Seasonal Changes in Biology and Biochemical Composition of *Labeo gonius* (Hamilton) Reared in Mini Earthen Pond

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By

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Seasonal Changes in Biology and Biochemical Composition of *Labeo gonius* (Hamilton) Reared in Mini Earthen Pond

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DECLARATION

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

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TO

MY BELOVED PARENTS

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ABSTRACT

To study the biology of small indigenous species *Labeo gonius* reared in mini earthen pond in the Khulna University campus monthly changes in length – weight relationship, GSI and fecundity were observed in the Laboratory. A total of 114 species of *L. gonius* was collected randomly during the one year study period from September 2004 to August 2005. The equation for total – length weight relationship of the species was found to be $W = 1.122TL^{1.0418}$. The mean value of condition factor (K) and relative condition factor (K_n) for *L. gonius* was 229610 and 0.90 respectively. The average value of SD was found ±309780.1 in case of condition factor and ±0.88 in case of relative condition factor.

The fecundity is more directly related to the ovary weight. The regression line of fecundity on total length, body weight and gonad weight were all found to be linear and positive and their co-efficient were all positive and significant at 5% level of significance except the total length – body weight relationship which was found insignificant at 5% level of significance.

From their monthly dynamics in GSI, spawning seemed to have taken place somewhere between May to July with a peak in May for male and July for female. Furthermore, GSI revealed that *L. gonius* has a short spawning season.

Monthly changes in nutrient content like protein, lipid, ash and moisture were assessed in the *L .gonius* in wet weight basis during the month September 2004 to August 2005. The highest value of protein percentage in the body flesh was found in February where (20.62 ± 0.509) for combined sex. The highest value of lipid % in the body flesh was found in April (9.55 ± 0.59) for combined sex. The highest value of moisture % in the body flesh was found in June (87.92 ± 1.195) for combined sex. The highest value of ash % in the body flesh was found in May (2.93 ± 0.050) for combined sex. From the nutritional point of view it shows that the nutrient content of *L .gonius* is undeniable to other small and large fishes.

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LIST OF ABBREVIATIONS

BBS	Bangladesh Bureau of Statistics
GDP	Gross Domestic Products
DOF	Department of Fisheries
GSI	Gonado Somatic Index.
K	Condition Factor
K_n	Relative Condition Factor
W	Weight
TL	Total Length
SL	Standard Length
TW	Total Weight
GL	Gonad length
GW	Gonad Weight
BW	Body Weight
TBW	Total Body Weight
d.f.	Degree of Freedom
SS	Sum of Square
SST	Total Sum of Square
SSE	Error Sum of Square
SSTR	Treatment Sum of Square
MS	Mean Square
MSE	Error Mean of Square
MSTR	Treatment Mean Square
SD	Standard Deviation
SIS	Small Indigenous Species.

ANOVA	Analysis of Variance.
cm	Centimeter
gm	Gram
Sig.	Significance
F.M.R.T	Fisheries & Marine Resource Technology Discipline
S	September
O	October
N	November
D	December
J	January
F	February
M	March
A	April
M	May
J	June
J	July
A	August

CHAPTER ONE

GENERAL INTRODUCTION

GENERAL INTRODUCTION

Bangladesh has a geographical area of 1.4 million Km^2 with an estimated population of about 120 million. Her vast water area includes 43.1 million hectare of fresh water which is an excellent ecological condition for the propagation of fish and related organism (BBS 1994). Fish is one of the most important export items of the country that contribute about 5.10 % of the export earning and 4.91 % to GDP. About 63 % animal proteins are supplied from fish (DOF, 2002 – 2003). The importance of fish for consumption is increased rapidly because of increased population. As a result daily per capita consumption of fish has dropped 26 gm/day. Per capita fish consumption is needed 18 kg/annum, where as the actual picture is 14.14 kg/annum (DOF, 2002 - 2003). About 80% of our annual catch comes from inland waters of which are breathing fish like singi, magur, koi, bata and account for about 20% of the total catch in Bangladesh (GoB, 1984).

Bangladesh steps in a new millennium with high hopes and aspirations, strengths weakness and new opportunities and constraints for its development. Bangladesh is blessed with vast natural resources and fisheries resources are more significant among these. Fisheries sector plays a vital role from the point of nutrition supply, employment generation, foreign exchange earning and others areas of economy. The total production from the freshwater resources of our country is very high in the world except from China, and India, producing more inland fish than Bangladesh (Nuruzzaman, 1987).

The country is extremely flat and intercepted by thousand of branches of three main rivers. Every year when snow on the Himalayas melt, the onrush of waters passes through the country gradually overflowing the bank of these rivers and flooding a large portion of the country. The flooded lands are extremely fertile because of deposited sediment and provide a rich habitat for freshwater tropical fish. Beels are excellent natural habitat for large and small indigenous fishes of different food habit (Mustafa *et al.*, 1983).

Among the aquatic lives, the number of freshwater indigenous fish species has been recorded a total of 260 including some brackish water species (Rahman, 1989). Recently, FAP17 (1994) identified 231 species in Bangladesh from several freshwater habitats. Most of these are small and were abundant in all the compartment of the aquatic habitat.

Prior to 1970, many different small indigenous fishes like Koi, Taki, Veda, Pabda, Bata, Gulsa, Mola, Puti, Shing and Magur etc were abundant in almost all the freshwater areas of Bangladesh. Due to the price and availability, these species of fish always occupy an important part of the daily consumption of all classes of people especially low income groups. Moreover, these small indigenous fish were delicious and popular food items in their diet. They were commonly caught by the large number of subsistence fishermen and provide a major portion of their protein intake. Moreover, these indigenous fish were favorite and popular for their taste (Moniruzzaman, 2000).

There are 260 freshwater species in Bangladesh (DOF, 2002). *Labeo gonius* is an important species of the class Osteichthyes under the phylum Chordata. They are belonging to the family Cyprinidae. Fish stock particularly those dwelling in inland open waters, have gradually become endangered. Ameen *et al.* (2000) has documented about 56 freshwater fish species critically or somewhat endangered and *Labeo gonius*, locally called as goni bata, or Bata, is not exceptional one. It is one of the most popular food fish among bata species and once was widely distributed throughout the rivers, haors, baors, beels jheels, canals and ponds of Bangladesh. Once easily available in nature the fish has, recently became scare because of many adverse changes on their natural breeding and growing habitats. For this reason, *Labeo gonius* fry is very rare in nature.

