# Biological aspects of mud crab in south-west region in Bangladesh



**A Thesis**

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# Biological aspects of mud crab in south-west region in Bangladesh

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# DECLARATION

## Biological aspects of mud crabin south-west region in Bangladesh

The results presented in the thesis with the above mentioned title are entirely of the candidate's own investigations and no part of the results has been accepted for any degree nor is it being concurrently submitted for any degree.

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*Dedicated To*

*My Beloved Parents*

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**April, 2014** **S.M. Shahjahan Siraj**

## ABSTRACT

The present study was conducted to obtain an idea on the taxonomy and other biological aspects like gonadosomatic index, alimentosomatic index, condition factor, food and feeding habit of mud crab during December 2013 to March 2014. Total 60 live specimens were assayed during the study period. Of them, 30 specimens were collected from sundarban mangrove forest and 30 from gher.The body of mud crab was dorso-ventally flattened, broader than long. The body was composed of 3 parts (head, thorax, and abdomen). Cephalo-thorax was covered by a calcareous exoskeletal structure known as carapace. Male was larger than female. The shell colour varied from a blackish or reddish brown to light black.The taxonomical study showed that body weight, carapace Length, carapace Width, gonad weight, gut weight in sundarban mangrove forest ranged from 63 - 126.2g, 5.1 - 6.3 cm, 7.1 - 8.6 cm, 1.6 – 2.6 g, 0.5 – 1.4 g respectively. Body weight, carapace length, carapace width, gonad weight, gut weight in gher ranged from 42.10-124.50g, 4.20-6.30 cm, 6.10-8.80 cm, 1.70-2.30 g and 0.50-1.40 g. The gonadosomatic index of Mud crab specimens ranged from 2.31 to 4.22.Mean alimentosomatic Index of all samples was found 1.11± 0.24 and ranged from 0.73 to 2.22. The condition factor of Mud crab specimens ranged from 34.19 to 66.96.Relationships between different variables were found to be linear. Present investigation also showed the food and feeding habit of mud crab both in wild and sundarban mangrove forest. The blue green algae, unicellular and filamentous algae, diatoms, rotifer, copepods, decayed organic matter etc. were the main food items of mud crab. It indicated that the species is omnivorous in its feeding habits. The mean values alimentosomatic indices indicated feeding intensity in mud crab during the investigation period.The mud crab is a common and valuable species of Bangladesh.Very little detail work has been reported on the taxonomy and other biological aspects of this species. Detailed investigations on important aspects like taxonomy, biological characters and food and feeding habit in order to evaluate their utility in aquaculture are very meager.This study thus can be treated as an attempt for contribution of some information to this direction

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## LIST OF ABBREVIATION

| ABBREVIATION | ELABORATION |
|---|---|
| FMRT | Fisheries And Marine Resources Technology Discipline |
| *et al.* | Et alli; Latin word meaning " and others" |
| CW | Carapace Width |
| BWt | Body Weight |
| CL | Carapace Length |
| GSI | Gonadosomatic Index |
| SD | Standard deviation |
| SMF | Sundarban Mangrove Forest |
| MT | Metric Ton |
| DoF | Department of Fisheries |
| PCAMRD | Philippine council for Aquatic and Marine Research and Development |
| ASL | Alimentosomatic Index |
| CF | Condition Factor |

# CHAPTER ONE

# Introduction

# CHAPTER 1

## INTRODUCTION

### 1.1 Background of study

Mud crabs namely (*Scylla serrata, S. tranquebarica, S. olivacea, S. paramamosain*) which are distinguished by external morphology (such as- shell colour, carapace spine number, carapace width, anterolateral teeth of carapace, and outer spines of cheliped carpus etc). *Scylla serrata* is an economically important species found in Australia and Asia (FAO, 2011). *S. tranquebarica* is found in mangrove areas from Pakistan and Taiwan to the Malay Archipelago and other Indo-Pacific regions. *S. paramamosain* is found in Japan, Taiwan, China (including HongKong), Vietnam,Cambodia, Singapore and Indonesia. In their most common form, the shell colour varies from a deep, mottled green to very dark brown. *S. olivacea*, is the most valuable local crab sold in markets. These crabs are caught in traps or hooked out of their burrows during low tide. These crabs can survive out of water for extended periods as long as they are kept cool. Mud crabs are widely distributed in the tidal waters of Cox's Bazar, Noakhali, Barisal, Potuakhali, Satkhira, and Khulna and around the offshore islands particularly Moheshkhali, Kutubdia, Sandwip and Hatia in Bangladesh (Khan and Alam, 1991).

Mud crab mainly grown up in the coastal waters of 15-30 ppt salinity and particularly dominates in the mangrove fauna (Khan and Alam, 1991). It is also available in the coastal shrimp ponds and ghers. The mud crab has emerged as one of the most potential export-earning aqua-resources in Bangladesh since 1977 when export of live crab had started (Ahmed, 1991). The species has been being overfished due to high demand and good price (Azam *et al.*, 1998). At present, mud crab is largely exported to Singapore, Hongkong and Malaysia. Exporting rate of mud crab from Bangladesh is increasing very rapidly. However, the major part of the export is based on the harvest from the wild resources. As a result the continued pressure on the species could lead to ultimate extinction.

At present, mud crab is largely exported to Singapore, Hongkong and Malaysia. Exporting rate of mud crab from Bangladesh is increasing very rapidly. The production of crab was 4485 MT (Metric Ton) in the production year of 2010-11 and value was 540.11 million (BDT) (DoF, 2012). In the previous year, the production was 692 MT (DoF, 2012). In 2011-2012 fiscal years, Bangladesh has earned 7.23 million US dollars indicating its importance in the foreign exchange earnings (Aftabuddin *et al.*, 2013).

For proper conservation and management of mud crab, adequate knowledge on its biology is crucial. The knowledge of biological aspects depends on the success on good scientific planning and management of fish species (Joadder, 2006).Taxonomy, the study of the theoretical bases, principles, and procedure necessary to an understanding of relationship is the source of information for classification. To identify any species, Morphometric and meristic characters of fish is very important tool. Among of different methods, meristc counts and morphometry are considered as the earliest and authentic methods for the identification of species (Aktar, 2008). Gonadosomatic index (GSI) helps to explain the maturity of mud crab. Identification and development of successful breeding and culture technique of mud crab require clear information on the taxonomy, general biology and food-feeding habit of this species. However, there is no much information on the food and feeding habit of mud crab. along with the rapid expansion of prawn breeding and culture in the south-west region of Bangladesh as an export industry in the last decade crabs became increasingly popular among the fishermen and traders because of the good price offered for the large mud crab in both export and local markets . As a result an interest is now growing among investors to start culture of crabs in mud ponds and gher. Therefore, an investigation on the food and feeding habits of mud crab in the Bangladesh situation is very necessary.

(Ahmed, 1991; Khan and Alam 1991; Azam *et al.*, 1998) reported some aspects of the resource, production, culture, potential, bio-economics, and ecology and length-weight relation of mud crab from Bangladesh.(Bairagi ,1998) studied the sex ratio, length-weight relationships and condition factor of mud crab from south-western region of Bangladesh for limited period. (Ali *et al.*, 2004) long time ago studied biological studies of the mud crab of the sundarbans mangrove ecosystem. Information on biological aspects of mud crab is scanty in Bangladesh. With this consideration, Present study is necessary to gather some basic information on biology of the mud crab in south-west region in Bangladesh.

Thus a detailed study for identification taxonomy, to assess general biology and food-feeding habit of mud crab was needed. The present study was conducted to obtain an idea on the taxonomy and other biological aspects *e.g,* gonadosomatic index, alimentosomatic index, food and feeding habit, condition factor of mud crab. The aim of the present study on taxonomy, general biology and food-feeding habit of mud crab that will be useful in future for stocking, successful farming and management of this species.

