SOME BIOLOGICAL ASPECTS OF *Gerres filamentosus* (Cuvier, 1829) IN MERBOK ESTUARY, KEDAH, PENINSULAR MALAYSIA

by

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LIST OF SYMBOLS AND ABBREVIATION

ASP	=	Available Sum of Peak
a	=	Constant of proportionality
BW	=	Weight of fish in gram
b	=	Length exponent/slope
cm	=	Centimeter
DO	=	Dissolved Oxygen
E	=	Exploitation rate
ELEFAN I	=	Electronic Length-Frequency Analysis I
ESP	=	Explained Sum of Peak
F	=	Fishing mortality
FISAT II	=	FAO-ICLARM Stock Assessment Tools II
FL	=	Fork Length
GSI	=	Gonadosomatic Index
GW	=	Weight of gonad in gram
g	=	gram
K	=	Growth coefficient
Kn	=	Relative condition factor
L	=	Litre
LWR	=	Length-Weight Relationship
Lc	=	Length at first capture
$L\infty$	=	Asymptotic length
M	=	Natural mortality
m	=	Metre
mg	=	Miligram
mm	=	Milimetre
NA	=	Negative Allometric
ns	=	Not significant
PA	=	Positive allometric

ppt	=	Parts per thousand
Rn	=	Goodness of fix index
R^2	=	Regression coefficient
SD	=	Standard Deviation
SE	=	Standard Error
SL	=	Standard Length
t0	=	Theoretical age
TL	=	Total Length
vBGF	=	von Bertalanffy Growth Function
W	=	Observed weight
W’	=	Calculated weight
Z	=	Total mortality
Ø'	=	Growth performance index
ρ	=	Spearman correlation

BIOLOGI POPULASI *Gerres filamentosus*

(Cuvier, 1829) DI MUARA SUNGAI MERBOK, KEDAH,

SEMENANJUNG MALAYSIA

ABSTRAK

Biologi populasi *Gerres filamentosus* di muara Merbok dikaji dari bulan Januari hingga bulan Disember 2011 dengan menggunakan sampel dari tangkapan bulanan. Setiap sampel terdiri daripada 50-100 ikan yang berbeza saiz dari yang terkecil (10.1 cm) hingga yang terbesar (18.3 cm). Hubungan panjang-berat dianalisis bagi *G. filamentosus* dengan menggantikan panjang dan berat ikan ke dalam $W = aL^b$. Didapati hubungan panjang-berat $W = 0.011L^{3.154}$ dan $W = 0.013L^{3.103}$, diperolehi dari betina dan jantan. Nilai eksponen, b = 3.154 untuk betina dan b = 3.103 untuk jantan menunjukkan bahawa kedua-dua betina dan jantan *G. filamentosus* mempunyai pertumbuhan allometrik positif. Selain itu, faktor keadaan relatif (Kn) yang diperolehi ialah 0.999 ± 0.074SD dan 1.002 ± 0.080SD untuk betina dan jantan, mendedahkan keadaan jantan lebih baik daripada betina, pada masa yang sama membuktikan bahawa muara Merbok berada dalam keadaan yang baik dan menggalakkan utuk kelangsungan spesis ini. Selain itu, didapati nisbah jantina ialah 1:1.45 (jantan: betina). Kitaran pembiakan spesis ini telah dianalisis dengan menggunakan indeks gonadosomatik, melalui pemerhatian makroskopik dan kaedah histologi. Peringkat kematangan *G.filamentosus* telah diklasifikasikan kepada empat peringkat testis dan lima peringkat ovari. Di sini, *G. filamentosus* bertelur sepanjang tahun dengan dua puncak bertelur, satu pada Oktober 2011 dan yang kedua pada Februari 2011, yang bertepatan dengan musim hujan pada peringkat maksimum

utama (September hingga November) dan peringkat minimum rendah (Januari hingga Februari). Di samping itu, dengan menggunakan ELEFAN I dalam perisian FiSAT II, panjang asimptot ($L\infty$) dan pertumbuhan malar (K) untuk *G. filamentosus* didapati adalah 19 cm dan 1.08 $tahun^{-1}$ masing-masing. Anggaran indeks prestasi pertumbuhan (Ø) adalah 2.591 untuk *G. filamentosus*. Anggaran jumlah kematian (Z), kematian semula jadi (M) dan kematian tangkapan (F) adalah 4.51 $tahun^{-1}$, 2.21 $tahun^{-1}$ dan 2.29 $tahun^{-1}$. Corak rekrut bermusim menunjukkan bahawa *G. filamentosus* telah direkrut dalam dua puncak kekuatan yang tidak sama rata. Secara keseluruhan, semua maklumat ini adalah penting bagi tujuan pengurusan perikanan untuk menubuhkan perancangan pemuliharaan yang lebih baik bagi mampan strategi sumber perikanan pada masa depan.