Labeo gonius (Hamilton) is the dominant species of carp found in the natural water of Assam. This species is cultivated in the ponds of Assam, along with the major carp *Labeo rohita* and *Catla catla,* in preference to *Cirrhinus mrigala,* which is not consumed by the majority of people in this state on religious grounds. There is hence a high demand for the seed of *L. gonius* in the state from fish culturist. To know the origin of stock or separation of stocks and races of commercially important species of this fish morphometric characters are only studied by Chatterji (1985).

According to Day (1878), the habitat of *Labeo gonius* is throughout nortern and eastern India, as low as the Krishna in peninsular India, Pakistan, Bangladesh and Burma. Job *et al.* (1955) have reported that in Mahandi this fish, though found in rapid and slow moving waters, prefers to inhibit shallower portion of the river, where there is plentiful growth of submerged weeds and that economically it does not constitute an important fishery.

The medium size carp, like other Indian carps, breeds in inundated rivers during the monsoon months. The spawning habits of this fish have been studied by Khan (1924) and Ahamed (1936, 1944) and its life story, by Ahamed (1944) and Mookerjee and Ganguli (1949). The identifying characters of the larval and post-larval stages of the species have been described by Khan (1926), Ahamed (1944), Mookerjee (1943) and Mookerjee *et al.* (1944). Some observations on the maturation and induced breeding of *L. gonius* have been made in Assam by Parameswaran *et al.* (1970, MS). However, there is paucity of published information on the various aspects of the bionomics of the fish.

Intensive study of various aspect of biology of fish such as length – weight relationship, fecundity, gonado – somatic index etc is of crucial important in fishery management. Analysis of proximate composition including moisture, protein, fat and ash is very important to evaluate food value and also to find out seasonal quantitative variation in order to correlate with the gonadal variation. Proximate analysis is an index of nutritive value because the fractions it isolates are correlate with some of the properties of organisms that are nutritionally significant.

Labeo gonius occupies a good position among all the freshwater fishes. Although this fish is commercially important but few research have so far been done on the length –weight relationship, gonado – somatic index, fecundity and proximate composition for the following purposes.

- To know details information about length – weight relationship, gonado – somatic index and fecundity.
- To asses the annual changes of proximate composition.

CHAPTER TWO

BIOLOGY OF *Labeo gonius*

INTRODUCTION

2.1.1 Background of the study:

Bangladesh is blessed with vast natural resources which are full of fishery resources. But the fishery resources are depleted every day due to water pollution, physiochemical changes of water and above all improper fisheries management and conservation measure. Bangladesh is one of the populous countries in the world. Here population is increasing day by day at an alarming rate in comparison with land. As the days proceed the nutritious foods are decreasing with the increasing of population of Bangladesh. About 75% people have been suffering from malnutrition. So the millennium the greatest challenge of Bangladesh is to combat the prevalent malnutrition and it is possible to fight against such sort of challenge by proper utilization of biological resources especially fisheries resources.

Fish is an excellent source of protein. Hossain *et al* (1994) mentioned that among the fishing communities' small fish occupy an important position as a popular food item. Small indigenous fishes have a high nutritional value in terms of both protein and presence of micronutrients, vitamins and minerals (Akteruzzaman *et al.,* 1997). They contain large amount of calcium and most likely also iron and zinc (Tripathi, 1997). But over the last several decades the supply of fish had been declining and fish was becoming scare day-by-day. As a result daily per capita consumption of fish has dropped. Per capita annual fish needed in our country about 18 kg but per capita annual fish intake is about 14.14 kg (DOF, 2003). Unfortunately, the present productions are unable to fulfill the country's demand and as a result there is a severe chronic deficiency in essential nutrients in the diet of the people of Bangladesh (Ahamed *et al.,* 1984).

For commercial fisheries, the determination of optimum catch volume in the mandatory in order to determine the optimum level or rate of any aquatic animals of commercial value, the information on its exploitation, abundance, size, sex, and growth, recruitment and mortality are essential. In any fisheries management regime, the growth, sex ratio, length –weight relationship, size frequency distribution and other biological factors are foremost important in taking a balance management decision.

Knowledge of length – weight relationship is essential to establish growth equation in production computation (Rao *et al.* 1987). It can also provide data of seasonal variation, multiple spawning and variation in food consumption. (Rounsefell and Eveerhat, 1953; and Lagler, 1956). The length – weight relationship is used in fishery geology to investigate environmental adaptability, racial discrimination as well as to estimate growth of species. The departures from the relationship between length and weight are used in fishery biology to investigate environmental suitability, racial discriminations, general well being or relative robustness of fish by means of a condition factor (Hile, 1936). The condition factor also serves as a useful index of the nutritional and biological cycle *viz.* gonadal development, spawning etc. of the species.

Relative condition factor (K_n) is a useful index for estimating the physical well being as well as nutritional and biological cycle. A cycle change in condition occurs annually as the fish; particularly the female develops its gonad. While upon grow the fish become relatively heavier, so that 'n' increases and may be greater than 3. directly after spawning the fish is thin and poor in condition so value of 'n' drops down to less than 3 (Le Cren, 1951).

The reproductive capacity of a population is a function of the fecundity of the females. Fecundity is the general term used to describe the number of mature eggs produced by an individual female (Lagler, 1949). Fecundity or reproductive potential can be defined as the number of ova shaded during a particular spawning season (Pillay, 1964). Fecundity can also be defined as the number of ripening eggs in the female period to the next spawning season (Bagenal, 1968). Fecundity is one of the most important biological aspects of the fish. This must be known to assess the productive potential and evaluate the commercial potentialities of a fish stock and also be used to assess the abundance and reproductive potential of spawning stock. Variation in fecundity is very common among the same species of fish depending on their size, age and environmental condition (Lagler, 1956). Studies on fecundity are receiving attention now a day as they play a key role in fish stock management.

Gonado somatic index (GSI) was done to know the maturity and exact time of spawning which is essential for providing better understanding in spawning. Maturation refers to the cyclic morphological changes which the female and male gonads undergo to attain full growth and ripe.

2.1.2 Objectives of the study:

Considering the importance and need of the species, *Labeo gonius* the present study was planned in order to achieve the following objectives.

