

**LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR
OF *Puntius sophore* (HAMILTON 1822) FROM CHIKLI RIVER,
NILPHAMARI DISTRICT IN BANGLADESH**

A THESIS

BY

MOST. JANNATUL FERDOUSI

Examination Roll No.: 1705506

Registration No.: 1705506

Session: 2017-2018

Semester: January-June, 2019

**MASTER OF SCIENCE
IN
FISHERIES MANAGEMENT**



**DEPARTMENT OF FISHERIES MANAGEMENT
HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY
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JUNE 2019

**DEDICATED
TO MY
BELOVED PARENTS**

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Finally, I would like to thank my elder brother and other family members for their infinite love and support during study period.

The Author

ABSTRACT

The present study was conducted to observe the length-weight relationship condition factor and growth parameter of *Puntius sophore* in Chikli river under Nilphamari district, Bangladesh. The study was conducted for 12 month during March 2018 to February 2019. Study fish samples were collected monthly from Chikli river. At first, a gear was set in selected point. Fishing was done 10 times for 2 hours per sampling by a cast net. Same effort was maintained throughout the year. A total of 620 individuals were collected from Chikli river during March 2018 to February 2019. Among them, 359 were female and 261 were male. Minimum and maximum length of female is 4 cm and 9.5 cm respectively, minimum and maximum weight of female is 0.86 g and 10.22 g respectively. Minimum and maximum length of male is 3.8 cm and 9.2 cm respectively, minimum and maximum weight of male is 1.01 g and 11.58 g respectively. In present study, maximum length and weight of *P. sophore* recorded 9.5 cm and 11.58 g. Study of the length-weight relationship of *P. Sophore* were described according to male, female and combined populations. Study of the length-weight relationship of *P. sophore* were described according to male, female and combined populations. In current study, length - weight relationship were found as $BW=0.123TL^{2.29}$, $BW=0.19TL^{2.02}$ and $BW=0.051TL^{2.87}$ for female, male and combined population, respectively. The value of intercept 'a' was found as 0.123, 0.190 and 0.051 for female, male and combined population, respectively. The value of regression coefficient 'b' was found as 2.29, 2.02 and 2.87 for female, male, and combined population, respectively. Moreover, coefficient of determination (R^2) found as 0.88, 0.86 and 0.74 for female, male and combined population, respectively. The generalized 'b' value was 2.87 indicating negative allometric growth of *Puntius sophore*. The mean value of condition factor was recorded as 1.46, 1.45 and 1.46 for male, female and combined population, respectively indicating good well-being of fishes. The asymptotic length (L_∞) was found as 8.93 cm, 9.98 cm and 9.98 cm for male, female and combined population, respectively. The growth coefficient (K) was found as $0.970\ y^{-1}$, $1.500\ y^{-1}$ and $10.00\ y^{-1}$ for male, female and combined population, respectively. The growth performance index (Φ) was recorded as 1.88, 2.17 and 2.99 for male, female and combined population, respectively.

Keywords: Length-weight relationship, condition factor and growth parameters.

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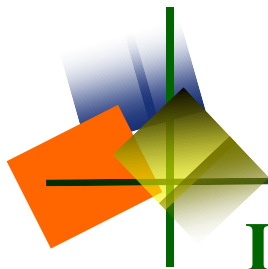
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LIST OF ABBREVIATION

BW	: Body weight
TL	: Total length
NA	: Negative allometric growth
PA	: Positive allometric growth
LWR	: Length-weight relationship
a	: Intercept
b	: Slope
CF _f	: Fultons condition factor
Ø	: Growth performance index
L _∞	: Asymptotic length
K	: Growth coefficient
R ²	: Coefficient of determination



CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

1.1 General and taxonomic information of *Puntius sophore*

Bangladesh has 260 freshwater fish species among them 150 species are small indigenous species (Hanif *et al.*, 2015a). Small indigenous species are generally considered those fishes that grow to a length of less than 25 cm in adult (Felts *et al.*, 1996). These small fishes have high nutritional value because they contain protein, vitamin A, iron, calcium, phosphorus etc. (Banu *et al.*, 1985). The fish, *Puntius sophore* locally known as pool barb, is an important member of small indigenous species belonging to the order of Cypriniformes (Rahman, 2005). This species is available in rivers, streams, ponds, rice fields, floodplains, canals and some mighty river tributaries flowing from Bangladesh, India, Myanmar, Pakistan and Nepal.

Inland waters, mainly the open waters are the main source of the SIS. Bangladesh is a land of rivers. There are 280 rivers are found in our country. The Padma, the Meghna, the Jamuna, the Brahmaputra etc. are largest river. About 700 rivers including tributaries flow through the country constituting a channel of total length around 24,140 km (15,000 mi).

Small indigenous species contains huge amount of vitamin A and vitamin D. These vitamins are very important for human bones, teeth, skin, and eyes. SIS also supply large amount of calcium, phosphorus, iron, iodine etc. which are essential for developing resistance against disease. Among SIS, *Puntius sophore* provide a large amount of protein which is essential for development of cell.

Pool barb, *Puntius sophore* is a small indigenous fish of Bangladesh. It is broadly distributed throughout the Indian sub-continent including Bangladesh, Bhutan, 1572 haors in plains and sub-montane regions dominantly (Craig *et al.*, 2004; Menon, 1999). It is a vital target species for small scale fishers (Rahman, 2005; Shafi and Quddus, 1982).

A range of traditional fishing gears (Kibria and Ahmed, 2005) is used for catching them. However, *P. sophore* is declining rapidly owing to heavy fishing pressure and in recent studies from the Indian waters, it is categorized as lower risk near threatened (Balasundaram *et al.*, 2000; Dua and Parkash, 2009). This fish is a main source of animal

protein and micronutrients in the diet of rural small-scale farmers (Roos *et al.*, 2007). Besides, it is an important small indigenous fish species of Bangladesh and very much famous food fish item (Rahman, 2005) and can also be used as aquarium fish (Froese and Pauly, 2011).

Taxonomic classification of *Puntius sophore*

Kingdom: Animalia

Phylum: Chordata

Sub-phylum: Vertebrata

Class: Actinopterygii

Order: Cypriniformes

Family: Cyprinidae

Genus: *Puntius*

Species: *sophore*



Figure 1.1: *Puntius sophore*

1.2 Length-weight relationship (LWR)

The study of length-weight relationship is used to inform of biological significance such as maturity, taxonomic differences in species, population dynamics, suitability of habitat etc. LWRs are important for assessing growth, stocking density, maturity, productivity of a particular habitat etc. (Simon *et al.* 2009).

The growth of any animal is measured in terms of increase in volume. The volume is expressed by weight, which is linked to the cube of linear dimensions. Thus, there is a exact relationship exists between the length and weight of an animal.

In general, the growth pattern follow the cube laws in fishes. Such relationship will be applicable when the fish growth is isometric. In such cases, the experimental value must be closely 3. But in veracity, the actual correlation between length-weight may depart from the ideal value as a result of environmental conditions or condition of fish. This relationship is articulated by the equation “ $W=aL^b$ ”. This mathematical relationship between length and weight is a practical index fit for understanding their survival,

growth, maturity, gonadal development and general well being of the fish. General equation also forms the base for the calculation of unknown weights from known lengths or unknown lengths from known weights.

The common expectation is that the weight increases as the cube of length (Lagler, 1952; Rounsfell and Everheart, 1953). Besides, the length relationship indicates the degrees of stabilization characters in fish species and very helpful in the management and exploitation of fish populations (Pervin and Mortuza, 2008). This is also a useful tool that provides important information regarding the structure and function of fish populations (Anderson and Neumann, 1996).

1.3 Condition factor

The relationship between length and weight as well as the condition factors are useful parameters for assessing the well-being of the individuals and for determining possible differences among different stocks of the same species (King, 2007). Moreover, relative weight (W_r) is one of the most popular indexes for assessing condition of fishes in the USA for the last two decades (Rypel and Richter, 2008). Though, condition factor is a quantitative parameter of the state of well-being of the fish which influence on growth, reproduction and survival. Moreover, the condition of a fish fluctuates by interaction among feeding conditions, parasitic infections and physiological factors (Le Cren, 1951).

Fulton's condition factor (CF_f) (Fulton, 1904), free from regression parameters ("a" and "b"), exploited to know the physical status of fishes which applied to alter two-dimensional LWRs into a single value being a sign of energy stores in fishes under an isometric growth. However, this assumption is infringed in CF_f and lengths relationship during allometric growth pattern ($3 < b > 3$) of fishes. In this situation, relative body weight (BW_r) is a good physiological indicator that contrast body weights of an individual of same fishes and same length. Moreover, BW_r regularly use to know the prey availability, food abundance and sexual maturity of fishes (Anderson and Neumann, 1996) and to review the condition of fishes concerning their conservation.

Knowledge of quantitative aspects of fishes such as length-weight relationships (LWRs) and condition factor is essential for the fish stock assessment, knowing well-being or fitness of individuals, comparing life histories of separated populations of same fish species present in different regions and proper management of their population.

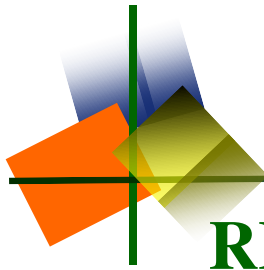
This is the first report on length-weight relationship, condition factor and growth parameters of *Puntius sophore*, potentially important small indigenous species from river Chikli. To protect and conserve fishes specially small and threatened species, we need to understand the stock structure and growth by different management strategies. This data will be helpful for researchers, fish farmers, fisheries personnel's for the future management and conservation of this species.

1.4 Growth parameters

Growth parameters are important parameter to know the growth performance of fish productivity. Successful fish production depends on the suitable growth rate of fish. To know the growth performance of fish has many ways. Among of them, length-weight relationship is relatively easy ways and widely accepted procedure to understand the growth performance of fish by using regression analysis.

1.5 Objectives of the study

- To study length-weight relationship of *Puntius sophore* in Chikli river under Nilphamari district.
- To find out condition factor of *Puntius sophore*.
- To estimate the growth parameters based on length frequency data of this species.



CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

The purpose of the study is to review previous studies, opinions and observations of experts which are related to the present study. Comprehensive reviews of previous research works offer a strong base for carrying out any scientific research. The relevant and significant literature for length-weight relationships and condition factor of a number fish species are documented related to SIS.

2.1 Length-weight relationship (LWR)

The study of length-weight relationship of *P. sophore* is necessary for understanding their survival, growth, maturity, gonadal development and general well being of the fish.

Pal *et al.* (2018) conducted an experiment on length-weight relationship and condition factor of *P. sophore* from the river Ghargharia at Cooch behar, India. A total of 25 species were collected. The equilibrium constant “b” is found to be 3.3204. It showed positive allometric growth.

Latif *et al.* (2016) examined the relationship between length and weight of *Puntius sophore* from Chenab River, Punjab. A total of 231 samples of *Puntius sophore* were collected. The slope “b” in the length-weight relationship is 2.63 indicating negative allometric growth.

Das *et al.* (2015) examined the length-weight relationship, relative condition factor of fish species *Puntius sophore* collected from deepar beel of Assam, India. The growth performance of length-weight relationship is found high since the correlation coefficient ‘r’ exhibits high degree of relationship but shows negative allometric correlation. The growth coefficient value of ‘b’ in all cases is lower than 3.0 indicating negative allometric growth.

Kaushik and Bordolai (2015) investigated length-weight relationships (LWR) and length-length relationships (LLR) of four species collected from different wetlands of Lakhimpur, India. The species were, *Puntius sophore*, *Puntius chola*, *Pethia ornatus* and *Pethia ticto*. The values of the parameter slope (b) in the LWR were 3.32 for *Puntius sophore*, 3.22 for *Puntius chola*, 2.61 for *Pethia ornatus* and 3.27 for *Pethia ticto*.

Habiba *et al.* (2015) carried out the length-length relationships (LLR), length-weight relationship (LWR) and condition factor of nine freshwater small indigenous species viz. *G. giuris*, *E. danricus*, *M. pancalus*, *L. guntea*, *C. fasciatus*, *P. sophore*, *H. fossilis*, *C. punctatus* and *M. cavasius* collected from the water bodies of Nageshwari, Bangladesh. The “b” values range from 2.65-3.03.

Monalisa *et al.* (2013) studied length-weight relationship and condition factor of *P. sophore* that estimated from 483 individuals collected from Kolkata and sub-urban fish markets. Values of ‘a’, ‘b’ and r^2 were 0.00800, 3.152 and 0.902.

Rahman *et al.* (2012) worked on sex ratio, length-frequency distributions (LFDs), length-weight relationships (LWRs), condition factors, relative weight and fecundity of *Puntius sophore* in the Chalan beel, Bangladesh. A total of 185 specimens of *P. sophore* were collected. The coefficient b of the LWRs indicated positive allometric growth ($b > 3.00$) for *P. sophore*. The results also indicated that the LWRs were highly correlated ($r^2 > 0.945$).

Torre *et al.* (2012) worked on length-weight relationships of 76 fish species from the gulf of Cadiz, Spain. The results revealed that 18 species showed negative allometries ($b < 3$), 47 positive allometries ($b > 3$) and 11 isometric growth ($b = 3$).

Hossain *et al.* (2010a) observed length-weight relationships of unsexed *Puntius ticto* in Ganges lower region, Bangladesh, where he studied on 441 unsexed species of *P. ticto*. Standard length varied from 3.0 cm to 9.0 cm and the values of ‘a’, ‘b’ and r^2 were 0.03490, 2.920 and 0.951 respectively.

Veiga *et al.* (2009) worked on weight-length relationships for 54 species of the Arade estuary, Portugal. The ranged of b values 2.55-3.56.

Ismen *et al.* (2007) worked on weight-length relationships of 63 fish species in Saros bay, Turkey. The values of b ranged from 2.7 to 3.4.

Prasad *et al.* (2007) conducted research on length-weight relationship of a cyprinid fish, *Puntius filamentosus* from Chalakudy river, Kerala India. A total of 412 fishes were collected. The value of $a = 0.01170$, $b = 2.992$ and the value of coefficient of determination $r^2 = 0.956$.

Hossain *et al.* (2006) observed the length-weight relationships of 441 species of mixed *Puntius sophore* collected from Mathabhanga river, Bangladesh. Values of 'a', 'b' and r^2 were 0.00802, 3.132 and 0.904.

Pet *et al.* (1996) studied the length-weight relationships of *Puntius chola* in Tissa Wewar eservoir, Sri Lanka. A total of 1150 species were collected. The values of 'a', 'b' and r^2 were 0.01330, 3.042 and 0.970 respectively.

2.2 Condition factor

Condition factor is a quantitative parameter of the state of well-being of the fish that will determine the present and future population success by its influence on growth, reproduction and survival (Richter, 2007).

Islam *et al.* (2017) investigated on length-weight relationships (LWRs) and condition factors (CFs) of 13 fish species collected from the Atrai and Brahmaputra Rivers, Bangladesh. Fulton's condition factor (CF_f) found between 0.99 and 1.54 (1.24 ± 0.02).

Satyajit *et al.* (2017) conducted an experiment on the length-weight relationship and relative condition factor in *Glossogobius giuris* found in river Singla in the Karimganj district of Assam, India. The relative condition factor, $Kn = 1.523$ remained greater than 1 for the species indicating their general well-being to be good in the river.

Das *et al.* (2015) worked on the length-weight relationship, relative condition factor of fish species *Puntius sophore* collected from deepar beel of Assam, India. The relative condition factor of Sub Adult *Puntius sophore*, Adult *Puntius sophore*, are 0.93-1.07, 0.85-1.19 respectively.

Monalisa *et al.* (2013) studied length-weight relationship and condition factor of *P. sophore* that estimated from 483 individuals collected from Kolkata and sub-urban fish markets. The mean condition factor of the fish was found to 1.10 indicating good condition of the fish.

Rahman and Hossain (2012) worked on length-weight relationship (LWR), length-length relationship (LLR), Fulton's condition factor (K) of *P. sophore* from three major rivers of different geographical locations of Bangladesh. A total of 784 species were collected. The calculated Fulton's condition factor (K) values ranged from 0.69-2.35, with a mean value 1.64 ± 0.30 .

Hossain *et al.* (2012b) observed an experiment on length-weight relationships (LWRs) and condition factors (CFs) of the five threatened fishes from the Jamuna, Bangladesh. CF_f values found as 0.46 to 1.19 (0.71±0.12).

Rahman *et al.* (2012) worked on LWRs and CFs of *Puntius sophore* from the Chalanbeel Bangladesh. The CF_f values were 0.69 to 2.35 (1.64±0.30) and BW_r were 48.62 to 179.96 (102.28±16.38).

Muchlisin *et al.* (2010) studied on LWRs and CFs of *Rasborata warensis* and *Poropuntius tawarensis* in lake Luttawar of Indonesia. For *R. tawarensis*, CF_f values ranged from 1.19 to 2.24 (1.85±0.14) and 1.05 to 2.15 (1.73±0.16) in female and male whereas 2.03 to 2.94 (2.44±0.16) and 2.10 to 2.76 (2.41±0.14) in *P. tawarensis* female and male, respectively.

2.3 Growth pattern

Cilbiz and Yalim (2017) investigated the growth patterns of *Oncorhynch mykiss* in Turkey where the values of K (growth coefficient) and L_∞ (asymptotic length) were estimated as 0.33 year⁻¹ and 36.50 cm respectively.

Nadeem *et al.* (2017) worked on the growth parameters of *Sardinella longiceps* in India where the values of L_∞=25.20 cm and K=1.40 year⁻¹.

Divakar *et al.* (2017) conducted an experiment on length-based population indicators of *Katsuwonus pelamis* in the Andaman waters. The parameters L_∞ and K were 74.55 cm, 0.59 year⁻¹.

Ragheb (2016) investigated the growth pattern and natural mortality of *Mormyrus kannume* (Egypt). The different growth parameters were estimated as K (growth coefficient) 0.14, L_∞ (asymptotic length) 80.65 cm.

Fakhri *et al.* (2015), worked on the growth parameters of Von Bertalanffy factors from *Scomberomorus commerson* captured from the Persian Gulf. The estimated value of L_∞=143.85 cm, K=0.31 year⁻¹ and growth performance index (Ø)=3.81.

Kaymaram *et al.* (2014) carried out an experiment on length-based population parameters of *Thunnus albacores* collected from the Oman Sea, Turkey. The value of L_∞=183.3 cm and K=0.45 year⁻¹.

Koya *et al.* (2012) worked on fishery biology and stock structure of *Katsuwonus pelamis* from Indian waters. The Von Bertalanffy growth factors were $L_{\infty}=92.0$ cm and $K=0.50$ year⁻¹.

Ferdous *et al.* (2012) investigated on growth study of the pool barb *Puntius sophore* collected from old Brahmaputra river, Bangladesh. The Von Bertalanffy growth factors were $L_{\infty}=63.90$ mm and 74.17 mm for male and female respectively. The value of K was 0.156 year⁻¹ and 0.141 year⁻¹ for male and female respectively. The value of growth performance index (Φ) was 2.80 and 2.89 for male and female respectively.



CHAPTER III

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

3.1 Study area

The study fish species (*Puntius sophore*) was collected from Chikli river. This river is located at Nilphamari district of northern Bangladesh within latitudes 88°56'E and longitudes 25° 48'S.



Figure 3.1: Chikli river (sampling site)

Chikli river houses a number of indigenous fish species, and a very rich ecosystem of numerous aquatic fauna and flora. The water body is used as feeding, breeding and nursery ground of many fish species. The study area of the experiment was the river Chikli nears at Saidpur upazila in Nilphamari district.