SOME BIOLOGICAL ASPECTS OF *Gerres filamentosus* (Cuvier, 1829) IN MERBOK ESTUARY, KEDAH, PENINSULAR MALAYSIA

ABSTRACT

Some biological aspects of *Gerres filamentosus* in Merbok estuary were studied from January to December 2011 using samples from monthly catches. Each sample consists of 50-100 fishes which varied from the smallest (10.1 cm) to the largest (18.3 cm) sizes. The length-weight relationship was analyzed for *G. filamentosus* by substituting the fish length and weight values into $W=aL^b$. The calculated length-weight relationships of $W=0.011L^{3.154}$ and $W=0.013L^{3.103}$, obtained from female and male respectively. The exponent value, b = 3.154 for female and b = 3.103 for male showed that both male and female of *G. filamentosus* had positive allometric growth. Besides, the relative condition factor (Kn) obtained was 0.999±0.074SD and 1.002±0.080SD for female and male, had revealed that male had a better condition than female, at the same time proved that Merbok estuary was in good ambience for survival and favorable for this species. Moreover, the sex ratio was found to be 1:1.45 (male:female). The reproductive cycle of this species was analyzed using the gonadosomatic index, through macroscopic observation and histological method. The maturity stages of male and female *G.filamentosus* were classified into four stages of testes and five stages of ovary. Herein, *G. filamentosus* spawn throughout the year with two spawning peaks, one in October 2011 and the second one in February 2011, which coincided with the primary maximum (September to November) and primary minimum (January to February) of rainfall. In addition, by using ELEFAN I in FiSAT II software, the asymptotic length ($L\infty$) and growth coefficient (K) for *G. filamentosus* were found to be respectively 19 cm and 1.08 $year^{-1}$. The estimated growth performance index (Ø) was 2.591 in *G. filamentosus*. Instantaneous rates of mortality (Z), natural mortality (M) and fishing mortality (F) were 4.51 $year^{-1}$, 2.21 $year^{-1}$ and 2.29 $year^{-1}$. The seasonal pattern of recruitment suggests that *G. filamentosus* was recruited in two pulses of unequal strength. Overall, all this information was a great importance for fisheries management purpose in order to establish a better planning conservation for sustainable fisheries strategies resources in future.

CHAPTER 1

GENERAL INTRODUCTION

1.1 Background

This study focuses on the some biological aspects of *Gerres filamentosus* including its length-weight relationship, relative condition factor, reproductive biology, growth parameters, mortality rates and recruitment pattern. In Malaysia's water the study of this population is still scattered. Little is known of the reproductive biology and population dynamics of Gerreidae fishes, in spite of their wide distribution and abundance along the Malaysian estuary waters. The study of the length-weight relationship, condition factor, reproductive biology and population dynamics of a *Gerres filamentosus* have been conducted in South East coast of India (Sivahanthini, 2008a; 2008b; 2009). However none of the study is conducted on the reproductive biology and population dynamics of a *Gerres filamentosus* are done in Malaysia's water.

This information will be necessary to formulate management and conservation policies as well as fishery development for this species in Malaysia's water in the future. Therefore, these findings will contribute to an improved understanding of Gerreidae not only in this region but for all regions where Gerreidae are important. The technical information obtain from this study will contribute to the establishment of a management program for conversation and sustainable management of the artisanal fisheries.

Merbok estuary has been selected in this study due to its function and ecological services such as agriculture, aquaculture, fisheries, plantation and other agro ecosystems. This fishing area is important for the mariculture activities on prawns or shrimps, finfish, cage culture and mollusk collection. Besides, it is important for artisanal fisheries (Mansor *et al.,* 2012b). The Merbok estuary is known as the mouth of one of the major rivers in Southern Kedah. Merbok estuary is connected to the other major river, the Sungai Muda via Sungai Terus. When the whole length of Merbok estuary is being tidally influenced, the saltwater intrusion can be experienced until the upstream end of the river, or is known as mangrove-fringed. The catchment area of Merbok estuary estimated about 500,000,000 m^2, where the freshwater discharge into the mangrove estuary is not from a single river but rather from numerous small streams that feed into number of estuarine tributaries (Lim *et al.,* 2009). The water cover area of the Merbok estuary measure about 20 km^2 at low water and there are mangrove vegetation measure 50 km^2 occur in the intertidal zone of Merbok estuary (Ong *et al.,* 1991). According to Mansor *et al.,* (2012b), there are about 69 species representative of 45 genera and from 36 families of fish and 2 families, 3 genera and 8 species of shrimps occupy Merbok estuary, Kedah.