- To know the maximum and minimum length of the species.
- To know the growth rate of fish species.
- To know the condition & relative condition factor of the species for corresponding length group.
- To know the exact number of fecundity present in the ovaries this is highly important to evaluate the recruitment pattern.
- To observe the maturity and exact time (season) of spawning which does essential for providing better understand in spawning.

REVIEW OF LITERATURE

Prior to conduct an experiment, it is essential to know the information about the previous related works. So far as, Bangladesh is concerned there is a little publication on the different aspects of biology of *Labeo gonius*. The following information was reviewed in favor of the present study, which was performed elsewhere in the world and relevant to the study.

A number of authors established some relationship between fecundity and total length, body weight and gonad weight. Bagenal (1996) reported that the relationship between fecundity and length for most species was curvailinear. Pillay (1958) found the linear relationship between fecundity and the body weight of hilsa, and the relationship between fecundity and length was curvilinear. However, there are also reports having a linear relationship between the length and the fecundity (Mathur, 1964; Swarup 1961; Doha and Hye, 1970; Shafi *et al.*, 1977).

Khan *et al.* (2002) reported that the fecundity of *Plotous canius* was a linear relationship to total length, body weight and ovary weight. The results of correlation regression equation of total length – fecundity, body weight – fecundity and gonad weight – fecundity were r = 0.832619, r = 0.933599 and r = 0.9618. On average 2.3718 ova are produced in per gram weight of body. Study on gonado somatic index indicated that the mature fish become available from April to August, the peak being July.

Ali *et al.* (1992-94) observed that the male female ratio of *Clarias batrachus* was 1: 0.857. From their monthly dynamics in GSI and spawning seemed to have taken place somewhere between April and May. There existed highly positive correlation between fish body weight and fecundity (r = 0.938), length and fecundity (r = 0.979), total weight and gonad weight (r = 0.979), ova diameter and fecundity (r = 0.852) and a weakly positive correlation between ova diameter and gonad weight (r = 0.706). The maximum fecundity was 6050.

Hoda and Khan (1997) reported that spawning occurred twice a year i.e. February to April and September to October, as evidenced by ova diameter polygons, GSI and K_n values. The equation between fecundity and total length, fish weight, ovary weight and ovary length has been determined. Mean fecundity was 38318. Male-female sex ratio found to be 1.6: 1.

Khan *et al.* (1992) observed that of the total 139 female specimen of *Mystus tengra* collected in 12 months, the smallest 5 cm was found in October and the biggest 7.7 cm in May. Statistical analysis showed a significant correlation between length and weight (r = 0.9365248, P = 0.1). Fecundity studied during the peak-breeding season June and July varied from minimum 720 to maximum 733 eggs.

Sarker *et al.* (2002) showed that fecundity and gonado somatic index of *Mystus gulio*. At different length ranged from 10 – 20 cm of fish showed different fecundity and significantly highest mean fecundity was found 21589 (19394 - 23481) from 20 – 22 cm in length ranges of fish. Whereas significantly lowest mean fecundity was 11887 (11436 - 12712) from 10 – 12 cm length ranges of fish. Ovary weight ranges from 16 – 18 gm. Showed significantly highest fecundity 21378. This study stated that the fecundity of fish increased with the increase in size, weight and gonad weight as well. The highest GSI values were found in July. Furthermore, GSI showed that *M. gulio* has a wide spawning season.

Chattergi and Siddiqui, (1979) showed that *Labeo bata* normally breeds in river during monsoon months in inundated flood plains as Indian major carps do and attains a maximum length of 290 mm and weight of 180 g (Rahman, 1989). The relative condition factor was found to be high during monsoon months (spawning period) from April to July reflecting the maturity of the fish.

Chatterji, A. (1985) showed Mean standard length. Mean head length and mean body length of *Labeo gonius* were calculated to be 82.07%, 17.20% and 46.8% respectively in the fishes of river Kali and 82.88%, 16.44% and 65.43% respectively in the fishes of Chau Tal. The regression lines of different body measurements on total length were found to be linear, which shows an isometric growth of fishes.

Doha and Hye (1970) reported that the fecundity of *Hilsa ilisha* was found to be very high ranging from 348318 (fork length of fish 273 mm) to 1465969 (fork length of fish 42 mm) in number. A regression equation, Y = 1000 (-1679.282454 + 7.0658x), with r = 0.916. It appears that the fork length and the fecundity bear a linear relationship.

Shafi and Quddus (1973, 1974 and 1975) reported that total length with weight of the fecundity of the different species of carp like *Labeo nandina*, *Catla catla, Labeo calbasu, Labeo rohita* and *Cirhina mrigala* were estimated by the gravimetric method. Mathematical relationships of total length with girth condition factor had been estimated.

Dewan and Doha (1979) reported that the fecundity of seven species of pond fishes viz. *Chela phulo, Esomus danrica, Amblypharyngodon mola, Aplocheilus panchax, Ambassis nama, Glossogobius giuris* and *Colisa lalius* ranging from 176 – 3930, 392 – 2412, 1021 – 13815, 39 – 486, 110 – 2448, 376 – 24668 and 127 – 2309, respectively.

Mustafa *et al.* (1980) studied the food, feeding habits and fecundity of the fresh water perch, *Nandus nandus.* They reported that fish length ranged from 6 to 16.8 cm and body weight ranged from 5 to 60 gm. The fecundity ranged from 7381 eggs for a fish with body length of 13.5 cm and 46222 eggs for a fish with body length of 13.5 cm. the fish was highly fecund for its size. Breeding season ranged from June to July. Mathematical relationship between body length – fecundity and body weight – fecundity were found to be linear.

Bhuiyan and Rahman (1983) reported that the fecundity of *Channa gachua* (Hamilton) ranged from 487 to 4482 eggs. The r-values for F/TL, F/TW, F/GL, and F/GW, were 0.757743, 0.760288, 0.895879 and 0.932916, respectively.

Mustafa *et al.* (1983) studied the biology of *Puntius sarana* and they reported that its fecundity ranged from 18925 to 78929 and length between 155 mm and 250 mm. Mathematical relationship between fecundity and total length, fecundity and body weight, and fecundity and ovary weight were linear where as a curvilinear relationship was noted between fecundity and standard length of the fish.