**1.2 Objectives of the study:**

- To assess the morphometric and meristic characters of mud crab.
- To assess general biology e.g. condition factor, gonadosomatic index, alimentosomatic index.
- To investigate food and feeding habit of mud crab.

# CHAPTER TWO

# REVIEW OF LITERATURE

## CHAPTER 2

### Literature review

### 2.1 Systematic position of mud crab:

The mud crab belongs to the phylum Arthropoda, sub-phylum crustacea. Like most cultured crustaceans (prawns, shrimp, lobsters, crayfish, and crab) mud crab belongs to the order Decapoda (King, 1995). (Keenan *et al.*,1998) have confirmed the presence of four distinct species within the genus Scylla: *S. serrata* (ForskÂl, 1775), *S. olivacea* (Herbst, 1796), *S. tranquebarica* (Fabricius, 1798), and *S. paramamosian* (Estampador 1949). The genus *Scylla* has four species namely *serrata, tranquebarica, oceanica* and *paramamosain*. Although genus *Scylla* has four identified species (Keenan *et al.,* 1998; Imai *et al.,* 2004), their proper identification is still unclear. (Mohanty *et al.,* 2006) distinguished the above two species of *Scylla* collected from Chilika lagoon of Odisha basing on morphological parameters.

### 2.2 Habitat of mud crab

Mud crab is an abundant marine/brackish water species that is considered to have an excellent potential for culture. The natural distribution of mud crab ranges from tropical to temperate zones (Keenan, 1999a). The mud crab (*Scylla serrata*) is an economically and recreationally important portunid crab distributed throughout the coasts of the Indo-West Pacific. Adult mud crabs are generally found in muddy, mangrove-lined estuaries, and the ovigerous females move offshore to spawn (Hill, 1994). Since, mud crabs prefer brackish water habitat, they migrate from high salinity to estuarine or brackish water bodies during their post larval or juvenile stages (Srinivasagam *et al.,* 2000). Tagging, telemetric and ultrasonic transmitter studies and laboratory experiments have clearly demonstrated the anadromous behavior of mud crabs in relation to habitat selection (Webley *et al.,* 2009). Muddy bottoms of mangrove forest with fluctuating salinity are preferred by *S. serrata* (Vay, 2001). Oshiro (1991) reported that *S. serrata* prefers marshy mangroves at Okinawa where as *S. oceanica* prefers high salinity in addition to sandy muddy bottoms of seaward water at Taiwan and Philippines. However, the habitat preference of *S. tranquebarica* is intermediate of the two habitats preferred by *S. serrata* and *S. tranque barica*. Megalopa larvae of *Scylla sp.* prefer a structurally complex habitat rich with refuge and food (Webley *et al.,* 2009).

### 2.3 Distribution of mud crab

Bhuya and Das (1976) made a taxonomic investigation and reported 15 species of crab from the intertidal zones.( Azam *et al.*,1998) described the distribution of mud crab in coastal region and the Sundarbans. Mud crabs in the genus Scylla inhabit brackish waters, such as mangrove areas and estuaries, throughout the Pacific and Indian Oceans, from Tahiti, Australia, and Japan to southern Africa (Chahpgar 1947; Hill 1975; Sakai 1976; Dai and Yang 1991).(Overtone 1997) documented about the distribution of Scylla species in Indo-Pacific regions.(Srinivasgam *et al.*, 2000) and (Kathirvel *et al.*, 2004) reported the presence of only two species i.e. *S. serrata* and *S. tranquebarica* in Indian water bodies. Mud crabs are distributed in Indo-pacific regions, South Africa, Indonesia, Philippines, Taiwan, Japan, China, east and west cost of Australia, Western Samoa, Salmon Island, Fiji, New Caledonia, Malaysia and Singapore (Roy and Das, 2000; Roy and Bhadra,2005)



### 2.4 General biology

#### 2.4.1 Taxonomic key of mud crab

The mud crab is a relatively large crab, has a very smooth broad carapace and can grow to in excess of 3 kilograms( *Kaliola et al.*, 1993*)*. The colour of the mud crab can vary from dark brown to mottled green, depending on the environment. Located on each side of the carapace are nine spines, all of them very similar in size and the hind legs are flattened in order to aid the animal in swimming ( *Kaliola et al.*, 1993*)*. (Oriola *et al.*, 2010) reported that the maximum carapace length is 6.0 cm (4.38±0.04 cm) in *Cardiosomaarmatum* and 7.0 cm (5.17±0.04 cm) in *Callinectespallidus*. Mean body weights are 110.21±4.14 g and 126.27±4.01 g, respectively. All body proportions and counts except the right chelae diameter are significantly different (p> .05) in the two species. According to the Chu (1999) there is a marked sexual difference in relative growth of the cheliped. The female abdomen increases in size at puberty, which is also accompanied by a reduced allometric growth rate. Analysis of gonad development gave the estimate of 50% gonadal maturity at 42 mm and 36 mm carapace width for females and males, respectively.

(Chang *et al.,* 2004) found that, the size at maturity was represented by LM50 and estimated theoretically from maturity curves, indicating that LM50 for females is 97.00 mm CW in Keelung Shelf, and 82.36 mm CW in Taiwan Bank, whilst for males it is 92.62 mm CW in both areas. The result of statistical comparisons is coincidental that external morphometric characters of female between the different waters are significantly different. (Mia *et al.,* 2006) described the meristic characteristics and gonadal development of mud crab (*Scylla serrata*) in the Sundarbans

(Sangthong *et al.,* 2006) established that the morphological differences among crab morphs were confirmed by considerably high value of Mahalanobis' Distance in the range of 53.283 – 60.806 but those within morphs are in the range of 6.922 – 15.027. Both CVA and Mahalanobis' Distance as well as their morphological data suggested that these three crab morphs of "black" "white" and "violet" should be classified into three distinct species of *S. olivacea*, *S. paramamosain* and *S. tranquebarica*, respectively.

**2.4.2 Ecology of mud crab**

(Overton *et al.,* 1996) examined that the degree of dissimilarity between the different morphs of commercially shed stocks of *S. serrata* vary in relation to the ecology, fishery management and aquaculture potential of *S. serrata.* According to Silva *et al.,* (2009) the morphometric analysis corroborated the division into two clades (i.e. In haca Island/Maputo Bay and northern populations) and also detected less shape variation among populations that were few kilometers apart. The significant spatial genetic structuring between the southern and the northern populations of *P. guttatum along* the geographic gradient under study, combined with morphological differences, suggests that these populations may be considered as cryptic species.

**2.4.3 Food and feeding habit**

The nutritional biology of *Scylla serrata* has been studied by several authors in the past, particularly, with the intention of determining various culture requirements of the species. (Hill, 1976) studied the food constituents of all stages of the crab and described the species as predators of sessile and slow moving benthic invertebrates. In a subsequent study he has found that their major prey groups were attached and burrowing bivalves and small crabs

and also that they locate their food by chemoreception (Hill, 1979). Later (Lijauco *et al.,* l980) found that only 5% of the natural diet of *Scylla serrata* consists of fish and that it cannot thrive on a fish diet alone. There have been various other studies on the nutritional biology of *Scylla serrata* in different parts of the region (Matilda and Hill, 1980).

