STUDY ON THE MORPHOLOGICAL CHARACTERISTICS OF AVAILABLE GOBIIDAE FAMILY FISHES IN CHATTOGRAM COAST

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Roll No: 0119/06

Registration No: 705

Session: 2019-2020

A thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Marine Bioresource Science

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This is to certify that we have examined the above Master's thesis and have found that it is complete and satisfactory in all respects and that all revisions required by the thesis examination committee have been made

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LIST OF ACRONYMS AND SYMBOL USED

Abbreviation and Symbols	Elaboration
cm	Centimeter
DoF	Department of Fisheries
^{0}C	Degree Celsius
CVASU	Chattogram Veterinary and Animal Sciences University
DW	Distilled water
et al.	Associates
FAO	Food and Agriculture Organization
g	Gram
<	Less than
ml	Milliliter
%	Percent
SPSS	Statistical Package for Social Sciences
Wt.	Weight
St.	Station
&	And

ABSTRACT

One of the most famous fish's families for consumption in Chattogram coast is Gobiidae family but no such work was done on this specific family in this coast before. So, variations among different species under the Gobiidae family was investigated using morphometric and meristic characters. A detailed one year (February 2019 to January 2020) long survey considering 2 months of ban periods (June-July 2019) was done for checking out the available Gobiidae in the Chattogram coast, including three stations. Two stations in Chattogram metropolitan area (Patenga and Kattoli) and one in Cox's Bazar. Morphometric data collected from the survey went through the statistical analysis of correlation and simple regression (intra-species) and independent sample T-test and dendrogram (inter-species). In total, eight species and a genus under the Gobiidae family could be able to find out. After every sampling, initially samples were sorted into different group on the basis of visual examination, then the morphological process confirmed species of different sorted group. From every sample, nine morphological data (length) and six meristic counts were collected for statistical analysis and for generating a fin formula for each species. A detailed morphological study to differentiate among closely related species was the study's basis. The frequency of availability of *Psedapocryptes elongates* was the most among the species both in stations and months. Some species such as *Apocryptes bato, Odontamblyopus rubicundus,* and *Acentrogobius sp.* were found less frequently. *Odontamblyopus rubicundus* and *Taenioides buchanani* showed the most significant mean difference with *Psedapocryptes elongates* in the T-test. Within species, all species were more than 90% correlated. Gobiidae family might influence the environment, the economy because of being the diverse fish family, and this study was an initial step towards this process. Further scientific experiment on Gobiidae family can use this study as baseline experiment.

Keywords: Morphometric, Meristic, Gobiidae, Availability, Chattogram

CHAPTER 1

INTRODUCTION

1.1 Background study

Marine water covers 71% of our planet, which is 97.95% of our world's total water, and is regarded as the earth's life-supporting environment due to its capacity for supporting marine resources (Cenedese *et al.* 2020). The study of marine habitats and their nature has a profound influence on the marine ecological sector. Marine ecology deals with the place where it covers versatile things, and the marine ecosystem is complicated. So, the largest maritime region of coastal states indicates the largest marine ecosystem. In this diverse and unique ecosystem, fish groups and fish species play a vital role in being an active dwellers group by their number. Being a part of this enormous ecosystem, Bangladesh possesses 432 marine species (DoF, 2019) and 260 freshwater species of fish (DoF, 2017). This diverse fish species itself contributes to the ecosystem along with its other roles to the aquatic environs. More than 17 million people, among which 1.4 million working women, remain associated with the fisheries sector for leading their livelihood in Bangladesh (BFTI, 2016). This fisheries sector contributes 3.50% to the nation's GDP during the year 2018-19. In the present situation, more than 12% of the whole population is engaged with fisheries directly and indirectly (DoF, 2019). All over the world, maximum peoples depend on animal protein for the dietary satisfaction specially coastal people. Among the dietary animal protein, fish protein is the best protein for easy digestion for all age groups and availability in nature. Fish protein contributes approximately 17% of world consumption for protein demand (WRI, 2013). In Bangladesh, 60% of animal protein consumption is solely dependable on fish protein consumption (DoF, 2016).

1.2 Significance of study

The three main basic part of the present study is morphology, gobiiade and Chattogram coast. So, the importance of these three parts combined together and make the study more important.

1.2.1 Importance of morphology

Morphological characteristics of fish are the characteristics that can be observed through visible external appearances, while meristic characters refer to the characters representing in numeric function. Morphometric characters measure with scale as length, weight, and meristic characters are counted. Both morphometric and meristic characters have great importance in fisheries science. It can suggest that morphometric and meristic work is the initial and base experiment for any further complicated molecular level experiment from the concept of (Villee, 2018). In stock assessment, fish morphology accomplishes the initial process. The experiments on morphometric and meristic characteristics include an initial strategy in cohort estimation, asymptotic length, finding the distribution of a specific species, a record of new species in different geological areas according to Ahmed *et al*. (2017) and Hanif *et al.* (2017). Another application of morphological and meristic characteristics in aquaculture is measuring hormone treatment (Yanong *et al.*, 2010). Estimating feed nutritional quantity for fish is essential step of aquaculture. As feed nutrition requirement consider the factor which are body weight and age so estimating feed is controlled by morphology in some extend because weight is a morphological character and age can be known by morphology Davis, (2015). Nowadays, morphometric characters get emphasized by scientific communities. In all these cases, the result is coming out either in the form of weight or length. In breeding biology, age is an important factor and the circuli on the scale, marks, or unique patterns on the body may indicate the fish age, Carbonara *et al.* (2019). The most crucial purpose of morphometric and meristic characters is to the identification of fish. To isolate the very much related species among themselves is primarily dependent on morphometric and meristic characters. The suspected fish sample is first to go through a morphometric way, and then it is gone through the genetic experiment for further confirmation. Morphometric characters give the best result in genetic experiments like hybridization, inbreeding, and comparing between the parents' generation and F1 and F2 generation, Khan *et al.* (2002). This decision is also taken based on morphometric and meristic characters, especially when selecting the strain. Cryopreservation or live conservation is also dependent on morphological and meristic characters. An individual of a species with remarkable growth or an individual with outstanding quality is usually preserved for the future. So, the decision of cryopreservation or live condition conservation also initially depends on morphometric characters. They may seem to be an indirect process, but the dependency of morphometric characters' processes is unavoidable.

1.2.2 Importance of Gobiidae

Among the colorful existing fishes, Gobiidae is the family that contains a significant number of species. Fish family Gobiidae is one of the largest families among 2000 species under 270 genera (Patzner *et al*., 2011). Gobiidae is a diversified family of colorful fish that are under the Osteichthyes group and order Perciformes. The most exciting fact about Gobiidae is that the family possesses one of the smallest vertebrate members and the species of lightest vertebrate *Trimmatom nanus***,** which is 8.0 mm at its highest standard length. Some other Gobiidae are also the members of small vertebrates of the world. Such as *Pandaka pygmaea* which standard length has a maximum value of 11 mm. The lightest vertebrate in the world, weighing about 2 mg, is *Schindleria brevipinguis,* Patzner *et al*. (2011). Gobiidae distribution generally in a tropical area where temperature varies from 30°C to 35°C. The largest number of fishes of Perciformes is under the Gobiidae family representing 5-10% of all marine, brackish and freshwater teleosts of the world (Patzner, 2011). Some other interesting facts about goby are individual male guards the egg and fanned them to provide eggs with oxygen and female maintain burrows. They are also showing parental care. Gobies' lifespan can be one to ten years, and goby of the warmer region live more than cold areas. However, there is evidence of having goby in the temperate region. The polar region may have Gobiidae fishes or not, but there is no evidence yet published. One of the goby of the temperate region is *Leucopsarion petersi*. This naturally abundant fish shows an excellent nutrient profile. *Boleophthalmus dussumeiri* provides 0.40g of carbohydrate against the consumption of 100 g of the liver (Kanejiya *et al*., 2017). Besides the liver and muscles of *Boleophthalmus dussumeiri, Scartelaos hishophorus* have a profound source of protein, lipid, and carbohydrate (Kanejiya *et al*., 2017).

1.2.3 Importance of Chattogram coast

Chattogram coast is one the most diversified coast in Bangladesh specially in case of marine and estuarine fish. Fish production was 42.77 lac metric ton, whereas the Chattogram region contributes 11.69 lac metric ton, and Cox's Bazar contributes .90 lac metric ton. (DoF - 2018). Chattogram contributed 27.33% of total production, whereas Cox's Bazar contributed 7.73% of Chattogram's production. (DoF- 2018) Chattogram coast of Bangladesh has unavoidable opportunities and strength to study this goby family. A study of Alam *et al*. (2013) shows that six species represent 9.52% of the full plenty of fish in the Halda reservoir, which is the only study on Chattogram Coast. All these works followed the morphometric and meristic way of the identification process.

1.3 Status of Gobiidae in Bangladesh

In the present condition, 12 species of freshwater gobies and 12 species of marine gobies existed in the aquatic environs. Again, Bangladesh possesses only 18 species under 15 genera (Rahman, 2005). Due to the burying habits of *Taenioides***,** they are not common in the collections and do not establish individual fishery. From studies of Latifa *et al*. (2015), in Nijhum Island, Hatiya, Pashur River, and the Bay of Bengal, seven species of goby were reported. Another work on the gobies of Atrai, Padma, Bramhaputra River was done only on *Glossobogius guiris* by Islam *et al*. (2016)**.** A study executed in the greater Noakhali region was focused on the locally available species. Besides, ten species of goby fish were found from the Noakhali coast, among which six species were of marine or coastal environment (Hossain, 2013). Azad *et al.* (2018) worked with the sample from Gorai River, and it was tank goby, which is morphological and meristic characters to identify and estimate the stock abundance of goby from the southwestern part of Bangladesh.

1.4 Objectives of the Study

The prime objective of this research initiative is -

- To identify the morphometric and meristic differences among the available fishes under the Gobiidae family along the Chattogram coast.
- To record and investigate new cases arising of any specimen of species under the Gobiidae family in Chattogram coast.

CHAPTER 2

REVIEW OF LITERATURE

The fish population, family, and species are theoretically and systematically different due to their morphometric and meristic variation. This variation differs in genetic nature with parasitological ways applying morphometric and meristic differentiations. Genetically or in a parasitological way is another method for the confirmation of the interpretation. In all cases, morphological and meristic characters are taken under consideration to identify initial variation among related species, groups, populations, or families. This chapter reviewed the studies associated with the morphological and meristic characters of fish populations, families, and species in Bangladesh and other countries.

2.1 Studies were done in Bangladesh (Associated with the *Gobiidae* family)

Azad *et al*. (2018) studied a successful experiment to observe the morphometric relationship of tank goby *G. guiris* by using multiple linear dimensions. A total of 13 linear dimensions of *G. guiris* were used, and the samples were collected from the Gorai River of the south-western part of Bangladesh. These dimensions exposed morphometric relationships, including Length-Weight Relationships (LWRs) and Length-Length Relationships (LLRs). The study also gave focus on meristic characters of samples. As the part of the result fin formula of *G. guiris* was come out in the form of a result. The fin formula for *G. guiris* was D1. VI; D2. 8–11 (II–III/8–11); pectoral, P1. 17–22 (II-VI/14–19); pelvic, P 2. 10–13 (II–III/8–10); anal, A. 7–12 (II–IV/5–8); and caudal, C. 16–21 (IV–VIII/12–13). This study has a useful contribution for species recognition and stock assessment of *G. guiris* in the Gorai River and adjoining ecosystems or can be applied in another area.

The available fish under the Gobiidae family of Nijhum Island, Hatiya adjacent to Meghna River, and Pashur River from Sundarban based on sampling work are investigated by Latifa *et al*. (2015). This experiment carried out an in-depth observation of morphometric and meristic characteristics. The main objectives of the study were to classify and morphologically distinguish the available Gobiidae fish. There were seven species of Gobiidae fish that had been described by the findings of the study. The species were *Taenioides buchanani* (Day, 1873); *Odontamblyopus* *rubicundus* (Hamilton, 1822); *Trypauchen vagina* (Bloch and Schneider 1801); *Pseudapocryptes elongates* (Cuvier, 1816); *Scartelaos histophorus* (Valenciennes, 1837); *Apocryptes bato* (Hamilton, 1822) and *Boleophthalmus boddarti* (Pallas, 1770). A comparative study on the conceptual idea of morphometric and meristic characteristics was done in the study could open a further opportunity to identify Gobiidae fish in other available Gobiidae of Bangladesh.

