CHAPTER 1

INTRODUCTION

1.1 Background:

Bangladesh is blessed with abundant inland and marine water resources, which contain a significant number of fishes. Bangladesh possesses a large wetland area such as the overall maritime boundary of Bangladesh expands up-to 354 NM which includes 12 NM of sovereign rights over the resources and an economic marine zone of 200 NM (Islam and Shamsuddoha 2018). It comprising diversified fisheries resources. Fish and fisheries are an important element of Bangladesh's economy, with significant export and revenue possibilities (Shamsuzzaman et al., 2020). The exporting of about 0.071 million MT of fish and fisheries products brought in BDT 39851.50 million in 2019-20 (DoF 2020).

Bangladesh has a 480-kilometer coastline along the Bay of Bengal's north and northeast coasts. It covers 7,325 square nautical miles of internal estuary water up to a 10fathom depth baseline, 2,640 square nautical miles of territorial waters beyond the baseline, 41,040 square nautical miles of EEZ, and 2,480 square nautical miles of continental shelf (Mondal et al., 2018). The total area of sea water is around 48,365 square nautical miles, which is nearly as large as the country itself (Mondal et al., 2018) Full-time fisherman, small fish sellers, fish transporters, processors, packers, and other workers in the fishing industry employ an estimated 20 million people (World Bank, 1998). In any fishing region, a single operation of any sort of fishing gear takes in a variety of species of all sizes and ages (Mondal et al., 2018).

The Bay offers a potential source of fisheries for Bangladesh. A total of 475 species of belonging to 133 families were recorded and out of these 65 species are of commercial importance (Jit et al., 2014; Amin et al., 2006; Ghosh et al., 2016; Islam, 2003; Miah et al., 2015; Johnson and Welch, 2009). Being a part of this enormous ecosystem, Bangladesh possesses 432 marine species (DoF, 2019) and 260 freshwater species of fish (DoF, 2017). As a leading coastal district, Chattogram plays a crucial role in the commercial industry of fishing. This district is closely connected to the Bay of Bengaland provides a large proportion of the marine area's capture rate. A significant number of commercially important fish species are found in the coastal harbor of Chattogram region (DoF, 2017).

Fish is the predominant protein source in the Bangladeshi diet, accounting for over 60% of total animal protein consumption, with per capita fish consumption reaching 62.58 grams, which is greater than their daily protein need according to the report of the demand (60 gram) (BBS, 2017). It contributes 3.61% to Bangladesh national GDP and around 24.41% to the agricultural GDP (DoF, 2017). Last ten years of average growth performance of this sector is almost 5.43%. Bangladesh has ranked 3rd in the world in inland fish production, 5th in aquaculture production and 11th in marine fish production in 2018 (FAO, 2018).

Flat fishes are excellent food fish and these are marketed mostly fresh, frozen and also dried salts (Khalil and Ibrahim., 2016). Flat fishes are abundant in the open continental shelf and are fished on a commercial scale (Munro, 1967). The fishes of this family are considered one of the most important predators in benthic communities (Khalil and Ibrahim, 2016). The family Cynoglossidae (tongue sole) is a species group of Pleuronectiformes, encompassing about 20% of described species in this order, distributed among three genera (*Cynoglossus, Paraplagusia and Symphurus*). Flatfish are an important source of energy for converting benthic production into a form that can be consumed by humans (Khalil and Ibrahim, 2016). *Cynoglossus* sp. mainly inhabit the soft, muddy bottom, but some inhabit the areas of gravel and sand. They are considered one of the most important predators in benthic communities (Khalil and Ibrahim., 2016). The most unique characteristic of the flatfish is its asymmetry, with both eyes lying on the same side of the head. In some families, the eyes are usually on the right side of the body. The family Dasyatidae in the Order Myliobatiformes is one of the biggest families of Batoid fishes (Lim et al. 2015). Batoids are flat bodied, cartilaginous fish which have five ventral slot-like body openings called gill slitsthat lead from the gills. The body of the Dasyatids is distinguished by a broad oval, circular or rhomboidal disc covered in denticles, throns, and tubercles on the dorsal side, and occationally on the tail (Carpenter & Niem,2001). Batoids make up a significant portion of the biomass in coastal and nearshore ecosystems, yet few data are available on the functional role and life history characteristics of rays in these environments (O'Shea, 2013).

1.2 Morphological study:

Identification of a species is a preliminary step towards any research work and it also plays a major role for the behavioral study. Morphological characteristics are mainly

useful for identifying a species and taxonomic study (Brraich and Akhter, 2015). Morphological systematic is a term that defines the identification of any specimen using morphometric measurements and meristic counts (Nayman and Freake, 1965). Morphometrics is the study of quantitative analysis of living organisms such as size and shape, which can be attained by using linear measurements and these studies are also necessary for understanding the taxonomy as well (Naeem and Salam, 2005).

The measurable characters of a fish are morphometric characters, while the countable characters are meristic characters. These morphological dimensions, meristic counts, shape, and size provide a variety of data for taxonomy classification (Ihssen et al., 1981). The relationship between different morphological characters is considered obligatory for estimating various physiological and morphological aspects such as length and age structure, growth rate and other important parameters of fish population dynamics (Kolher et al., 1995).

1.3 Relation between length and weight:

In fisheries studies the length weight data are used to estimate the growth rate and the length-weight relationship (LWR) is considered as a very important parameter for understanding the growth dynamics of a fish population (Bintoro et al., 2019). The length-weight relationship is important for managing fisheries resources and comparing morphological characteristics and life histories of fish populations in different locales (Martin et. al., 2016). By using the knowledge, the growth pattern of a particular species can be determined and the growth pattern reflects the condition of the species in a region (Martin et. al., 2016). In both fisheries biology and fisheries management, length-weight relationship is widely used (Froese and Pauly, 2006) and it is essential to stabilize the taxonomic characters of the species (Pervin and Mortuza, 2008).

1.4 Significance of this research:

The focus of this study has been the family sharing species of Cynoglossidae and Dasyatidae of Bangladesh in Chittagong coast. Chittagong is port city of Bangladesh and situated beside Bay of Bengal. It has the largest sea beach in the world, so we can assume the huge, diversified fish that are found in Chittagong. *Cynoglossus* are (largescale tongue sole), *Cynoglossus cynoglossus* (bengal tongue sole), *Cynoglossus lingua* (long tongue sole), *Cynoglossus puncticeps* (speckled tongue sole) these sp. of

Cynoglossidae family are found in Bangladeshi coast (Akter et al,.2017). *Dasyatis zugei* (Pale-edged Stingray / sharp-nose stingray) under the family of Dasyatidae also found in the South-eastern coast of Bangladesh.