Previous studies on crabs that report on the feeding and diet of various species already have provided some relevant data, which are, however, mostly incomplete and certainly cannot be directly applied to the situation of *Scylla serrata* in the region here studied. (George, 1965) described the anatomy and histology of different parts of the digestive system of *Portunus sanguinolentus* (Herbst, 1783). Studies have been made on the morphology of the mouthparts, the structure of the gut, and the digestive physiology of the mud crab, *Scylla serrata* (Forskål, 1775) (cf. Barker & Gibson, 1978). Jewett & Feder (1982) analysed the food and feeding habits of the king crab, *Paralithodes camtschaticus* (Tilesius, 1815) near Kodiak Island, Alaska and found that Mollusca (mainly the bivalves *Nuculana* spp., *Nucula tenuis,* and *Macoma*spp.) and Crustacea (mainly barnacles) were the dominant food groups in terms of percentage wet weight and frequency of occurrence; fishes were the next most important group of prey. There are several reports on the food and feeding of various species like, *Scylla serrata* (Williams, 1978; Hill, 1976, 1980; Joel and Raj, 1986; Prasad and Neelakantan, 1988) reported to consume mixed diets of molluscs, crustaceans, fishes, and polychaetes. *Portunus spp* (Hill, 1980; Stephenson *et al.,* 1982; Campbell, 1984; Wassenberg and Hill, 1987; Sumpton and Smith, 1990; Josileen, 2011) reported that there was no significant difference in the quantity of the food consumed by males and females in their study. *Thalamita crenata* (H.Milne Edwards 1834 ;anicci *et al.,* 1996) also reported that consume mixed diets of molluscs, crustaceans, fishes, polycheates etc. *Callinectes sp.* (Tagatz, 1968; Paul, 1981;Laughlin, 1982; Stoner and Buchanan, 1990; Rosas *et al.,* 1994) reported the absence of molluscs from the gut contents of *Callinectes amnicola,* but they have not furnished the possible reasons for the absence of molluscs.

Analysis of the undigested gut content of mud crabs in India reveals the presence of remaining of molluscs, crustaceans, fishes and plant materials (Kathirvel *et al.,* 2004; Mohapatra *et al.,* 2005)

### 2.4.4 Length-weight relationship

(Mia *et al.*,2006) described Carapace and body width of both male and female crabs are strongly correlated, and abundance of male is highest in November and female in August-October, GSI value for male varies from 8.04-10.53 and that for female from 9.68-17.52, indicating that mud crab breed throughout the year.(Khan and Alam,1991) estimated the CW-weight relationship for males and females separately as well as combined. The combined CW-weight relation is found to be 0.00033 (L=2~2). For males it is .00158 (L=2.62) and for females it is .00071 (L=2.73). (Ali *et al.*, 2004) stated that biology of *Scylla serrata* changes with the season and environment. They also measured the overall sex ratio male: female (1: 0.94) during May, 2001 to February, 2002. The relationship between carapace width and body weight are, W= -128.25+4.06 CW, log W=-3.73+3.06 log CW for male and W= -89.59+2.387 CW, log W= -1.6035+1.8928 log CW for female. The value of condition factor is 24.65 where $K_c$ is 0.41 to 0.53 for male and 1.03741711 to 1.00746021 for female. (Mohapatra *et al.*, 2010) established the CW-BW relationship and found 27 g increase of total weight with the increase of 1 cm of carapace width.

(Araújo and Lira, 2012) studied on the relationship of WW vs CW, and described through the potency equation, was allometrically positive for both males (b = 3.12) and females (b = 3.02), a result also observed in other swimming crabs. The mean condition factor of males is8.0 10-5 ± 1.5 10-5, and that of females is 11.5 10-5 ± 2.8 10-5, being significantly higher in females ($p< 0.05$), due to the fact that female gonads are heavier than that of males. The condition factor oscillated throughout the sampling year, for both sexes, which is related to the reproductive cycle

(Ikhwanuddina *et al.*, 2011) estimated the relationship between body weight and carapace width of mud crab species shows that *Scylla tranquebarica* are generally heavier than *Scyllaolivacea* for both sexes. The CW–BW relationship for females and males of *Scyllaolivacea* is: $y = 11.24e^{0.264x}$ ($R^2 = 0.735$; n = 751) and $y = 4.79e^{0.37x}$ ($R^2 = 0.86$; n = 665), respectively. The CW–BW relationship for females and males of *Scylla tranquebarica* is: $y = 11.56e^{0.26x}$ ($R^2 = 0.89$; n = 270) and $y = 5.767e^{0.34x}$ ($R^2 = 0.87$; n = 312), respectively.

# CHAPTER THREE



# Materials and Methods

# CHAPTER 3

## Materials and Methods

### 3.1 Study area and period

The experiment was carried out in Khulna region during December, 2013 to March 2014.

### 3.2 Sample collection

A total of 60 live specimens of mud crabs were collected from khulna region. Among them 30 were taken from Gher and 30 were from the Sundarban mangrove forest. Live crabs were carried to Fish Biology Laboratory of Fisheries and Marine Resources Technology Discipline of Khulna University.

### 3.3 Taxonomic study

#### 3.3.1 Morphometric characters measurement

Body color and twelve morphometric characters viz body weight, carapace Length , carapace width, eye stock length, left chelate leg length, left chelate leg width, fifth abdominal segment length, fifth abdominal segment width, gonad weight, Gut weight, right chelate leg length, right chelate leg width were recorded separately. The measurements were taken by using normal centimeter scale, fine pointed divider, forceps and slide calipers and recorded to the nearest cm. The relationship among different morphometric characters were analyzed by regression in statistics