A survey type study on the availability of fishes of the greater Noakhali region reviewed the available Gobiidae fishes of the Noakhali region (Hossain, 2013). Based on available Gobiidae fish, the observation of morphometric and meristic traits variation was done. Ten species were found under the Gobiidae family. They were *Taenioides buchanani, Odontamblyopus rubicundus, Pseudapocryptes elongates, Glossogobius guiris, Awaous guamensis, Acentrogobius caninus, Acentrogobius viridipunctatus, Oxyurichthys micorlepis, Parapocryptes batoides.* Identifying them and variating initially by morphological traits among them was the objective of that study. The stage, condition of availability, and other fundamental characteristics related to these species were also studied in the observation.

Mollah *et al.* (2012) ran an experiment to examine the morphological variation of *G. guiris* among three different habitats. The study was conducted in different trails as a pond of Mymensingh, haor of Kishorgonj, and the estuary of Barishal using different landmark-based morphometric data and meristic data. In this study, 13 general morphometric trait data and 23 size-adjusted landmarked based data were measured to reveal the variation among the three populations. It showed that haor stock was different in the case of transverse scale on the lateral line. Another significant difference revealed through dendrogram was that, between two main clusters, the pond possessed one group and a hoar and estuary stock that showed a very close relationship between the estuary and haor stock of *Glossogobius guiris*. For determining the differences of the same species among the different populations, the study will be a helpful guide.

Islam and Mollah. (2013) have again studied morphological variations and their association to estimate the outcome of induced PG (Pituitary Gland) breeding in *Glossogobius guiris.* The research was a morphological method or a way of testing the efficacy of another factor (PG effectiveness) rather than a truly morphological examination of the species. In the study, it revealed that the lengths of *Glossogobius guiris* were correlated with total length (LT) except the eye length (LE), the snout length (LSN), and the mouth gap (MG). They were correlated with a head length (LH) at a 1% level of significance. Few differences were also observed in meristic traits. Length-weight (WB= body weight, LT= total length) relationship was revealed as Ln WB = - 4.493 + 2.887 Ln LT with correlation coefficient "r" was 0.976 representing 97.6% of correlation in body weight and total length in male. For females, the weight-length equation was Ln WB = - 5.327 + 3.291 Ln LT with a 99.9% correlation between body weight and total length presented in the form of "r." The value of "b" was 2.887 for males and 3.291 for females. They concluded with PG's acceptable dose for a certain month for a special group of fish to urge the best result.

2.2 Associated Gobiidae family studies (International boundary aspect)

Iranian Goby's morphological variation (*Ponticola iranicus*) was studied by Nikmehr *et al*. (2020). Morphological features of *Ponticola iranicus* populations of Anzali Wetland drainage were investigated during this research. A total of 22 morphometric characteristics were measured in this analysis. The findings showed a substantial difference in the interorbital gap, the minimum width of the caudal peduncle, and the eye's diameter between the studied populations under the statistical test with a 5% level of significance. The study also revealed that the Anzali wetland population was different from others due to morphological characteristics.

Boltachev *et al.* (2016) experimented on an alien species of the Black sea, *Potamoschistus bathi.* The study was mainly focused on the distribution, ecological and biological features of the species. During the experiment, all parts, especially the study's physical aspect, went through the morphological analysis. The result revealed the fin formula of the species that D1- (VI-VII), D2- (I/12-13), A-I(II)/10-12, P-(14-16) and possessed 32-38 scales on the transverse row.

Reflecting the pattern of morphological differences, meristic and morphometric characters of white Goby (*Glossogobius guiris* Hamilton, 1822) from three lakes of Southern Luzon, the Philippines as Laguna de Bay, Taal Lake, and Naujan Lake were compared by Campang and Ocampo (2015). It was exposed that there were significant variations in some morphometric characters. This study found variation in

3 dimensions in the case of morphometric characteristics. They were head dimensions as head length, lower jaw length, head width; trunk dimensions as predorsal length, snout to anus length, length from snout to second fin origin, body depth and body width at ventral fin and anal-fin origin; and fin dimensions including anal fin base length, caudal fin length and pelvic fin length among the three sites. The findings of the study are the variant of characters for which the population differed from each other. Variations in measurements such as snout to the anus (SA), pre-dorsal length (Pre1), pre-pelvic length (PPL), pelvic fin length (VFL), and length from pelvic fin to the anus (VFA) were the main contributors of population variation. Significant differences with a 5% level of significance were also found in the case of some meristic characters, including scale on lateral line (LLS), caudal fin ray (CR), pectoral fin ray (PR), and anal fin ray (AR). According to the authors' assumption, the morphological variations of *Glossogobius guiris* among the selected sites were not the cause of genetic variance; instead, they could be the plasticity of traits due to geographic isolation and the differences in habitat.

A detailed comparative study between two closely related species, *Glossogobius guiris,* and *Glossogobius celebius,* was executed by Mahilum *et al.* (2013). The study focused on the different morphometric characters both between species and male, female sex groups. The authors used 24 morphometric data from the samples of Lake Lanao Mindanao, Philippines. The study's result suggested that *G.celebius* showed more uncorrelation in morphometric measurement in females, and *G. guiris* showed it for males. Otherwise, within the two species, there was no such significant difference.

Harold and Winterbottom (2012) were focused on the jaw morphology of a fish, which was the resulting appearance of the new species *Gobiodon brochus* from the west of the South Pacific.

Daud *et al*. (2005) have experimented with morphometric studies on *Boleophthalmus boddarti* (Malaysian Goby). This study was based on the morphological analysis with traditional morphometric data, truss morphometric and meristic data from *Boleophthalmus boddarti* samples from five populations counted from Pulau Pinang, Kuala Selangor, Banting, Port Dickson, and Melaka areas. The study was carried out with 15 morphometric data, 28 morphometric trusses, and nine meristic data to analyze the degree of heterogeneity between the five populations. All morphometric character data were analyzed within and between populations and found a substantial difference of less than 5% of significance. The three groups of morphometric truss data consist of Kuala Selangor and Banting populations in the first group, Melaka and Port Dickson populations in the second group, and Pulau Pinang populations in the third group. This third group was somewhat different from the other two groups. The findings revealed details about the shape of mudskippers on the peninsula of Malaysia. At the border of the northern part of Malaysia, mudskippers were distantly differentiated from the species of middle and southern regions. There was no identification for grouping in the case of meristic results. The authors established a relationship between the length and weight mentioned in the *Boleophthalmus boddarti* study was logW = log 0.754 + 1.029 log TL.

2.3 Morphometric studies of other fishes

Ahmed *et al*. (2017) recorded New record for Concertina fish, *Drepane longimana* (Perciformes: Drepaneidae) from St. Martin's Island, Bangladesh. The species was verified by a morphometric analytical method. It showed that the body was oval and tightly compressed. The mouth was strongly protruding, creating a tube pointing down the ward as it was protruding. A single dorsal fin with 8 to 9 (usually 8) spines (fourth-largest spine) and 19 to 23 soft rays and anal fins consisted of 3 spines and 17 to 19 soft rays. In color, the head and body were silvery. The appearance of four to nine sub vertical dark bars on the dorsal part from the tip of the head to the caudal fin base makes it easy to differentiate the species from other closely related species of the genus *Drepane*. Thus, morphometric and meristic data confirm the presence of *Drepane longimana* in Bangladesh. This study updates this species' geographical distribution, confirming its existence in the coastal area of Bangladesh.

Mahfuj *et al.* (2017) studied the morphological characteristics to estimate *Labeo bata* populations' variations from Bangladesh's six rivers. The study's motto was to detect *Labeo bata*'s population status in the northern and south-western parts of Bangladesh. The study was executed based on morphometric traits analysis and landmark analysis. A total of 22 morphometric characters were taken under observation, among which 15 characters showed significant inter-stock variation. The finding was concluded that the populations showed variation among themselves distinctly, which represented separate locations. Still, it was also assumed that this variation might result from environmental influences (plasticity of traits) rather than genetic variation.

Parvez and Nabi. (2014) executed morphometric and meristic analysis with a view to racial investigation of *Coilla ramcarati* from Chattogram and Cox's Bazar coast. Morphometric measurements and meristic counts of *Coilia ramcarati* were analyzed in the study statistically to establish the certainty of the possible racial difference in the species from Chittagong and Cox's Bazar coasts of the Bay of Bengal. Some variations were found, which were insignificant with a 5% level of significance, indicating that the populations of *Coilia ramcarati* from Chittagong and Cox's Bazar coasts were not racially different.

CHAPTER 3

MATERIALS AND METHODS

3.1 Sampling Area

The research was conducted in the Chattogram coast along the north-eastern Bay of Bengal to reveal Gobiidae fish's availability. As the research executed on the Chattogram coast, so the main focus was to find out available marine and coastal Gobiidae fishes. The sampling areas were decided by following the study goal. Based on the assumption, this study decided three sampling areas were satisfying the condition of being in the coastal zone and the fish landing stations of estuarine and marine fish. The sampling areas were as following:

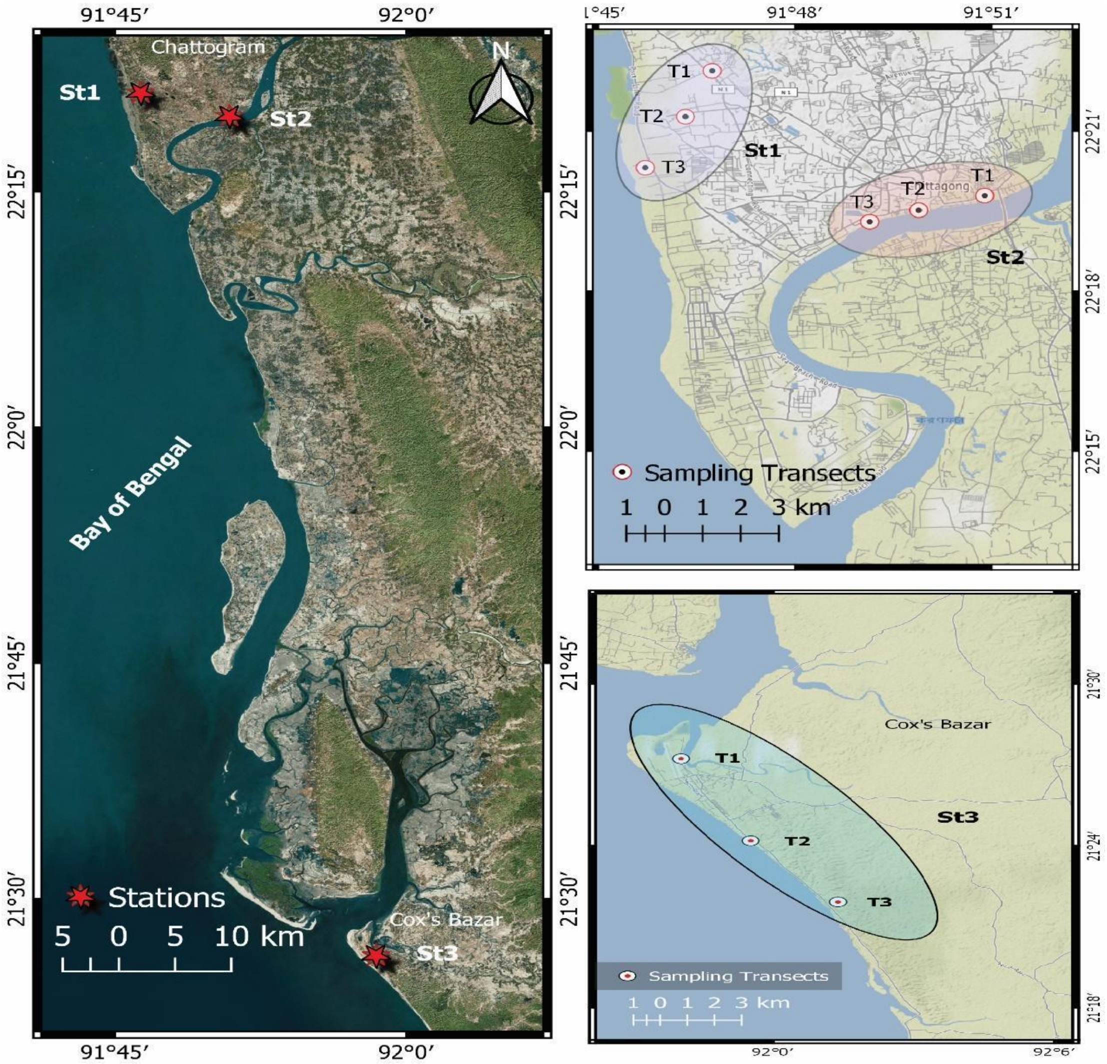


Figure 1 Map of sampling stations with transects

1) **Sampling station 1** (Patenga, Chattogram)

In the hub of Chattogram, the new Fishery Ghat region is the place of available fish species having geographical location as the latitude 22^{0}32$^{'}$97.36''N and longitude 91^{0}84'58.20"E. This station covers a wide area of Chattogram coast including Patenga sea beach region, Pathoarghata, Fishery ghat (New and old), other adjacent fish landing site of Chattogram.