On the basis of family-wise contribution in diversity, the richest family in terms of the number of species was Sciaenidae (11%) represented by 6 species, Gobiidae (9%) and Scombridae (9%) represented by 5 species. Whereas Engnaulidae and Cynoglossidae scored (7%) with 4 species. The latter come to the families of Carangidae, Carcharhinidae, Dasyatidae, Drepanidae, Dussumieriidae, Latidae, Muraenesocidae, Ophichthidae,Pangasiidae, Platycephalidae, Sphyrnidae, Synbranchidae, Synodontidae, Tachysuridae, Terapontidae, Tetraodontidae, Trichiuridae (2%) represented by 1 species (Akter et al., 2017). The studies say that these fishes are found from 2-7% of the total catch. There is no continuous stock structure information available for these fishes of Bangladesh. To fulfill the research gap and to initiate other related studies on Cynoglossidae and Dasayatidae fish family in the coastal region, the present research is very crucial. That's why the morphological distribution, identification is very important for fisheries management in Bangladesh. As one of the major components of the blue economy and food security, coastal and marine fisheries resources are vital for the sustainable economic development, livelihood security, management and conservation. Both qualitative and quantitative data concerning the current perspectives of fishery resources to assessing the existing realities of species compositions were accounted.

1.5 Aims and objectives:

This study aims at investigating the morphological approach to identify the fish species from Cynoglossidae and Dasyatidae family and determine their structure, diversity and abundance of stock along the Chattogram coast. It will experimentally test the variation among different morphological characteristics to update the stock information. The main objectives of this research addressed here in the study are as follows:

- To identify all the available species under Cynoglossidae and Dasyatidae family determining their morphometric and meristic characters.
- To determine the seasonal variation of availability and the regional distribution of the species under Cynoglossidae and Dasyatidae family.

CHAPTER 2
REVIEW OF LITERATURE

The fishes of the Order Pleuronectiformes, commonly known as flatfish, are characterized by a laterally compressed body and the adults have both eyes on one side of the head. They live on the bottom sediments lying on one side of the body. Flatfish (flounders, tonguefish, soles) are benthic predators and some species can bury themselves in the sediments to avoid predators and search for prey. Because of their benthic habitat they are frequently captured incidentally as by-catch by trawl nets used by shrimp fishing vessels. Most of the adult tropical flatfish captured are of small size, with total lengths of less than 40 cm and only larger specimens are usually saved for local consumption or for sale at fish markets. The number of pleuronectiform species worldwide has been estimated to be 1 042 (Nair & Gopalakrishnan, 2014).

There appears to be more species of flatfish in the tropics than in temperate regions, being tropical species relatively smaller than temperate ones (Pauly, 1994). Local factors such as depth, sediment type and oxygen concentration may influence their local diversity and distribution (Gibson, 1994). Tropical flatfish studies usually provide scarce information on species identifications, depth and sediment types. For the Pacific coast of lower Central America, a total of 37 species of flatfish have been reported belonging to the families Achiridae, Bothidae, Cynoglossidae, and Paralichthyidae (Bussing & López, 2015).

The family Dasyatidae includes stingrays, or whiprays, and river stingrays, encompassing nine genera and about 70 species. Stingrays can be found in all tropical and subtropical seas. River rays form a freshwater subfamily of Dasyatidae and live only in fresh water in parts of South America and Africa. Most stingrays are benthic, burying themselves partially under sand or mud in relatively shallow water (Allen and Robertson, 1994). Stingrays feed on mollusks, worms, crustaceans, fishes, clams, crabs, and shrimps. They uncover buried organisms by scooping the sand or mud with their pectoral fins. For some, turbulent coastal surf provides a constant flow of

invertebrates. The pelagic stingray eats squid and jellyfish along with crustaceans and fish (Allen, et.al., 1994).

2.1. Cynoglossidae:

Cynoglossidae are small to medium-sized benthic fishes found in marine environments from tidal pools to the continental shelf and upper slope to depths of 1,500 meters (Munroe, 2001). Some works has been done on different species of Cynoglossidae at different parts of the world. From the Bay of Bengal, limited number work has been done on Cynoglossidae. Worldwide studies like new species identification based on morphometric and meristic features, length-weight relationship and condition index were done on Cynoglossidae.

2.2.Morphological Study of Cynoglossidae:

Mainly morphological studies were conducted to identify a new species from a water body. New species were identified on the basis of their different length measurements, number of scales and fin rays, mouth patterns, snout shape etc. Various morphological study of Cynoglossidae was conducted at different parts of the world. Fricke, (2021) identified new species of Cynoglossidae (*Cynoglossus*) at Indian ocean based on some morphological and meristic characters such as its bluntly rounded snout type, different lengths, number of scales, fin rays etc. Yokogawa, et al., (2008) also identified a new species *(Cynoglossus ochiaii)* in the East China Sea based on morphological and meristic characters. Besides these, Seshappa, (1970) compared five species *(C. macrostomus, C. dubius, C. puncticeps, C. bilineatus and C. lida)* of Cynoglossidae from the west coast based on some selected morphometric and meristic characters where he used Pearson's coefficient of variation as a measure of the degree of variability for comparison.

2.3. Length-weight relationship of Cynoglossidae:

Some works has been done on length-weight relationship of different species of Cynoglossidae. Karna, et al., (2018) studied length–weight relationship of three fish species, *Cynoglossus puncticeps, Cynoglossus lingua and Cynoglossus lida* of family Cynoglossidae from Chilikalagoon, India. The estimated b values were 3.12 for *C. puncticeps*, 3.09 for *C. lida,* and 2.88 for *C. lingua*. Condition factor of some species of Cynoglossidae was estimated to determine the condition of that species in its habitat for conservation purpose. Tanjin, et al., (2021) conducted a study from Bangladesh regarding the condition factor of *Cynoglossus cynoglossus* in the Bay of

Bengal to determine the physiological condition of fish where the result of this study indicates unstable physiological condition.