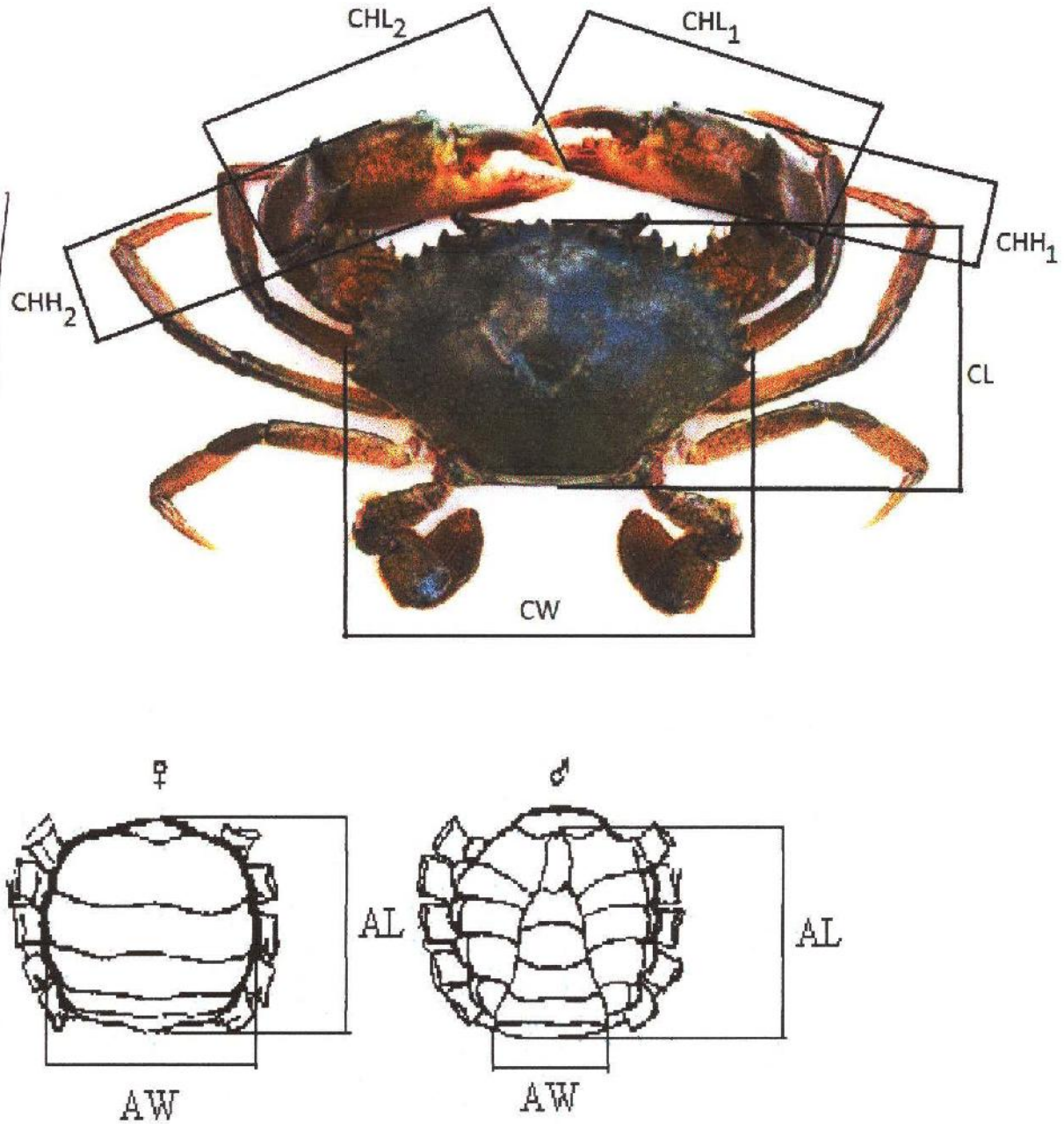



**Fig. 2. A schematic of mud crab morphometric measurements.**

**Right claw length (CHL1), Height (CHH1), left claw length (CHL2), Height (CHH2), Carapace length (CL), Carapace width (CW), Abdominal width(AW), Abdominal length (AL).**

### 3.3.2 Meristic characters measurement:

Meristic characters viz number of antenna, number of chela teeth, number of frontal spine, number of carapace spine, number of walking leg and swimming leg, left Chelate Spine number, right chelate Spine Number were recorded separately as shown in fig.2

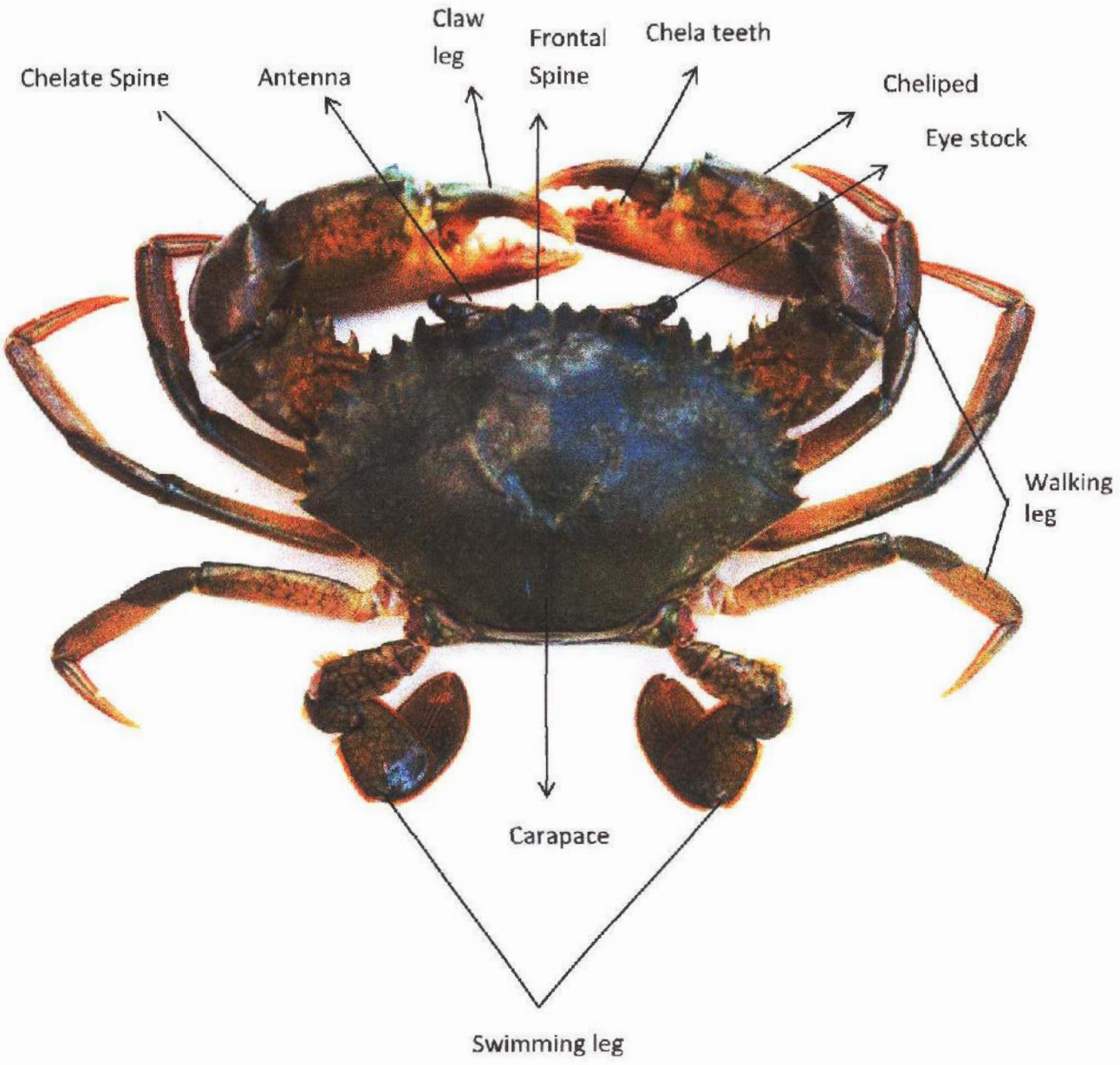



**Fig. 2. A schematic of mud crab meristic measurements.**

### 3.4 Biological study

Gonadosomatic index, Alimentosomatic Index (ASI), Condition factor (CF) were determined according to Parameswarn *et al.*(1974), Hile (1936); Hamilton ( 1822); respectively.

### 3.5 Food items identification

For food and feeding habit study, 60 live fresh samples were collected from Khulna region. The mud crabs were dissected. Guts were removed and weighted. The gut of each mud crab was dissected out and the contents of the stomach were removed very carefully in a Petri dish and then diluted in distilled water for determining the different food items eaten by the mud crab. After that, the food items were identified under a binocular microscope. Food particles were identified by investigating the external morphology. Attempts were made to identify the chief constituents of the stomach contents.

### 3.6 Data analysis

The data were presented in tabular and graphical forms using Microsoft excels, KaleidaGraph.SPSS software (version 16.0) was used for regression analysis.

# CHAPTER FOUR

# Results

# CHAPTER 4

## 4.0 RESULTS

### 4.1 Taxonomic study of mud crab

Mud crabs were large in size with a smooth, broad Carapace. More than 8 cm shell breadth and 100 g in body weight were found. Male were larger than female. They had 9 similar sized spines on each side of their eyes. Hind legs were flattened like swimming pads. Robust claws are used for crushing shells. Their body dorso-ventally flattened, broader than long. The body was composed of 3 parts (Head, thorax, and abdomen). Cephalo-thorax was covered by a calcareous exoskeletal structure known as carapace. Carapace was perfectly smooth excepting a curved transverse ridge crossing and either protogastic or branchial region. Abdomen consisted of a series of 7 segments, which remained flexed and folded underneath the cephalothorax. Segmentation somites were not apparent dorsally. They had 1 pair of cheliped , 1 pair of swimming legs and 3 pair of walking legs. The shell colour varied from a blackish or reddish brown to light black.

#### 4.1.1 Morphometric characters of mud crab:

In the Sundarbans mangrove forest , total body weight, Carapace length, Carapace width, Fifth abdominal segment length, Fifth abdominal segment width were observed as 81.77±17.71, 5.54±0.26, 7.76±0.42, 3.13±0.21, 2.57±0.32 respectively. Mean value of different morphometric characters of mud crabs in the Sundarbans mangrove Forest (table 1) and in Gher (table 2) are given below.