2) **Sampling station 2** (Kattoli coast, Chattogram)

Adjacent to Sagorika beach, Halishohor, Chattogram including Foillatoli Bazar, Be-tech Bazar, Colonel Hat Bazar were investigated under this sampling station 2. The positioning of this station is latitude 22^{0}34'46.15''N and longitude as 91^{0} 77$^{'}$87.25" E.

3) **Sampling station 3** (Cox's Bazar)

Sampling station 3 includes the BFDC Landing Center region, coastal sites of CVASU field station, and adjacent coasts of Cox's Bazar. The geographical location of St3 is 21^{0} 44' 53.36''N latitude and 91^{0} 97'35.1"E longitude.

3.2 Working schedule –

During the research process, a schedule was maintained. That was-

Table -1- Working schedule of whole thesis work

Activities	**Feb 2019**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**Dec 2019**	**Jan 2020**	**F**
Laboratory Setup													
Sampling					**BAN-PERIOD**								
Laboratory Analysis													
Data Analysis													
Report Writing													

3.3 Sampling frequency and sampling period

Sampling was started following the monthly pattern during February 2019 to complete the target of one year's sampling period, which ended in January 2020. Every month, sampling was done from three stations, maintaining a full moon period within 1-2 days intervals from one station to another. Samples were done even on the same day of a month.

3.4 Sampling strategy

Sampling was done by following the "Stratified Random Sampling" method. As the work focused on the morphological aspect, and big sized fishes preferred that. Nevertheless, sampling was not that way of finding a significant size. Three related measures categorized in small, medium, and big size of the available samples were taken as a specimen to represent the population and avoid biases. The size of the fish, a stratified process was preferable. Otherwise, total sampling was following the random method. A total of 150 samples were collected from 3 stations throughout the sampling period. After completing the sample collection, they were transported with ice in an insulated icebox to maintain the sample's freshness and secure all body parts uninfected from physical injury and chemical disruption (Fig – 2.2).

Figure 2.1 Bazar

Figure 2.2 Collected sample in ice box

3.5 Laboratory work and measurement

Laboratory work was conducted immediately after completing the sampling. The laboratory measurements were done in the Oceanography Laboratory under the

Faculty of Fisheries of Chattogram Veterinary and Animal Sciences University. This step had some segments.

1. Confirmed the species of the specimen by dint of the previous record
2. Measured the total weight of the sample and also measuring the individual specimen weight
3. Measured morphometric characteristics
4. Counted meristic characters

Figure 3 Measurement

The measured morphometric and meristic characteristics are enlisted in Table-1. Also, the graphical representation of the morphometric and meristic characteristics are represented in Fig-4.

Table- 2 - Morphometric and meristic characters

Morphometric data		**Meristic Data**	
Pattern	**Length**	**Fin Rays**	**Scales**
Mouth Caudal fin	Total Length (TL) Standard Length (SL) Head Length (HL) Pre-orbital Length (PrOL) Pre-dorsal Length (PrDL) Pre-pectoral Length (PrPL) Pre-pelvic Length (PrVL) Pre-anal Length (PrAL) Body depth (BD)	Dorsal Fin (DF) Pectoral Fin (PF) Pelvic Fin (VF) Anal Fin (AF) Caudal Fin (CF)	On lateral line

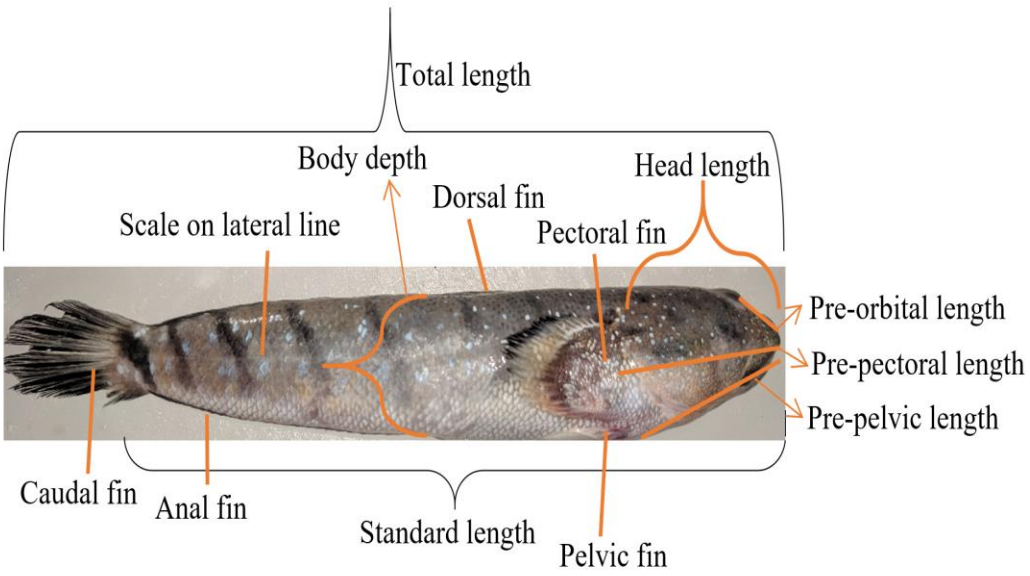


Figure 4 Morphometric and meristic characters measured

Morphometric characters

Regular scale (Fig-5) and digital slide calipers (Fig-6) measured morphometric characters. The characters were as follows:

1. Total length (TL)= Length of fish in centimeter from starting point of mouth to ending point of the tail
2. Standard length (SL)= Length of fish in centimeter from the tip of the head to caudal peduncle
3. Head length (HL)= Length of fish in centimeter from the very first point of head to the end of operculum
4. Pre-orbital Length (PrOL)= Length of fish in centimeter from the very first point of head to the starting of eye border
5. Pre-pectoral Length (PrPL)= Length of fish in centimeter from the very first point of head to starting of the pectoral fin base
6. Pre-pelvic Length (PrVL)= Length of fish in centimeter from the very first point of head to starting of the pelvic fin base
7. Pre-dorsal Length (PrDL) = Length of fish in centimeter from the very first point of head to starting of dorsal fin base.
8. Pre-anal Length (PrAL) = Length of fish in centimeter from the first point of head to anal-fin base.
9. Body depth= Maximum distance between dorsal and ventral portion of fish in centimeter.

Figure 5 Normal Scale used to measure length

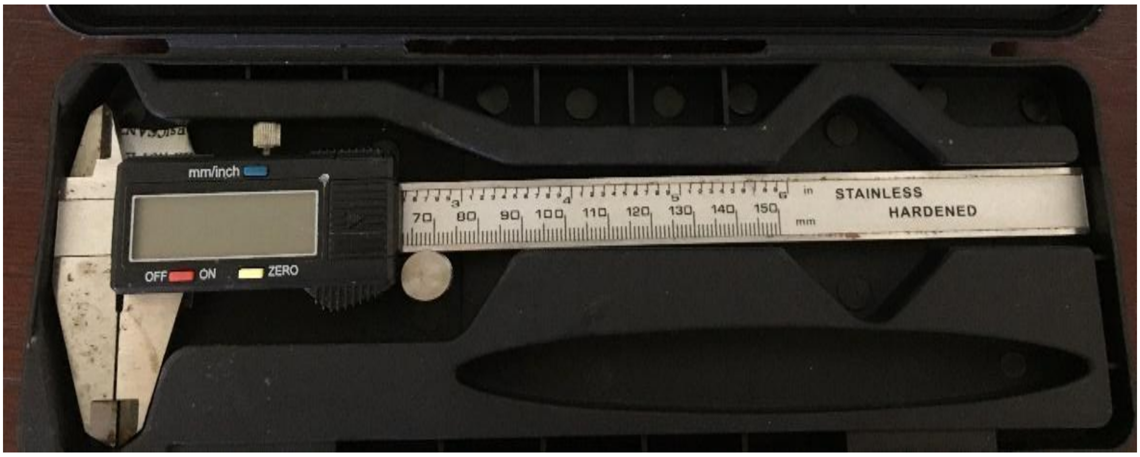


Figure 6 Digital Slide Calipers used to measure length

3.6 Species Identification

Before data collection, species were confirmed by morphological characteristics from previous studies. Some distinct features of species played a very influential role in the identification of species. All these characters were observed from samples and they showed similarities with the characters documented in work of Latifa *et al*. (2015) and Hossain (2013). The distinctive characteristics were (Table-3)-

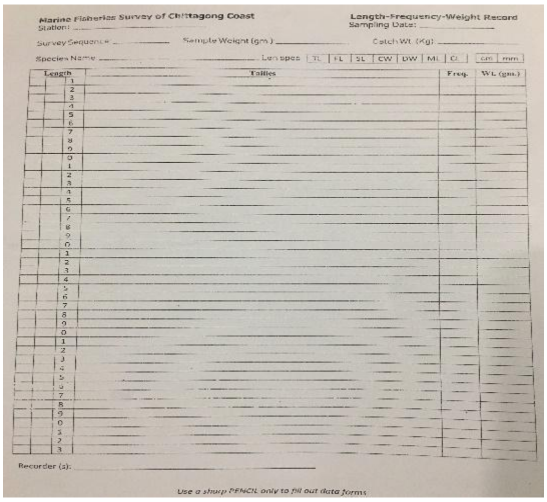
Table-3- Distinct Characters

Species	Distinct Characters
Taenioides buchanani	Vertical fins are blackish. Brownish -olive superiorly, reddish inferiorly. Pectoral and pelvic fins yellowish. 6-7 canine teeth

	are on each jaw. Pre-Anal distance is more than 40%of Standard length.
Pseudapocryptes elongates	The caudal fin appears longer than the head when rays gather together some black broken stripe-like mark on dorsal profile up to the caudal peduncle. The dorsal face is darker with numerous olives to brown spots, and the ventral profile is pale and lacks scale. The lateral line is covered with more than 150 scales.
Apocryptes bato	Ventral fins and anal fin have a pale or colorless appearance. Teeth notched. The dorsal fin is higher than the anal fin. The pectoral fin and dorsal fin may have very minute dots.
Parapocryptes batoides	Both dorsal fins are of equal height. Dorsal, anal and caudal fins blackish
Odontamblyopus rubicundus	Pectoral fins as long anal fin separated from caudal fin by a notch. Red above, whitish below. Pectoral, pelvic, dorsal, and anal fins are reddish. The caudal fin is blackish and much.
Glossogobius guiris	The median lateral series fills with 30-32 scales. 4-6 blackish blotches all over the body. The caudal fin shape is following a pointed pattern. The black stripe is spreading all over the dorsal fins, pelvic fins, and anal fin. Dorsal fins are closed together.
Acentrogobius sp.	The lateral line fills with 25 scales. Head is a depressed frontier like a helicopter with swollen cheeks. Fins decorate with a black zigzag shape Pectoral fin bluntly pointed and as long athe head. The body is somewhat blackish in the shade.
Boliophthalmas boddarti	The zigzag pattern is on the caudal tail. Bluish –white round dot is spreading all over the body. Pectoral and pelvic fin bases are orange-yellow. Blackish stripes form angular shape against the straight dorsal profile of the body and frequency is 10.
Trypauchen vagina	Mostly reddish-pink. The fins are all colorless and translucent. The lateral scale fills with 78-82

3.7 Data collection and recording

The pictorial record was documented by a portable photo lab (Fig- 7). After measuring one specimen's data, the raw data was collected in a record sheet (Fig-8), and all data were gathered in MS Excel-13 for further analysis.