Moreover, estuarine ecosystems serve many advantages in providing a diversity of food resources, protect fish from other predator and provide a high abundance that suits with its function as a breeding sanctuary for resident and transient species of fishes (Peterson & Whitfield 2000). These habitats play an important role in the ecology of commercially, ecologically important resources and life history (Segar, 1998). Feeding, refuge from predation and support of reproduction is used as medium to link the habitat with the species (William & Thoms, 2001; Segar, 1998). Recently, there are widely documented the presences of the populations of fishes in the early stage of recruitment in the estuarine environment. This statement is proved by Mansor *et al.* (2012a). They reported the Merbok estuary was occupied by the juvenile fishes and this place becomes as a preferable nursery ground for estuarine fishes.

Rapid change in environmental factors such as temperature, salinity and current makes the estuaries becomes one of the complex habitats for aquatic organism (Williams & Thoms, 2001). Comparing with the aquatic environment such as freshwaters and oceans, the estuary habitats usually support the small number of species. This situation causes the estuarine organism to perform higher adaptation relates to their complex environmental condition.

1.2 The studied species

Plate 1.1: *Gerres filamentosus*

Kingdom: Animalia

Phylum: Chordata

Class: Actinopterygii

Order: Perciformes

Family: Gerreidae

Genus: Gerres

Species: *Gerres filamentosus*

Commercial name: Whipfin silverbiddy

Local name: Kapas filamen

Gerres are economically important food found in the Indo-Pacific region includes under family Gerreidae. Gerreidae play an important role not only as animal feed, particularly known as fishmeal but also use as human food equipped with protein and fat. The Gerreidae family is formed by approximately 44 species belonging to 8 genera such as *Diapterus, Eucinostomus, Eugerres, Gerres, Parequula, Pentaprion, Ulaema* and *Xystaema* in the world water (Nelson, 2006).

The member of family Gerreidae also known as mojarras, silver-biddies or pursue mouths inhabit warm seas, are marine and estuarine, although they occasionally occur in freshwater (Cyrus & Blaber, 1982; Blaber *et al*., 1995; Ndaro & Olafsson, 1995). These are widespread in all warm seas of the Indo-pacific, from the east coast of Africa through the Indo-Malayan archipelago, South China Sea, Northern Australia and the west pacific islands also westward to east and South Africa (Froese & Pauly, 2000).

There are many species in family Gerreidae. They look much similar and sometimes difficult to identify. Sometimes the same species are put under different names in different areas and some authors missed the identification of the species. Moreover, different authors put the same species under different names in the same area (Mohamed & Adnan, 1984). The family Gerreidae comprises small to medium size, strongly compressed fishes is characterized by a pointed snout with highly protrusible mouth (Nelson, 1994). Gerreidae inhabits tropical and subtropical shallow coastal areas and clear waters around the islands. Overall, Gerreidae species from the Indo-Pacific have similar appearance, coloration and similar counts and necessitating an urgent taxonomic revision of the group which is bring to the taxonomically confused in many researchers (Woodland, 1983; Iwatsuki *et al*., 1999).

Gerres filamentosus or whipfin silverbiddy is locally known as Kapas filamen in Malaysia. It belongs to order Perciformes and family Gerreidae. The Gerreidae family comprised of 8 genera and 44 species *Diapterus, Eucinostomus, Eugerres, Gerres, Parequula, Pentaprion, Ulaema* and *Xystaema* in the world water (Nelson, 2006). This species distributed mainly in Indo-Pacific from the east coast of Africa through the Indo-Malayan Archipelago to the West Pacific islands; south to northern Australia, north to Ryukyu Islands. It is common in the waters around Taiwan (www.fishbase.org).

On the other hand, the common whipfin silverbiddy, *Gerres filamentosus* also is found to be inhabited shallows coastal sandy beaches and muddy areas and also occurs in the mouth of estuary. *Gerres filamentosus* lives in shallow coastal waters to depths of at least 50 m on sandy bottoms, including around coralline areas, also entering lower freshwater reaches of rivers. Moreover, it is found inhabit tropical and subtropical shallow coastal areas and clear waters around the islands. They exist over muddy and sandy bottoms, in estuaries, hypersaline lagoons and fresh water (Cervigon *et al.*, 1993).