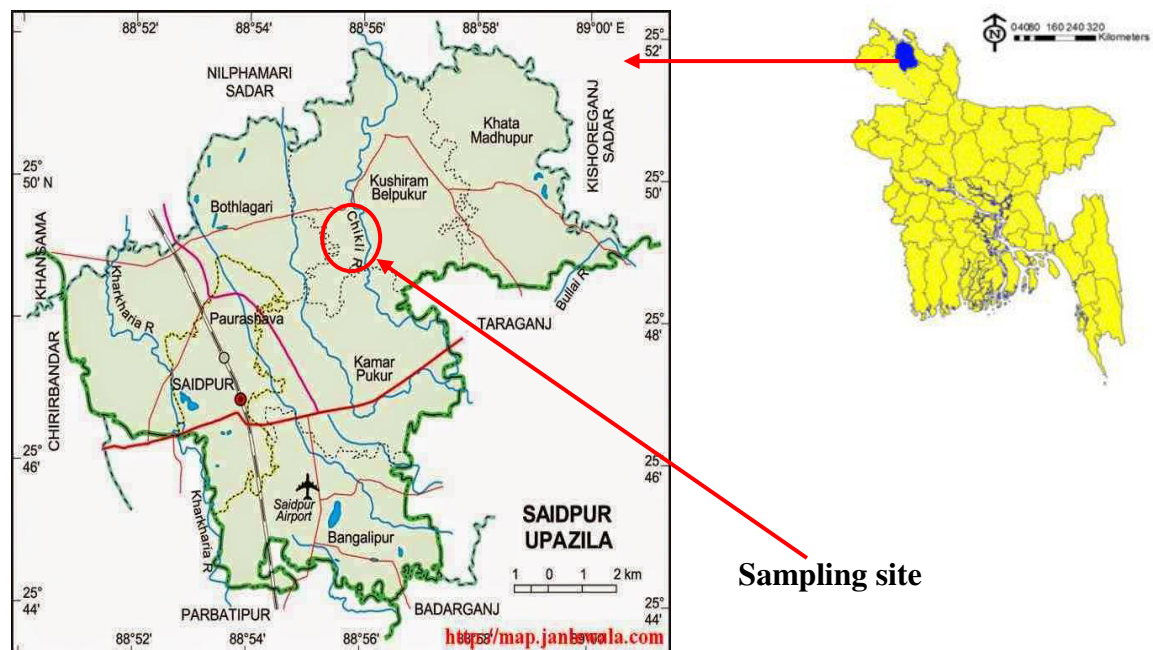


Figure 3.2: Map showing the location of sampling site (Chikli river)

3.2 Sampling and preservation

The study was conducted for 12 month during March 2018 to February 2019. Study fish samples were collected monthly from Chikli river. At first, a gear was set in selected point. Fishing was done 10 times for 2 hours per sampling by a cast net. Same effort was maintained throughout the year. After catching, the fish sample was preserved with 10% buffer formalin in a small plastic container as soon as possible to prevent decomposition of fish. The fish samples were transferred to the laboratory for measuring length and weight.

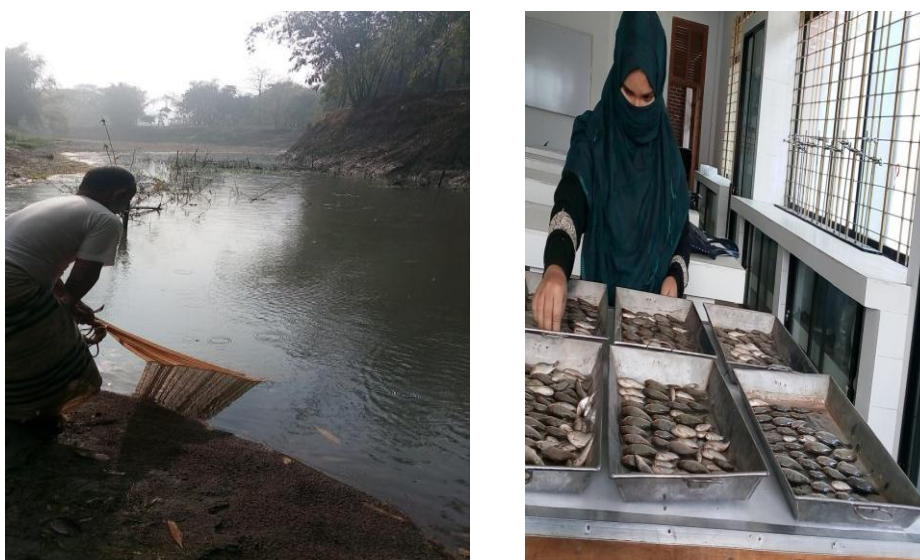


Figure 3.3: Capturing of fish sample using cast net (left) and sorting of sexes (right) through the examination of external morphological characters at the laboratory condition.

3.3 Measurement of length and weight

The preserved fishes were washed with running tap water for half an hour to remove dirty materials and formalin. Then fishes were put on a tray. To clean any filthy substances and absorbed excess water was dried on blotting paper from the body and finally left in room temperature for remove of all moisture content. Total length (TL) and body weight (BW) were measured. As the research work was on the relationships between total length and body weight. So length was measured in the laboratory using centimeter scale fitted upon a wooden structure. The body weight of individual fish was weigh by an electric balance nearest to 0.001g. All the measurement data were recorded on a data register.



Figure 3.4: Measuring of length (left side) and weight (right side) of *Puntius sophore*

3.4 Length-weight relationships

The relationship between total length (L) and total weight (W) of fish was analyzed by measuring length and weight of fish specimens collected from study area. The statistical relationship between these parameters of fishes was established by using the parabolic equation:

$$BW=aTL^b \text{ (Le Cren, 1951)}$$

Where,

BW = weight of fish in (g)

TL = total length of fish in (cm)

a = proportionality constant (intercept) and

b = regression coefficient (slope) indicating isometric growth ($b = 3.0$) or

allometric growth ($3.0 < b > 3.0$).

However, the regression parameters “a” and “b” of the linear equation were calculated through the following equation as:

$$b = \frac{[n\sum XY - \sum X \sum Y]}{[n\sum X^2 - (\sum X)^2]} \text{ and}$$

$$a = Y - bX$$

Where,

b = Exponent (slope)

Y = Dependent variable

X = Independent variable

a = Intercept (constant)

n = Number of individual

3.5 Calculation of Condition Factor

Indices of condition factors (CFs) are commonly used by fisheries managers or scientists to review well-being, reproduction and survival (Richter, 2007) and to compare relative health of fishes (Froese, 2006). However, Fulton condition factor is commonly used to assess the physical condition of fishes described as follows.

3.5.1 Fulton condition factor

Condition factors (CFs) used to assess the health status of *P. sophore* from study area. Fulton's condition factor (CF_f) measure the physical condition of a specimen among sexes of this species where it assumes the body weight of an individual proportionate to the cube of its length. However, this health indicator determined as the following formula as:

$$CF_f = (BW \times 100) / TL^3 \text{ (Fulton, 1904)}$$

Where,

CF_f = Condition factor of an individual

BW = Body weight (g)

TL = Total length (cm)

3.6 Growth parameters

Estimates of the growth parameters were based on the von Bertalanffy growth formula (VBGF), which is expressed as follows:

$$L_t = L_{\infty} [1 - \exp\{-K(t-t_0)\}]$$

Where,

L_{∞} = Asymptotic length at which an average fish would achieve until their live and grow

K = growth coefficient

t_0 = age the fish would have been at zero length.

Moreover, based length frequencies data, L_{∞} was taken from the Powell-Wetherall plot using the equation as:

$$L_{\infty} = -a/b$$

Where,

L_{∞} = Asymptotic length

‘a’ and ‘b’ = Regression parameters from LWR.

According to Pauly (1983)

Growth performance index (ϕ) was considered through the following equation as:

$$(\phi) = \text{Log}K + 2\text{Log } L_{\infty}$$

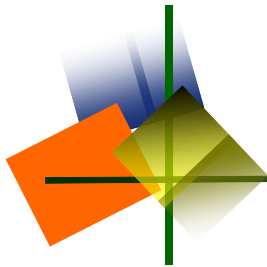
Where,

L_{∞} = Asymptotic length

K = Growth coefficient of the fish species (year^{-1})

3.7 Statistical analysis

Statistical analysis for each species were done through Microsoft Office Excel, ELEFAN I in FAO ICLRAM Stock Assessment Tool (FiSAT software) version 1.2.2 and SPSS software version 22.



CHAPTER IV

RESULTS

CHAPTER IV

RESULTS

4.1 Total length and body weight

Linear regression ($Y = a + bX$) analyses and Power curve equation $BW = aTL^b$ were used to establish the relationship between total length (cm) and body weight (g). The number of total population is 620. Minimum and maximum length of female is 4 cm and 9.5 cm respectively, minimum and maximum weight of female is 0.86 g and 10.22 g respectively (Table 1). Minimum and maximum length of male is 3.8 cm and 9.2 cm respectively, minimum and maximum weight of male is 1.01 g and 11.58 g respectively (Table 2). In present study, maximum length and weight of *P. sophore* recorded 9.5 cm and 11.58 g (Table 3). Study of the length-weight relationship of *P. Sophore* were described according to male, female and combined populations.