Marine Fisheries Survey of Chittagong Coast — Length-Frequency-Weight Record

Station: ____ Sampling Date: ____

Survey Sequence ____ Sample Weight (gm.) ____ Catch Wt. (Kg) ____

Species Name ____ Len spec TL | FL | SL | CW | DW | ML | CL | cm | mm

Length	Tallies	Freq.	Wt. (gm.)

Recorder (s): ____

Use a sharp PENCIL only to fill out data forms

Figure 7 Portable Photo-lab

Figure 8 Data Collection Sheet

3.8 Preservation

After completing all measurements, finally, the specimens were preserved permanently (Fig-12). For that, a process of Sweeney *et al*. (1983) was followed. That was-

1. First of all, made a solution of 37% formaldehyde.
2. Then, injected the solution into the fish intravenously.
3. Dipped fish into a 10-15% formaldehyde solution and let them be in for 24 hours.
4. Finally, preserved fishes in a jar with 35% alcohol, glycerin, and ethanol solution. (For 10liter solution ,7.5 L DW+2.5 L formalin+250ml glycerin+250ml ethanol).

Figure 9 Preserved Gobiidae

3.9 Statistical analysis.

This study was mainly focused on the morphological and meristic characters of available *Gobiidae* family fish along the Chattogram coast. As it was a morphological study, the conducted statistical analysis was parametric analysis, including the simple linear regression with the correlation coefficient, independent sample T-test, and dendrogram representation. The analysis was conducted for eight different morphological lengths. The eight different length data were collected from a different sample of 9 available Gobiidae family species. The equation followed for the simple regression and coefficient was

Y= aX+b

Here,

Y= Total Length of the fish sample

a= Constant

X= Different measured Length

b= Correlation coefficient

Statistical Package executed all statistical data analysis for Social Sciences (SPSS) version-25 with Microsoft office excel, 2013.

CHAPTER 4

RESULT

The result portion of the analysis summarizes the output of the performance of the study's interest. As the analysis was based almost entirely on the morphological and meristic characteristics of the available Gobiidae fish on the Chattogram coast, so the main emphasis went on to the manual morphological analysis for collecting data and for doing further analysis. A total of 8 species and one genus of Gobiidae from the Chattogram coast were reported from the study and the entire research process. The available species frequency was some of this kind presented in the pictorial presentation (Fig-10).

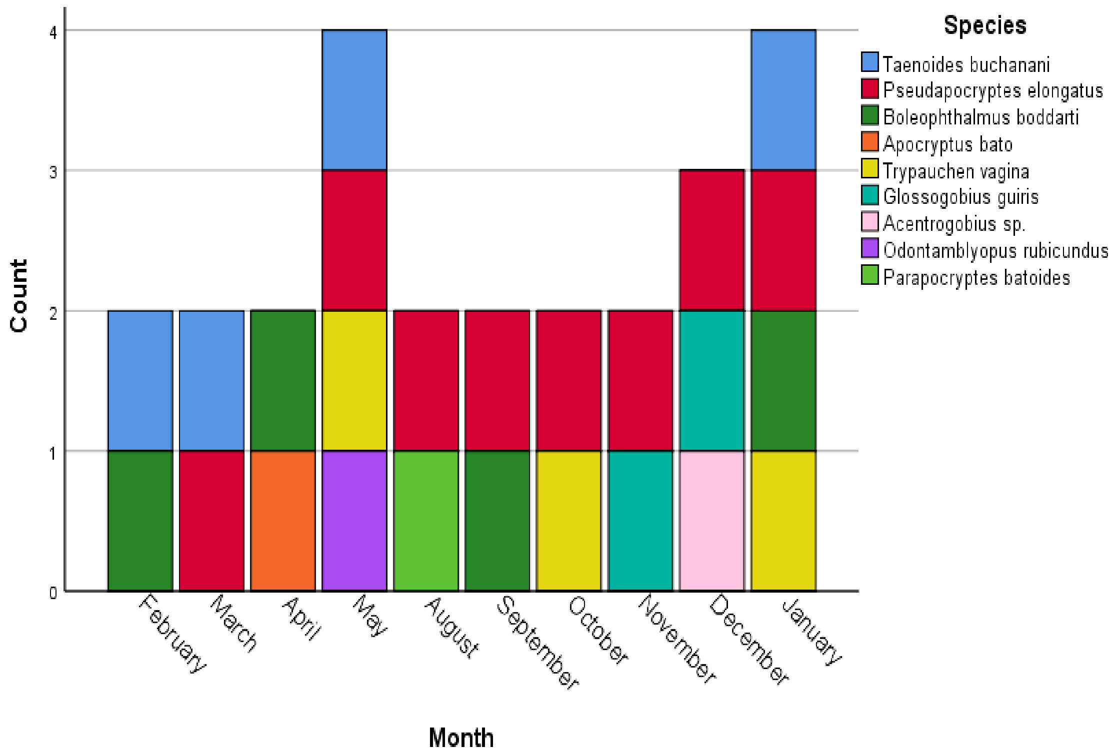


Figure 10 Monthly available species

The month wise available species got from the data which representing that month-May and January were the months showing highest species availability, and *Pseudapocryptes elongatus* was the highest in availability of Gobiidae species on Chattogram coast among the stations.

4.1 Intra-species relation and variation

The relation and variation within single species were analyzed by the a) Fin formula b) Correlation and c) Linear regression. Fin formula revealed the unique criteria for every species. Correlation represented the associations between the measured parameters. Test result might show the higher correlation with insignificant value that could symbolize that the ratio of change would not be constant.

4.1.1 *Taenioides buchanani*

Fin Formula – D(VI/42), P (19), V (7), A(I/34), C (12).

Table-4 -Correlation table for *Taenioides buchanani*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	.98	1							
HL	.92	.89	1						
PrOL	.92	.93	.84	1					
PrPL	.92	.89	1.00	.84	1				
PrVL	.92	.89	1.00	.84	1.00	1			
PrDL	.94	.90	.86	.93	.86	.86	1		
PrAL	.97	.95	.88	.93	.88	.88	.97	1	
BD	.98	.98	.88	.90	.88	.88	.90	.94	1

* $p<0.05$

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth

Comment- All parameters were correlated but not significantly correlated at ($p<0.05$) in case of ***Taenioides buchanani***

4.1.2 *Pseudapocryptes elongates*

Fin Formula – D1-V, D2 –I/28, P (19), V (10), A (I/23), C (13)

Table-5-Correlation table for *Pseudocryptes elongates*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	.99	1							
HL	.96	.96	1						
PrOL	.94	.95	.96	1					
PrPL	.96	.96	1.00	.96	1				
PrVL	.96	.96	1.00	.96	1.00	1			
PrDL	.96	.96	.95	.93	.95	.95	1		
PrAL	.99	.99	.96	.94	.96	.96	.96	1	
BD	.98	.97	.95	.91	.95	.95	.92	.98	1

*p<0.05

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth

Comment- No parameter was significantly correlated at (p<0.05)

4.1.3 *Apocryptes bato*

Fin Formula – D1-V, D2-I/23, P (23), V (10) A-I/22, C (20).

Table-6-Correlation table for *Apocryptes bato*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	1.00*	1							
HL	1.00*	.99*	1						
PrOL	.96	.97	.96	1					
PrPL	.99*	.99	.99*	.94	1				
PrVL	.99*	.99*	1.00	.95	.99*	1			
PrDL	.92	.93	.92	.99	.90	.91	1		
PrAL	.99*	1.00*	.99*	.97	.99	.99	.94	1	
BD	.99	.99	.98	.99	.97	.98	.97	.99	1

*p<0.05

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth

Comment- PrOL, PrDL, BD were not significantly correlated with other parameters.

4.1.4 *Parapocryptes batoides*

<u>Fin Formula</u> – D1-VI, D2-I/22, P-(21-22), V-12, A-(I/22-23), C-15

Table-7- Correlation table for *Parapocryptes batoides*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	1.00	1							
HL	.96	.96	1						
PrOL	.96	.95	.98	1					
PrPL	.96	.96	1.00	.98	1				
PrVL	.96	.96	1.00	.98	1.00	1			
PrDL	.98	.99	.97	.93	.97	.97	1		
PrAL	1.00	1.00	.96	.95	.96	.96	.99	1	
BD	.98	.98	.98	.99	.98	.98	.97	.98	1

* $p<0.05$.

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth

Comment – No parameter was significantlly correlated at ($p<0.05$)

4.1.5 *Odontamblyopus rubicundus*

<u>Fin Formula</u> – D-VI/34-39, P-(28-30), V-(I/5), A-I/32-37, C- 22

Table-8-Correlation table for *Odontamblyopus rubicundus*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	.99*	1							
HL	.99	.99	1						
PrOL	.94	.93	.97	1					
PrPL	.99	.99	1.00	.97	1				
PrVL	.99	.99	1.00	.97	1.00	1			
PrDL	.99*	.99*	.99*	.95	.99*	.99*	1		
PrAL	1.00*	.99*	.99*	.95	.99*	.99*	1.00	1	
BD	.99*	1.00	.99	.93	.99	.99	.99*	.99*	1

*$p<0.05$

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth.

Comment - SL significantly correlated with BD ($p<0.05$). HL showed an insignificant correlation with PrOL and BD. PrOL was insignificantly correlated with others. PrPL was significantly correlated with PrAL ($p<0.05$).

4.1.6 *Glossogobius guiris*

<u>Fin Formula</u> – D1- VI, D2- I/9, P- 18, V- 10, A- I/9, C-13

Table-9-Correlation table for *Glossogobius guiris*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	.99	1							
HL	.92	.89*	1						
PrOL	.99	.98	.94	1					
PrPL	.97	.96	.96	.99	1				
PrVL	.97	.96	.96	.99	1.00	1			
PrDL	.98	.97	.96	.99	.98	.98	1		
PrAL	.96	.93	.99	.98	.99	.99	.98	1	
BD	.95	.91*	.97	.96	.97	.97	.97	.98	1

*$p<0.05$

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth.

Comment – SL significantly correlated with HL and BD ($p<0.05$).

4.1.7 *Acentrogobius sp.*

<u>Fin-Formula</u> – D1-VI, D2-I/10, P-18, V-5, A-17, C-16

<u>Morphometric measurements</u>-

The species was not confirmed yet, so the statistical analysis could not be applied in this species like in other cases. However, the ratio of other's length was measured with the total length. So, an output was come out on this species in the form-

Table- 10- Length percentage table of *Acentrogobius sp.*

Constant factor	Variable factor	Ration	Value	Percentage
Total length(TL)	Standard length(SL)	SL/TL	0.818	81.8%
Total length(TL)	Head length(HL)	HL/TL	0.273	27.3%
Total length(TL)	Pre-orbital length(PrOL)	PrOL/TL	0.045	4.5%
Total length(TL)	Pre-pectoral length (PrPL)	PrPL/TL	0.318	31.8%
Total length(TL)	Pre-pelvic length (PrVL)	PrVL/TL	0.318	31.8%
Total length(TL)	Pre-doesal length (PrDL)	PrDL/TL	0.318	31.8%
Total length(TL)	Pre-Bnal length (PrAL)	PrAL/TL	0.4	40%
Total length(TL)	Body depth (BD)	BD/TL	0.364	36.4%

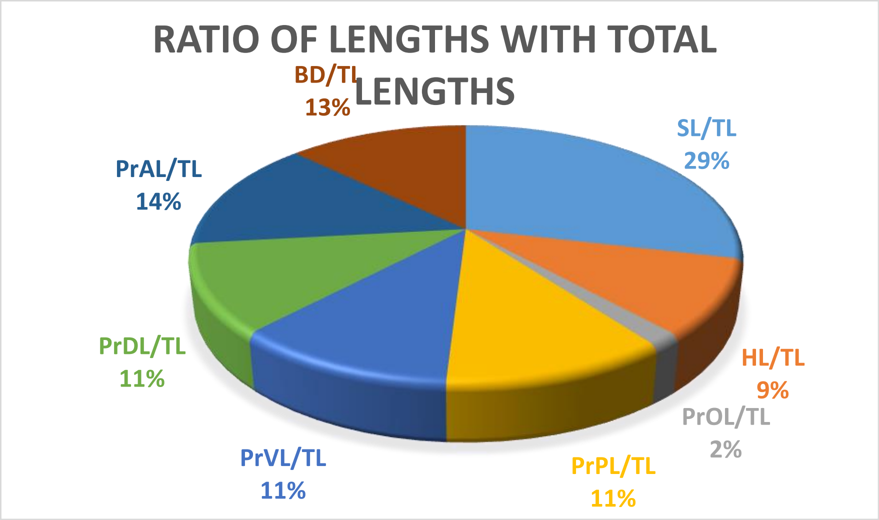


Figure 11 Ratio of lengths with total lengths

4.1.8 *Boliophthalmas boddarti*

<u>Fin Formula</u> – D1- 5, D2-29, P (10), V (10), A (27), C (15**)**

Table- 11 -Correlation table for *Boliophthalmas boddarti*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	.97	1							
HL	.98	.95	1						
PrOL	.98	.96	.99	1					
PrPL	.96	.93	.98	.98	1				
PrVL	.96	.93	.98	.98	1.00	1			
PrDL	.99	.97	.98	.98	.97	.97	1		
PrAL	.99	.97	.97	.98	.97	.97	.993	1	
BD	.98	.94	.97	.97	.94	.94	.981	.973	1

*$p<0.05$

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth.