Gerres filamentosus are easily recognized by their very long and characteristic second dorsal spine, together with the pronounced evaluated body shape and other morphological dimensions of the body, which are quite different from the other Gerres species, so it cannot be confused with other Gerres species

(Mohamed & Adnan, 1984). They spend part of their life cycle in estuaries and move to coastal water to spawn (Cyrus & Blaber, 1982).

In India, these fishes are in third tropic level and consumed by larger fishes. Moreover, these fishes have established a place among people living in the southeast and west coasts of India as the cheapest fish available throughout the year (Sivashanthini, 2008b).

1.3 Objectives

In view of the present status of estuary fish studies in Peninsular Malaysia, this research is undertaken with the following objectives:-

a- To study the relation between the length-weight relationship, relative condition factor and its relation to the physical parameter in Merbok estuary.

b- To study on the reproductive biology of *Gerres filamentosus.*

c- To estimate the growth parameters, mortality rates and recruitment pattern of *Gerres filamentosus*.

CHAPTER 2

LITERATURE REVIEW

2.1 Fish morphology

Gerres filamentosus has other morphological dimensions of the body, which are quite different from the other Gerreids species (Mohamed & Adnan 1984). The second dorsal spine of *Gerres filamentosus* is laterally compressed and very long, together with the pronounced elevated body shape so it cannot be confused with other Gerreids species. Third dorsal spine laterally compressed, as long as the distance from tip of snout to preopercular margin. Moreover, the bodies of *Gerres filamentosus* are compressed, elevated back and deep. It`s body depth contained 2 to 2.5 times in standard length in larger specimens, up to 3 times in smaller specimen, mouth small, strongly protrusible, fine teeth in the jaws. Pectoral fin long, tip of depressed fin reaching to level of origin of first anal spine, second anal fin spine much shorter than fin base. Caudal fin deeply forked, its longest rays 3 times the length of median rays and slightly longer than length of head. Color silvery, with 7 to 10 columns of ovoid spots on the upper portion of the sides, coalescing as bars in small specimens. On lateral line 44 to 47 scales (Shutharsan & Sivashanthini, 2008).