Table 1. Length-weight relationship parameters of monthly samples of *Puntius sophore* (Female)

Month	No.	TL		Mean±SD	BW		Mean±SD	a	b	95% CI a	95% CI b	F	R ²	CF _F	Growth type
		Min	Max		Min	Max									
March	31	4.6	8	6.41±0.77	1.16	6.83	3.19±1.28	0.008	3.13	-8.270 to -5.464	1.351 to 1.776	226.727	0.94	1.14	PA
April	34	5	9.5	6.56±1.14	2.88	8	3.96±1.11	0.284	1.39	-2.799 to -1.374	0.815 to 1.029	308.586	0.94	1.47	NA
May	32	5.5	9	6.69±0.85	1.72	10.03	3.54±1.72	0.008	3.16	-10.840 to -7.612	1.668 to 2.147	265.281	0.93	1.11	PA
June	25	5.2	7.9	6.81±.91	2.93	8.2	4.63±1.67	0.086	2.05	-8.808 to -2.693	1.079 to 1.969	50.230	0.77	1.45	NA
July	29	4.5	8	6.74±1.08	2.2	8.2	4.89±1.88	0.097	2.02	-7.664 to 3.119	1.193 to 1.859	88.436	0.84	1.59	NA
August	31	4.8	8.7	6.55±1.24	1.68	9.52	4.72±2.29	0.061	2.27	-8.186 to -4.137	1.357 to 1.965	125.090	0.85	1.63	NA
September	28	4.8	9.4	7.03±1.36	1.78	9.48	5.79±3.26	0.014	3.01	-12.286 to -8.025	1.970 to 2.565	245.514	0.94	1.46	PA
October	31	5.5	8.9	7.02±0.78	2.53	10.22	5.18±1.90	0.013	3.02	-13.043 to -9.403	2.078 to 2.593	344.091	0.95	1.43	PA
November	28	4.6	8	5.87±0.87	0.86	5.51	2.39±1.15	0.007	3.23	-5.763 to -4.600	1.192 to 1.388	734.202	0.96	1.09	PA
December	31	4.7	7.4	6.03±0.87	1.3	6.22	3.66±0.99	0.225	1.53	-3.443 to -0.440	0.682 to 1.174	59.433	0.62	1.68	NA
January	30	4	7.1	5.76±0.92	1.7	4.5	3.27±0.63	0.380	1.22	-0.917 to -0.128	0.592 to 0.727	399.38	0.912	1.81	NA
February	29	4.5	7.3	5.87±0.92	2	4.5	3.38±0.69	0.297	1.34	-1.449 to -0.619	0.665 to 0.801	488.52	0.92	1.61	NA
Generalized	359	4.8	8.2	6.44±0.97	1.89	7.60	4.05±1.54	0.123	2.29	-6.955 to -3.967	1.220 to 1.666	977.872	0.88	1.45	NA

TL=Total length, BW=Body weight, Min=Minimum, Max=Maximum, PA=Positive allometric growth, NA=Negative allometric growth, R²=coefficient of determination, CF_F=Fultons condition factor, a=intercept, b=slope

Table 2. Length-weight relationship parameters of monthly samples of *Puntius sophore* (Male)

Month	No.	TL		Mean±SD	BW		Mean±SD	a	b	95% CI a	95% CI b	F	R ²	CF _f	Growth type
		Min	Max		Min	Max									
March	22	5.2	8.5	6.53±0.82	1.44	7.10	3.38±1.40	0.007	3.22	-8.525 to -6.565	1.525 to 1.823	549.999	0.97	1.15	PA
April	26	4.5	8.1	5.88±0.87	1.90	5.93	3.14±0.89	0.121	1.82	-3.284 to -2.051	0.885 to 1.093	387.625	0.94	1.56	NA
May	28	4.7	8.3	6.09±1.02	1.04	6.57	2.72±1.55	0.006	3.31	-7.108 to -5.407	1.336 to 1.611	484.478	0.96	1.08	PA
June	20	4.8	7.2	6.22±0.72	2.77	4.10	3.48±0.38	0.725	0.85	-0.174 to 1.097	0.384 to 0.587	101.111	0.86	1.52	NA
July	18	4.5	7.7	6.11±0.99	2.80	7.00	3.70±1.00	0.441	1.16	-3.187 to 0.667	0.501 to 1.123	30.582	0.72	1.72	NA
August	18	4.6	7	5.93±0.72	2.00	3.8	3.11±0.63	0.201	1.53	-2.093 to -0.787	0.658 to 0.877	221.927	0.93	1.52	NA
September	20	4.5	7.5	6.21±0.78	1.80	5.43	3.46±0.78	0.142	1.73	-3.511 to -0.832	0.694 to 1.122	79.372	0.85	1.49	NA
October	25	4.8	9.2	6.67±1.30	1.38	11.58	4.49±2.81	0.010	3.13	-11.182 to -7.300	1.773 to 2.345	222.040	0.95	1.33	PA
November	20	4	6.5	5.22±0.60	1.01	3.3	1.67±0.61	0.021	2.62	-4.315 to -1.972	0.699 to 1.145	75.596	0.80	1.14	NA
December	22	4.7	7.3	5.88±0.74	1.31	4.46	3.19±0.66	0.189	1.58	-2.618 to -0.361	0.607 to 0.988	76.226	0.64	1.60	NA
January	23	3.8	7.1	5.45±0.82	1.12	3.89	2.81±0.70	0.150	1.71	-2.308 to -0.518	0.613 to 0.938	98.726	0.82	1.77	NA
February	19	4	7.3	5.64±0.95	1.50	4.46	2.91±0.78	0.183	1.58	-2.179 to -0.931	0.684 to 0.902	235.198	0.91	1.68	NA
Generalized	261	4.5	7.6	5.98±0.86	1.67	5.63	3.17±1.01	0.19	2.02	-4.207 to -2.080	0.863 to 1.212	778.540	0.86	1.46	NA

TL=Total length, BW=Body weight, Min=Minimum, Max=Maximum, PA=Positive allometric growth, NA=Negative allometric growth, R²=coefficient of determination, CF_f=Fultons condition factor, a=intercept, b=slope

Table 3. Length-weight relationship parameters of monthly samples of *Puntius sophore* (Combined)

Month	No.	TL		Mean±SD	BW		Mean±SD	a	b	95% CI a	95% CI b	F	R ²	CF _f	Growth type
		Min	Max		Min	Max									
March	53	4.6	8.5	6.46±0.79	1.16	7.1	3.27±1.32	0.007	3.219	-8.009 to -6.289	1.481 to 1.745	600.915	0.973	1.150	PA
April	60	4.5	9.5	6.26±1.08	1.91	8.11	3.61±1.09	0.183	1.614	-2.923 to -1.986	0.894 to 1.042	691.819	0.926	1.510	NA
May	60	4.7	9.0	6.41±0.97	1.06	10.03	3.16±1.68	0.006	3.265	-8.238 to -6.454	1.501 to 1.775	659.017	0.96	1.099	PA
June	45	4.8	7.9	6.55±0.87	2.77	8.17	4.12±1.39	0.161	1.710	-6.100 to -2.225	0.972 to 1.558	75.698	0.719	1.485	NA
July	47	4.5	8	6.50±1.08	2.2	8.1	4.44±1.69	0.1541	1.773	-5.848 to -2.601	1.086 to 1.579	118.668	0.796	1.644	NA
August	49	4.5	8.7	6.32±1.13	2	9.4	4.13±2.01	0.067	2.201	-7.372 to -4.253	1.329 to 1.815	169.760	0.844	1.593	NA
September	48	4.5	9.4	6.69±1.22	1.8	11.17	4.82±2.77	0.022	2.775	-10.991 to -7.520	1.849 to 2.360	275.388	0.912	1.481	NA
October	56	4.8	9.2	6.86±1.05	1.66	11.58	4.87±2.36	0.010	3.147	-11.089 to -8.547	1.957 to 2.323	549.665	0.951	1.393	PA
November	48	4	8	5.60±0.83	1.09	5.51	2.09±1.02	0.011	2.997	-5.092 to -4.015	1.092 to 1.282	631.869	0.924	1.116	NA
December	53	4.7	7.4	5.97±0.82	2.67	6.22	3.46±0.89	0.201	1.581	-2.961 to -0.887	0.731 to 1.075	111.089	0.622	1.671	NA
January	53	3.8	7.3	5.62±0.88	1.12	4.5	3.07±0.69	0.238	1.472	-1.485 to -0.544	0.644 to 0.809	312.372	0.822	1.800	NA
February	48	5.1	6.2	5.87±0.94	2.87	3.42	3.20±0.76	0.225	1.492	-1.723 to -0.990	0.714 to 0.837	643.556	0.908	1.640	NA
Generalized	620	3.8	9.5	6.25±0.97	1.01	11.58	3.73±1.47	0.051	2.287	-5.985 to -3.859	1.187 to 1.516	1.795E3	0.748	1.46	NA

TL=Total length, BW=Body weight, Min=Minimum, Max=Maximum, PA=Positive allometric growth, NA=Negative allometric growth, R²=coefficient of determination, CF_f=Fultons condition factor, a=intercept, b=slope

4.2 Combined population monthly

January 2019

The ln-ln plot based on total length and body weight of *Puntius sophore* in January was shown in Figure 4.1. The regression line calculated that the intercept (a) and the slope (b) were 0.238 and 1.472, respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.906 and 0.822, respectively. The correlation coefficient (0.906) showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.238 and 1.472, respectively. The power curve that best fitted the observed data is shown (Figure 4.2) and the equation is $BW=0.238L^{1.472}$

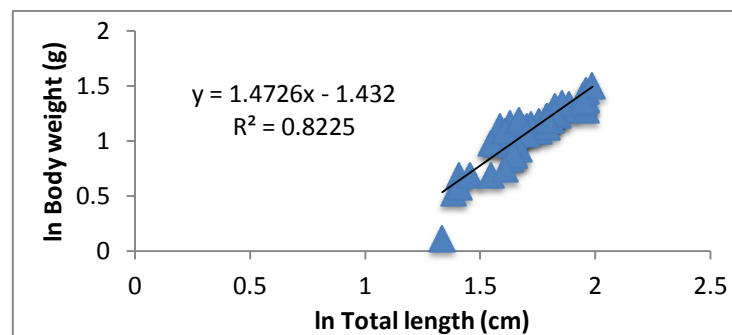


Figure 4.1: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on January 2019

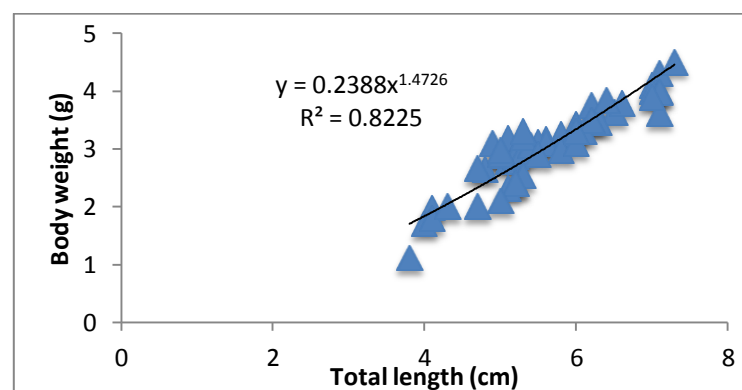


Figure 4.2: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on January 2019

February 2019

The body weight and total length of *Puntius sophore* through ln-ln plot in February was shown in Figure 4.3. The regression line calculated that the intercept (a) and the slope (b) were 0.225 and 1.492 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.952 and 0.908, respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.225 and 1.492, respectively. The power curve that best fitted the observed data is shown (Figure 4.4) and the equation is $BW=0.225TL^{1.492}$