**Table: 1. Mean of various morphometric characters of mud crab in the the Sundarbans mangrove Forest**

| Characters | Mean ± SD | Range |
|---|---|---|
| Body Weight (g) | 81.77±17.71 | 63 - 126.2 |
| Carapace Length (cm) | 5.54±0.26 | 5.1 - 6.3 |
| Carapace Width (cm) | 7.76±0.42 | 7.1 - 8.6 |
| Eye stock Length (cm) | 0.82±0.13 | 0.4 – 1.0 |
| Left chalet leg length (cm) | 6.26±0.71 | 5.3 - 7.3 |
| Left chelate leg width (cm) | 2.25±0.58 | 1.7 – 3.0 |

| | | |
|---|---|---|
| Fifth abdominal segment length (cm) | 3.13±0.21 | 2.8 – 3.6 |
| Fifth abdominal segment width (cm) | 2.57±0.32 | 2 – 3.3 |
| Gonad weight (g) | 2.0±0.40 | 1.6 – 2.6 |
| Gut weight (g) | 0.85±0.21 | 0.5 – 1.4 |
| Right chelate leg length (cm) | 6.03±0.54 | 5 - 7.2 |
| Right chelate leg width (cm) | 1.86±0.29 | 1 – 2.6 |

**Table:2. Mean of various morphometric characters of mud crab in Gher**

| Characters | Mean ± SD | Range |
|---|---|---|
| Body Weight (g) | 74.75 ±20.79 | 42.10-124.50 |
| Carapace Length (cm) | 5.30 ±0.55 | 4.20-6.30 |
| Carapace Width (cm) | 7.40 ±0.71 | 6.10-8.80 |
| Eye stock Length (cm) | 0.78 ±0.12 | 0.60-1.10 |
| Left chelate leg length (cm) | 5.76 ±0.71 | 4.70-7.50 |
| Left chelate leg width (cm) | 2.11 ±0.23 | 1.50-2.90 |
| Fifth abdominal segment length (cm) | 2.92 ±0.43 | 2.00-3.60 |
| Fifth abdominal segment width (cm) | 2.47 ±0.39 | 2.00-3.30 |
| Gonad weight (g) | 2.02 ±0.17 | 1.70-2.30 |
| Gut weight (g) | 0.86 ±0.22 | 0.50-1.40 |
| Right chelate leg length (cm) | 5.58 ±0.78 | 4.30-7.50 |
| Right chelate leg width (cm) | 1.82 ±0.30 | 1.30-2.70 |

There were no significant difference among mud crabs collected from gher and Sundarbans mangrove Forest

In the present study, total body weight, Carapace length, Carapace width, Fifth abdominal segment length, Fifth abdominal segment width were observed as 78.26± 19.47, 5.42±0.44, 7.58±0.61, 2.52±0.36 cm respectively. Mean value of different morphometric characters of mud crabs are present in the Table 3.

**Table: 3. Mean of various morphometric characters of mud crab**

| Characters | Mean ± SD | Range |
|---|---|---|
| Body Weight (g) | 78.26± 19.47 | 42.1 - 126.2 |
| Carapace Length (cm) | 5.42±0.44 | 4.2 - 6.3 |
| Carapace Width (cm) | 7.58±0.61 | 6.1 - 8.8 |
| Eye stock Length (cm) | 0.80±0.12 | 0.4 – 1.1 |
| Left chalet leg length (cm) | 6.01±0.69 | 4.7 - 7.5 |
| Left chelate leg width (cm) | 2.17±0.30 | 1.5 – 3.0 |
| Fifth abdominal segment length (cm) | 3.02±0.35 | 2.0 – 3.6 |
| Fifth abdominal segment width (cm) | 2.52±0.36 | 2.0 – 3.3 |
| Gonad weight (g) | 2.02± 0.30 | 1.6-2.6 |
| Gut weight (g) | 0.86±0.21 | 0.5 – 1.4 |
| Right chelate leg length (cm) | 5.80±0.70 | 4.3 - 7.5 |
| Right chelate leg width (cm) | 1.84±0.29 | 1.0 – 2.7 |

### 4.1. Relationship between different morphometric characters:

The relationship between different morphometric characters were presented in the linear equation in fig. 1. Body weight = -101.39+ 33.13×CL ($r^2$ = 0.57); Body weight = -108.79+ 24.68×CW ($r^2$ = 0.59). The relationship between carapace length and body weight is not strongly correlated that is found from t-test. Again the relationship between carapace width and body weight is also not significantly correlated that is known from t-test.

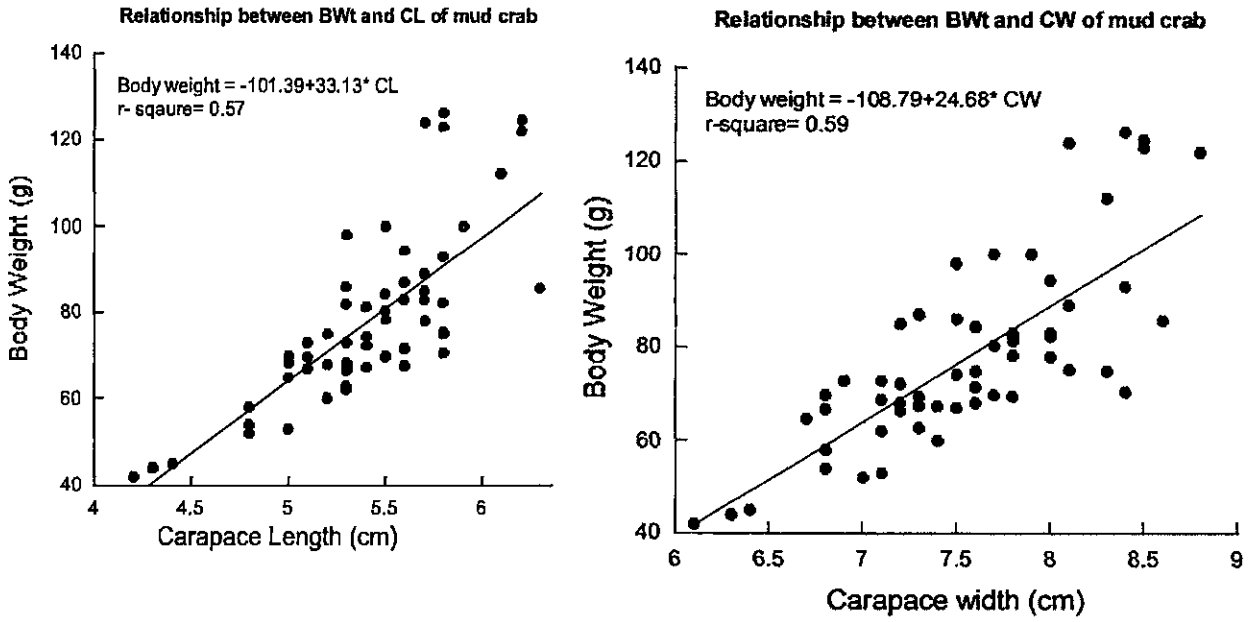



**Fig. 1 Relationship between different morphometric characters of mud crab**

### 4.1.2 Meristic data measurement:

Mud crab had spines on the carapace. Spine and teeth had present in the chelate leg. Walking and swimming legs were found during meristic data measurement. Different meristic characters of mud crabs are given in Table 3.

**Table 4. Different Meristic characters of mud crab**

| Characters | Numbers |
|---|---|
| Carapace spine number | 24 |
| Left chelate leg spine number | 10-12 |
| Right chelate leg spine number | 11-13 |
| Left chelate leg teeth number | 11-15 |
| Right chelate leg teeth number | 11-14 |
| Eye stock | 2 |
| Walking legs | 6 |
| Swimming legs | 2 |
| Carapace frontal spine | 4 |
| Antenna | 2 |

### 4.2 Biological study

### 4.2.1 Gonadosomatic index (GSI):

The mean gonadosomatic index of all samples Mud crab was 2.70±0.43. The gonadosomatic index of Mud crab specimens ranged from 2.31 to 4.22.The relationship of gonadosomatic index with others parameters were shown by figures 3, 4. T-test indicates that there was no relationship between gonad weight and body weight of mud crab.