2.4.Dasyatidae :

Very few research has been conducted on Dasyatidae family. Mainly length-weight relationship of some species of Dasyatidae were estimated at different parts of the world. Özbek, et al., (2015) estimated length-weight relationship of four species *Dasyatis centroura, D. marmorata, D. pastinaca,* and *D. tortonesei* at various depth levels and seasons in the Gulf of Antalya by calculating total length-weight (TL-W), disc length–weight (DL-W) and disc width–weight (DW-W). These calculations were done to determine the biomass and abundance of those species at that area. Yeldan, et.al., (2018) determined the relationships between seven morphometric characters of *Dasyatis pastinaca* and *Dasyatis marmorata* from the Northeast Levantine coast of Turkey.This study was conducted by measuring different lengthweight of the individuals of those species where length-weight relationships showed allometric growth. Besides these, Last, et al., (2016) done a re-classification of the family Dasyatidae based on some new morphological data.

CHAPTER 3

MATERIALS AND METHODS

3.1. Study area and sampling stations: The research was mainly based on the availability of fish species from Cynoglossidae and Dasayatidae family in Chattogram coastal area. For this reason, Chattogram coastal area was the main focused area of the research. To make the sample collection easier the whole study area was segmented into three selective sampling stations.

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˚32’97.36”N and longitude 91˚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 sites of Chattogram.

Sampling station 2 (Kattoli coast, Chattogram): Adjacent to Sagorika beach, Halishohor, Chattogram including Foillatoli Bazar, Bectech Bazar, Kornel Hat Bazar was investigated under this sampling station 2. The positioning of this station is latitude 22˚34’46.15”N and longitude as 91˚77’87.25”E.

Sampling station 3 (Cox’s Bazar): Sampling station 3 includes the region of BFDC Landing Center, coastal sites of CVASU field station and other adjacent coats of Cox’s Bazar. The geographical location of station 3 is 21˚44’53.36”N latitude and 91˚97’35.1”E longitude.

3.2. Sampling period and sampling frequency: The sampling of fish was carried out for a period of one year from February 2019 to January 2020 by regular visits to the sampling stations at monthly intervals. Sampling from each station was done at the same date of every month. All samplings of a month were also done maintaining 1-2 days interval from one sampling to another sampling.

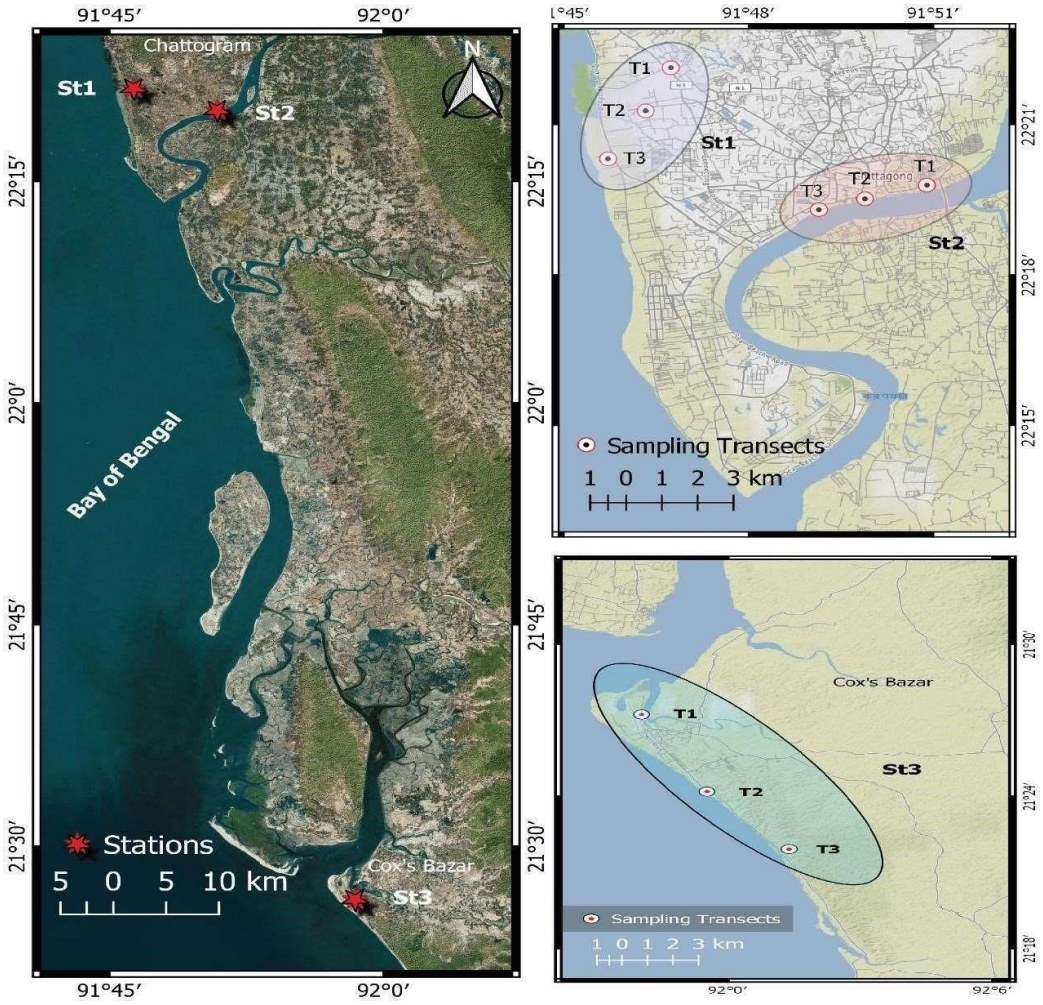

Figure 1: Study area (St1 = Potenga, CTG; St2 = Kattoli, CTG; St3 = Cox's Bazar) ; (T1 = Transect 1, T2 = Transect 2, T3 = Transect 3)

3.3. Collection of fish samples: The fish specimens were collected by simple random sampling method. Fishes which showed the basic phenotypic characteristics of the Cynoglossidae and Dasayatidae family were considered as sample species. During sampling, the fishes with fresh appearance and having all fins and scales were taken as samples. 3-5 individuals of each species were collected in each sampling.