Banu *et al.* (1985) reported the fecundity of *Anabus testudineus* (Bloch) varies from 12355 eggs (a fish with total length 12.3 cm and weight 30.24 gm) to 41820 eggs (a fish with total length 15.5 cm and weight 66.62 gm). The correlation co-efficient was highest in case of relationship between fecundity and ovary weight, which indicated that fecundity bears strong relationship with ovary weight. The fecundity was found to be linear relationship with total length, somatic and ovary weight.

Danwattana and Nakorn (1985) reported that the number of eggs of *Channa straitus* was within the range of 12970 – 60283 and having size of 250 – 850 gm in weight and 29.5 – 45.8 cm in length.

Barua *et al.* (1986) are of opinion that *Clarias batrachus* has a single spawning season that last from May to July. Gonado Somatic Index varies in both sexes, reaching the peak in the month of June. They also observed that the mean GSI value was the highest during the highest temperature and the highest rain fall of the year.

Azadi *et al.* (1987) reported that fecundity of the *Mystus vittatus* (Bloch) with the length between 89 and 115 mm was found to range from 2515 – 9789. The fecundity was found to bear linear relationship with total length, body weight and ovary weight.

Azadi and Naser (1996) showed calculated equations for the length-weight relationship for the male, female and combined fishes were $W = 0.00579\ TL^{3.1645}$ or $\log W = -2.2372 + 3.1645 \log TL$ ($r = 0.99$, $t = 62.86$), $W = 0.005176\ TL^{3.2012}$ or $\log W = -2.2859 + 3.2012 \log TL$ ($r = 0.99$, $t = 66.73$) and $W = 0.005449\ TL^{3.1852}$ or $\log W = -2.2636 + 3.1852$ LOG TL ($r = 0.99$, $t = 66.73$) respectively. The relative condition for (K_n) for male, female and combined sexes ranged from 0.96 (for 16-17 cm length range) to 1.08 (9-10 cm length range) (mean 1.001 ± SD 0.0256), 0.96 (length range 15-16 cm) to 1.06 (length range 9-10 cm) (mean 1.0007 ± SD 0.0228) and 0.97 (length range 15-16 cm) to 1.07 (length range 9-10 cm) (mean 1.007 ± SD 0.0225) respectively.

Das *et al.* (1989) reported that the fecundity of the *Heteropneustus fossilis* ranged from 1200 – 23500, total length from 103 mm – 298 mm and body weight 7.5 gm to 73 gm with an average fecundity of 9722. The diameter of eggs ranged from 800 to 1500 microns. The fecundity of this fish bears linear relationship with total length and also with body weight.

MATERIALS AND METHODS

From the present study, a total of 115 random specimens of *Labeo gonius* were collected monthly from September 2004 to August 2005 from the cultured pond, Khulna University Khulna. Live fish were firstly washed and cleaned by blotting paper to dry the specimen. Then the total length (TL) was measured with the help of a centimeter scale. The total body weight was taken with the help of electric balance (B-303S). The length and weight were recorded in the nearest centimeter and gram respectively. The experiment was conducted in the Fish Nutrition Laboratory of Fisheries and Marine Resources Technology Discipline, Khulna University, Khulna.

2.3.1: Length – weight Relationship

It has been found that the length – weight relationship of most fishes can be described satisfactory by the following relationship given by Le Cren, (1951).

$$W = a\,L^n \quad \text{.......................................} \quad (I)$$

Where 'a' is a constant or intercept and 'n' is an exponent or slope. This formula has been followed in the present study.

The exponential form of relationship in formula (I) can be expressed in the logarithmic form:

$$\text{Log } W = \text{Log } a + n \text{ Log } L \quad \text{.....................} \quad (II)$$

The values of 'a' and 'n' have been calculated for the total length – weight (TL – W) standard Length – Weight (SL - W) and fork Length – Weight relationships, using log – log relationship in formula (II)

The values of 'a' and 'n' in formula (II) were calculated by using the following mathematical relationship. (Reounsefell and Evehart, 1953; Lagler, 1956; Doha and Dewan, 1979):

$$Loga = \frac{\sum LogW.\sum (LogL)^2 - \sum LogL \sum (LogL \times LogW)}{N.\sum (LogL\,)^2 - (\sum LogL)^2}$$

and $$n = \frac{\sum LogW - (N.Loga)}{\sum LogL}$$

Where, W = Weight in gram (gm)

L = Length (TL) in cm and

N = Sample Size

In calculating the co-efficient of regression for the least square (Y = a + bx) was followed and co-efficient of correlation 'r' was calculated from the following formula:

$$r = \frac{\sum XY - \frac{\sum X.\sum Y}{N}}{\sqrt{\left[\left\{\sum X^2 - \frac{\left(\sum X^2\right)}{N}\right\}\left\{\sum Y^2 - \frac{\left(\sum Y^2\right)}{N}\right\}\right]}}$$

The significance of 'r' is tested by 'F' test; 'F' was calculated by following formula.

Source	df	SS	MS = SS/df	F - statistic
Treatment	k – 1	SSTR	MSTR = SSTR/k - 1	F = MSTR/MSE
Error	n – k	SSE	MSE = SSE/n – k	
Total	n - k	SST		

When n = Sample number and k = Number of treatment.

2.3.1.1: Condition Factor (K)

The condition factor can be calculated by the following formulas

$$W = KL^3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(I)}$$

Where W = Weight

L = Length (cm)

K = Condition Factor.

In the present study, the value of 'K' will be known as the condition factor. Formula (I) can be written as:

$$K = W/L^3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(II)}$$

But in general, the value of 'K' is determined by the following formula,

$K = W \text{ X } 10^b / L$ (Jennings *et al.*, 2001)………….. (III)

Where K = Condition factor L = Total length.

W = Body weight b = Power of the length weight equation.

2.3.1.2: Relative Condition Factor (K_n)

In the present study, relative condition factor (K_n) was also determined. Because Le Cren (1951) recommended the relative condition (K_n) as preferable to K, as in former, the effect of length and other correlated factors are eliminated. A total of 115 specimens of *Labeo gonius* were randomly collected from the culture pond for the study of condition factor. Specimens were measured nearest to 0.1 cm and weighted to 0.01 gm.

