24 hours) is calculated by adding the 'night landing' obtained by enquiry on the second day covering the period of 1800 hrs of the first day to 0600 hrs of the next day to the day landings. When the number of boats/craft landings is large during an observation period, it is not practicable to record the catches of all boats landed. Then it becomes essential to sample the boats/craft. All the boats are enumerated for catch and other particulars when the total number of boats landed is 15 or less.

However, if the total number of boats exceeds 15, the following procedure is followed to sample the number of boats:

Number of units landed	Fraction to be examined
Less than or equal to 15	100 %
Between 16 and 19	First 10 and the balance 50 %
Between 20 and 29	1 in 2
Between 30 and 39	1 in 3
Between 40 and 49	1 in 4
Between 50 and 59	1 in 5

The arrival of the multiday trawlers at the fishing harbour in a 12 hour period is taken as one unit effort. For arriving at the days' catch, the average by catch and species composition by weight for the observed units were multiplied by the number of units landed on that day. For raising to the month, the total species wise catch and effort were multiplied with a factor obtained by dividing the actual fishing days by the total number of days in the month.

Multistage stratified random sampling technique is superior to other sampling techniques in that greater precision is achieved with a relatively smaller sampling size. However, care should be taken that landing centres are properly classified or stratified for it to be accurate.

2.4. RESULTS

2.4.1. Fishing ground:

In West Bengal, *P. monodon* are caught by multi-day shrimp trawlers operating off the Digha coast. Crafts fishing *P. monodon* are with length ranging from 15 to 16 m OAL and an engine power varying between 86 to > 120 hp. Trawl nets having a codend mesh size of 15 - 25 mm are used in the fishery. The trawlers fish for 7 to 14 days in the sea depending on fish production and environmental condition. The fishing areas are covering near about 80 nautical miles away from the shore. Each boat makes 3 to 4 hauls of 3-4 hours duration. The

multiday trawl fishing is performed targeting all types of prawns and fishes. Generally, fishing is carried out both during the day time and in the night hours until the target is fulfilled. Details of trawlers and trawl net exploiting *P. monodon* at Digha coast is given below.

Details	Small trawlers	Large multi-day trawlers
Length Overall	9.14 - 11.41 m	15 - 16m
Engine power	65 - 86 hp	> 120 hp
Crew strength	6	9
Type of trawl net	Shrimp trawl	Shrimp trawl
Cod end mesh size	10 - 20 mm	15 - 25 mm
Depth of operation	10 - 70 mm	Upto 100 m
Fish hold capacity	2 - 3 t	5 - 8 t
Duration of voyage	3 - 4 days	10 - 15 days

2.4.2. Species composition:

Species composition of penaeid prawn landings in West Bengal during 2011 - 2013 shows about 11 commercial species of penaeid prawns, of which five are large sized species viz., *Penaeus monodon* (1.9%), *Fenneropenaeus indicus* (3.6%), *P. merguiensis* (6.3%), *P. penicillatus* (1.3%), *Metapenaeus monoceros* (5.9%), *M. affinis* (7.2%), *M. dobsoni* (13.3%), *Parapenaeopsis stylifera* (11.7%), *P. hardwickii* (18.7%), *Solenocera* spp (13.2%) and *Metapeneopsis spp* (8.6%). Small sized commercial species (*M. lysianassa* and *M. moyebi*) also contributed in low quantities to the landings at the Digha coast (Figure 2.1).

2.4.3. Annual landing:

The average annual catch of *P.monodon* for the period 2011 – 2013 was 281.29±9.67 tonnes, which contributed 0.41% to the total trawl net catches at Digha coast (Table 2.1). The average catch rate for the period was 43.41 kg/h (Table 2.2). The percentage contribution of *P. monodon* to total trawl net catch fluctuated between 0.36% (2013) to 0.39 % (2012) (Table

2.3). The percentage contribution of *P. monodon* to total shrimp catch was 1.94% from trawl landings at Digha coast during the period (Table 2.4).

2.4.4. Month wise landing:

Monthly mean landing of 28.13±0.97 t was recorded for *P. monodon* from trawl nets during 2011-2013 (Table 2.5 and 2.6). Peak landing was observed from June to November with a maximum of 56.46±1.97 t in the month of September and lean landing was observed during December to March with minimum landings of 6.12±0.21 t in March.

2.5. DISCUSSION:

The marine landings of West Bengal exhibited wide inter-annual fluctuations with an average of around 3 lakh tons, of which the contribution of penaeid prawns is around 5%. According to Maheswarudu (2017), in India, the average contribution of penaeid prawns is around 7.4% and of non penaeid prawns is around 5.4%. Recent contribution of penaeid prawns in West Bengal has decreased from 6.4% observed during 1996 - 2011. *P. monodon* is caught in small numbers throughout the season in the Kerala backwater fishery. Similarly in the Gautami estuary, though catch is recorded in all the months, intense fishery is from November to early January (Subrahmanyam, 1965). In Philippines, the ‘sugpo` fry season starts from May and ends by October. In Mumbai, the commercial catches are observed from August to October. Similar observation on seasonal abundance has been recorded in the present study. The catch of *P.monodon* was observed to be steady throughout the year with maximum from June to November. Catch and catch rates recorded in the present study is commensurate with the marine landings recorded by ICAR-CMFRI from West Bengal over the years. The catch recorded along the north-east coast has increased in recent years due to trawlers extending their range of operations and the duration of voyage.