Basic phenotypic characteristics of Cynoglossidae family which were considered during sample collection:

- Body highly compressed and tapering to a point posteriorly
- Lance- or tongue-shaped flatfishes with eyes on left side of body
- Eyes small and usually close together
- No spiny rays in dorsal, anal, and pelvic fins
- Mouth small, sub terminal, asymmetrical

- Pectoral fins absent
- Usually only right pelvic fin present

Figure 2: Cynoglossidae

Basic phenotypic characteristics of Dasayatidae family which were considered during sample collection:

- Strongly depressed
- Broadly expanded pectoral fins forming oval-shaped to nearly round disc
- Tail distinctly demarcated from disc
- No dorsal fins or caudal fin
- Tail very slender, tapering, much longer than disc
- Long, poisonous spines on tail
- Skin on dorsal side naked or armed with tubercles or prickles

Figure 3: Dasyatidae

3.4. Sample transportation: After collecting all the specimens were immediately preserved in ice box. In the ice box, and ice to fish ratio of 1:2 was generally maintained. But the ratio could be changed according to the situations such as temperature, distance, traffic jam ect. The samples were then transported to the

Oceanography Laboratory of Faculty of Fisheries of Chattogram Veterinary and Animal Sciences University where morphometric analysis was carried out.

3.5. Laboratory analysis: All the collected fish specimens were analyzed in fresh condition immediately after arriving at the laboratory. At first, the total length and weight of each sample was measured and recorded. The weight was measured in gram by electric weighing machine. A total of seven morphological characters were measured

3.6. Morphometric measurements: The seven morphometric characters were measured by using measuring board and digital slide calipers. Total length, head length and pre-orbital length were determined by measuring board consisting essentially of a wooden piece with a central scale. The fish body was straightened along the central scale and the reading was taken from the scale. The other morphometric characters were measured by digital slide calipers. All the morphometric measurements were recorded in centimeters.

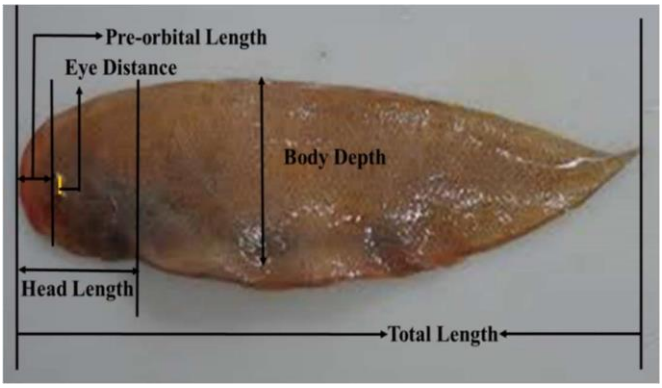

Figure 4: Morphometric measurements of Cynoglossidae

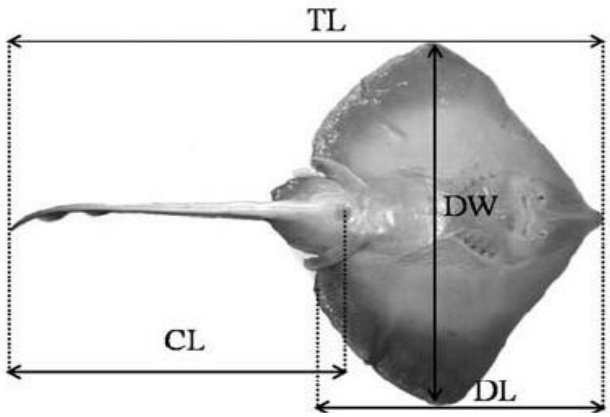

Figure 5: Morphometric measurements of Dasyatidae (TL = Tail length, CL=Caudal length, DW=Disc weight, DL = Disc length)

The following morphometric characters were taken into consideration for the study-

Total Length (TL): Distance from the tip of the mouth to the ending point of the caudal fin.

Head Length (HL): Distance from the tip of the mouth to the rear end of the operculum.

Body Depth (BD): Maximum distance from the dorsal part to the ventral part of fish body.

Pre-orbital Length (PL): Distance from the tip of the mouth to the front margin of the eye orbit.

Eye diameter (ED): Diameter of eye.

Figure 6: Measuring equipment

3.7. Apparent body characteristics: Two apparent body characteristics such as scale type and mouth pattern were taken into consideration for the study of Cynoglossidae.

3.8. Species identification: By using phenotypic characters, the fish species were identified according to the reference books (Fish Encyclopedia).

3.9. Data collection and record: The collected weight, morphometric measurements, and apparent body characteristics of each specimen was recorded in a form where sampling station, sampling number and date were also recorded for the specimen. All the raw data were then gathered in MS Excel- 13 for further statistical analysis. For capturing the image of every fish species, the species was cleaned in fresh running tap water and placed with its name on the platform of the portable photo lab. The images of the species were captured by a digital camera.

Figure 7: portable photo lab

3.10. Preservation: All the identified species were preserved at room temperature in the Oceanography laboratory of Chattogram Veterinary and Animal Sciences University by the following method.

Step 1: A solution of 20% formalin was injected in the different parts of the fish body.

Step 2: The fish was soaked in formalin for 24 hours.

Step 3: The fish was finally preserved in the preservative solution (Formaldehyde) which contains specific proportion of distilled water, formalin, glycerin and ethanol (For 10-liter solution, 7.5 L DW+2.5 L formalin+250ml glycerin+250ml ethanol).

3.11.Statistical analysis:

For the purpose of some statistical analysis, size effects were eliminated from the data set. All individual morphometric measurements were standardized according to the following formula given by Elliott et al., (1995):

$M_s = M_o (L_s/L_o)^b$

Where,

M_s = Standardized measurement

M_o = Original measurement

L_s = Overall mean of standard length for all fish samples of a species

L_o= Standard length of the fish sample

Parameter 'b' for each measurement was estimated as the slope of the regression of $logM_o$ on $logL_o$ using all fishes in all groups.

The relationship between the total length and body weight of every fish species was estimated using the following equation (Hayes,1995):

$W = aL^b$

Where,

W = Body weight of fish in gm

L = Total length of fish in cm

a = Constant (Intercept)

b = Growth exponent

The statistical part of the study mainly emphasized on the morphological parameters of available Cynoglossidae and Dasayatidae family fishes along Chattogram coast. In form of trait relationship like length-length and length-weight relationship percentage and power curve was drawn. To estimate the association among the morphometric characters of available species correlation was done. All statistical analysis of the investigation was carried out by Microsoft office excel, 2010.