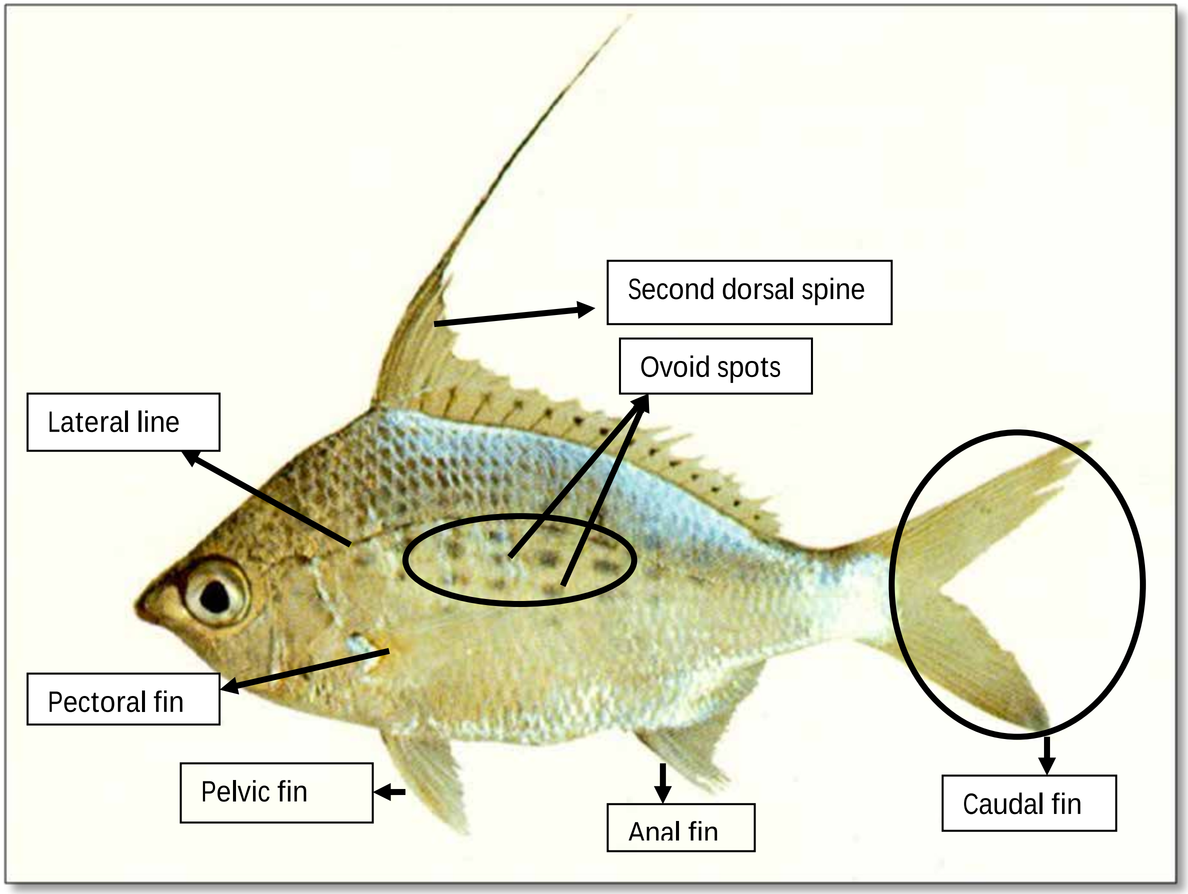

Figure 2.1: Morphological structures of a *Gerres filamentosus*

2.2 Length-weight relationship

Fish population can be analyzed using the length-weight relationship. The length-weight relationship data are important to the fisheries research because this analysis allows the conversion of the growth in length equation for growth in weight. Other than that, this analysis is used in estimating the standing stock biomass. Besides, it is used to estimate the condition of the fish and very useful in comparing the life histories of different species between regions (Goncalves *et al.*, 1996; Froese & Pauly, 1998; Moutopoulos & Stergiou, 2002).

2.3 Relative condition factor (Kn)

The relative condition factor (Kn) is known as the side factor or an extrinsic factor and is calculated by the formula of Le Cren (1951), where:

Kn = W/W'

Kn = Relative condition factor

W = the weight of the fish in a gram (Observed weight)

W' = aL^b (Calculated weight)

The function of this relative condition factor is to compare conditions between species and within their size class. Moreover, a better condition of relative condition factor (Kn) was found during the wet season. Mostly, during the wet season the active gonad development will happen according to the availability of food during this period of time. This is based on Anibeze (2000) who study the *Heterobranchus longifinis*. Lower value of relative condition factor is usually due to the fact that a large part of the energy required for certain activities like growth and emptying of ovaries (Da Costa & Araujo, 2003). Through this study, the relation between relative condition factor and the physical parameter including temperature, conductivity, turbidity, rainfall, pH, salinity, DO and water depth in Merbok estuary were studied.

Other than that, the relative condition factor values are used to link up gonad development with reserve material such as protein and lipid that resides in the muscle which will be transferred to the gonad during the maturity process (Htun-Han, 1978b; Delahunty & de Vlaming, 1980).

2.4 Physical parameters

Rivers physical parameters play important roles in the fish study because of their influences in the population of fish as well as other lives. The temperature (Rakocinski *et al.*, 1992), turbidity, salinity (Szedlmayer & Able, 1996) and water depth (Winemiller *et al.*, 2000) are known as the abiotic factors and these abiotic factors are believed associated with the occurrence of fish in estuary.

2.4.1 Temperature

Temperature in the upper layer of water is higher compared to the lower layer. The changes of temperature from upper to lower layers of water depend on the mixing of water influenced by wind (Boyd, 1979). Usually, the low water temperature is influenced by the presence of the riparian vegetations that provide the inputs of allochthonous organic material (Rohasliney & Jackson, 2009) and shades most of stream water surfaces prevented excessive warming (Allan & Castillo, 2007).

Temperature influences feeding, reproduction and the abundance of fish. Fish are known as poikilothermic animals which are means that their body temperature is maintained as 0.5°C to 1°C above or below the water temperature where they live. The metabolic rate of fish closely correlated to the water temperature. When water temperature is high, the metabolism of fish will get greater. The body temperature, growth rate, food consumption and feed conversation of fishes are influenced by the increasing of water temperature (Gadowaski & Caddel, 1991; Kausar & Salim, 2006).

Increasing in enzyme activities are caused by an increase in temperature that will accelerate the digestion of nutrients (Shcherbina & Kazlauskene, 1971). Besides, the high temperatures can lead to disease outbreaks that cause inhibition of fish growth (Platts *et al.,* 1983). High water temperatures commonly above 20°C will cause the cold-water fishes become less active and consume less food. Usually, eggs and fish larvae require a lower temperature range than the adult fish that can live in the high temperature range.

