# CHAPTER -1

## 1. GENERAL INTRODUCTION:

India with high diversity of marine fishery resources is a tropical country possessing 2.02 million square kilometers Exclusive Economic Zone (EEZ) and coastal length near to about 8219 km with an annual harvestable potential of about 4.4 million metric tons. The coastline encompasses 9 states and 2 Union Territories (UT) and is bound by the Arabian Sea in the west and Bay of Bengal in the east. Livelihood is provided to nearly 4.0 million people by the marine fisheries sector in India and a significant proportion of the food and nutritional requirement of the population are met from it. Annually, Rs. 30,000/- crores is earned by the country from the exports of marine fishery products. As, overexploitation of the resources is likely to harm the diversity and cause decline in the availability of some of the resources, sustainable harvest is necessary for the marine fishery resources of the country. The Central Marine Fisheries Research Institute (CMFRI) through a scientific data collection and estimation system regularly monitors the harvest and the diversity of marine fishery resources of the country from all along the coast. The data generated is used for fish stock assessment for deriving management measures and advisories on the same is provided to the regulatory authorities for implementing and keeping the harvest of the resources at sustainable levels (FRAD, CMFRI, 2015).

*Penaeus monodon* (Fabricius 1798) is economically important and has great demand and is widely distributed. There is no considerable data on stock assessment, reproductive biology and feeding status of *P. monodon* from Digha coast. Very few works has been done from Indian waters on *P. monodon*. Frequent assessments are necessary because population size, structure and distribution fluctuate in response to environmental variation. Study on abundance, size, age structure, maturity, fecundity of fish in a population are essential for stock assessment of shrimp. To quantify the tropic interactions between fish and the prey and

predators, established levels of competition between fish species within the study region needs to be examined and the impacts of climate change to be assessed. Population assessments of fish typically aim to maintain or enhance the stock state and stock health of these species. Fisheries of the world aim to integrate population assessments into the biology of fishes for implementing ecosystem management properly. The present study was therefore undertaken to give a comprehensive account on length-weight relationship, reproductive biology such as length at first maturity, breeding season, food and feeding and the stock structure covering age and growth, mortality, yield-per-recruit and maximum sustainable yield (MSY) for better management and rational exploitation of *P. monodon* resource from Bay of Bengal waters particularly off Digha coast, West Bengal, India. It is assumed that that the catch landed in Digha is from one unit stock, which is reproductively isolated from other such stocks. There is no replenishment of this stock by recruitment from other unit stocks. There is a spawning ground for *P. monodon* in the northern Bay of Bengal along the coasts of southern West Bengal and northern Odisha as evident in the substantial landings of mature individuals and juveniles from this area. Digha, being the principal landing centre along the northern Bay of Bengal, almost the entire catch from this area is being landed here.

## 1.2. AIMS AND OBJECTIVES:

**1.2.1. AIMS :** The present study was undertaken to observe the fishery and the biological characteristic viz, length – weight relationship, sex ratio, length at first maturity ($LM_{50}$), breeding season, fecundity and trophodynamics including feeding habits and feeding intensity. Stock structure of the species covering age and growth, mortality, exploitation and recruitment were aimed at studying. Results obtained on maximum sustainable yield (MSY), stock, biomass and yield per recruit would be useful for providing management advisories for sustainably exploiting the stock of *P. monodon* at Digha coast.

### 1.2.2. OBJECTIVES

- To elucidate the fishery of *Penaeus monodon* from Digha coast of West Bengal, India.
- To study the reproductive biology of *Penaeus monodon* landed at Digha coast.
- To study the food and feeding habits of *Penaeus monodon* landed at Digha coast.
- To estimate the stock structure (growth and mortality parameters) of *Penaeus monodon* caught at Digha landing center.

## 1.3. DESCRIPTION OF THE STUDY AREA:

The state of West Bengal lies between longitudes $85^{0}50^{'}$ N and $89^{0}50^{'}$ E and latitudes $21^{0}38^{'}$ E and $27^{0}10^{'}$ N. The state has a coastline of 158km (Srinath et al., 2007) along its two coastal districts viz., Purba Medinipur and South 24 Parganas. Approximately, 3.6% of the countries continental shelf area lies in the waters off West Bengal. The continental shelf area encompasses 20,000 sq km and extends up to 200 m water depth. The bottom is muddy and it is affected by the large river systems and tidal currents. In the two most important coastal districts of Purba Medinipur and South 24 Parganas, there are 59 marine fish landing centers of which Digha Mohana is the biggest landing center. At Digha Mohana, both multiday trawlers and gillnetter are operated. The geographical location of Digha Mohana is $21^{0}41^{'}0^{''}$ North and $87^{0}33^{'}0^{''}$ East.