Relative condition factor was calculated by using the following formula:

$$K_n = W / W'$$

Where W = Observed weight

W' = Calculated weight

2. 3. 2: Fecundity

For the fecundity study, 9 female species were randomly collected from May 2005 to July 2005. The fishes were dissected and the ovary was removed very carefully. In the present studies sex of every young fishes was ascertained by examination of gonad under microscope. The ovaries were identified by the presence of rounded ova in them. The ovaries were preserved in 5% formalin with proper labeling to permit hardening of the ova facilitate for subsequent studies.

Samples from anterior, middle and posterior regions of each lobe of the paired ova were weighed accurately with the help of electronic balance (B – 303S). The numbers of matured and maturing eggs were then found out by counting with the help of a needle and magnifying glass. The maturing eggs were identified by their brownish color whereas the matured eggs were yellow in color. The mean number of eggs was then calculated in the two lobes of each specimen. This mean number of eggs multiplied by the total weight of the two lobes gave the total number of eggs in a particular fish.

It has been shown by Kesteven (1942) that the number of ova holds some exponential relation with the length of fish in the same way, as does the weight. The relationship between fecundity – total length, fecundity – body weight and fecundity – gonad weight were determined by the method of least square, regression lines were fitted to the data and coefficient of correlation was calculated.

The arithmetic relationships between them are as follows:

Fecundity – Total length: F = a + b TL

Fecundity – Body weight: F = a + b BW

Fecundity – Gonad weight: F = a + b GW

The logarithmic relationships between them are as follows:

Fecundity – Total length: Log F = Log a + b Log TL

Fecundity – Body weight: Log F = Log a + b Log BW

Fecundity – Gonad weight: Log F = a + b Log GW

2. 3. 3: Gonado Somatic Index (GSI)

The gonado somatic index of the collected samples was calculated for males and females separately. For the GSI study, 18 specimens were collected of which 9 species were male and 9 species were female. The fishes were dissected and the ovary and testes were removed very carefully. In the present studies sex of every young fishes was ascertained by examination of gonad under microscope. The ovaries were identified by the presence of round ova in them. The weight of each ovary and testes were taken with the help of electronic balance (B-303S).

GSI was calculated according to the following equation cited by Parameswarn *et al* (1974). It can be calculated to ascertain the spawning season of a fish and the seasonal analysis would indicate the peak spawning activity. This is more suitable to explain the maturity of fishes.

$$GSI = \frac{W_1}{W_2} \times 100$$

Where

W_1 = Wet weight of gonad

W_2 = Total wet weight of fish (male or female).

RESULTS

2.4.1: Length – Weight relationship

For determining the length weight relationship of *Labeo gonius,* a total of 114 fish species was collected randomly during the one year study period from September 2004 to August 2005. The total lengths of those fishes were collected in cm scale as well as the total body weight was collected simultaneously in gm. The mean length and weight of each size group of fishes was calculated and plotted in graph against the value of mean weight.

2.4.1.1: Total Length – Weight relationship

The scatter diagram revealed the presence of a linear relationship between total lengths and weight. The regression line of weight on total length was found to be linear and positive (Fig-1). So the relationship can be expressed as Y = a + b TL Therefore

$$W = -8.8221 + 2.409\ TL\ (r = 0.895 \text{ and } F_{cal} = 32.090)$$

The co-efficient of correlation (r= 0.904) was tested by F test and found to be significance at 5 % level of significance ($F_{0.05} = 5.32$) with 9 d.f (Appendix-A)

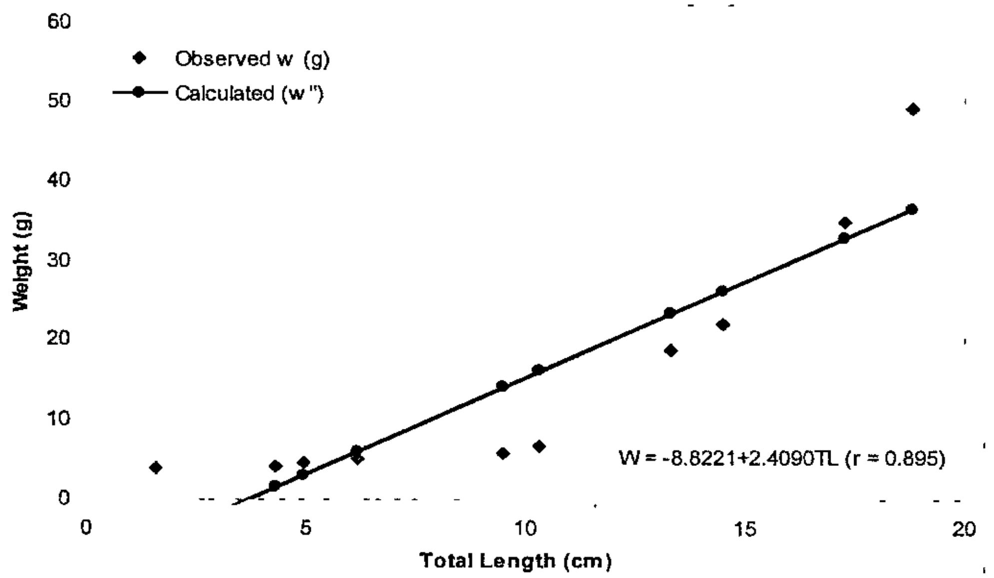

Fig 1: The total length and weight relationship of *Labeo gonius* in Arithmetic scale.

2.4.1.2: Log Total Length – Log Weight relationship

The scatter diagram revealed the presence of a linear relationship between Log total lengths and Log weight. The regression line of Log weight on Log total length was found to be linear and positive (Fig-2). So the relationship can be expressed as

$$\text{Log } W = \text{Log } a + n \text{ Log } L$$

Therefore Log W = 0.05 + 1.1041 Log TL ($r = 0.831$ and $F = 18.488$). Where the value of Log a and 'n' for *Labeo gonius* were found to be 0.05 and 1.1041 respectively.