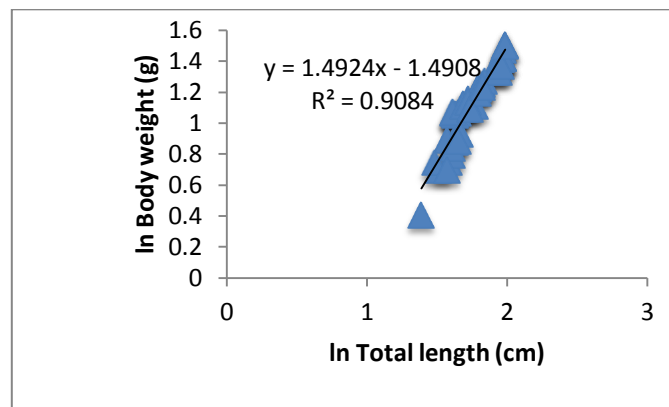


Figure 4.3: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on February 2019

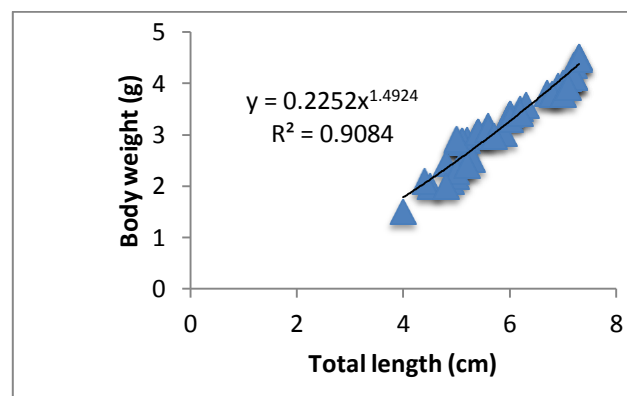


Figure 4.4: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on February 2019

March 2018

The total length and body weight of *Puntius sophore* through ln-ln plot in March was shown in Figure 4.5. The regression line calculated that the intercept (a) and the slope (b) were 0.007 and 3.219 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.986 and 0.973 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as and, respectively. The power curve that best fitted the observed data is shown (Figure 4.6) and the equation is $BW=0.007TL^{3.219}$

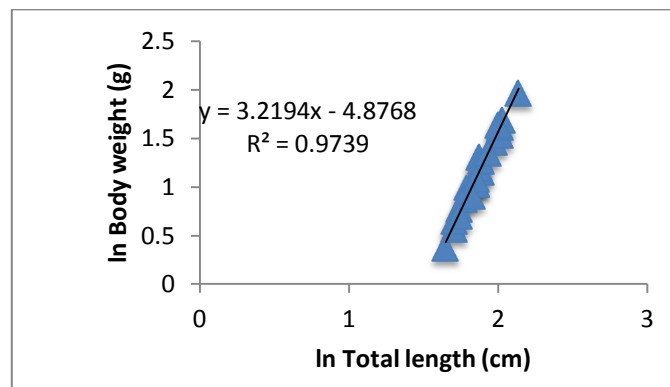


Figure 4.5: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on March 2018

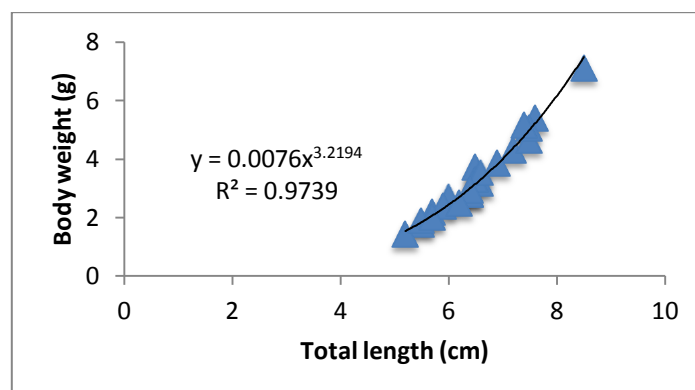


Figure 4.6: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on March 2018

April 2018

The ln-ln plot based on total length and body weight of *Puntius sophore* in April was shown in Figure 4.7. The regression line calculated that the intercept (a) and the slope (b) were 0.183 and 1.614 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.962 and 0.926 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.183 and 1.614 respectively. The power curve that best fitted the observed data is shown (Figure 4.8) and the equation is $BW = 0.183TL^{1.614}$

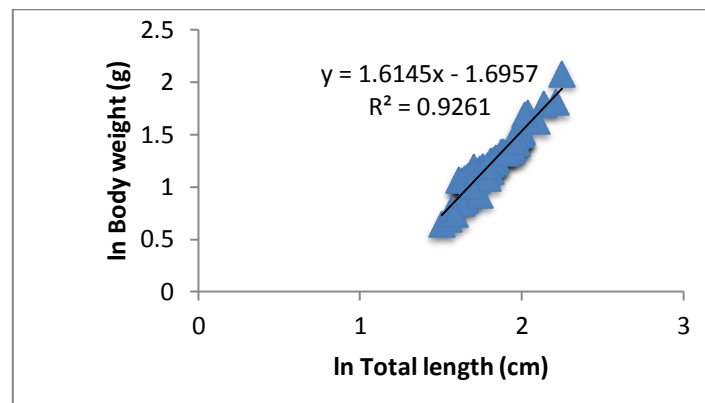


Figure 4.7: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on April 2018

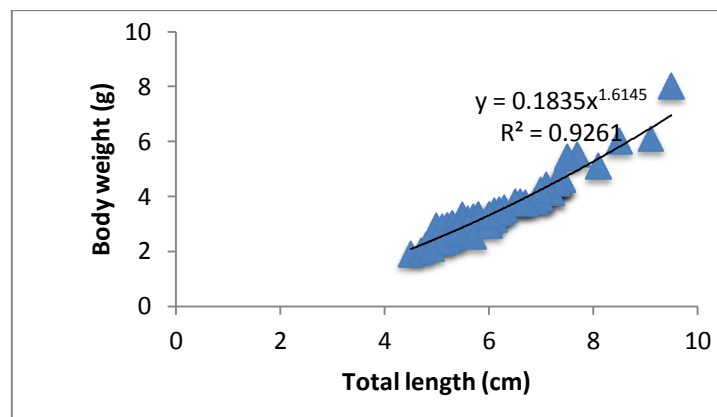


Figure 4.8: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on April 2018

May 2018

In May, the ln-ln plot based on total length and body weight of *Puntius sophore* was shown in Figure 4.9. The regression line calculated that the intercept (a) and the slope (b) were 0.006 and 3.265 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.979 and 0.960 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.006 and 3.265 respectively. The power curve that best fitted the observed data is shown (Figure 4.10) and the equation is $BW=0.006TL^{3.265}$

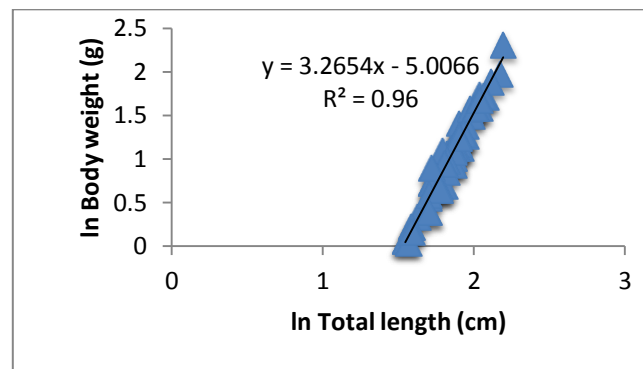


Figure 4.9: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on May 2018

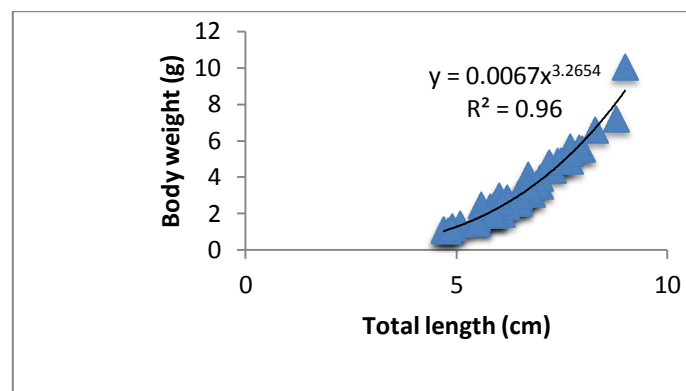


Figure 4.10: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on May 2018

June 2018

The ln-ln plot based on total length and body weight of *Puntius sophore* in January was shown in Figure 4.11. The regression line calculated that the intercept (a) and the slope (b) were 0.161 and 1.710 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.847 and 0.719 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.161 and 1.710, respectively. The power curve that best fitted the observed data is shown (Figure 4.12) and the equation is $BW=0.161TL^{1.710}$