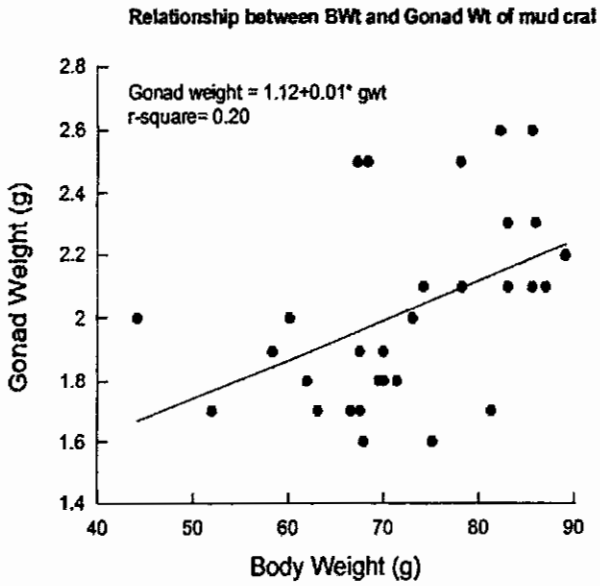



**Fig.2. Relationship between BWt and Gonad Wt of mud crab**

### 4.2.2 Alimentosomatic index

The intensity of feeding was studied by determining by alimentosomatic Index. Mean alimentosomatic Index of all samples was found 1.11± 0.24 and ranged from 0.73 to 2.22. The relationship of Alimentosomatic index with others parameters are shown by figures 5, 6.T-test indicates that there was no relationship between gwt and BWt of mud crab.

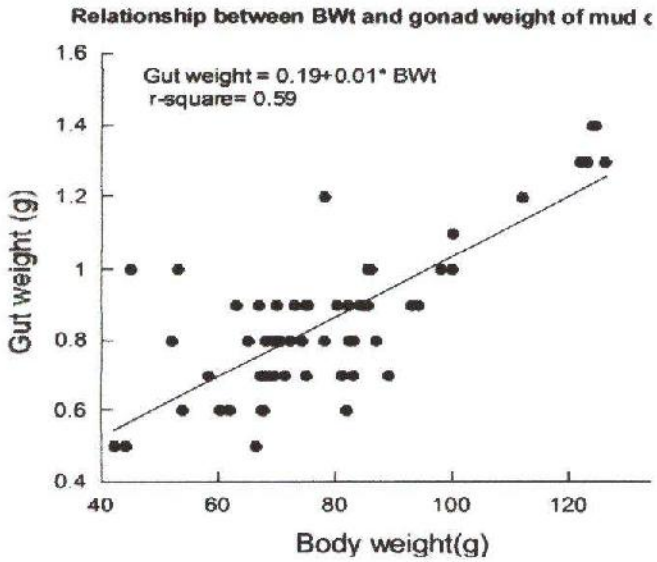





**Fig.3. Relationship between gwt and BWt of mud crab**

### 4.2.3 Condition factor:

Mean condition factor of all samples of mud crabs was 48.68 ± 7.39. The condition factor of Mud crab specimens ranged from 34.19 to 66.96. T-test indicates that relationship between body weight and carapace length of mud crab is not significant strong.

### 4.3 Food and feeding habit

### 4.3.1 Food materials

The stomach contents were found to contain mixed food items. Most of the mud crabs were with full the rest were with partial full. None of the specimens had an absolutely empty stomach. The food analysis of 60 specimens mud crabs revealed that the food consisted of crustaceans, insects, plant materials and semi-digested materials, phytoplankton, zooplankton, detritus, mud, sand etc. (Table 4.)

**Table 5. List of food items found in the gut content of mud crabs**

| plankton | Group/Species | Most abundant |
|---|---|---|
| Phytoplankton | Blue green algae, Green algae, Diatoms, *Anabaena, , Spirogyra, , Ulothrix, , Protococcus, Pinnularia, Microspora, Closterium, Chaetomorpha, Ulothrix, Spirulina, Nostoc, Polysiphonia, Navicula* | Blue green algae, Green algae, *Anabaena, Spirogyra, Closterium, Navicula* |
| Zooplankton | Rotifers, Cladocerans, Ostracods, Copepods, Daphnia, *Polychaete* moults, Mysids, | Rotifers, Copepods, |
| Others | Eggs and nauplii, Small benthic organisms, Sand, Mud, Detritus, Decayed organic matter, fish particles, Miscellaneous matter etc. | Sand, Mud, Detritus |