CHAPTER 4

RESULT

4.1 Morphometric characteristics of Cynoglossidae:

Cynoglossus lida:

- Upper side of body brown with black specks, fins dusky
- Eyed side with 2 lateral lines, none on blind side
- Rostral hook comparatively long, extending at least to vertical through middle of fixed eye

Figure 8: ***Cynoglossus lida***

Cynoglossus macrolepidotus:

- Interorbital length 1/3 of eye diameter
- No lateral line on right body side
- Ctenoid scales on left side of body, cycloid on right side

Figure 9 : ***Cynoglossus macrolepidotus***

Pseudorhombus elevatus:

- Dark rings in 5 longitudinal rows on the eyed side

- Dark blotch at junction of straight and curved parts of lateral line, and 2 smaller ones on lateral line at posterior half of body and anterior end of caudal peduncle
- Small dark spots and elongate markings on median fins

Figure 10: ***Pseudorhombus elevatus***

Paralich algoeusis:

- They are distinguished by the presence of a long hook on the snout overhanging the mouth, and the absence of pectoral fins
- Their eyes are both on the left side of their bodies, which also lack a pelvic fin

Figure 11: ***Paralich algoeusis***

4.2 Morphometric characteristics of Dasyatidae:

Himantura walga:

- It reaches a diameter of roughly 25cm, with most specimens measuring around 1520cm
- The body is oval in shape, with a pointed snout

- Without any marks, the body color is basic beige or pinkish. Without markings, the tail is long and whip-like. The tail does not have a skin fold.
- The female's tail is shorter and bulbous towards the end
- It possesses 4-6 enlarged spear-like spines on its tail that can inject venom and produce a painful wound.

Figure 12: *Himantura walga*

Dasyatis bennettis:

- This demersal species is found inshore and on continental shelf to at least 50 m depth
- It feeds on small bony fishes and crustaceans
- The eyes are tiny and have little interorbital space
- Maximum size may reach up to 85 cm

Figure 13: *Dasyatis bennettis*

Gymnura poecilure:

- Body compressed and thin, pectoral fin expanded–rhomboid in shape
- Disc width 1.9– 2.0 times to disc length
- Snout short with a weak apical lobe, pre oral length 6.9–9.2 % to disc width

Figure 14: *Gymnura poecilure*

- Tail spines present or absent; juveniles mostly without spines
- Dorsal surface smooth, without thorns/denticles

4.3 Monthly species availability of Cynoglossidae:

During the study a total of 72 specimen were collected from three sampling stations throughout the sampling period. After examining and analyzing the morphological and meristic characteristics 4 species were identified as the member of Cynoglossidae family. Among the specimen 27 were *Cynoglossus lida*, 22 were *Cynoglossus macrolepidotus*, 11 were *Pseudorhombus elevatus* and 12 were *Paralich algoeusis*. The abundance of this family was found in December which is 25 individuals of 2 species *Cynoglossus lida* and *Cynoglossus macrolepidotus* were found all year round but not found in June and October. In July and September one species was found. *Pseudorhombus elevatus* species were mainly found in the month of March, April and May. *Cynoglossus macrolepidotus* were found in December and *Paralich algoeusis* were recorded during March and May.

4.4 Monthly species availability of Dasyatidae:

Among 36 specimens of Dasayatidae family there were 16 species of *Himantura walga, 10* individuals in both *D. bennetis* and *G. poecilure*. Most species were found from January to May and December. The highest number of fishes were found in April. Both *G. poecilure* and *D. bennettis* were found in that peak month. In February 2 individuals were found under *H. walga. H. walga* species were available during January to March, May and December.

4.5 In percentage of total body length (Cynoglossidae):

The morphometric measurements were expressed as the percentage of total length in the following Figure. *Cynoglossus lida* has preorbital length at percentage of 8.617%,

head length 17.264%, body depth 21.805, eye diameter 1.254% in percentage of total body length. *C. macrolepidotus* has 6.19% pre-orbital length, head length 16.084%, body depth 28.274%, eye diameter 1.621%. *Pseudorhombus elevatus* has pre-orbital length 3.433%, head length 18.197%, body depth 36.738%, eye diameter 1.212%. *Paralich algoeusis* has pre-orbital length 5.24%, head length 14.797%, body depth 30.996%, eye diameter 1.255%.