Comment - No parameter significantly correlated (p<0.05).

4.1.9) Trypauchen vagina

Fin-Formula- D-I/40, P-18, V-11, A-14, C-32

Table-12-Correlation table for *Trypauchen vagina*

Parameters	TL	SL	HL	PrOL	PrPL	PrVL	PrDL	PrAL	BD
TL	1								
SL	.99	1							
HL	.98	.99	1						
PrOL	.96	.97	.97	1					
PrPL	.96	.97	.98	.94	1				
PrVL	.96	.97	.98	.94	1.00	1			
PrDL	.97	.98	.99	.97	.99	.99	1		
PrAL	.98	.99	.99	.97	.97	.97	.99	1	
BD	.96	.96	.94	.92	.93	.93	.94	.92	1

*p<0.05

Description- TL= Total length, SL = Standard length, HL= Head lemgth, PrOL = Pre-orbital length, PrPL = Pre-pectoral length, PrVL = Pre- pelvic length, PrDL = Pre-dorsal length, PrAL = Pre- anal length, BD = Body depth.

Comment- Parameters showed a high level of insignificant correlation at p<0.05

Regression-

Regression illustrated the effect of one definite parameter upon other parameters and how changes in one defined factor affecting other dependent factor or factors. This study considered the total length (TL) as the influencer characters upon other morphometric characters. Eight linear regressions were done for each species. From the performed statistical test it would seem that the least was 0.858 came out as the regression value of TL and PrOL in case of *T. buchanani*, 0.894 for *P. elongatus* (TL- PrOL regression line), regression value was 0.935 for *A. bato* (regression outcome of TL- PrOL), 0.922 for *P. batoides* (TL-PrOL), 0.893 for *O. rubicundus* (TL – PrOL), 0.85 for *G. guiris* (TL-HL), for *B. boddarti* it was 0.93 in TL- PrPL regression line and 0.924 for *T. vagina*. It summarized that all regression values of TL with other length was more than 85% for *T. buchanani*, beyond 89% for *P. elongatus*, 94% for *A. bato*, more than 92% for *P. batoides*, more than 89% for *O. rubicundus*, exceed 85% for *G. guiris*, more than 93% *B. boddarti* for and more than 92% for *T. vagina* . It seemed that the influence of TL over other lengths was more than 85% for every species separately. TL showed a great influential dominance over other lengths (Appendix I- VIII). All species presented same trend of positive association of TL and others lengths separately. All species mostly followed the trend of *P. elongatus* (Fig-12).

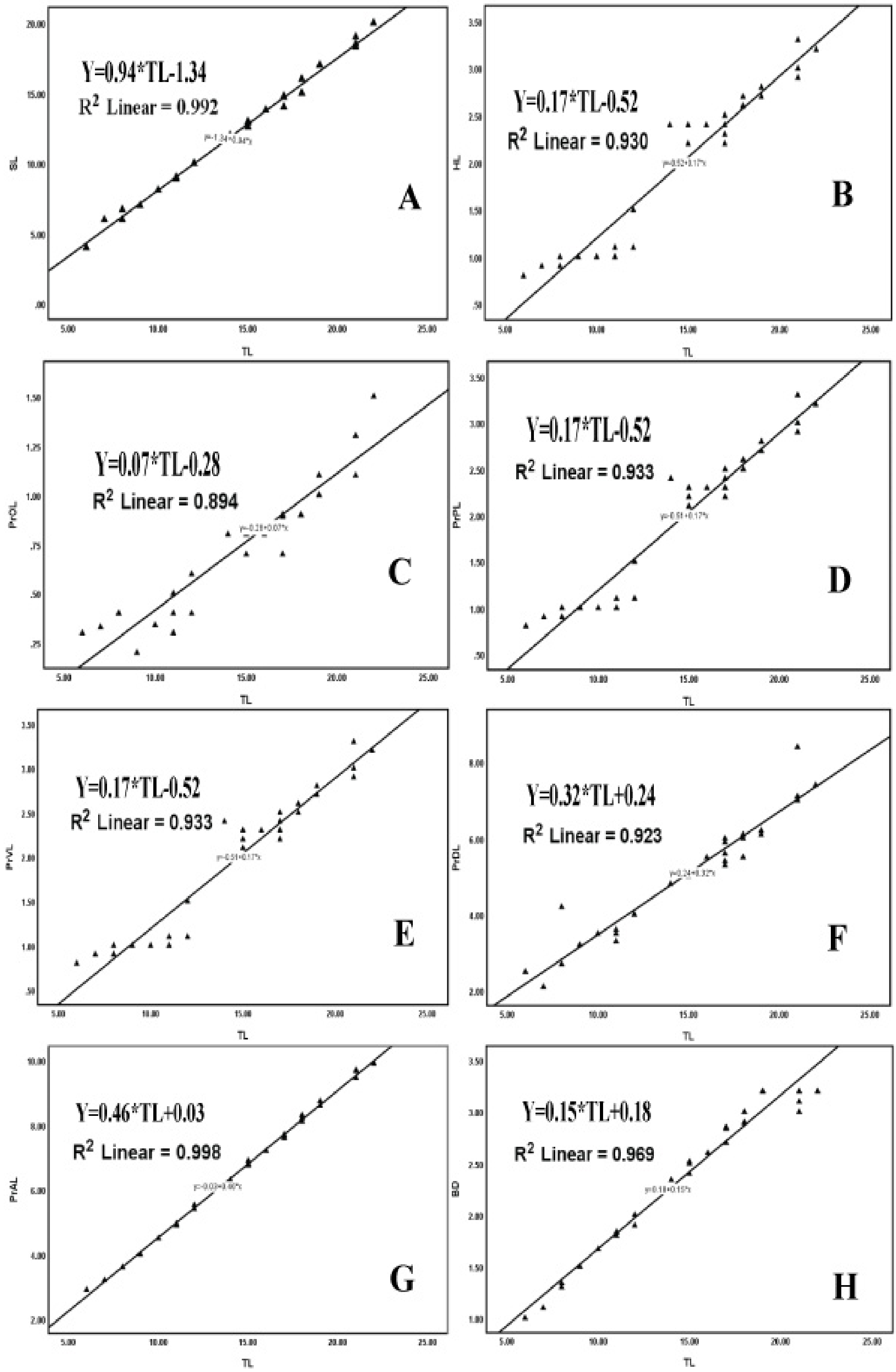


Figure 12 Regression line of (A, B, C, D, E, F) length on total length for *P. elongatrus* (A= Standard, B= Head, C= Pre-orbital, D= Pre-pectoral, E= Pre- pelvic, F= Pre-dorsal, G= Pre-anal, H= Body depth)

4.2 Inter-species relation and variation

Inter-species relation and variation were determined by the analysis of the independent sample T-test and dendrogram. An Independent T-test was performed to check the difference between the mean of different parameters of two different species groups. Here *P. elongatus* was common in every comparison group as it was the most available species.

Independent T-test -analysis illustrated that all parameters showed a significant difference between mean in the case of *T. buchanani* and *O. rubicundus*. So, it could be suggested that species *T. buchanani* and *O. rubicundus* were not related species. HL, PrPL, PrVL, BD revealed a significant difference in the case of *B. boddarti*, *G. guiris, A. bato*. But *A. bato* and *G. guiris* also showed the difference in PrOL. *P. batoides* showed a significant difference in the section of TL, SL, PrDL, PrAL, and *T. vagina* showed a difference in the case of TL, HL, SL, PrPL, PrVL, and PrDL. (table -13).

Table -13- Table for T-test between species group

Species	Parameters	T-test	Sig (p<0.05)	Mean difference
Taenioides buchanani	**TL**	6.47	.000	7.68
	SL	5.78	.000	7.07
	HL	9.24	.000	2.56
	PrOL	-2.77	.008	-1.99
	PrPL	9.73	.000	2.56
	PrVL	9.7	.000	2.561
	PrDL	3.16	.003	1.34
	PrAL	2.38	.022	1.15
	BD	12.57	.000	2.19
Boleophthalmus boddarti	**TL**	0.458	0.649	0.517
	SL	0.494	0.624	0.551
	HL	-7.03	.000	-1.43
	PrOL	1.18	0.245	0.1
	PrPL	-6.19	.000	-1.18
	PrVL	-6.2	.000	-1.179

	PrDL	0.311	0.758	0.142
	PrAL	0.362	0.719	0.191
	BD	3.55	0.001	0.643
Apocryptes bato	**TL**	-0.425	0.674	-1.15
	SL	-0.87	0.392	-2.21
	HL	-2.53	0.017	-1.199
	PrOL	2.58	0.016	0.17
	PrPL	-2.63	0.013	-1.25
	PrVL	-2.54	0.016	-1.2
	PrDL	0.606	0.549	0.519
	PrAL	1.19	0.243	1.44
	BD	2.34	0.026	0.3
Trypauchen vagina	**TL**	-2.946	.006	-4.7
	SL	-3	.004	-4.64
	HL	-4.44	.000	-0.87
	PrOL	0.994	0.327	0.07
	PrPL	-4.3	.000	-0.86
	PrVL	-4.29	.000	-0.865
	PrDL	4.778	.000	1.56
	PrAL	1.84	.074	0.85
	BD	-1.44	0.159	-0.25
Glossogobius guiris	**TL**	-0.25	0.805	-0.48
	SL	0.328	0.745	0.58
	HL	-3.681	0.001	-1.42
	PrOL	-2	0.044	-0.3
	PrPL	-3.14	0.004	-1.61
	PrVL	-3.141	0.004	-1.6
	PrDL	0.383	0.704	0.238
	PrAL	0.061	0.952	0.057
	BD	-2.55	0.016	-0.84
	TL	-4.21`	.000	-11.15
	SL	-3.4	.002	-8.45

Odontamblyopus rubicundus	**HL**	-10.53	.000	-1.98
	PrOL	-3.5	.002	-0.25
	PrPL	-10.52	.000	-1.99
	PrVL	-10.53	.000	-1.98
	PrDL	-4.15	.000	-3.48
	PrAL	-7.7	.000	-4.15
	BD	5.73	.000	0.805
Parapocryptes batoides	**TL**	-3	0.005	-5.82
	SL	-3.38	0.002	-6.06
	HL	-.078	0.939	-.015
	PrOL	1.858	0.076	0.143
	PrPL	-0.078	0.94	-0.149
	PrVL	-0.078	0.939	-0.149
	PrDL	-3.448	.002	-2.114
	PrAL	-2.97	.005	-2.584
	BD	1.831	0.086	0.342

Dendrogram-

Dendogram was done for checking the formation of cluster by the differences among the parameters. Here the parameters which were in close could be found. Some parameters of all species formed cluster and parameters showed distant relation. Mainly, two main clusters were formed by the all traits of all species. It showed that PrPL, PrVL, HL, BD, PrOL were very closely related and made a cluster and other traits made another cluster. PrDL was closely related with the main cluster and PrDL and PrAL were strongly correlated. TL was distantly related with the PrDL and TL and SL were strongly correlated. TL was mainly formed another cluster.