2.4.2 Conductivity

Conductivity is a measurement of the total amount of dissolved ions or dissolved salt content in the water column (Michaud, 1991). According to Boyd (1979), generally when the conductivity is high, the concentration of ions in the water column is greater. Conductivity also is influenced by temperature of the water column. This is due to the incoming of seawater from the ocean with high content of salt concentration. Heavy rainfall reduces the conductivity because the dilution of dissolved salt will reduce the concentration of ions in the water bodies (Michaud, 1991). Conductivity is useful in measuring the stream of water quality. Each stream has a relatively constant range of conductivity that can be used as a baseline for comparison with regular conductivity measurements. Besides, the significant changes in conductivity can be used as an indicator that functioning in discharge. Discharges to streams can change the conductivity and a failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate; an oil spill would lower the conductivity.

2.4.3 Turbidity

The ability of water to transmit light is decreased by the material in water which is known as turbidity (Boyd, 1979). High turbidity meant high of sediments and suspended solids ranging in size from colloidal to coarse dispersions (Boyd, 1979) in the water bodies and it will cause the light cannot pass through the water bodies easily. High turbidity can reduce the photosynthesis mechanism (Zweig, 1989). Many fish species are sensitive to prolonged exposure to turbidity and monitoring of turbidity is an important criteria for assessing the quality of water. Based on Cyrus & Blaber (1992), the turbidity preference of fishes is a species-specific response.

2.4.4 Rainfall

According to Agostinho & Zalewski (1995), the seasonal rain can be considered as a factor that influences environmental parameters. Heavy rain (wet season) will stimulate some water quality parameters such as increasing in water depth, turbidity and temperature but a decrease in conductivity, salinity and pH. Study by Mario & Omar (2003) on the seasonal changes of estuarine fish assemblages in the Cie’naga Grande de Santa Marta, they found that higher fish catches during the rainy season. This is related to an important flushing of organic matter from the mangrove swamps (Bateman, 1998).

2.4.5 pH

pH is defined as the basic character of the solution at a given temperature or as the intensity of the acidic. Commonly, pH is a simple parameter but is valuable, since most of the chemical reactions in aquatic environment are controlled by any change in its value. Anything either highly acidic or alkaline would kill marine life (Singare, 2011). Generally, estuary areas have a lower pH level and pH level is indicated by certain situation such as by uptake of carbon dioxide or oxygen deficient in water bodies by the process of photosynthesis. Ellis (1937) stated the most suitable pH values for fish condition are ranging from 6.5 to 9.0 at day and when the pH values are below than 6.5, it will reduce the reproduction process (Mount, 1973). pH level will change drastically if the rainfall higher. The high value of pH (Boyd, 1979) will cause alkalosis because the higher value of blood pH. Fish also have to balance internal pH, and even small fluctuation of blood pH can be fatal, or can result in acidosis or alkalosis of the blood.

2.4.6 Salinity

According to Gordo & Cabral (2001), salinity could be related to the feeding habits due to the organism's temperature tolerances. Salinity level is higher in the river mouth because of seawater intrusion and the salinity is low at the upstream, because the freshwater flushed out. The high value of salinity will decrease the amount of dissolved oxygen. During the dry season, salinity values will increase causes the temperature to increase. Many bottom-dwelling and demersal animals like crustaceans can tolerate the salinity changes. Salinities at the environment negatively affect the growth and reproduction of the bottom-dwelling species and eventually reduce their survival capability.

2.4.7 Dissolved oxygen (DO)

In general, the concentration of dissolved oxygen will be the result of biological activity. Based on Keith (2005), photosynthesis of some aquatic plants will increase the DO during daylight hours and the DO levels will fall during the night time hours. On the other hand, oxygen is removed by the aerobic degradation of organic substances by bacteria and by the respiration of all the organisms present in the water. The concentration of oxygen dissolved in water can be expressed as mg per liter (mg/L) or as percentage of air saturation value. Different fish species have different requirements for the concentration of oxygen dissolved in water. The oxygen requirements of fish also depend on a number of other factors including the temperature, pH, and CO_2 level of the water, and the metabolic rate of the fish. Besides, at a higher temperature, oxygen requirements will increase and oxygen requirements per unit weight of fish significantly decline with increasing individual weight.

2.4.8 Water depth

According to Winemiller *et al.* (2000), maximum water depth can be a good indicator of habitat stability. Water depth is categorized as deep (>50 cm), moderate (20-50 cm), shallow (5-20 cm) and very shallow (0-5 cm) (Gorman & Karr, 1978). Variation in channel form such as pools and riffles will create variation in water depth (Gordon *et al.*, 1996). Generally, pools and run habitats are more complex and are deeper than riffle with the presence of debris, roots or group of boulders with extensive space in between (Martin-Smith, 1998). Normally, small and young fish inhabited shallow, slow flowing rivers. Whereas, larger and older fish inhabits deep rivers (Schlosser, 1982 & Bain *et al.*, 1988).