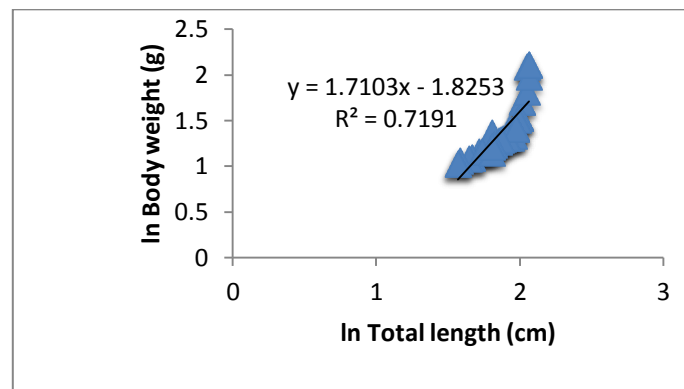


Figure 4.11: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on June 2018

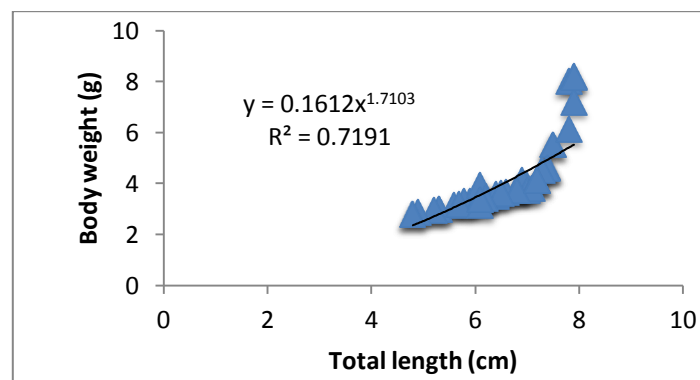


Figure 4.12: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on June 2018

July 2018

The ln-ln plot based on total length and body weight was shown in Figure 4.13. The regression line calculated that the intercept (a) and the slope (b) were 0.154 and 1.773 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.892 and 0.796 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.154 and 1.773 respectively. The power curve that best fitted the observed data is shown (Figure 4.14) and the equation is $BW=0.154TL^{1.773}$

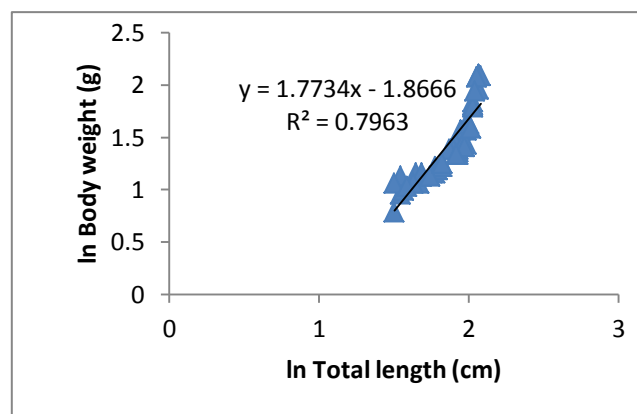


Figure 4.13: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on July 2018

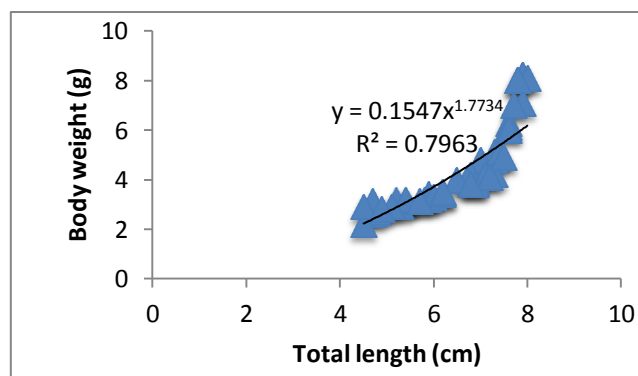


Figure 4.14: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on July 2018

August 2018

The ln-ln plot based on total length and body weight of *Puntius sophore* in August was shown in Figure 4.15. The regression line calculated that the intercept (a) and the slope (b) were 0.067 and 2.201 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.918 and 0.844, respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.067 and 2.201, respectively. The power curve that best fitted the observed data is shown (Figure 4.16) and the equation is $BW=0.067TL^{2.201}$

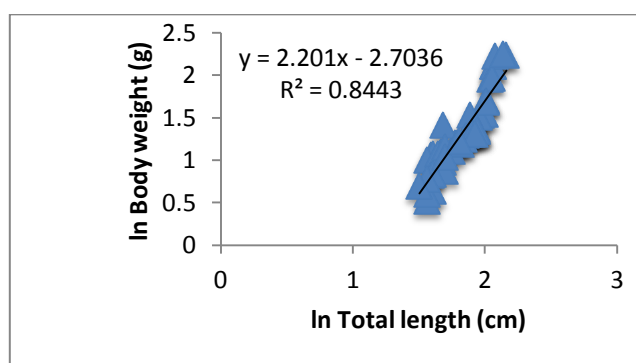


Figure 4.15: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on August 2018

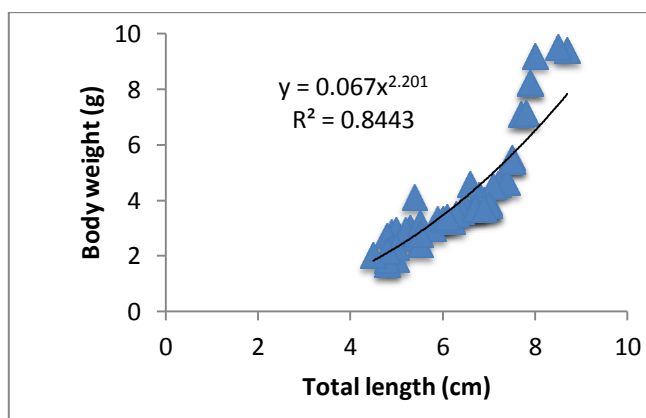


Figure 4.16: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on August 2018

September 2018

The ln-ln plot based on total length and body weight of *Puntius sophore* in September was shown in Figure 4.17. The regression line calculated that the intercept (a) and the slope (b) were 0.022 and 2.775 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.954 and 0.912, respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.022 and 2.775 respectively. The power curve that best fitted the observed data is shown (Figure 4.18) and the equation is $BW=0.022TL^{2.775}$

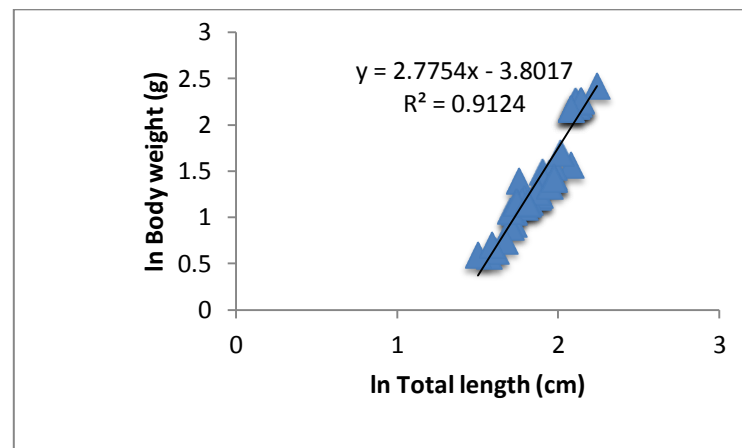


Figure 4.17: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on September 2018

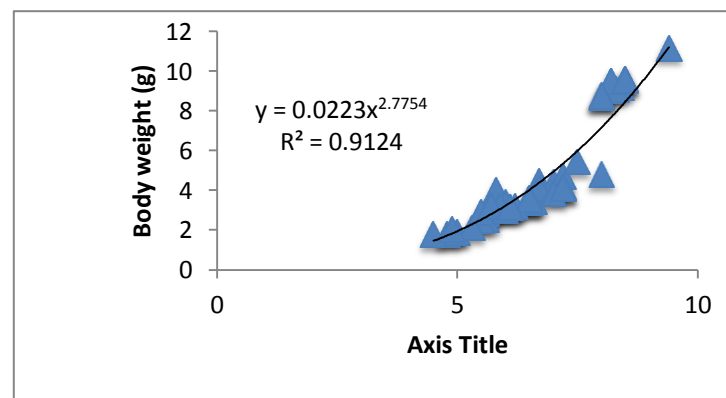


Figure 4.18: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on September 2018

October 2018

The ln-ln plot based on total length and body weight of *Puntius sophore* in October was shown in Figure 4.19. The regression line calculated that the intercept (a) and the slope (b) were 0.010 and 3.147 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.975 and 0.951 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.010 and 3.147, respectively. The power curve that best fitted the observed data is shown (Figure 4.20) and the equation is $BW = 0.010TL^{3.147}$

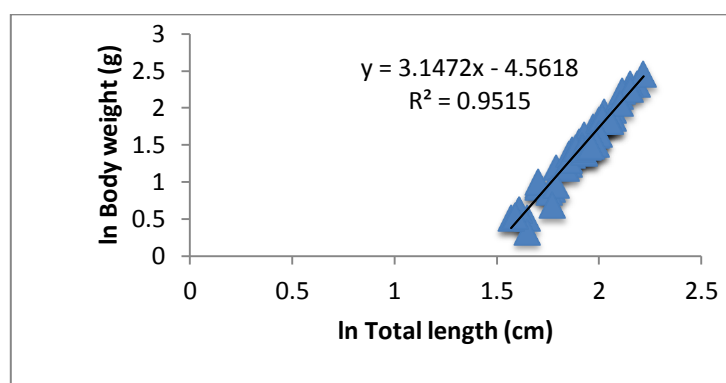


Figure 4.19: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on October 2018

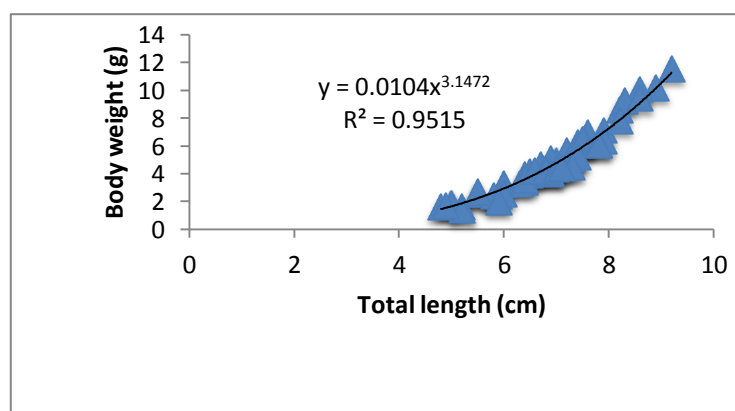


Figure 4.20: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on October 2018

November 2018

The ln-ln plot based on total length and body weight of *Puntius sophore* in November was shown in Figure 4.21. The regression line calculated that the intercept (a) and the slope (b) were 0.011 and 2.997 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.961 and 0.924 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.011 and 2.997 respectively. The power curve that best fitted the observed data is shown (Figure 4.22) and the equation is $BW = 0.011TL^{2.997}$