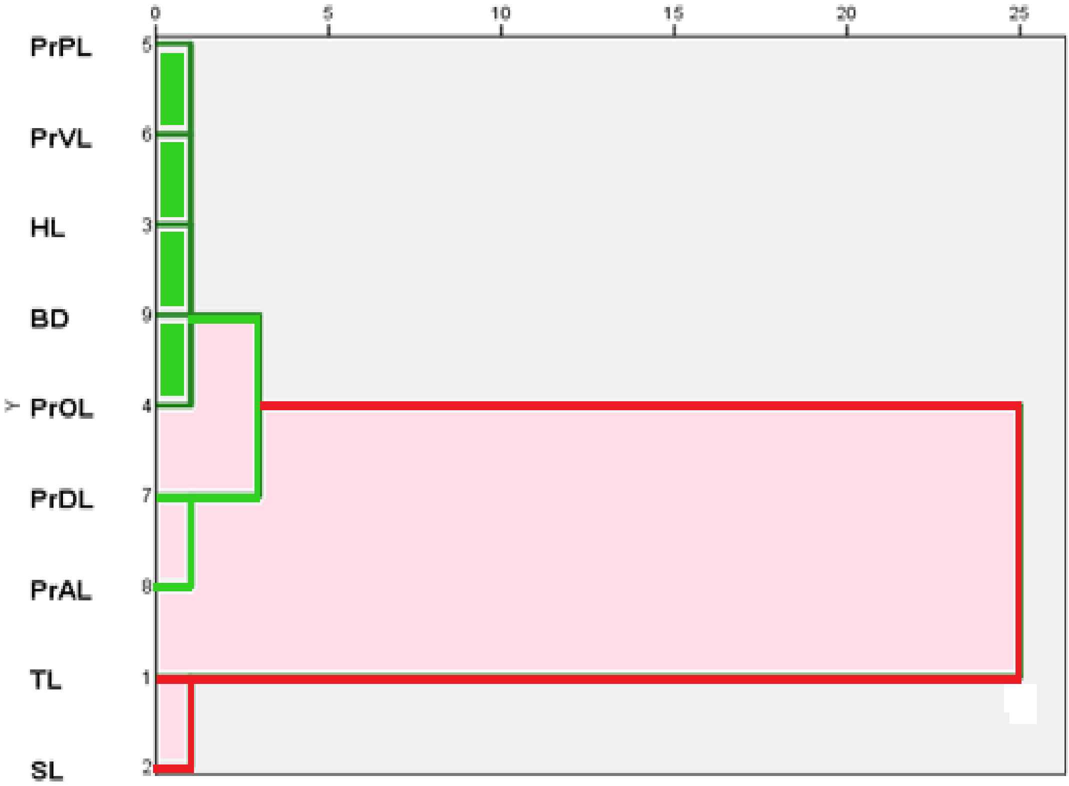


Figure 13 Dendrogram of the mean of all parameters of species

4.3 Meristic counts

Meristic counts of this study did not show much variation in their value. They were kind of fixed type. Meristic counts could be varied with the heredity, environmental facts and the geological distance. In that case, such no variations were found. For establishing fin formula which was the basic logical way to find out any species all datas of meristic counts were collected. Here, meristic counts of species were gathered in a charted form to interpret the characters of fish quickly.

Table - 14 - Table for the meristic count for all available species

Meristic counts and Abbreviation	***Pseudapocryptes elongatus***	***Taenioides buchanani***	***Apocryptus bato***
Dorsal Fin Ray (DFR-1)	-	40-42	-
Dorsal Fin Ray (DFR-2)	27-30	-	23
Spine in Dorsal Fin (DF-1)	V(5)	VI(6)	V(5)
Spine in Dorsal Fin (DF-2)	I(1)	-	I(1)
Pectoral Fin Ray (PFR)	17-19	18-19	15
Pelvic Fin Ray (VFR)	9-11	6	10
Anal Fin Ray (AFR)	26-30	37-39	24
Spine in Anal Fin (AF)	I(1)	I(1)	I(1)
Caudal Fin Ray (CFR)	11-15	15-17	23
The scale on the lateral line	95-161	-	100
Meristic counts and Abbreviation	***Glossogobius guiris***	***Parapocryptes batoides***	***Trypauchen vagina***
Dorsal Fin Ray (DFR-1)	-	-	40
Dorsal Fin Ray (DFR-2)	9	22	-
Spine in Dorsal Fin (DF-1)	VI(6)	VI(6)	I(1)
Spine in Dorsal Fin (DF-2)	I(1)	I(1)	-
Pectoral Fin Ray (PFR)	18-19	21-22	17-19
Pelvic Fin Ray (VFR)	9	10-12	9-11
Anal Fin Ray (AFR)	10	22	32
Spine in Anal Fin (AF)	I(1)	I(1)	-
Caudal Fin Ray (CFR)	12-14	78-80	13-15
Scale on lateral line	31-34	-	80
Meristic counts and Abbreviation	***Boleophthalmus boddarti***	***Acentrogobius sp***	***Odontamblyopus rubicundus***
Dorsal Fin Ray (DFR-1)	27-29	5	37
Dorsal Fin Ray (DFR-2)	-	9	VI(6)
Spine in Dorsal Fin (DF-1)	-	I(1)	-
Spine in Dorsal Fin (DF-2)	-	-	-
Pectoral Fin Ray (PFR)	9-10	14	29
Pelvic Fin Ray (VFR)	9-10	5	5
Anal Fin Ray (AFR)	24-27	16	37
Spine in Anal Fin (AF)	-	-	-
Caudal Fin Ray (CFR)	14-15	17	15
Scale on lateral line	62-70	27	-

Result was the core section of the study. As the part of findings, the result part showed that there was both similarities and dissimilarities among the species. But some were closely related species.

CHAPTER 5

DISCUSSION

The morphological and meristic analysis measures and observes external appearances and interpretation of obtained data that revealing the outcome. The present study reveals the information about the available species of the Gobiidae family along the Chattogram coast. In this process of identification, eight species were recorded under this Gobiidae family. The whole study revealed data about those available species.

Investigation work to identify species

A detailed morphological work on the available species of Nijhum Island, Hatiya junction, and Pashur River were experimented by Latifa *et al*. (2015) and that study found *Taenioides buchanani, Odontamblyopus rubicundus, Pseudapocryptes elongates, Apocryptes bato, Trypauchen vagina, Scartelaos histophorus,* and *Boleophthalmus boddarti*. In the present study, the recorded species were *Taenioides buchanani, Odontamblyopus rubicundus, Pseudapocryptes elongates, Apocryptes bato, Glossogobius guiris, Parapocryptes batoides, Trypauchen vagina* and *Boleophthalmus boddarti*. The present study found all species found by the Latifa et al. 2015 and the present study found 8 species and one genus but the mentioned author found 6 species. The fin formula that were revealed as D-47, P-18, V-5, A-39, C-14 for *T. buchanani***,** D- (50- 57), P-17, V-12, A- (44-50), C-14 for *T. vagina***,** D-42, P-31, V-6, A-36, C-18 for *O. rubicundus***,** D1- 5, D2 – 32, P-17, V-5, A- 29, C- 22 for *P. elongates***,** D1- 5, D2 – 21, P-23, V- 12, A- 22, C- 20 for *A. bato* and D1- 5, D2 – 20, P- 18, V- 12, A- 24, C- 20 for *B. boddarti*. The present investigation demonstrated the fin formula of species were D-(VI/42), P-19, V-7, A-(I/34), C-12 for *T. buchanani,* D1-V, D2-(I/28), P -19, V-10, A-(I/23), C-13 for *P. elongates,* D1-V, D2 - (I/23), P- 23,V- 10, A-(I/22), C- 20 for *A. bato,* D1-VI, D2- (I/22), P-(21-22), V12, A-(I/22-23), C-15 for *P. batoides,* D-(VI/34-39), P-(28-30), V-(I/5), A-(I/32-37), C-22 for *O. rubicundus,* D1-VI, D2-(I/9), P-18, V-10, A-(I/9), C-13 for *G.guiris,* D1-5, D2-29, P-10,V-10, A-27, C-15 for *B. boddarti* and D-(I/40), P-18, V-11, A-14, C-32 for *T. vagina.*

Again, by Hossain (2013), there were some species found under the Gobiidae family. They were *Taenioides buchanani, Odontamblyopus rubicundus, Pseudapocryptes* *elongates, Glossogobius guiris, Awaous guamensis, Acentrogobius caninus, Acentrogobius viridipunctatus, Oxyurichthys micorlepis, Parapocryptes batoides, Apocryptes bato*. Among them, four species were not found in the present study. Fin formulas in that study were D1-V, D2 - (I/21-23), P – (22-23), V- 10, A-(I/21-24), C-23 for *A. bato,* D1-V, D2-(I/27- 31), P-(19 – 21), V-10, A - (I/27-29), C-13 for *P. elongates,* D1-VI, D2-(I/9), P-(17-18), V-10, A-(I/9), C-13 for *G. guiris***,** D1-VI, D2-(I/22), P-(21-22), V-12, A-(I/22-23), C-15 for *P. batoides,* D-(VI/34-39), P-(28-30), V-(I/5), A-(I/32-37), C- 22 for *O. rubicundus* and D-(VI/42), P-19, V-7, A-(I/34), C-12 for *T. buchanani*. Hossain (2013) did not focus on the pelvic fin rays. The author found 10 species in greater Noakhali region among which 5 species and one genus were found in Chattogram through the present study. The present study recorded fin formulas for the found species were D-(VI/42), P-19, V-7, A-(I/34), C-12 for *T. buchanani,* D1-V, D2-(I/28), P -19, V-10, A-(I/23), C-13 for *P. elongates,* D1-V, D2 -(I/23), P- 23,V- 10, A-(I/22), C- 20 for *A. bato*, D1-VI, D2- (I/22), P-(21-22), V12, A-(I/22-23), C-15 for *P. batoides*, D-(VI/34-39), P-(28-30), V-(I/5), A-(I/32-37), C-22 for *O. rubicundus,* D1-VI, D2-(I/9), P-18, V-10, A-(I/9), C-13 for *G.guiris,* and D-(I/40), P-18, V-11, A-14, C-32 for *T. vagina.*

However, in both cases of Latifa *et al*. (2015) and (Hossain, 2013), the present study shared close similarities with them though little dissimilarity that these studies did not found all species found by present study and in fin formulas there were some dissimilarities might be occurred for the environmental influences in the coastal and maritime region of the Chattogram coast.

New case of existence

The morphological and meristic characters were performed by Ahmed *et al*. (2017) in a new dimension to examine the existence of new species from St. Martin's Island. This species was *Drepane longimana*, which was confirmed by the morphological study. In this present study, the length-length relationship was also done for the better representation of morphometric approaches. The present study revealed the presence of new existence of species under genus- *Acentrogobius***.** The record of new species be confirmed with key characteristics. Newly existed species had some characteristics such as the dorsal fin and anal fin position was much lower, swollen cheek with depressed head, the pectoral fin was as long as the head, and they were obtusely pointed, and it possessed 25-26 scales on lateral lines. Some other characteristics were- maxillary ended below the middle margin of eye border, dorsal fin structurally spine with the filamentous ending, and dark bands. The anal fin and were second dorsal fin posteriorly pointed, possessed oblong-shaped caudal fin, and pelvic fins were black.

All these characters were similar to *Acentrogobius canius* and *Acentrogobius viridipunctatus* (Hossain, 2013). Fin formula of *A. canius* was D1 VI; D2 I/11; P1 17-19; A I/9; LL 29-30, fin formula of *A. viridipunctatus* was D1 VI; D2 I/10; P1 18-20; A I/9; LL 35-36. Oanh *et al*. (2019) presented fin formula for *A. canius* was D1 VI; D2 I/9.5; P 18-19; V I/5; C 13-15; LL 29-30 and the fin formula of found genus *Acentrogobius sp.* was D1-VI, D2-I/10, P-18, V-5, A-17, C-16, LL- 28.

According to (Hossain, 2013) similarities of *Acentrogobius sp.* with *Acentrogobius canius* that both possessed some characteristics were the position of dorsal fin and anal fin was much lower, swollen cheek with depressed head, pectoral fin was as long as head and they were obtusely point and 27-28 scales on lateral lines. Dissimilarities with *Acentrogobius canius* were body elongated, anteriorly cylindrical and posteriorly compressed, maxillary extended posterior border of eye, caudal fin rounded and 9 spine and one ray in anal. Some characteristics were absent in *Acentrogobius sp.* were possessed by *Acentrogobius canius* were Body with alternating rows of large blackish brown spots, olive color on above, lighter shade in below and head with blue or pearl color spots.