2.5 Reproductive biology

The study of the reproductive biology of *Gerres filamentosus* have been conducted in Merbok estuary since there is no study on the reproduction biology of this species held in captivity has been made in the study area. The determination of *Gerres filamentosus* reproductive modalities has been derived from various methods. This study was based on the options of sampling of fish of different sizes caught at estuary and more or less detailed examination of their reproductive organs (gonads). Oocyte development in teleost fish follows a similar pattern and review of oocyte development have been given by de Vlaming (1983); Guraya, (1986; 1994); Selman *et al*. (1993); Bromage & Cumaranatunga, (1988); Selman & Wallace, (1989); West, (1990); Tyler & Sumpter, (1996). The recognition of fish sex is depending on the observation of gonad including size, physical characteristics and color of gonads. Generally, the female gonad will appear even larger and broad compare to the male gonads which are smaller, fine and lengthways. The color of gonad can be also used as an indicator to identify the stages of maturity. The male gonad tends to be pink and whitish creamy color while in females, the gonad tends to be pink, orange and yellow in color. These will be varied according to different gonads maturity stages (Nor Shafinaz, 2004).

2.5.1 Sex ratio

The composition of males and females of the species in a population is expressed by sex ratio. Sex ratio responsible in calculating the entire commercial season based on an estimate of total numbers of females and males landed. The sex ratio of the numbers sampled data are calculated according to their month or area of capture and this ratio involves a correction for any differences in average weight of the sexes (Klingbeil, 1978). The sex ratio is expressed either for all of the sampled population or more precisely for the size classes of individuals that compose the sample and it is defined as the relation between the numbers of males and the number of females, nevertheless numerous authors designate this term to be the proportion of males or females expressed as a percentage of the total number of individuals where sex has been determined (Cayré *et al.*, 1988).

2.5.2 Methods of spawning and spawning season

Most teleost spawn more than one during their lives or it is called as iteroparous. There are two forms of iteroparous which are synchronous spawning and serial or batch spawning. In the subtropics and tropics, most of coastal and estuarine teleosts are mainly serial spawners with a long spawning season (Longhurst & Pauly, 1987). According to de Vlaming (1972), the right spawning time is very important to the fish survival. West (1990) has suggested the histological studies as the methods to identify the spawning season of the fish. The most suitable methods to observe the seasonal developmental changes in gonads are by determining the reproductive cycle of fishes (Karlou-Riga & Economidis 1996; 1997). Basically, reproductive cycle involves the apparent changing to the gonad weight, heart and somatic tissue (Payne, 1975; Htun-Han, 1978a; Delahunty & de Vlaming, 1980). Changes in the gonad maturity can be seen during the reproductive cycle by using the changes of gonad weight during the reproductive cycle. *Gerres* *filamentosus* spawning season will be studied using gonadosomatic index (GSI) of the fish during the sampling periods.

2.6 Growth parameters

Growth parameters of *Gerres filamentosus* in Merbok estuary such as asymptotic length ($L\infty$), growth coefficient (K) are estimated using the appropriate routines of the FiSAT II software from the length frequency data. Growth is an aspect of fish biology essential for the use of numerous population dynamics models and thus also for the management of stocks. Population dynamics and essential parameters are an important part in growth characteristic of fish in order to take a serious decision on the management issues of any fishery. The growth parameters of fishes provide an important indication on the fisheries management and indispensable data to understand the dynamic of ichthyological populations and the level of their exploitation (Beamish & MacFarlane, 1987). Based on the fundamental data for growth parameter, the fishing pressure exerts on a particular fish population can be estimated. However before recommencing management measures it is important to research the growth parameters of fish at different locations. Most of the growth and mortality parameters were obtained from length based stock assessments and estimated using the FAO-ICLARM Stock Assessment Tools (FiSAT) software with the estimated range and mean of the species is given.

2.6.1 Mortality rates

In fisheries science, the fish mortality is defined as the removal of fish from a stock. There are two types of fish mortality which are natural (M) and fishing mortality (F). Natural mortality denotes the removal of fish from the stock due to the natural causes. For example, it can occur through predation or non-predation events such as senescence and disease. Where as, the fishing mortality related to physical injury of fish during capture (Sparre & Venema, 1992).