Plate 2.1. Digha Mohana Landing Center

Plate 2.2. Shankarpur Fishing Harbour

Table 2.1. Annual catch of *P. monodon* from Digha coast during January 2011 to December 2013.

Year	Catch (t)	Catch rate (kg/h)	% shrimp catch	% total trawl catch
2011	264.26	40.78	2.00	0.41
2012	297.73	45.95	2.00	0.42
2013	281.88	43.50	1.83	0.39
Average	281.29	43.41	1.94	0.41

Table 2.2. Monthly catch rate (kg/h) of *P. monodon* (Mean±SE) from Digha coast during 2011-2013.

Month	2011	2012	2013	Mean±SE
January	13.89	15.65	14.81	14.78±0.51
February	9.84	11.08	10.49	10.47±0.36
March	8.87	10.00	9.47	9.45±0.32
April	61.97	69.82	66.11	65.97±2.27
June	55.98	63.07	59.71	59.58±2.05
July	59.55	67.10	63.52	63.39±2.18
August	81.86	92.23	87.32	87.14±2.99
September	43.98	49.55	46.91	46.82±1.61
October	47.45	53.46	50.62	50.51±1.74
November	24.41	27.50	26.04	25.98±0.89
December	40.78	45.95	43.50	43.41±1.49

Table 2.3. Monthly percentage of *P. monodon* landings in total trawl catch (Mean±SE) from Digha coast during January 2011to December 2013.

Month	2011	2012	2013	Mean±SE
January	0.15	0.16	0.15	0.15±0.005
February	0.14	0.19	0.17	0.17±0.01
March	0.14	0.14	0.13	0.14±0.004
April	0.60	0.63	0.56	0.60±0.02
June	0.60	0.55	0.56	0.57±0.01
July	0.52	0.54	0.49	0.52±0.02
August	0.65	0.69	0.62	0.65±0.02
September	0.40	0.40	0.38	0.39±0.01
October	0.38	0.39	0.35	0.37±0.01
November	0.23	0.24	0.22	0.23±0.01
December	0.38	0.39	0.36	0.38±0.01

Table 2.4. Monthly percentage of *P. monodon landings* in total shrimp landings (Mean±SE) from Digha coast during January 2011to December 2013.

Month	2011	2012	2013	Mean±SE
January	0.90	0.95	0.85	0.90±0.03
February	1.03	1.09	0.98	1.03±0.03
March	1.40	1.48	1.32	1.40±0.04
April	4.26	4.50	4.04	4.27±0.13
June	2.08	2.20	1.97	2.08±0.07
July	2.86	3.02	2.71	2.86±0.09
August	2.25	2.38	2.13	2.26±0.07
September	1.78	1.68	1.69	1.72±0.03
October	1.57	1.30	1.19	1.35±0.11
November	1.27	1.35	1.21	1.28±0.04
December	1.94	1.99	1.81	1.91±0.07

Table 2.5. Monthly catch (t) of *P. monodon* (Mean±SE) from Digha coast during January 2011to December 2013.

Month	2011	2012	2013	Mean±SE
January	9.00	10.14	9.60	9.58±0.33
February	6.38	7.18	6.80	6.79±0.23
March	5.75	6.48	6.13	6.12±0.21
April	40.16	45.25	42.84	42.75±1.47
June	36.27	40.87	38.69	38.61±1.33
July	38.59	43.48	41.16	41.08±1.41
August	53.05	59.76	56.58	56.46±1.94
September	28.50	32.11	30.40	30.34±1.04
October	30.75	34.65	32.80	32.73±1.12
November	15.82	17.82	16.87	16.84±0.58
December	26.43	29.77	28.19	28.13±0.97

Table 2.6. Average seasonal abundance of *P. monodon* from Digha coast during January 2011to December 2013.

Month	Catch (t)	Catch rate (kg/h)	% in shrimp catch	% in total catch
January	28.74	14.78	0.90	0.15
February	20.36	10.47	1.03	0.17
March	18.36	9.45	1.40	0.14
June	128.24	65.97	4.26	0.60
July	115.83	59.58	2.08	0.57
August	123.23	63.39	2.86	0.52
September	169.39	87.14	2.25	0.65
October	91.01	46.82	1.71	0.39
November	98.20	50.51	1.33	0.37
December	50.51	25.98	1.27	0.23
total	843.87	434.09	1.94	0.41

Figure 2.1. Species composition of penaeid prawn landings from Digha coast during January 2011 to December 2013