The resemblance of *Acentrogobius sp.* with *Acentrogobius viridipunctatus* that both shared some characteristics were body elongated, anteriorly cylindrical and posteriorly compressed, maxillary ended below the middle margin of eye border and lower jaw prominent, dorsal fin structurally spine with filamentous ending and dark bands, caudal fin black without spot and oblong shaped and second dorsal fin and anal fin were posteriorly pointed. Difference with *Acentrogobius viridipunctatus* were yellowish-orange fin, rounded pectoral fin, 35-36 scales on lateral line and one spine and 9 rays on anal fin.

According to Wang *et al*. (2017) *Acentrogobius canius* had total length range of 5.9-13 cm and weight range 2.1- 29.8 g. The found specimen of the present study was of 11cm and 20 g.

In accordance with Oanh *et al*. (2019) length ratio percentages for *A. canius* were TL/SL= 129%, HL/SL= 27%, PrPL/SL=30%, PrVL/SL=31%, PrDL/SL= 33%, PrAL/SL=56% and BD/SL=20%. The present study shared percentages were TL/SL= 123%, HL/SL= 33%, PrPL/SL=38%, PrVL/SL=36%, PrDL/SL= 37%, PrAL/SL=54% and BD/SL=25%.

By this way, all the closeness of characteristics contributed to the confirmation of genus *Acentrogobius* but the species could not be stick to any specific name because of all dissimilarities with the shared characteristics of found genus. That was the reason why the newly existed species was placed under the *Acentrogobius sp*

Work on *Glossogobius guiris*

Mollah *et al*. (2012) investigated the *Glossogobius guiris* of three different stocks to determine the outcome of landmarked-based morphological analysis on the fishes. *Glossogobius guiris* had six rays on the first dorsal fin and 9-11 fin rays on the second dorsal fin which treated as the key identifying characteristics of this species in freshwater stock especially in pond stock. Also, they contained 15-17 fin rays on the pectoral fin, 9-11 rays on the pelvic fin, 8-10 fin rays on the anal fin, 13-18 fin rays on caudal-fin rays, and 28-30 scales on the lateral line. According to the same experiment but in different stock, the species revealed that it had six rays on the first dorsal fin, ten rays on the second dorsal fin, 20-21 rays on the pectoral fin, ten rays pelvic fin, and 14-16 rays on anal fin along with 30-32 scales on the lateral line. Another stock documented that the species of estuary stock possessed six rays on the first dorsal fin and 9-10 rays on the second dorsal fin also 17-21 rays on the pectoral fin, ten rays on the pelvic fin, 8-9 rays on anal fin and 16-18 rays on the caudal fin with 29-31 scales on the lateral line. This study also revealed that freshwater stock and brackish water stock shared similarities, but haor stock showed specific dissimilarities. According to the present experiment, *G. guiris* had six spines on the first dorsal fin and one spine and nine soft rays on the second dorsal fin. The *Glossogobius guiris* species of the present study also possessed 18-19 soft rays on the pectoral fin, nine soft rays on the pelvic fin, one spine and ten soft rays on the anal fin, and 12-14 rays on the caudal fin along with 30-32 scales on the lateral line. It seemed that the present research shared similarities with the estuary stock, but Mollah *et al*. (2012) did not mention anything about the fin spine.

However, in the scales on the lateral line, it showed similarities with the haor stock. As the Chattogram coast possesses the estuarine area, so the sample of *G. guiris* came from the estuary or coastal environment (as the experiment was based on a landing station as well as coastal Fish Market survey). That might be the reason for showing similarities with the estuary stock. *G. guiris* found from the study of (Hossain, 2013) also showed similarities with the present study and the estuarine stock of the species of study of Mollah *et al*. (2012). In the case of scale on the lateral line and all dissimilarities, it might occur due to the environmental influence or the genetic divergence. As many studies were executed on morphological and meristic analysis, so another experiment which was most similar to this study was done by Mahfuj *et al*. (2016) on *Labeo bata* of six rivers of Bangladesh, and they were the Mathabhanga River, the Kirtonkhola River, the Noboganga river, the Jamuna River, the Punorvoba River, and the Dinajpur River.

Islam and Mollah. (2013) experimented on the PG dose effect on both separated male and female groups of *G. guiris***,** but in this process, the authors were going through the morphological analysis to observe the growth. However, the study revealed the data about the external morphology, which were 29-35 scales on lateral line, six rays of the first dorsal fin, 10-11 rays on the second dorsal fin, 15-19 rays on pectoral fin, 10-12 rays on the pelvic fin, 8-9 rays on anal fin and 21-28 rays on the caudal fin. The present study shared few similarities with the experiment of the authors. This dissimilarities occurred for the geological distance and environmental factors experimented on the sample of Kaila beel of Ishwarganj, Mymensingh, which is the freshwater influenced northern part of Bangladesh. However, the present study was done in Chattagram, the southeastern part of Bangladesh, and dominated by estuarine or euro-haline characteristics. The study of Islam and Mollah. (2013) also presented the correlation of total length with other lengths, and a similar fact was demonstrated in the present study. Nevertheless, the authors did it both on male and female groups separately. So that study of Islam and Mollah. (2012) documented the ranges of length for male and female group were SL = (0.993- 0.992), HL = (0.939- 0.904), BD = (0.864- 0.895), PrDL = (0.981- 0.955), PrPL = (0.890- 889), PrVL = (0.951- 0.767), PrAL = (0.847- 0.983), PrOL = (0.735- 0.947). The present investigation along the northeastern part of Bay of Bengal revealed measurements as SL= 0.988, HL= 0.922, PrOL = 0.99, PrPL = 0.977, PrVL = 0.977, PrDL = 0.987, PrAL = 0.960, BD = 0.965.

The finding of this study represented that both cases shared various similarities, and the dissimilarities account for different environmental factors as current and light.

Another experiment was done on *G. guiris* of Gorai River Azad *et al*. (2018). This experiment revealed the fin formula as D1-VI, D2-(II-III/8-10), P-(II-VI/14-19), V-(II-III/8-10), A-(7-15), C-(16-21), and 30-32 scales on the lateral line. The present study exposed that D1-VI, D2- I/9, P- 18, V- 10, A- I/9, C-13, and 31-34 scales on the lateral line. There were found few specific similarities and dissimilarities that occurred for the geological distance and variation in environmental parameters. Again, this study revealed the length percentage (length-length relationship) based on total length. The percentages were SL/TL = 76.728%, PrDL = 37.291%, HL/TL = 22.664%, PrPL/TL = 23.051%, PrVL/TL = 24.188%, PrAL/TL = 46.658% and the calculated length percentages from present were SL/TL = 78%, PrDL = 30.04%, HL/TL = 20%, PrPL/TL = 18%, PrVL/TL = 18%, PrAL/TL = 38%. Length percentage also showed similarities, which are more than that of meristic characters. Again by (Hossain ,2013), the species revealed the fin formula D1- VI, D2- I/9, P- 17-18, A- I/9, C-13, and 31-34 scales on the lateral line. There was no evidence of the number of rays on pelvic fin; otherwise, the present study shared specific similarities with the previous study. The similar characteristics occurred due to the geological closeness of station, which was greater Noakhali (Hossain, 2013) and Chattogram (present study location) represented the southern and southeastern part of Bangladesh.

Mophological work on others species under Gobiidae family

An experiment with morphological analysis on *Boleophthalmus boddarti* of five distinct populations of Malaysia reported the length range as (10.53 – 13.05) cm for TL, (8.44 – 10.79) cm for SL, (2.16 – 3.07) cm for HL, (2.48 – 3.83) for PrDL and (1.3 – 1.75) for BD (Daud et al., 2005). The study also revealed the length ratios which were SL/TL = (0.79- 0.90), HL/TL = (0.17- 0.42), PrDL/TL = (0.07- 0.29) and BD/TL = (0.05 – 0.16). The meristic information about the study was D1- (5-7), D2-(23-27), P-(15-20), V- (15-19), A- (24-26) along with (59-78) scales on the lateral line. The present study revealed the length range as TL = (10-16), SL = (7 – 13), HL = (2.5 – 4), PrDL = (3.3 – 5.2) and BD = (1.2 – 2). The ratios showed that SL/TL = 0.816, HL/TL = 0.24, PrDL/TL = 0.275 and BD/TL = 0.12. The meristic information from the present study was recorded as D1- 5, D2- 29, P - 10, V- 10, A -27, and C – 15. It seemed after the analysis of both studies that in the length case, the present study investigated different species sample, but in length ratio, both studies shared similar pattern. In case of the length ratio, the present study recorded the similar range of ratios as mentioned by Daud *et a*l. (2005). A considerable difference was noticed in the case of meristic data, especially in the pectoral and pelvic fin rays. All the dissimilarities resulted from the geological distance (length range) and environmental influences or genetic divergence (meristic counts) Daud *et al*. (2005).

Boltachev *et al.* (2016) experimented on an alien species of the Black sea, *Potamoschistus bathi.* The study was mainly focused on the distribution, ecological and biological features of the species. During the experiment, all parts, especially the biological part of the study, went through the morphological analysis. The result revealed the fin formula of the species that D1- (VI-VII), D2- (I/12-13), A-I (II)/10-12, P-(14-16) and possessed 32-38 scales on the transverse row. The present study also revealed the fin formula of 8 species including one genus.

Different statistical test

Mahilum *et al*. (2013) experimented on *Glossogobius guiris* and *Glossogobius celebius***.** The experiment focused on the difference between the two species and male-female groups within species in both cases. That investigation performed independent T-test to check the mean difference between species and correlation for determining the association of parameters within male and female groups separately of a species. The study's result suggested that *G. celebius* showed more non-correlation in morphometric measurement in females, and *G. guiris* showed it for males. Otherwise, within the two species, there was no such significant difference. The present study also went through an independent T-test to determine the mean difference between the two species. It was found in the result that all parameters showed significant differences between mean in the case of *T. buchanani* and *O. rubicundus*. The HL, PrPL, PrVL, BD revealed a significant difference in *B. boddarti*, *G. guiris*, *A. bato. T. vagina* demonstrated a significant difference in all parameters except PrOL, PrAL, BD, and *A. bato* also showed the difference in PrOL. *P. batoides* showed a significant difference in the section of TL, SL, PrDL, PrAL. In the field of correlation, the present study revealed that all measured parameters were correlated but not significant at (p<0.05) in case of *Taenioides buchanani*, *Pseudapocryptes elongates, Trypauchen vagina, Boleophthalmus boddarti* and *Parapocryptes batoides.* PrOL, PrDL, BD were not significantly correlated with other parameters in the case of *Apocryptes bato***.** TL was not significantly correlated with SL, PrDL, PrAL, and BD (p<0.05). Again, SL significantly correlated with BD (p<0.05). HL showed an insignificant correlation with PrOL and BD. PrOL was insignificantly correlated with others. In addition, PrPL was significantly correlated with PrDL and PrAL (p<0.05) in case of *O. rubicundus***.** All parameters were significantly correlated (p<0.01) except SL with HL and BD were correlated in (p<0.05) in *G. guiris*. Both studies followed the same types of analysis to find out the difference. The dissimilarities were the species and the geological regions and the methodology of the two studies. Besides that, there was a common species, *Glossogobius guiris* as Mahilum *et al*. (2013) focused on the male and female group in within the species correlation), and all the similarities showed for being the same species of different geological locations.

The present study performed dendrogram to find the cluster formation of parameters among the species. Mainly, two main clusters were formed by the all traits of all species. It showed that PrPL, PrVL, HL, BD, PrOL were very closely related and made a cluster and other traits made another cluster. PrDL was closely related with the main cluster and PrDL and PrAL were strongly correlated. TL was distantly related with the PrDL and TL and SL were strongly correlated. TL was mainly formed another cluster. Though species were different but they shared mostly similar length ranges. Such as in maximum found species, PrOL was in 0.5-1 cm though their TL were of different measurements. That could be reason of showing such clustering. Malavasi *et al*. (2008) was performed cluster analysis on Gobiidae family fishes. The author performed to find out the interspecies acoustic signal variation in the Mediterranean Sea. The present study shared only same analysis and same fish family with the author’s study.