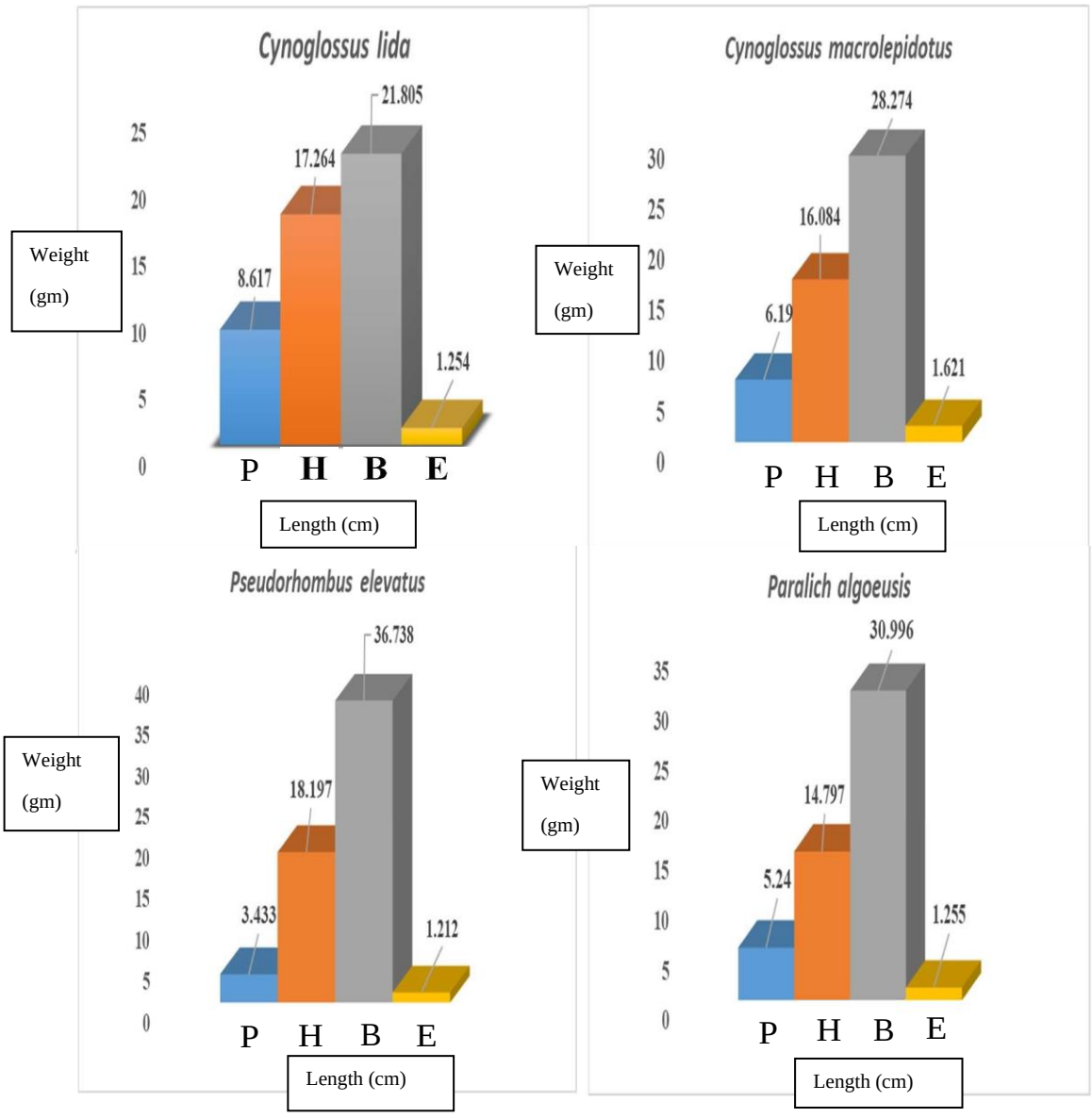

Figure 15: Morphometric measurements expressed as percentage of total length (TL= Total length, HL= Head length, BD= Body depth, P= Pre-orbital length, E= Eye diameter)

4.6 In percentage of total body length (Dasayatidae):

The percentage of disc length of *Himantura walga* is 47.5%, and tail percentage is 102.353%. In case of *Dasyatis bennetis* Disc length is 53.363%, tail is 149.327%, and in *Gymnura poecilure* the disc length is 55.955%, 139.326% is the tail percentage against the total body length.

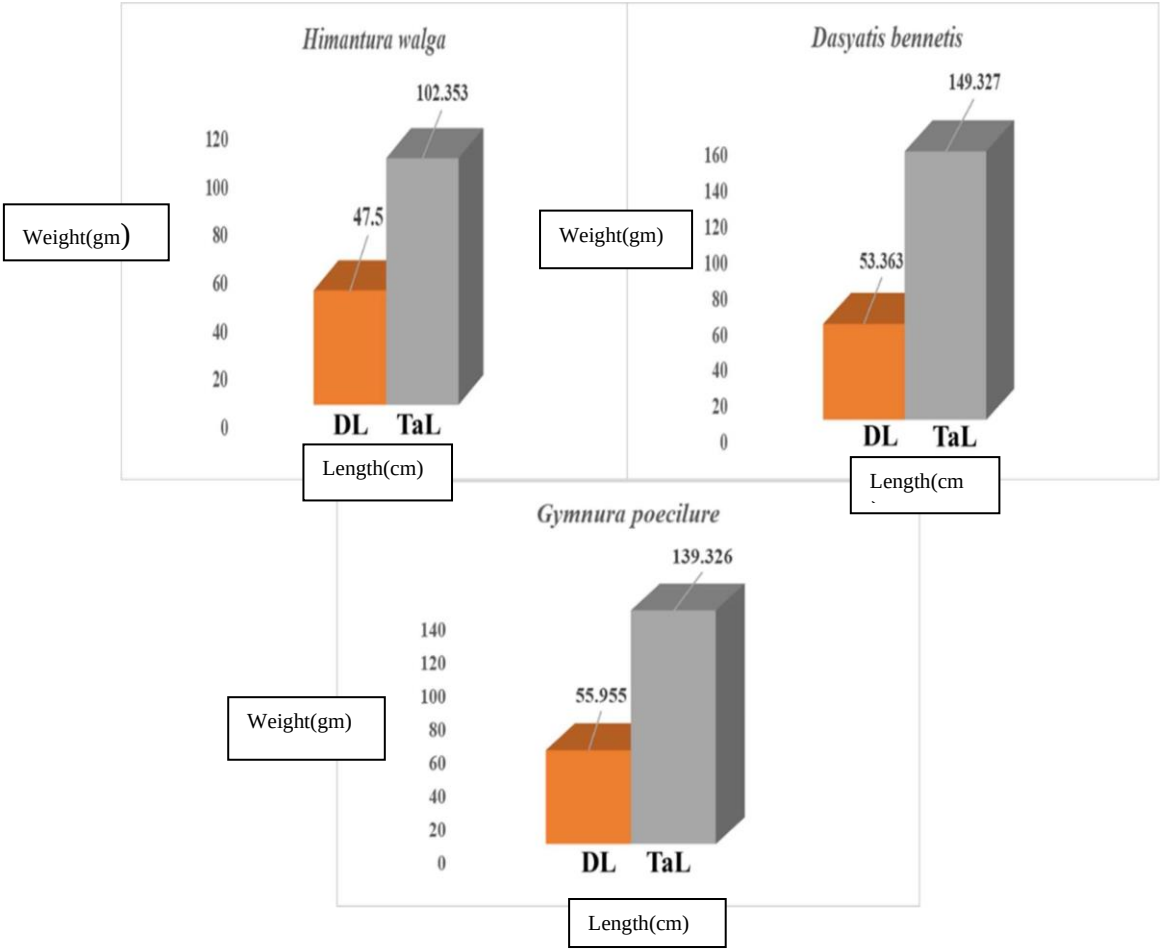

Figure 16: Morphometric measurements expressed as percentage of total length (TL= Total length, DL= Disc length, TL= Tail length)

4.7 Length-weight relationship of Cynoglossidae:

The weight of each specimen was measured as a morphometric parameter throughout the investigation. The length-weight association was created for each species by using total length and body weight data. The graphic depicted the length-weight association graph for each species. A power curve equation between total length and body weight was derived from the graph, using which the values of parameter "a" and "b" were estimated. The value of 'b' for Cynoglossidae varies from 0.592 to 2.188. For *C. lida* =2.1878, *C. macrolepidotus* = 2.1034, *P. elevatus* = 1.4135, *P. algoeusis* =0.5922.