The co-efficient of correlation ($r = 0.831$) was tested by F test and found to be significance at 5 % level of significance ($F_{0.05} = 5.32$) with 9 d.f (Appendix-A)

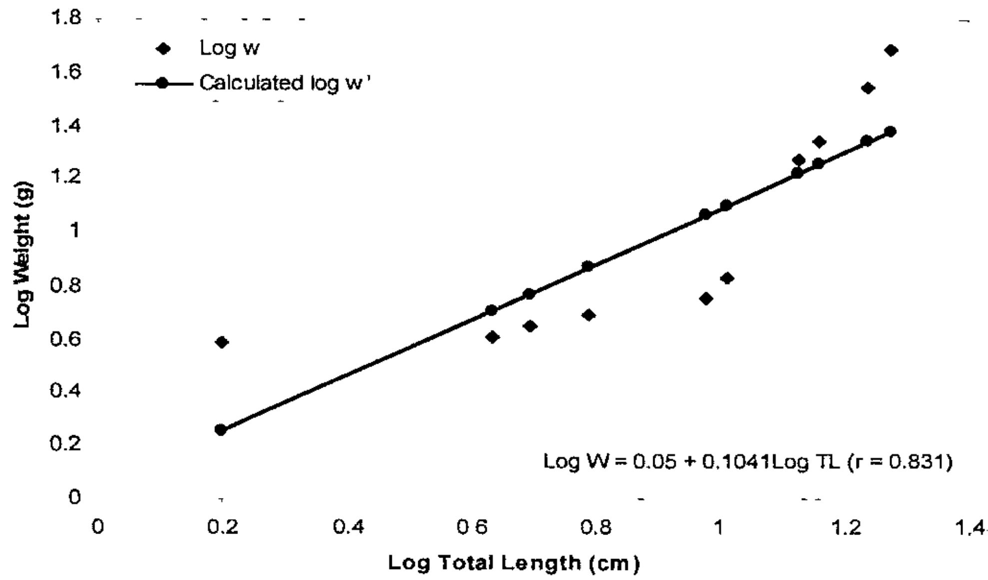

Fig 2: The total length and weight relationship of *Labeo gonius* in Logarithmic scale.

The power equation for total length and body weight relationship of *Labeo gonius* was found to be $W = 1.122\ TL^{1.0418}$

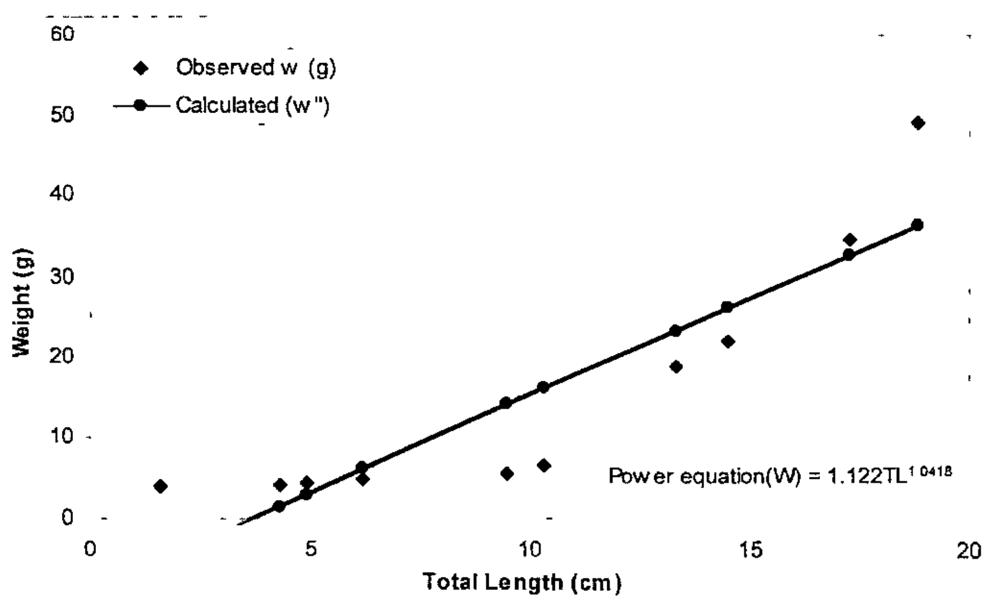

Fig 3: The total length and weight relationship of *Labeo gonius* in Power equation.

By using raw data the arithmetic equation for total length and body weight relationship of *Labeo gonius* was found to be

$$W = -5.012 + 1.921TL$$

Where the value of "r" and "Fcal "was found r = 0.849 and F_{cal} = 291.119 respectively.

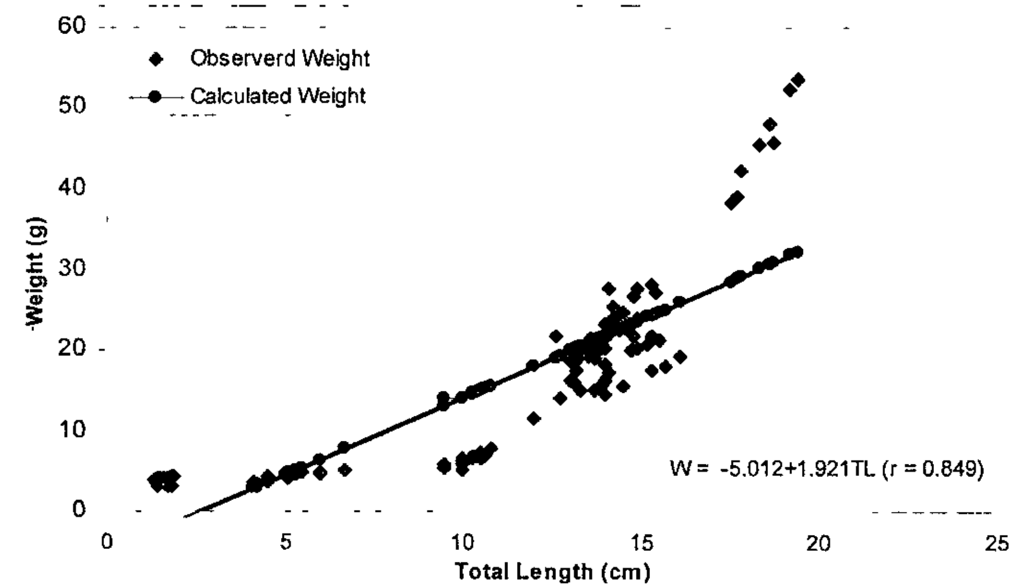

Figure 4: The relationship between total length and weight of *Labeo gonius.*

2.4.1.3: Condition Factor

Condition factor (K) was determined for *Labeo gonius.* The values of 'K' were plotted against mean values of total length. The results are present in Fig – 5. The observed condition factor was found to vary from 6184.286 to 924527.8 respectively with a mean value of 229610.9 and SD± (309780.1).