In addition, Parvez and Nabi. (2014) did quite relevant work as the location was quite similar to the present study. The experiment was done on *Coilla ramcarati* of Chattogram and Cox's Bazar to determine the possible racial difference through the morphological and meristic analysis between the samples of two isolated locations.

It was found that the most common species on which maximum experiments were done was *Glossogobius guiris*. Some studies were basic study like survey and some were in depth applied study like PG (Pituitary Gland) extract effect on fish growth. Still, huge scope of working on Gobiidae prevailed just only in Chattaogram coast let alone whole Bangladesh.

CHAPTER 6

CONCLUSION

The present study was executed on the specific family Gobiidae in Chattogram coast. From the study, available species under gobiidae family in Chattogram coast were detected in through the morphological way. So, the experiment was on a diversified family of fish in an important coast of Bangladesh followed a basic and very important process like morphology. A total 8 species and one genus was found. It was observed that there were such no variations in meristic characters but morphometric characters showed different results. From data set it might be concluded that *P. elongatus* was the mostly found species and there might be a new species *Acentrogobius sp.* which needed further care for confirmation. *T. buchanani* and *O. rubicundus* were totally deffirent from the *P. elongatus* and other species might be correlated with *P. elongatus.* The study was based on the survey type research. From tests it could be summarized that species with in species showed significant correlation and between species reveal both relation and differences. So, there were some closely related species. As an experiment created path for further researches, this study might work as basic data source for the further study on the fish of Gobiidae family.

CHAPTER 7

RECOMMANDATION

Following the study, some of these recommendations may make.

- ✔ ***Psuedapocryptes elongatus*** is the most found species. So, this species may help meet nutrition demand because of its easy availability. So, this species needs more concern.
- ✔ ***Boleophthamus boddarti*** is a species with aesthetic value. This species may use as aquarium fish.
- ✔ ***Apocryptes bato*** and ***Odontamblyopus rubicundus*** are less frequently found species. So they may require conservational concern.
- ✔ ***Glossogobius guiris*** is the species in Gobiidae, which is more acceptable in the local area than others. So, this species may require more focus to conserve.
- ✔ All found species required further genetic study to confirm their taxonomic position.
- ✔ A further nutritious study, the conservational research, may be conducted with each of the found species.

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APPENDICES

Appendix- I- Regression table for *Taenioides buchanani*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	0.890	-0.350	0.981	0.963	Y=0.89*TL-0.35
Head length	0.24	-0.8	0.963	0.928	Y=0.24*TL-0.8
Pre-orbital length	0.43	-0.436	0.926	0.858	Y=0.43*TL-0.436
Pre-pectoral length	0.24	-0.8	0.963	0.928	Y=0.24*TL-0.8
Pre-pelvic length	0.24	-0.8	0.963	0.928	Y=0.24*TL-0.8
Pre-dorsal length	0.326	-1.009	0.948	0.898	Y=0.326*TL-1.009
Pre-anal length	0.68	0.345	0.979	0.958	Y=0.68*TL+0.345
Body Depth	0.137	1.521	0.984	0.968	Y=0.137*TL+1.521

Appendix- II- Regression table for *Pseudapocryptes elongates*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	0.942	-1.341	0.996	0.991	Y=0.94*TL-1.34
Head length	0.17	-0.51	0.966	0.933	Y=0.17*TL-0.52
Pre-orbital length	0.069	-0.279	0.946	0.894	Y=0.07*TL-0.28
Pre-pectoral length	0.17	-0.51	0.966	0.933	Y=0.17*TL-0.52
Pre-pelvic length	0.17	-0.51	0.966	0.933	Y=0.17*TL-0.52
Pre-dorsal length	0.324	0.236	0.96	0.923	Y=0.32*TL+0.24
Pre-anal length	0.455	-0.03	0.998	0.999	Y=0.46*TL+0.03
Body Depth	0.149	0.181	0.984	0.969	Y=0.15*TL+0.18

Appendix- III- Regression table for *Apocryptes bato*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	0.947	-0.302	1	0.999	Y=0.95*TL-0.3
Head length	0.194	0.105	1	0.999	Y=0.19*TL+0.1
Pre-orbital length	0.012	0.365	0.967	0.935	Y=0.01*TL+0.36
Pre-pectoral length	0.202	0.035	0.998	0.995	Y=0.2*TL+0.03
Pre-pelvic length	0.192	0.146	0.999	0.999	Y=0.19*TL+0.15
Pre-dorsal length	0.334	-0.928	0.997	0.994	Y=0.33*TL-0.93

Pre-anal length	0.298	0.465	0.999	0.998	Y=0.3*TL+0.47
Body Depth	0.012	1.858	0.99	0.98	Y=0.04*TL+1.86

Appendix- IV - Regression table for *Parapocryptes batoides*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	0.901	0.065	1	1	Y=0.07*TL+0.9
Head length	0.109	-0.248	0.967	0.936	Y=0.11*TL-0.25
Pre-orbital length	0.041	-0.25	0.960	0.922	Y=0.04*TL-0.25
Pre-pectoral length	0.109	-0.248	0.967	0.936	Y=0.11*TL-0.25
Pre-pelvic length	0.109	-0.248	0.967	0.936	Y=0.11*TL-0.25
Pre-dorsal length	0.356	-0.244	0.989	0.979	Y=0.36*TL-0.24
Pre-anal length	0.448	0.045	1	1	Y=0.45*TL+0.04
Body Depth	0.12	-0.416	0.987	0.975	Y=0.12*TL-0.42

Appendix- V- Regression table for *Odontamblyopus rubicundus*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	0.893	-2.15	0.999	0.998	Y=0.89*TL-2.15
Head length	0.136	0.45	0.996	0.992	Y=0.45*TL+0.14
Pre-orbital length	0.036	0.05	0.945	0.893	Y=0.04*TL+0.05
Pre-pectoral length	0.136	0.45	0.996	0.992	Y=0.45*TL+0.14
Pre-pelvic length	0.136	0.45	0.996	0.992	Y=0.45*TL+0.14
Pre-dorsal length	0.336	-0.25	0.999	0.999	Y=0.34*TL-0.25
Pre-anal length	0.436	-0.45	1	0.999	Y=0.44*TL-0.45
Body Depth	0.063	-0.060	0.999	0.998	Y=0.06*TL-0.06

Appendix- VI - Regression table for *Glossogobius guisris*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	0.712	1.06	0.994	0.988	Y=0.71*TL+1.06
Head length	0.347	-1.833	0.922	0.850	Y=0.35*TL-1.833
Pre-orbital length	0.106	-0.553	0.99	0.98	Y=0.11*TL-0.55
Pre-pectoral length	0.315	-1.612	0.977	0.955	Y=0.32*TL-1.61
Pre-pelvic length	0.315	-1.612	0.977	0.955	Y=0.32*TL-1.61

Pre-dorsal length	0.345	-0.532	0.987	0.975	Y=0.35*TL-0.53
Pre-anal length	0.69	-3.893	0.960	0.922	Y=0.69*TL-3.84
Body Depth	0.292	-1.151	0.965	0.931	Y=0.29*TL-1.15

Appendix – VII - Regression table for *Boleophthalamyus boddarti*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	1.034	-2.704	0.973	0.947	Y=1.03*TL-2.7
Head length	0.267	-0.188	0.981	0.963	Y=0.27*TL-0.19
Pre-orbital length	0.044	-0.017	0.985	0.971	Y=0.04*TL-0.02
Pre-pectoral length	0.243	-0.142	0.964	0.93	Y=0.24*TL-0.14
Pre-pelvic length	0.243	-0.142	0.964	0.93	Y=0.24*TL-0.14
Pre-dorsal length	0.332	-0.014	0.996	0.993	Y=0.33*TL-0.01
Pre-anal length	0.498	-0.578	0.995	0.989	Y=0.5*TL-0.58
Body Depth	0.138	-0.242	0.988	0.976	Y=0.14*TL-0.24

Appendix – VIII - Regression table for *Trypauchen vagina*

Parameters	a	b	R	R^2	Y=aX+b
Standard length	0.945	-1.203	0.994	0.989	Y=0.95*TL-1.2
Head length	0.137	0.196	0.987	0.974	Y=0.14*TL+0.2
Pre-orbital length	0.038	-0.074	0.961	0.924	Y=0.04*TL-0.07
Pre-pectoral length	0.143	0.07	0.968	0.937	Y=0.14*TL+0.07
Pre-pelvic length	0.143	0.07	0.968	0.937	Y=0.14*TL+0.07
Pre-dorsal length	0.198	-0.477	0.978	0.957	Y=0.2*TL-0.48
Pre-anal length	0.272	0.487	0.983	0.966	Y=0.27*TL+0.49
Body Depth	0.119	-0.331	0.966	0.933	Y=0.12*TL+0.33

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Figures of found species:

Figure 14 *Taenioides buchanani*

Figure 15 *Pseudapocryptes elongatus*

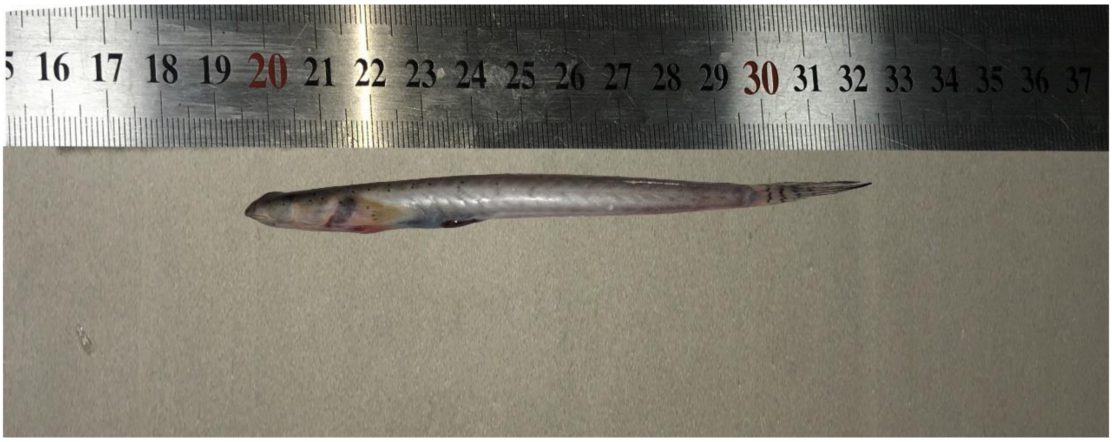

Figure 16 *Apocryptes bato*

Figure 17 *Parapocryptes batoides*

Figure 18 *Odontamblyopus rubicundus*

Figure 19 *Glossogobius guiris*

Figure 20 *Boleophthalmus boddarti*

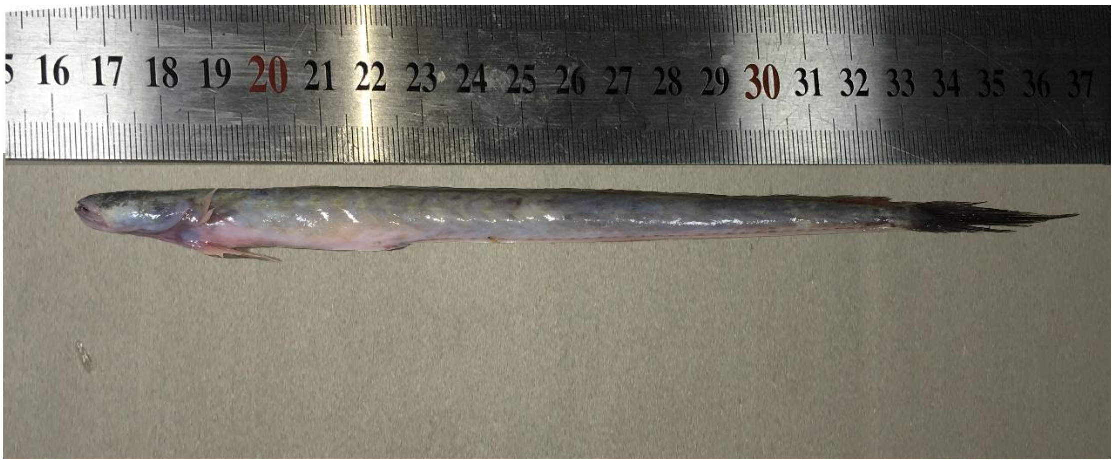

Figure 21 *Trypauchen vagina*

Figure 22 *Acentrogobius sp.*

BIOGRAPHY

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