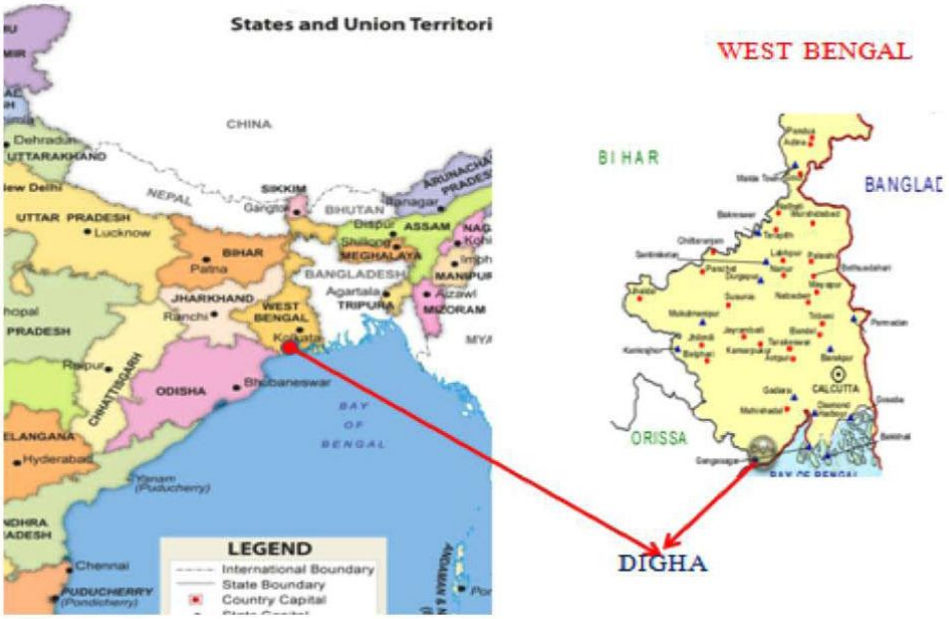


Figure1.1. Geographical location of Digha

## 1.4. DESCRIPTION OF THE SELECTED SPECIES (*Penaeus monodon*)

The giant tiger prawn, *P. monodon* is the largest and most commercially important species among the super family – Penaeoidae of marine decapods with overall 400 species (Ma et al., 2009) that are globally distributed. The species is widely distributed throughout the greater part of the Indo-West Pacific region; South Africa, Tanzania, Kenya, Somalia, Madagascar, South Arabia, Oman, Pakistan, India, Bangladesh, Srilanka, Indonesia, Thailand, Malaysia, Singapore, Korea, Japan, Australia and a host of other countries. *P. monodon* is distributed from $30^{o}$ E to $155^{o}$ E longitude and from $35^{o}$ N to $35^{o}$ N latitude. *P.monodon* supports a fishery in all the coastal states of the country (Mohammed, 1970). Between Cuddalore and the Sunderbans, along the east coast, there exists a good fishery for *P.monodon* (Rao et al., 1993). The revolution in brackish water aquaculture that took place in our country at the beginning of this century was contributed solely by *P. monodon*. *P. monodon* was extensively cultured in all coastal states of our country for a decade until disease outbreak limited its culture potential. The genus *Penaeus*(Fabricius 1798) was placed on the Official List of

Generic Names in Zoology as name No. 498 upon the discovery and description of *Penaeus monodon* by John Christ Fabricius in 1798 (Mohamed, 1970). With the revision of the specific name monodon by Holthuis (1949), the two species have become stabilized and the name *P. monodon* is generally accepted for the present species (Hall, 1961, Mohamed, 1970, Motoh, 1981). The systematic position of the giant tiger prawn (Solis, 1988) is as follows:

Phylum – Arthropoda
Class – Crustacea
Subclass – Malacostraca
Order – Decapoda
Suborder – Natantia
Infraorder – Penaeidea
Superfamily – Penaeoidae
Family – Penaeidae (Rafinesque, 1815)
Genus – Penaeus (Fabricius, 1798)
Subgenus – *Penaeus*
Species – *monodon*