For *C. lida* and *C. macrolepidotus* the 'b' value was smaller than 3, value in *P. elevatus* =1.4135, value in, *P. algoeusis*=0.5922. The 'b' value of these all species indicated that their growth was negatively allometric.

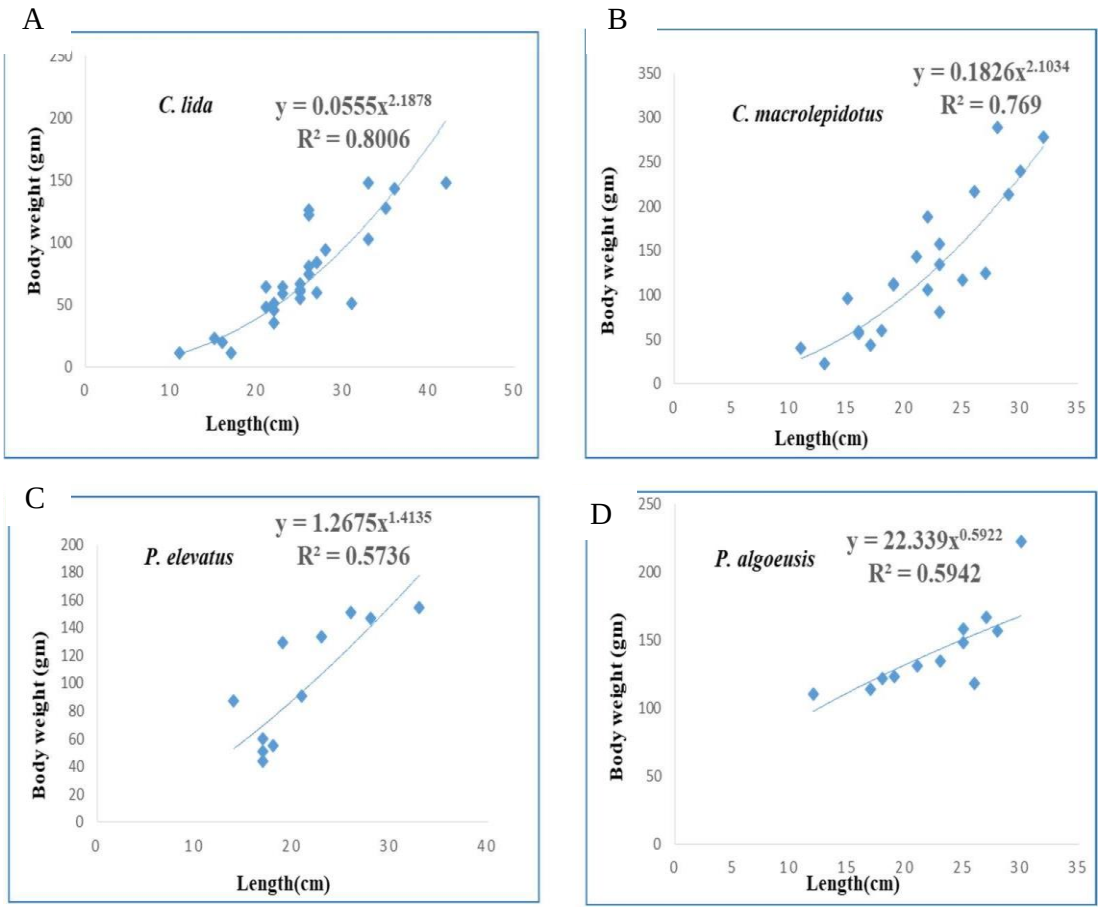

Figure 17: Length-weight relationship of (A) *Cynoglossus lida* (B) *Cynoglossus macrolepidotus* (C) *Pseudorhombus elevatus* (D) *Paralich algoeusis*

4.8 Length-weight relationship of Dasyatidae:

In Dasyatidae family, 3 species have different b values. For *H. walga* it is 1.2044, *D bennettis* is 0.6588, *G. poecilure* is 0.2485. All of them are below 3, that's why they are negatively allometric.

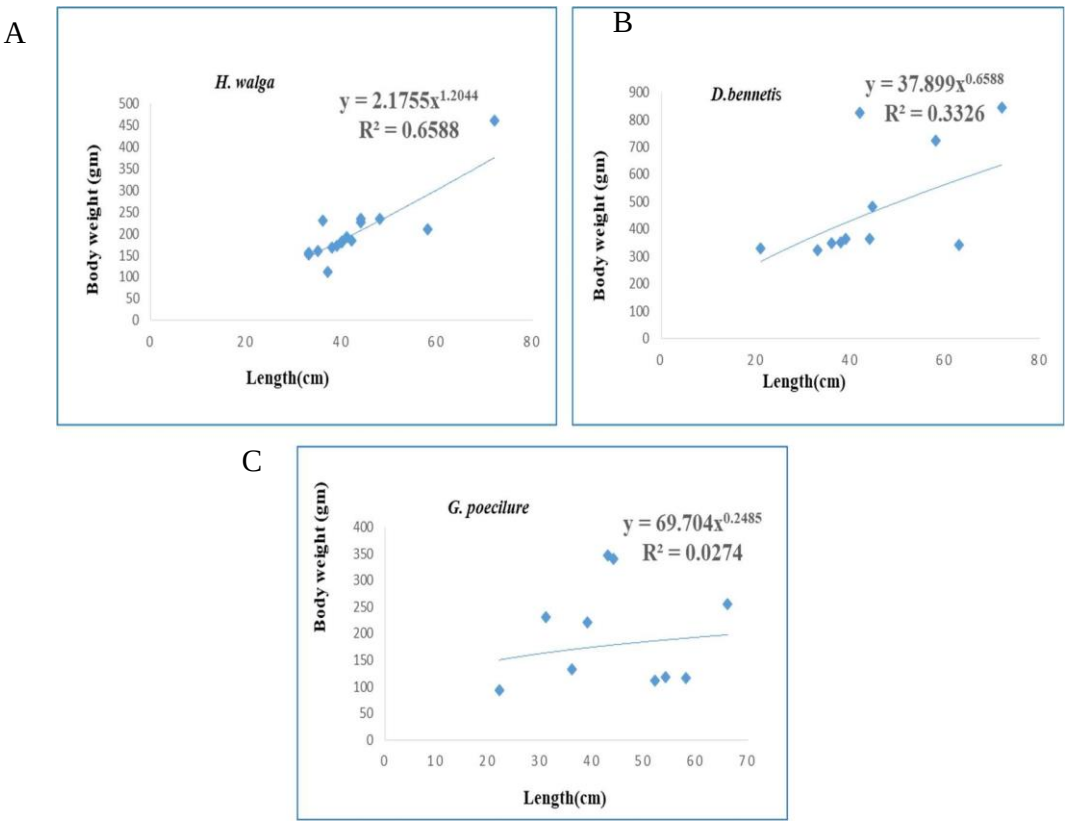

Figure 18: Length-weight relationship of (A) *Himantura walga* (B) *Dasyatis bennettis* (C) *Gymnura poecilure*