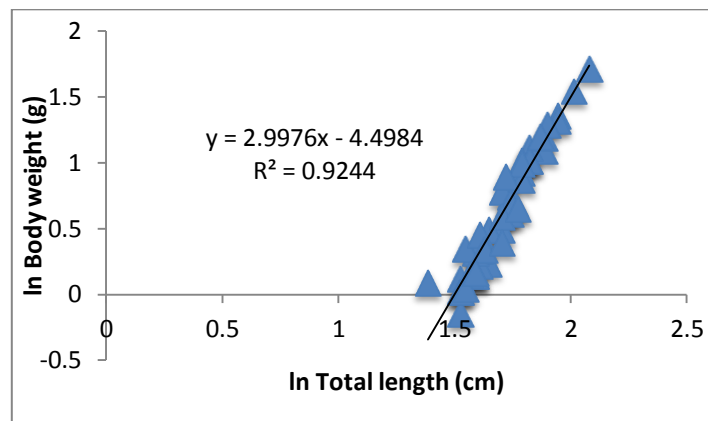


Figure 4.21: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on November 2018

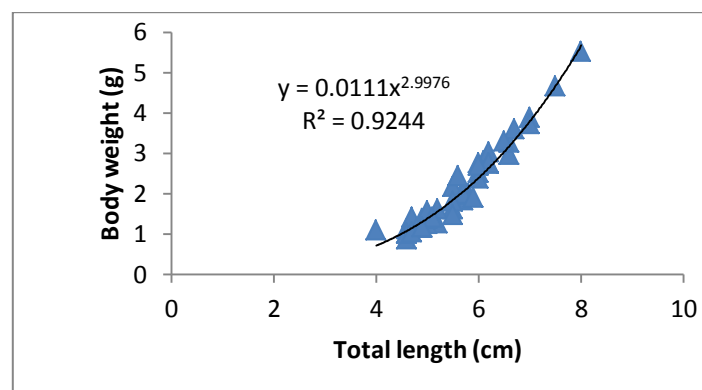


Figure 4.22: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on November 2018

December 2018

The ln-ln plot based on total length and body weight of *Puntius sophore* in December was shown in Figure 4.23. The regression line calculated that the intercept (a) and the slope (b) were 0.201 and 1.581 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.788 and 0.622 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.201 and 1.581 respectively. The power curve that best fitted the observed data is shown (Figure 4.24) and the equation is $BW=0.201TL^{1.581}$

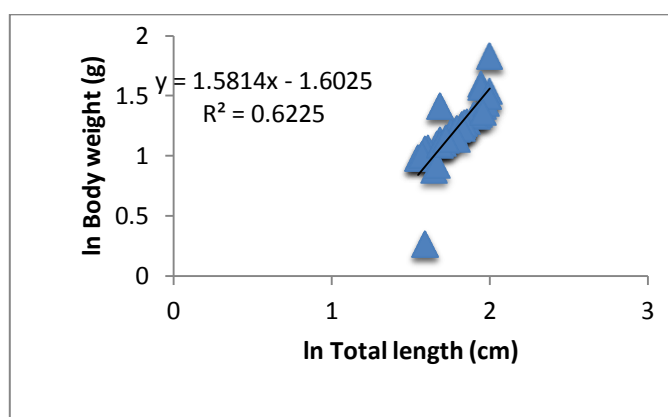


Figure 4.23: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore* on December 2018

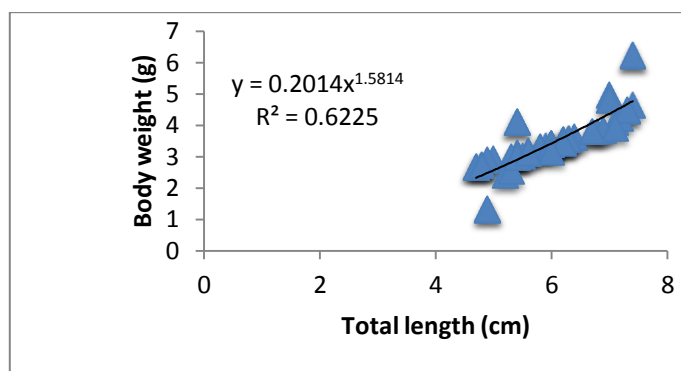


Figure 4.24: The relationship between total length (cm) and body weight (g) in the combined *P. sophore* on December 2018

Combined population

The ln-ln plot based on total length and body weight of *Puntius sophore* was shown in Figure 4.25. The regression line calculated that the intercept (a) and the slope (b) were 0.051 and 2.287 respectively. The correlation coefficient (r) and the coefficient of determination (r^2) were obtained as 0.864 and 0.748 respectively. The correlation coefficient showed that there was a high degree of correlation between total length and body weight in the sample and its positive value indicated that body weight increase with the increase of total length.

The constants 'a' and 'b' in power curve equation of length-weight relationship were obtained as 0.051 and 2.287 respectively. The power curve that best fitted the observed data is shown (Figure 4.26) and the equation is $BW = 0.051TL^{2.287}$. The growth coefficient (b) showed negative allometric growth.

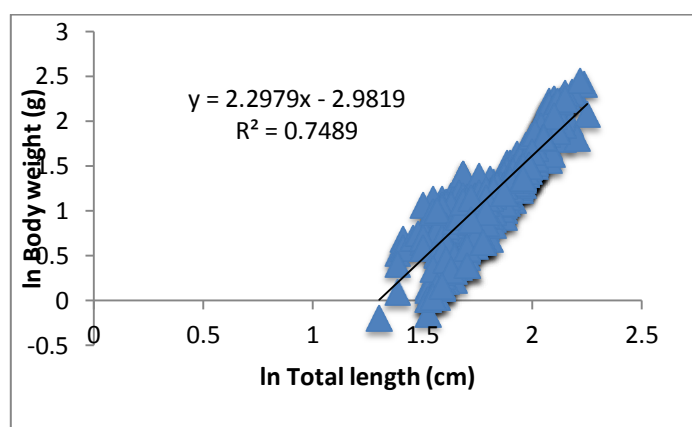


Figure 4.25: The relationship between the natural logarithm of total length (cm) and the natural logarithm of body weight (g) in the combined *P. sophore*

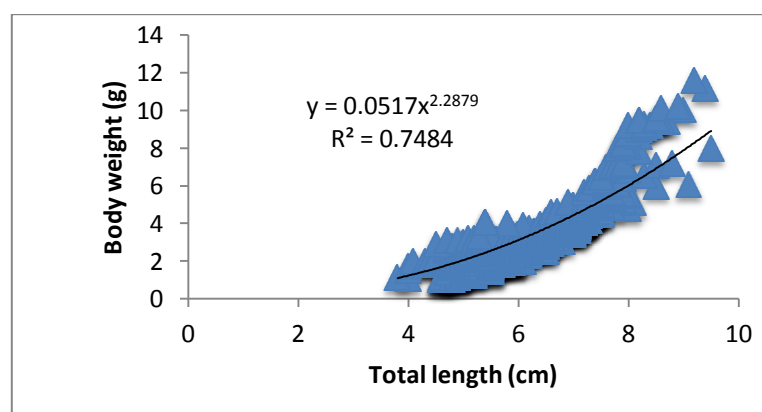


Figure 4.26: The relationship between total length (cm) and body weight (g) in the combined *P. sophore*

4.3 Condition factor

The mean value of condition factor was recorded as 1.46, 1.45 and 1.46 for male, female and combined population, respectively indicating good well-being of fishes. For female, the highest and lowest mean value of condition factor was recorded as 1.81 in January and 1.09 in November respectively. For male, the highest and lowest mean value of condition factor was recorded as 1.77 in January and 1.08 in May respectively. For combined population, the highest and lowest mean value of condition factor was recorded as 1.80 in January and 1.09 in May respectively.

4.4 Growth parameters

The value of asymptotic length L_{∞} and growth coefficient K obtained by ELEFAN-1 program based on length frequency data. The growth parameters are useful in assessing the growth rates between and within individuals in various environments. In the present study, the value of L_{∞} was found as 8.93 cm, 9.98 cm and 9.98 cm for male, female and combined population respectively. The value of K was found as 0.970 y^{-1} , 1.500 y^{-1} and 10.00 y^{-1} for male, female and combined population respectively. The value of ϕ was recorded as 1.88, 2.17 and 2.99 for male, female and combined population respectively.

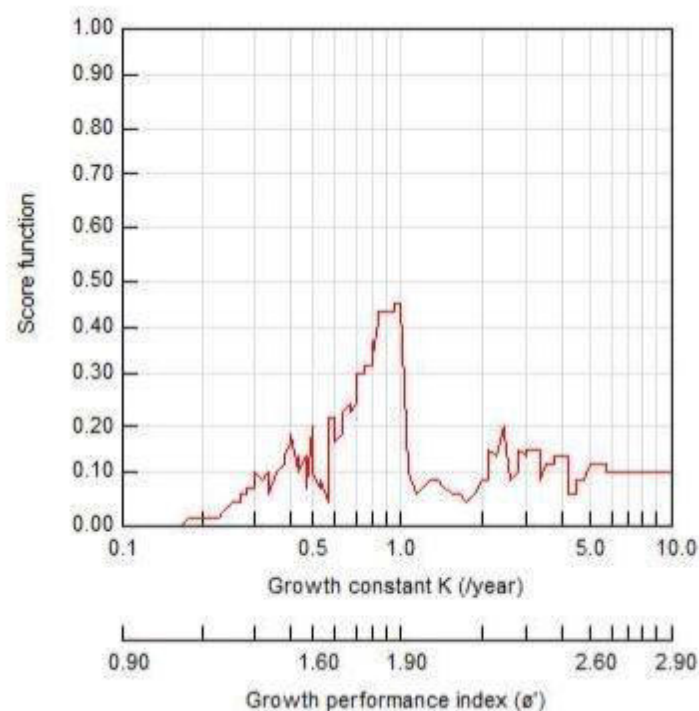


Figure 4.27: Growth coefficient and growth performance index of *P. sophore* (Male)