2.6.2 Recruitment pattern

The recruitment pattern is the number of new young fish that enter population in a given year (Sparre & Venema, 1992). This recruitment pattern is a result of the combined effect of recruitment and gear selectivity. The general form of recruitment curve may be determined by a proper knowledge of the biology of the species and estimation of the growth parameters and mortality rates. This recruitment curve is obtained by comparing the size composition of actual catches with known selectivity of gear. The knife-edge recruitment model identified in the Beverton & Holt (1957) yield-per recruit model (Gayanilo *et al.,* 1995) predicts all fish of a certain age below the age of recruitment that enter into fishery which are not exposed to fishing mortality.

CHAPTER 3

LENGTH-WEIGHT RELATIONSHIPS, RELATIVE CONDITION FACTOR OF *Gerres filamentosus* (Cuvier, 1829) AND ITS RELATION TO PHYSICAL PARAMETERS IN MERBOK ESTUARY, KEDAH

3.1 INTRODUCTION

Fishes are highly important in contributing source of protein. Protein in fishes has a low level of cholesterol suitable for diets of many populations. Importantly, it is functioning in economic and development of Merbok estuary. Knowledge of the length-weight data and condition factor (K) or ponderal index of fishes becomes an important tool in the study of fish biology. In fisheries, length-weight relationship is one of the most common uses in analyzing data, notably to raise length-frequency samples to total catch, or to allow the conversion of growth in length equations for growth in weight, for use in stock assessment models (Mendes *et al.,* 2004).

The length and weight data are the useful standard for fish sampling programs (Maroto *et al.,* 2001). Moreover, these data are important to estimate the other components of fish population dynamics such as well-being of fish, growth parameters, mortality rates, recruitment patterns, relative yield-per-recruit (Y'/R) and relative biomass per-recruit (B'/R) (Kolher *et al.,* 1995). Therefore, the length-weight relationship contributes a great importance in fishery assessments (Garcia *et al.,* 1989).

In fish stock assessment, knowledge of the length-weight relationship data is very crucial and play an important role in order to help estimate the standing stock biomass, enumerating condition indices and comparing the development history population of the fish from different locations (Petrakis & Stergiou, 1995). Towards a certain extent, length and weight data reveal important information to change in climate, environment and human consumption practices (Ecoutin *et al.,* 2005; Pauly, 1984).

The length-weight relationship data is used to derive the estimated coefficient of the condition factor and use as an index to understand the life cycle of the fish (Scheider *et al.,* 2000). The assumption that heavier fish of a given length are in better condition are used for comparing the 'condition', 'well-being' and 'fatness' of fish using condition factor (Tesch, 1968) .

The relationship between relative condition factor and physical parameters have been documented by several studies for example a study on length-weight relationship, relative condition factor of *Butis gymnopmus* and its relation to the physical parameters of Merbok estuary of Kedah (Nur Fadzilah Amirah, 2012) and a study on growth co-efficient and relative condition factor of the major carp, *Catla catla* by Sachidanandamurthy & Yajurvedi (2008) in two perennial lakes.

The deterioration in water quality directly or indirectly affects fish physiology and growth. High water pH causes alkalosis, damaging skin, browning of gill areas and increasing mucus production. High ammonia increases the toxicity of water, causing ammonia poisoning to the fish, with symptoms such as red streaking on the body and gills may appear pale in color. These types of diseases reduce or inhabit fish growth, affecting the value of the growth coefficient (b) (Sachidanandamurthy &Yajurvedi, 2008).

The length-weight relationship and relative condition factor have been used in fisheries research since the beginning of the 20^{th} centuries and yet there has been ongoing confusion about their correct interpretation and application. The length-weight relationships and condition factor of Gerreids from the Parangipettai waters (South East coast of India) have been studied by Sivashanthini (2008a). So far, there is a lack of study had been done on the length-weight relationship and relative condition factor of this fish species in Malaysia specifically in Merbok estuary. This present study is focused on the length-weight relationship and relative condition factor of *Gerres filamentosus* in Merbok estuary, Kedah.

Thus, not much information is available regarding the relative condition factor of this fish species with the physical parameters of this study area. Hence, the present study is an attempt to study information on some important physical parameters of Merbok estuary, Kedah and its relation to the relative condition factor of *Gerres filamentosus* in order to determine whether there were any differences in water quality that will affect the fish growth and relative condition factor.

3.2 OBJECTIVES

The objectives of this study are:-

a- To determine the length-weight relationship of *Gerres filamentosus* in Merbok estuary, Kedah.

b- To study the relative condition factor and its relation to physical parameters in Merbok estuary, Kedah.