Scientific name: *Penaeus monodon* (Fabricius 1798) (Plate 1.1)

Plate 1.1. *Penaeus monodon*

**Vernacular name of the species in India:**

| | |
|---|---|
| Common name | Tiger prawn or black tiger prawn or giant tiger prawn |
| West Bengal | Bada chingdi |
| Andhra Pradesh | Gaju royya |
| Tamil Nadu | Year |
| Kerala | Kara chemmeen |
| Karnataka | Shetli, Shingde |
| Maharashtra | Patteri jhinga, Vaghya chingul |

*P. monodon* is euryhaline in character and is capable of tolerating wide ranges of salinity. The post larvae, juveniles and the sub adults inhabit the backwater and estuaries. The adults inhabit deeper waters down to 162 m depth (Motoh, 1985). In the sea, the species inhabited from the near shore waters up to 100 m depth. The abundance of the species gradually increases from 11 to 60 m depth, but thereafter gradually declines towards 100 m depth (Rao, 1987).

*P. monodon* (Figure 1.1)morphology comprises of a head, tail, five pairs of swimming legs (pleopods) and five pairs of walking legs (pereopods), as well as numerous head appendages. The cephalothorax is enclosed in the carapace. The rostrum, which is sigmoid shaped, extends beyond the tip of the antennular peduncle, and consists of seven dorsal and three ventral teeth. The adrostral carina extends almost to the epigastric spine. Also the carina, extends to the posterior edge of the carapace. The posterior one-half distance between the post-orbital margin of the carapace and the hepatic spine is occupied by the gastro-orbital carina. A predominant hepatic carina is present with the anterior half being horizontal. The antennular flagellum is equal to or slightly larger than the peduncle. No exopod exists on the $5^{th}$pereiopods. From the anterior one-third of the fourth of sixth somite, the abdomen is

dorsally carinated. No arm is present on the telson. The carapace and abdomen are coloured transversely having bands of red and white. The colour of the antennae is grayish brown. The colouration on the pereopods and fringing setae are brown and red respectively. After keeping in ponds for a length of time, there is a change in colour to dark brown, and often to blackish blue.

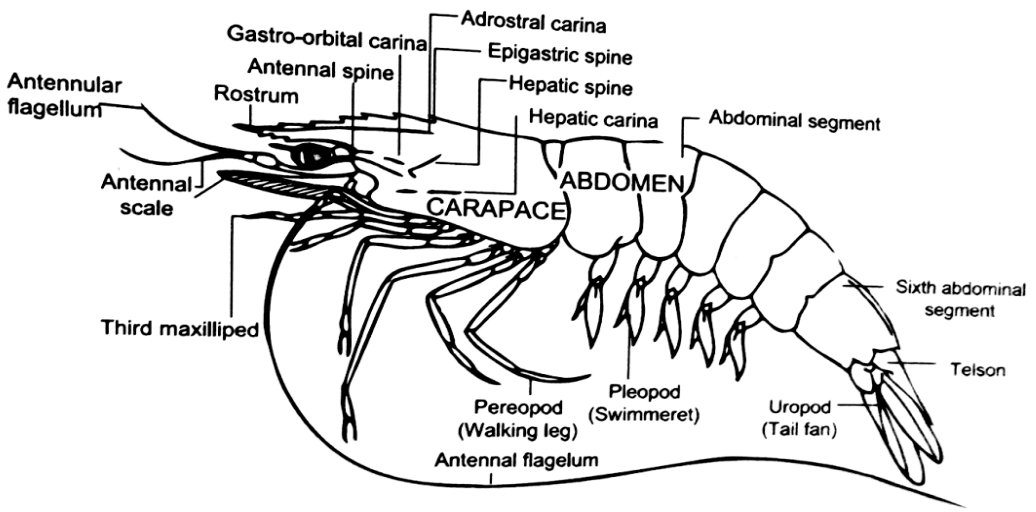


Figure 1.2. Lateral view of morphological features of *P. monodon*.

Sexes are separate in *P. monodon*. Sexually, females are larger than males. Males are distinguished by the presence of the external genital organs, which are a joined petasma, a pair of appendix masculine on the exopods of the second pleopods and a genital opening on the coxa of the 5$^{th}$ pereopods. Contrarily in females, the thelycum is present between the 4$^{th}$ and 5$^{th}$ pereopod with the genital opening on the coxa of the 3$^{rd}$ pereopod (Motoh, 1981; 1985).