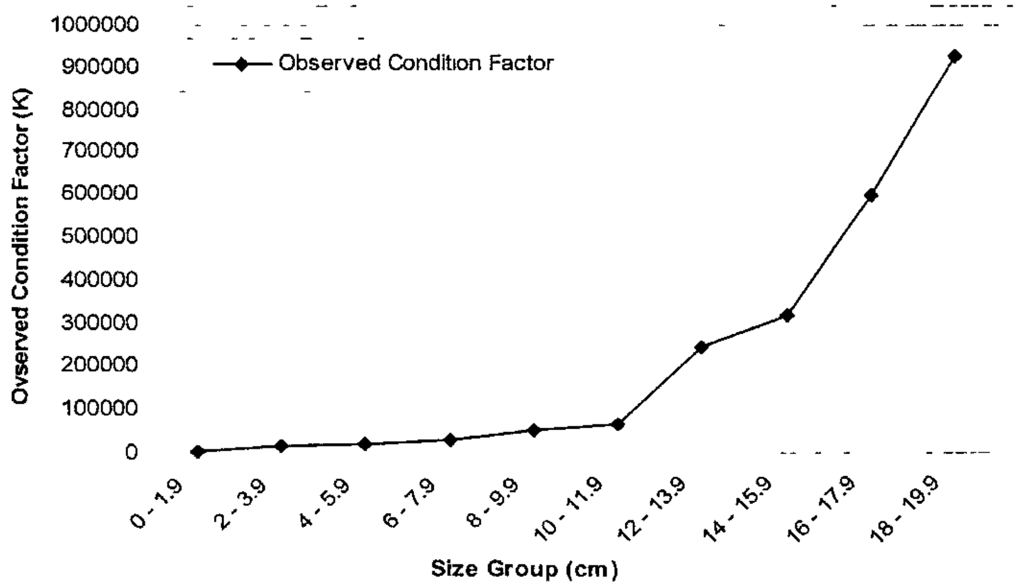

Fig 5: Observed condition factor of *Labeo gonius* in relation to total length.

2.4.1.4: Relative condition Factor

Relative condition factor (K_n) was determined for *Labeo gonius.* The values of 'K_n' were plotted against mean values of total length. The results are present in Fig – 6. The relative condition factor was found to vary from -0.78 to 2.67 respectively with a mean value of 0.90 and SD± (0.88).

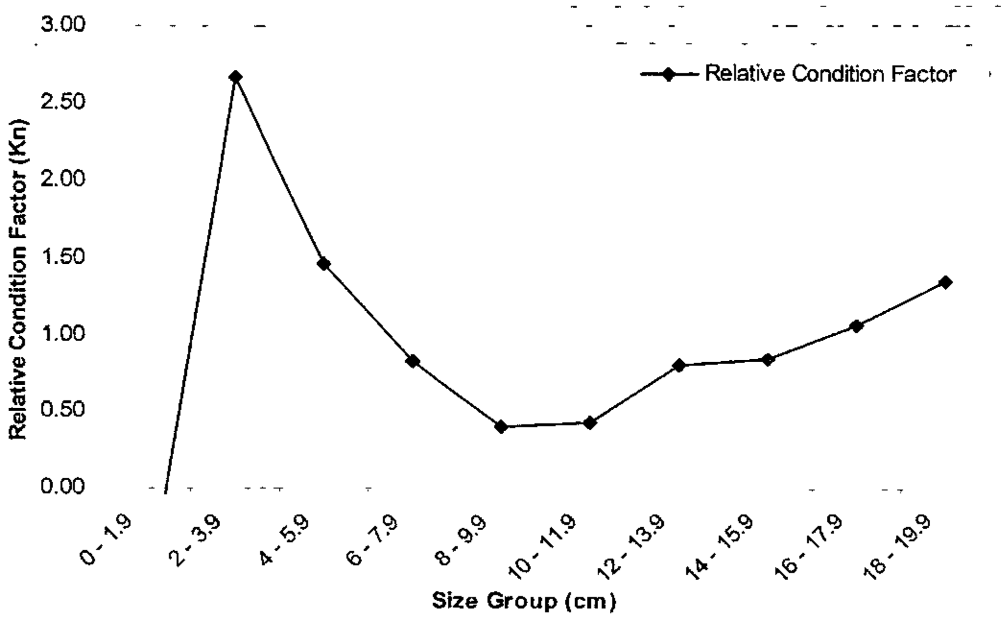

Fig 6: Relative condition factor of *Labeo gonius* in relation to total length.

Table 1: Total length and weight relationship, observed value, calculated value, condition factor of *Labeo gonius.*

Size group (cm)	Frequency	Mean TL (cm)	Observed wt (gm)	Calculated wt (w'')	log TL	log W	Calculated log w'	Condition factor k=(w/L3)*1000	Relative condition factor Kn=w/w''
0 – 2	14	1.59	3.90	-5.00	0.20	0.59	0.26	6184.29	-0.78
2 - 4	2	4.3	4.10	1.54	0.63	0.61	0.71	17630.00	2.67
4 - 6	10	4.94	4.50	3.08	0.69	0.65	0.77	22249.76	1.46
6 - 8	4	6.18	4.98	6.05	0.79	0.70	0.87	30720.63	0.82
8 - 10	2	9.5	5.72	14.06	0.98	0.76	1.07	54344.75	0.41
10 - 12	12	10.32	6.78	16.04	1.01	0.83	1.11	69934.83	0.42
12 - 14	26	13.34	18.70	23.31	1.13	1.27	1.22	249414.90	0.80
14 - 16	36	14.51	21.98	26.14	1.16	1.34	1.26	318990.84	0.84
16 - 18	4	17.28	34.85	32.79	1.24	1.54	1.34	602111.49	1.06
18 - 20	5	18.84	49.07	36.56	1.28	1.69	1.38	924527.78	1.34

Degree of freedom = 9, Significance at 0.05%

2.4.2: Fecundity

Breeding season was indicated by the presence of berried females in the catch. Accordingly, 9 berried female were randomly collected and analyzed for fecundity during three months. Fecundity defined as the number of eggs produced by an individual female (Lagler, 1949) varied in *Labeo gonius* from minimum 799.02 to maximum 4223.5 eggs in fishes having a total length 13.2 cm (18.724 g) and a total length 15.2 cm (20.882) respectively (Table - 2). From the Table – 2 it is revealed that the peak breeding season is in July.