CHAPTER 5

DISCUSSION

For taxonomic work and systematic studies, information about the morphometric characters of fishes and the statistical relationship among the characters are very essential (McConnel, 1978). The analysis of morphometric and meristic characters is considered as an important tool for differentiating closely related species having huge similarities of various parameters (Ahammad et al., 2018).

5.1 Species availability:

The main purpose of the study was to figure out the available fish species under the Cynoglossidae and Dasayatidae family from the Chattogram coastal region. In one year of sampling period, ten months sampling was done considering ban periods. In that process 7 species were identified and they were *Himantura walga, Dasayatis bennetis, Gymnura poecilure* which belong to Dasayatidae family and *Cynoglossus lida, Cynoglossus macrolepidotus, Pseudorhombus elevatus, Paralich algoeusis* from Cynoglossidae family. According to Aktar et al., (2017), Cynoglossidae (7%) with 4 species the latter come to the families of Carangidae, Carcharhinidae, Dasyatidae, Drepanidae, Dussumieriidae, Latidae, Muraenesocidae, Ophichthidae, Pangasiidae, Platycephalidae,Sphyrnidae,Synbranchidae,Synodontidae,Tachysuridae,Terapontidae , Tetraodontidae, Trichiuridae (2%) were found in Bangladeshi coast. These findings were quite relevant with this 4 species of Cynoglossidae (*C.lida, C. macrolepidotus, Pseudorhombus elevates, Paralich algoeusis)* were founds during the sampling.

5.2 Month and station wise variation in morphometric traits:

Cynoglossus sp. mainly inhabit the soft, muddy bottom, but some inhabit the areas of gravel and sand. They are considered one of the most important predators in benthic communities (Khalil & Ibrahim., 2016). *C. lida* were found all year round except the banned period. They were found both in sampling stations in Cox's Bazar and Chittagong fishery ghat. Highest numbers of individuals were found in the month of May. *C. macrolepidotus* were found mostly in cox's bazar coast in the month of November and December. *P. elevatus* and *P algoeusis* were only found in Cox's Bazar coast in the month of March. For Dasayatidae species *H. walga* were found in most of the months including January, February, March, July and December. Highest

were found in December month. Other species *D. bennettis* and *G. poecilure* were found in Cox's bazar station from December to March.

5.3 In percentage of total body length:

The graphical presentation expressing percentage of all morphometric measurements against total length showed that all the fish species followed same trend. For Cynoglossidae species all of them shows the same type where body depth is in highest percentage and eye diameter is lowest percentage. In case of Dasayatidae family the species also follows the similar trend. Where the tail is the highest percentage and disc has lowest percentage. There is no relevant data found in Bangladeshi coast according to the percentage of total body length of Dasyatidae and Cynoglossidae.

5.5 Length-weight relationship:

The length–weight relationship (LWR) is an important measure in fish stock and population evaluations in fisheries (Karna et al., 2018). The value of parameter 'b' of each fish species was calculated using the length-weight relationship, which revealed the species' growth trend. *Cynoglossus lida* had a 'b' value of 2.188 in the study, indicating that the species experienced negative allometric growth. The Tongue fishes of the Chattogram coastal region increased in length faster than in weight, according to the growth pattern. Habitat difference and influence of environmental or seasonal factors might cause dissimilarities between the results of current and previous studies. According to Carlander (1969), Froese (1998, 2006), the predicted b values of the regression for *C. lida* species stayed within the expected range for teleost between 2.5 and 3.5. According to Rastogo et al., (2016) the smallest specimen belonged to *Himatura walga* and measured 16.4 cm DL (weight = 140 g). In this study, *Himantura walga* had a 'b' value of 1.2044 which is less than 3, indicating a negative allometric growth. The majority of the examined species' 'b'-values were between 1 and 3., which was consistent with other studies' findings (Froese, 2006; Ilkyaz et al., 2008). Season, salinity, temperature, sex, fish health, and food supply (including special/temporal distribution) may all have an impact on LWRs in marine species (Froese, 2006).

CHAPTER 6

CONCLUSION

The study of morphological features in fish is considered to be an important tool since they may be used to distinguish taxonomic units and determine population fluctuations. Morphological systematics, which incorporates morphometric and meristic features, is the simplest and fastest method of fish identification. The present morphological study confirmed the identification of seven species of Cynoglossidae and Dasayatidae family in the Chattogram coastal region. From the data obtained by the study it might be concluded that *Cynoglossus lida* from Pleuronectiformes group was the most dominant fish species of the coastal area. pre-orbital length and body depth all the morphometric characters were correlated to each other; there is a monthly and station wise variation, as we found different species from different station in different month. All the species has shown negative allometric relation. As morphological study is the initial step for the advance studies on a fish species, so the information obtained from the present research will make the path of future research easier.

CHAPTER 7

RECOMMANDATION

According to this research work, the following recommendations may be done:

- Nutritional studies can confirm nutritional profile of the identified species of Cynoglossidae and Dasayatidae family and if any species is found as equivalent as conventional fishes in nutrition and flavor, then this species may reduce the pressure of high market demand on conventional fishes.

- Landmark based truss network can be applied as a part of morphological study to identify different stocks of *Himantura walga, Dasayatis bennetis*, *Gymnura poecilure*, *Cynoglossus lida, Cynoglossus macrolepidotus, Pseudorhombus elevates* and *Paralich algoeusis*

- Sufficient information about other identified Cynoglossidae and Dasayatidae fish species is not available. So further research such as biometric analysis and studies on the reproductive and population biology of the species will reveal detailed information of them

- Information about the growth pattern of the available species of these family will help in determining condition factor of the species

- Molecular based determination can validate the findings of present study

- As it is a pilot study, further studies may be conducted on similar field to make a concrete remark

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