**Some identified plankton figures are given below with classification:**

Phylam: Dinoflagellata

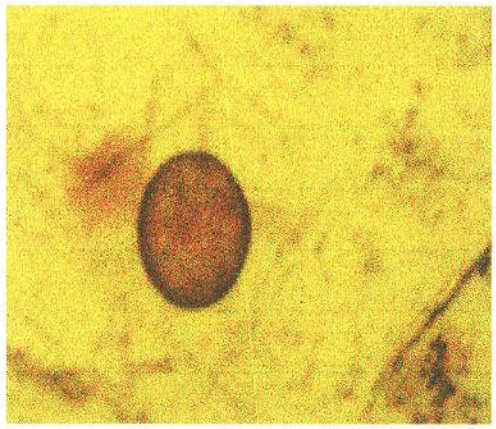
Class: Dinophyceae

Order: Dinophysiales

Family: Dinophysiaceae

Genus: Dinophysis

Species: *Dinophysis rotundata*



Division: Bacillariophyrta

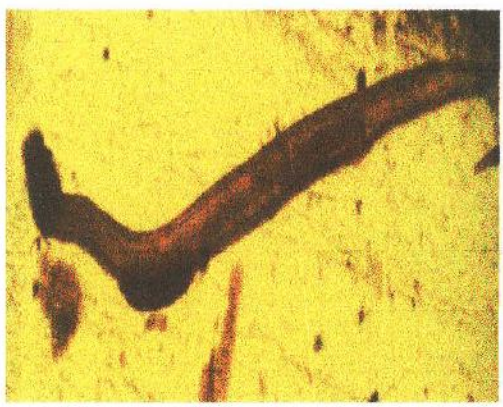
Class: Bacillariophyceae

Order: Bacillariales

Family: Bacillariaceae

Genus: Gonatozygon

Species: *Gonatozygon sp.*



Division: Thallophyta

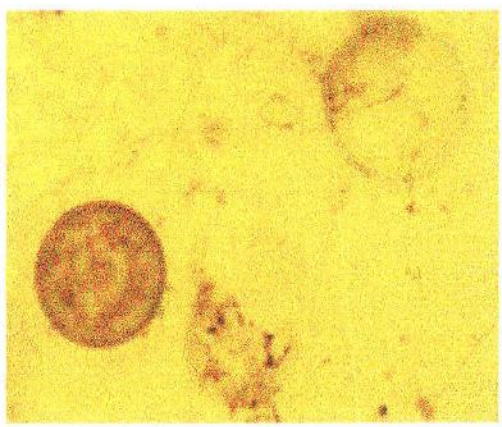
Class: Bacillariophyceae

Order: Centrales

Family: Coscinodisceae

Genus: Coscinodiscus

Species: *Coscinodiscus stellaris*



Phylam: Chlorophyta

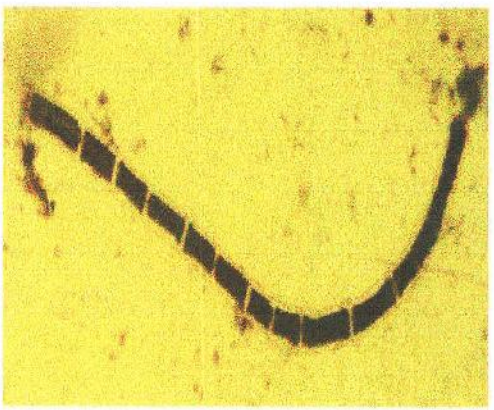
Class: Chlorophyceae

Order: Zygnematales

Family: Zygnemataceae

Genus: Spirogyra

Species: *Spirogyra sp.*



Phylam: Cyanobacteria

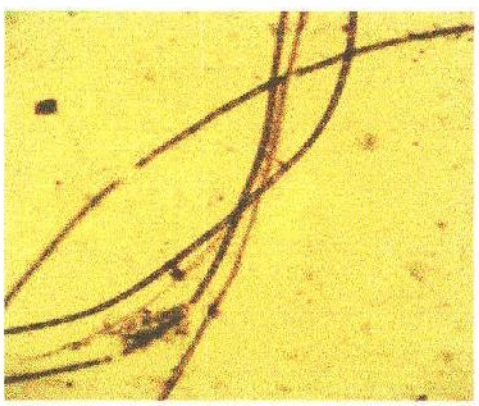
Class:Cyanophyceae

Order:Nostocales

Family: Nostocaceae

Genus:Anabeana

Species: *Anabeana sp.*



Phylam: Arthropoda

Class: Maxillipoda

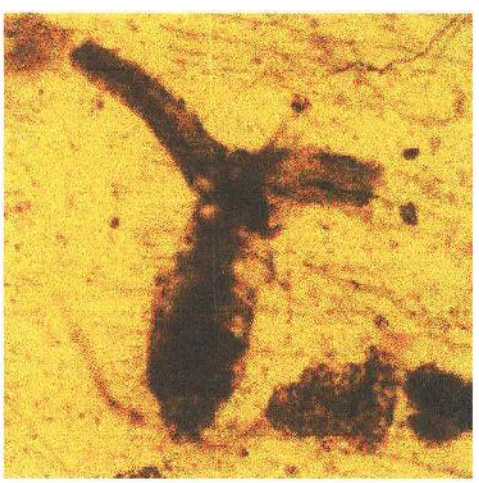
Sub class: Copepoda

Order: Calanida

Family: Metridinidae

Genus: Harpacticoida

Species: *Harpecticoida metridia*



Phylam: Annelida

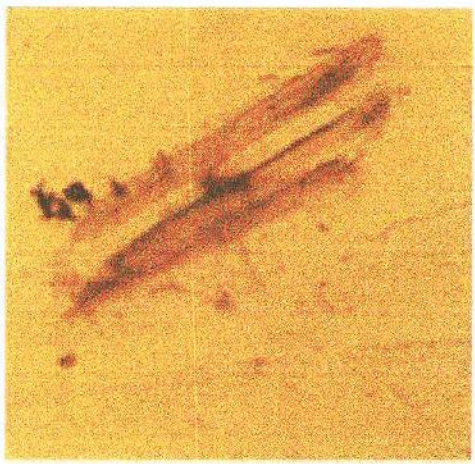
Class: Polychaeta

Order: Mysida

Family: Pectinariidae

Genus: *Pectinaria*

Species: *Pectinaria sp.*



Phylam: Arthropoda

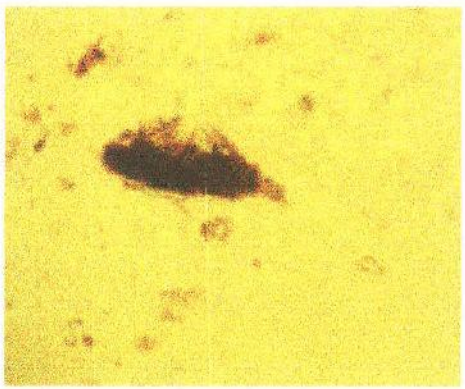
Class: Crustacea

Order: Copepoda

Family: Copepoidae

Genus: *Copepod*

Species: *Naupli of Copepod sp.*



Phylam: Arthropoda

Class: Maxillipoda

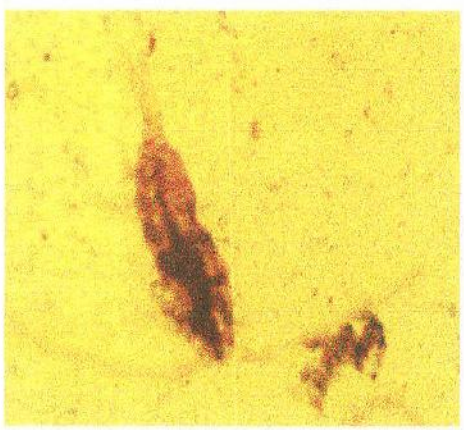
Sub class: Copepoda

Order: Cyclopoida

Family: Cyclopidae

Genus: Bicuspidatus

Species: *Bicuspidatus thomasi*



Division: Thallophyta

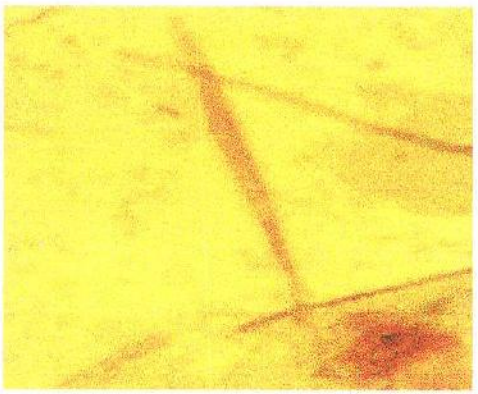
Class: Bacillariophyceae

Order: Pennales

Family: Naviculoideae

Genus: Navicula

Species: *Navicula sp.*



Phylam: Chlorophyta

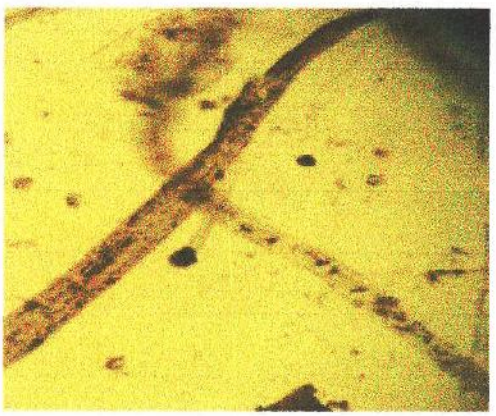
Class: Ulvophyceae

Order: Ulotrichales

Family: Ulotrichaceae

Genus: Ulothrix

Species: *U. zonata*



Phylam: Arthropoda

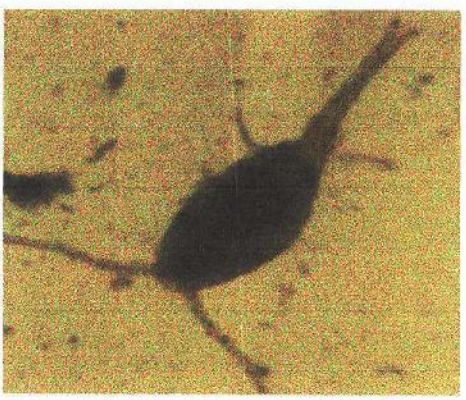
Class: Crustacea

Order: Copepoda

Family: Copepoidae

Genus: *Copepod*

Species: *Copepod sp.*



# CHAPTER FIVE

# Discussion

# CHAPTER 5

## DISCUSSION

Mud crabs were large in size with a smooth, broad Carapace. Male were larger than female. They had 9 similar sized spines on each side of their eyes. They had 1 pair of cheliped, 1 pair of swimming legs and 3 pair of walking legs. The shell colour varied from a blackish or reddish brown to light black. The body colour and size of mud crab observed in the present study was same to the observation of *Kaliola et al.,* (1993*).*

The relationship between different morphometric characters were presented in the linear equation in Body weight = -101.39+ 33.13×CL ($r^2$ = 0.57); Body weight = -108.79+ 24.68×CW ($r^2$ = 0.59). The relationship between carapace width and body weight were estimated by Ali *et al.*, (2004) as W= -128.25+4.06 CW. This relationship indicated that the growth of mud crab in the present study was not strong enough.