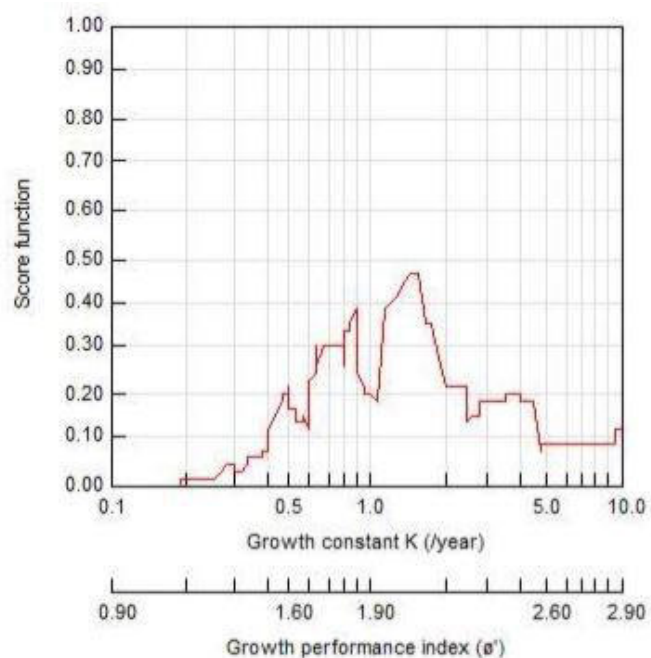


Figure 4.28: Growth coefficient and growth performance index of *P. sophore* (Female)

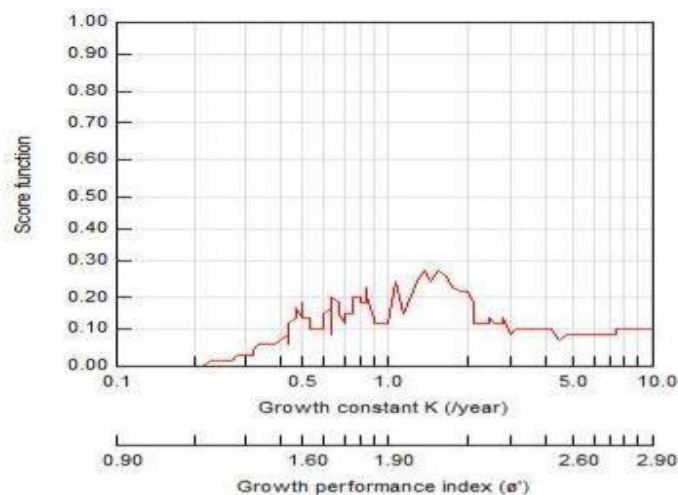
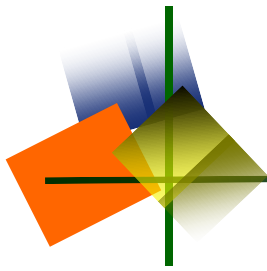


Figure 4.29: Growth coefficient and growth performance index of *P. sophore* (Combined)

Table 4: Growth parameters of *Puntius sophore* for male, female and combined population

Treatment	L_{∞} (cm)	K (y^{-1})	$\emptyset$
Male	8.93	0.970	1.88
Female	9.98	1.50	2.17
Combined	9.98	10.00	2.99

L_{∞} =asymptotic length, K =growth coefficient and $\emptyset$ =growth performance index.



CHAPTER V

DISCUSSION

CHAPTER V

DISCUSSION

The research analyzed a total of 620 individuals of *Puntius sophore*. Among them, 261 were male and 359 were female. The samples are monthly collected throughout the year. The maximum recorded length and weight of *P. sophore* from the Kolkata fish market, India was 11.10 cm and 21.1 g (Pal *et al.*, 2013) which were similar to the present study. However, In some Bangladeshi water bodies isometric growth ($b=2.95$) of *P. sophore* was reported with a maximum recorded total length of 10.66 cm (Hossain *et al.*, 2012) which was also similar to the present study.

5.1 Length-weight relationship

In the present study, the value of the growth coefficient (b) showed negative allometric. This value is significantly smaller than 3 showing that weight of the fish is less than a cube of its length and thus does not follow the cube law. Similar results to present study were reported for this fish species collected from Padma River, Bangladesh (Alam *et al.*, 2012), Chenab river, Pakistan (Latif *et al.*, 2017), Ganga river, Bangladesh (Hossain *et al.*, 2012). The negative allometric growth observed may be due to lower feeding proficiencies.

Dissimilar results of the growth coefficient (b) to present study were reported for this fish species collected from Chalan beel, Bangladesh (Rahman *et al.*, 2012), Kolkata Fish markets, India (Pal *et al.*, 2013), Mathabhanga river, Bangladesh (Hossain *et al.*, 2006b), Indus river, Pakistan (Haji *et al.*, 2016). Several researchers observed positive allometric growth due to the higher proficiencies in feeding, availability of food and other associated factors (Soni and Kathal, 1953; Kaur, 1981; Saikia *et al.*, 2011; Bura and Goswami, 2013; Deka and Bura, 2015).

5.2 Condition factor

In the present study, condition factor was recorded which is greater than 1 indicating good well-being of fishes. Similar results recorded which were collected from Kolkata and sub-urban fish markets (Monalisa *et al.*, 2013), Chalan beel (Rahman *et al.*, 2012; Rahman and Hossain 2012), Atrai and Brahmaputra Rivers (Islam *et al.*, 2017), Jamuna river (Hossain *et al.*, 2012b).

5.3 The growth parameters

L_{∞} is the largest theoretical length when a species could attain in its habitat (Rosli *et al.*, 2015). The Von Bertalanffy growth factors, $L_{\infty} = 63.90$ mm and 74.17 mm for male and female respectively were recorded of *Puntius sophore* collected from old Brahmaputra river, Bangladesh (Ferdous *et al.*, 2012) which was lower to the present study. The value of K was recorded as 0.156 year^{-1} and 0.141 year^{-1} for male and female respectively which was higher to the present study. The value of growth performance index (ϕ) was recorded as 2.80 and 2.89 for male and female respectively which was higher to the present study. The fluctuations of these parameters with present study may be due to food availability.



CHAPTER VI

SUMMARY AND CONCLUSION

CHAPTER VI

SUMMARY AND CONCLUSION

Puntius sophore is an important member of small indigenous species belonging to the order of Cypriniformes (Rahman, 2005). It is locally known as pool barb. It is mostly a nutritious fish species and found in a good amount in Chikli river. But day by day the production is decreasing. To increase the production of *P. sophore*, it is important to study the stock assessment, sustainable management and conservation initiative.

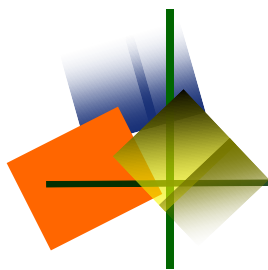
The study of length-weight relationship is used to inform of biological significance such as maturity, taxonomic differences in species, population dynamics, suitability of habitat etc. Condition factor is useful parameter for assessing the well-being of the individuals.

The present study was performed with the purpose of length-weight relationship and condition factor of *P. sophore* in Chikli river under Nilphamari district. Samples were collected monthly from March 2018 to February 2019. Length was measured in the laboratory using centimeter scale fitted upon a wooden structure. The body weight of individual fish was weighed by an electric balance nearest to 0.001g. A total of 620 fishes were collected. Among them, 359 were female and 261 were male.

In this study length-weight relationship were found as $BW=0.123TL^{2.29}$, $BW=0.190TL^{2.02}$ and $BW=0.051TL^{2.87}$ for female, male and combined population respectively. The value of intercept 'a' was found as 0.123, 0.190 and 0.051 for female, male and combined population respectively. The value of 'b' was found as 2.29, 2.02 and 2.87 for female, male, and combined population respectively. Moreover, coefficient of determination (R^2) found as 0.88, 0.86 and 0.74 for female male and combined population respectively. The generalized 'b' value was 2.87 indicating negative allometric growth of *Puntius sophore*. The mean value of condition factor was recorded as 1.46, 1.45 and 1.46 for male, female and combined population, respectively indicating good well-being of fishes. For combined population, the highest and lowest mean value of condition factor was recorded as 1.80 in January and 1.09 in May respectively. The condition factor greater than 1 indicating good well-being of fishes. The value of L_{∞} was found as 8.93 cm, 9.98 cm and 9.98 cm for male, female and combined population respectively. The value of K was found as 0.970 y^{-1} , 1.500 y^{-1} and 10.00 y^{-1} for male,

female and combined population respectively. The value of $\emptyset$ was recorded as 1.88, 2.17 and 2.99 for male, female and combined population respectively.

The current study provided the basic information about growth performance of *P. sophore* through length-weight relationship and condition factor in Chikli river which could be helpful for effective and sustainable fishery management. The regression coefficient indicated negative allometric growth in the present study. Moreover, the condition factor revealed that fish healthy in relation to their environment in Chikli river. Therefore, the present study will be helpful for fishery managers and future researcher to provide guidance in carrying out further detail study on other species in Chikli river and impose adequate regulations for sustainable fishery management.



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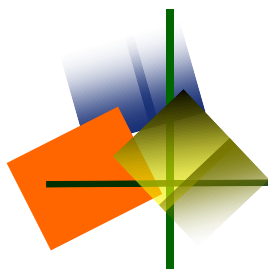
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APPENDICES

APPENDICES

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	946.877	1	946.877	977.872	.000 ^a
	Residual	342.780	354	.968		
	Total	1289.657	355			

a. Predictors: (Constant), General female total length

b. Dependent Variable: General female total body weight

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	377.061	1	377.061	778.540	.000 ^a
	Residual	125.438	259	.484		
	Total	502.500	260			

a. Predictors: (Constant), General male total length

b. Dependent Variable: General male total body weight

ANOVA^b

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1429.297	1	1429.297	1.795E3	.000 ^a
	Residual	492.028	618	.796		
	Total	1921.325	619			

a. Predictors: (Constant), General combined total length

b. Dependent Variable: General combined total body weight