The petasma is a pair of endopods on the first pleopods and is formed by the interlocking of hook-like structures. An oval shaped appendix masculine is located on the endopod of the 2 $^{nd}$ pleopod. The internal reproductive organ of the male consists of paired

testes, vasa - deferentia, and terminal ampoules located in the cardiac region dorsal to the hepatopancreas. The testis is translucent and composed of six lobes. Each lobe is connected in the inner margins leading to the vas deferens. The vas deferens consists of four portions namely; the short narrow proximal vas deferens, a thickened larger median portion or the medial vas deferens, the relatively long narrow tube as the distal vas deferens, and the muscular portion known as the terminal ampoule. The spermatophore is contained in the terminal ampoule, which opens at the base of the coxopod on the $5^{th}$ pereopods (Motoh, 1981; 1985).

The thelycum consists of an anterior and a pair of lateral plates and is situated between the $4^{th}$ and $5^{th}$ pair of pleopods. During mating, it receives the spermotophores. Thelycum in penaeids are classified as closed or open type, and *P. monodon* belongs to the closed type. Paired ovaries and oviducts constitute the internal reproductive organ of the female. The ovaries, which extends almost the entire length of the mature female is bilaterally symmetrical and is partly fused. The anterior lobe is located close to the oesophagus and the cardiac region of the stomach. The lateral lobes are located dorsal to the hepatopancreas and the abdominal lobe. The abdominal lobe is situated dorso-lateral to the intestine and ventro-lateral to the dorsal abdominal artery. The oviducts start from the tips of the sixth lateral lobe and leads to the external genital opening at the coxopods of the $3^{rd}$ pair of pereopods (Motoh, 1981; 1985).

The maturation of the ovary has been categorized into five stages, the classification of which is based on ovum size, gonad expansion, and coloration (Villaluz et al., 1969; Primavera, 1980; Motoh, 1981)

Stage – I (Immature): Ovaries thin, transparent, not visible through the dorsal exoskeleton. On dissection these appear as colorless strands without visible eggs.

Stage – II (Early maturing): Ovaries observed through the exoskeleton as a linear band as these start to increase in size, particularly in the anterior and middle lobes. Colour of dissected ovaries ranges from cloudy white to light brown and grayish-green.

Stage – III (Late maturing): Ovaries visible through the exoskeleton as a thick, solid, dark linear band as these expand considerably from the anterior thoracic to the posterior abdominal region. A somewhat "diamond" or "butterfly" outline can be seen at the level of the first abdominal segment. Dissected ovaries are mostly light olive-green, firm and granular in texture, and with visible clumps of eggs.

Stage – IV (Mature or ripe): The diamond-shaped expansion at the first abdominal segment is larger and more distinct, the linear band is thicker. Upon dissection the ovaries appear dark olive-green and are so distended as to occupy nearly all available space in the body cavity.

Stage – V (Spent): Completely spent ovaries are limp and thin and outwardly appear similar to Stage – I (immature) ovaries. Dissected ovaries are yellowish but become whiter as regression continues.

The eggs of *P. monodon* develop by slowly sinking to the bottom of the outer littoral areas. *P. monodon* completes through a complex life cycle involving three larval stages. Twelve to fifteen hours after spawning is completed, the nauplii hatch and have the appearance of tiny spiders. Larvae during this stage are carried by tidal currents from open ocean towards shore and survive on their yolks and do not accept extraneous feed. Nauplii pass through 6 quick molts with their body size increasing. With increase in body size and length, individuals proceed to the next larval stage, called protozoeas, characterized by the presence of feathery appendages and though still planktonic, start to feed. Protozoea proceed into the mysis stage after three more moltings. The adult characteristics begin to appear at this stage including segmented bodies, eye stalks, and tails. Mysis larvae transform to post larvae after three more molts. At this point in the life cycle, they change from planktonic to

benthic feeding. It takes two to three weeks to complete the entire process (Motoh, 1981; 1985). During the juvenile phase which lasts for one to six months, the shrimps continue to molt. Adults are distinguished from juveniles mainly by carapace length. In juveniles, the carapace length ranges from 2.2 – 11 mm and they inhabit mostly estuarine areas located at the river mouths and mangroves. Adults, on the other hand inhabit outer littoral areas of high salinity, with carapace lengths ranging from 37 – 81 mm (Motoh, 1981; Dall et al, 1991)