The mean gonadosomatic index of all samples Mud crab was 2.70±0.43. The gonadosomatic index of Mud crab specimens ranged from 2.31 to 4.22 which indicated that the maturity of mud crabs. (Mia *et al.,*2006) described GSI value for female from 9.68-17.52.The present study value was less than referred value that indicated less maturity of mud crab.

The intensity of feeding was studied by determining by alimentosomatic index. Mean alimentosomatic Index of all samples was found 1.11± 0.24 and ranged from 0.73 to 2.22. that indicated feeding intensity of mud crab is good in study area.

The condition factor is the relationship between length and weight of fish. Mean condition factor of all samples of mud crabs was 48.68 ± 7.39. The condition factor of Mud crab specimens ranged from 34.19 to 66.96. (Araújo and Lira, 2012) studied on condition factor and found that in case of males is 8.0 10-5 ± 1.5 10-5, and females is 11.5 10-5 ± 2.8 10-5.It indicated that the condition factor of present study was not satisfactory level. Different factors such as environmental condition, food availability, gonadal maturity etc. was responsible in the study area.

Traditionally mud crabs have been viewed as carnivores that show a preference for natural diets containing molluscs, crustaceans and dead fish (Hill, 1979). Mud crabs are known to prefer live food and locate pray by sight, touch and chemical means (Kailola *et al.,* 1993;

Baliao, 2000). According to (FAO, 2011) manual on mud crab aquaculture, Mud crab diet in the wild consists mainly of marine detritus, molluscs, crustaceans and fish, the importance of which to their diet appears to vary with location. According to (PCAMRD ,1996) current bulletin, under culture conditions, mud crabs have also been observed to feed on trash fish, animal entrails and hides, filamentous algae and detritus. The findings of present study agreed with the findings of (Neelakantan, 1988), (Hill, 1976; Tacon and Akiyama, 1997).

Blue green algae, unicellular and filamentous algae, diatoms, rotifer, copepods, cladocerans, Sand, Mud, Detritus, decayed organic matter etc. were the main food items of Mud crabs. Blue green algae, green algae, *Anabaena, Spirogyra, Closterium, Navicula* ,rotifers, copepods, Daphnia, sand, mud, detritus were found abundantly.. It also indicated that, the Mud crabs is omnivorous in its feeding habits.

However the major limitation of the present study was identifying of semi digested food particles such as plant materials and insects in of mud crab the gut content. Further study is needed on this topic. Modern technique like DNA analysis should be applied for correct taxonomic study. There was also a major limitation of identifying food particle due to appropriate identification technique and instrument. Other limitation was small sample size and short time duration.

# CHAPTER SIX

# CONCLUSION

## CHAPTER 6

### Conclusion

The shell colour varied from blackish or reddish brown to light black. The taxonomical study showed that Body weight (BW), Carapace Length (CL), Carapace Width (CW), Gonad Weight (GW), Gut Weight (GW) in the mud crabs were ranged from 42.1 - 126.2g, 4.2 - 6.3cm, 6.1 - 8.8cm, 1.6-2.6g, 0.5 – 1.4g respectively. The gonadosomatic index , alimentosomatic indices , condition factor of mud crab specimens were 2.70±0.43,1.11± 0.24 and 48.68 ± 7.39.The relationships between different variables were found to be linear. The blue green algae, unicellular and filamentous algae, diatoms, rotifer, copepods, decayed organic matter etc. were the main food items of mud crab. Blue green algae, green algae, *Anabaena, Spirogyra, Closterium, Navicula* ,rotifers, copepods, Daphnia, sand, mud, detritus were found abundantly. It indicated that the species is omnivorous in its feeding habits. However the major limitation of the present study was identifying of semi digested food particles such as plant materials and insects in of mud crab the gut content. For better production of mud crab, appropriate breeding technique should be developed immediately as the mud crab is one of the most important commercial species of Bangladesh. Further study on context of mud crab is essential to achieve success in mud crab aquaculture in Bangladesh.

# CHAPTER SEVEN

# REFERENCES

## CHAPTER 7

## REFERENCES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# CHAPTER EIGHT

# PHOTO GALLARY

## CHAPTER 8

## PHOTO GALARY

Fig 1: Sample weight measurement

Fig 2 :Sample dissection

Fig 3 : Morphometric data collection

Fig 4: Gut and gonad in petridish

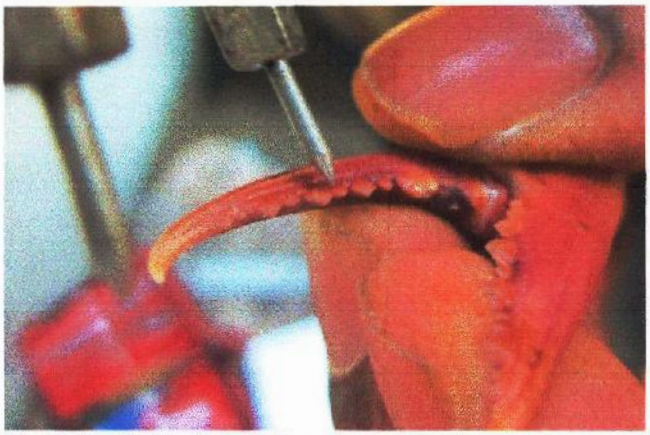

Fig 5: Meristic data collection

Fig 6: Using measurement instrument

Fig 7: Identification of food materials using microscope

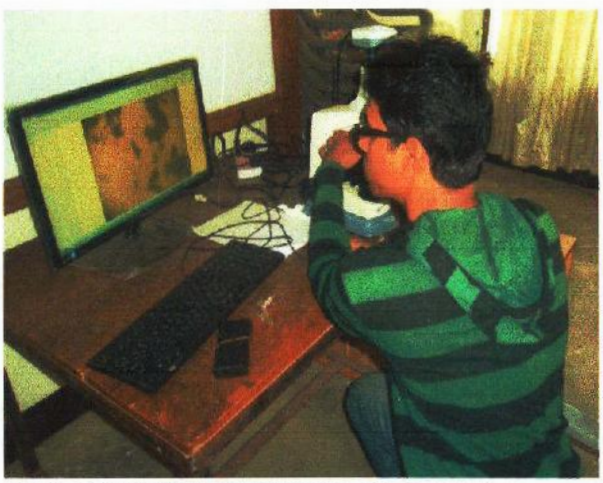

Fig 8: View of food materials on computer screen

# CHAPTER NINE

# APPENDIX

## CHAPTER 9

### APPENDIX

**1. Different morphometric relationship measurement:**

Different Morphometric relationship was measured by the well-known statistical formula Y = a + bX. Where,

Y, X = different Morphometric characters, 'a' is the interception on the ordinate and 'b' is the regression co-efficient.

2. **Gonadosomatic index (GSI):**

GSI was recorded according to the following equation. This is more suitable to explain the maturity of mud crab. GSI = [Weight of gonad / Body weight] × 100

Here , GSI = Gonadosomatic index

**3. Alimentosomatic Index (ASI):**

The alimento-somatic index was determined by the following equation:

ASI = [Total weight of the gut / Body weight] × 100 (Hile, 1936)

**4. Condition factor (CF):**

The growth of fish was estimated by determining the condition factor, which was calculated by the following formula:

CF = [BWt /TL3] × 100 (Hamilton, 1822).

Where, BWt= body weight in g, TL= total length in cm.