Table 2: Fecundity of *Labeo gonius.*

Months	TL	TBW	GW	Fecundity	Log TL	Log TBW	Log GW	Log Fecundity
May	13.2	18.724	1.066	799.02	1.12	1.27	0.03	2.90
	14.2	22.643	1.389	1149.79	1.15	1.35	0.14	3.06
	13.7	19.162	1.013	708.39	1.14	1.28	0.01	2.85
June	14.4	22.441	3.325	2856.08	1.16	1.35	0.52	3.46
	14	20.297	3.122	3269.1	1.15	1.31	0.49	3.51
	13.8	20.075	3.023	2212.33	1.14	1.30	0.48	3.34
July	15.2	20.882	3.244	4223.5	1.18	1.32	0.51	3.63
	15.5	21.225	3.364	4028.6	1.19	1.33	0.53	3.61
	15.3	21.883	3.342	4260.3	1.18	1.34	0.52	3.63
Mean ± SD	14.4 ± 0.80	20.815 ± 1.38	2.543 ±1.05	2611.90				

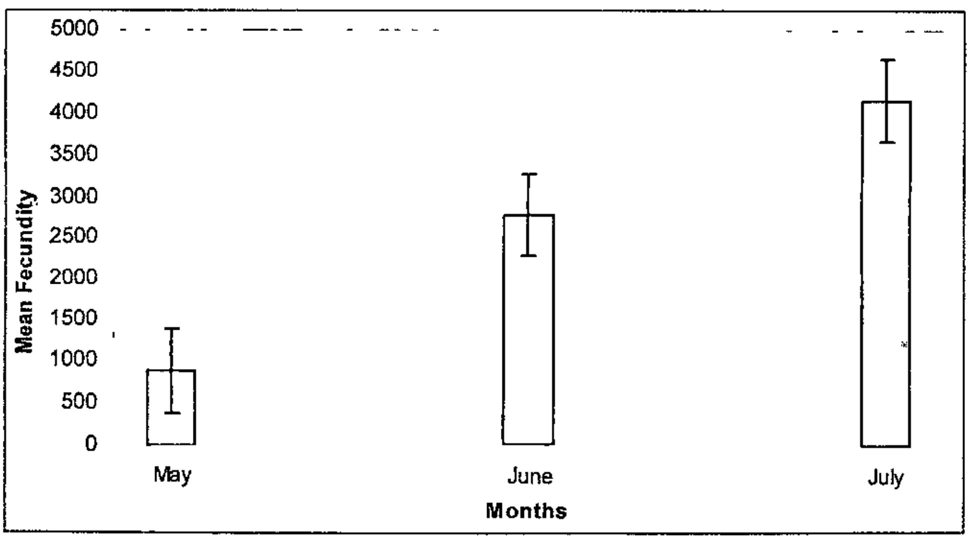

Fig 7: Mean fecundity of *Labeo gonius.*

2.4.2.1: Total Length – Fecundity Relationship

The scatter diagram revealed the presence of a linear relationship between total lengths and fecundity. The regression line of fecundity on total length was found to be linear and positive (Fig-8). So the relationship can be expressed as Y = a + b TL Therefore,

$$Y = -20051.7 + 1577.5\ TL\ (r = 0.867 \text{ and } F_{cal} = 21.171).$$

The co-efficient of correlation (r = 0.867) was tested by F test and found to be significance at 5 % level of significance ($F_{0.05} = 5.59$) with 8 d.f (Appendix-A)

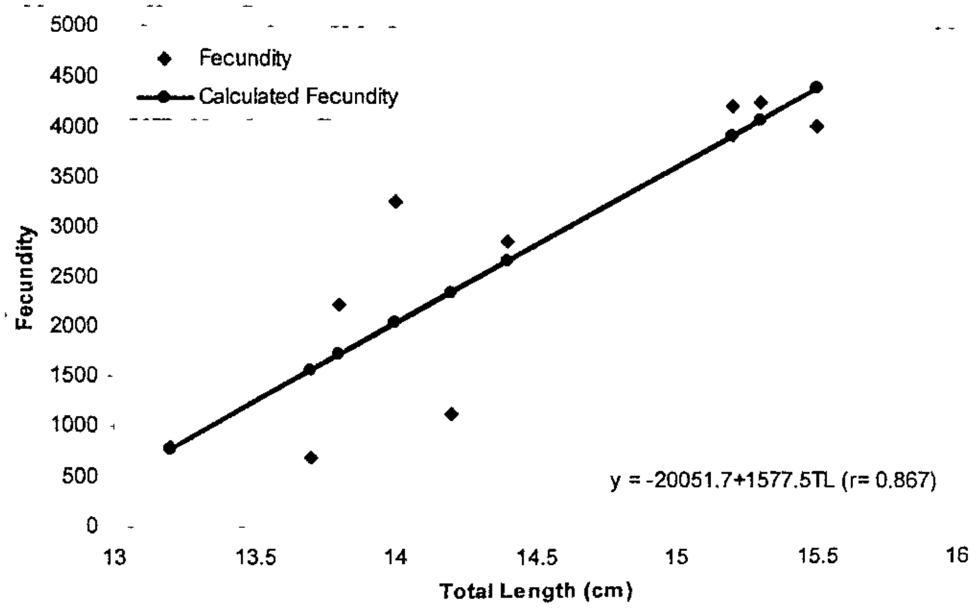

Fig 8: Arithmetic relationship between total length and fecundity.

2.4.2.2: Log Total Length – Log Fecundity Relationship

The scatter diagram revealed the presence of a linear relationship between log total lengths and log fecundity. The regression line of fecundity on log total length was found to be linear and slightly positive (Fig-9). So the relationship can be expressed as

Log Y =Log a + bLog TL Therefore,

$$\text{Log } Y = -9.878 + 11.421 \text{ Log } TL\ (r = 0.830 \text{ and } F_{cal} = 15.453)$$

The co-efficient of correlation (r = 0.830) was tested by F test and found to be significance at 5 % level of significance ($F_{0.05} = 5.59$) with 8 d.f (Appendix-A)

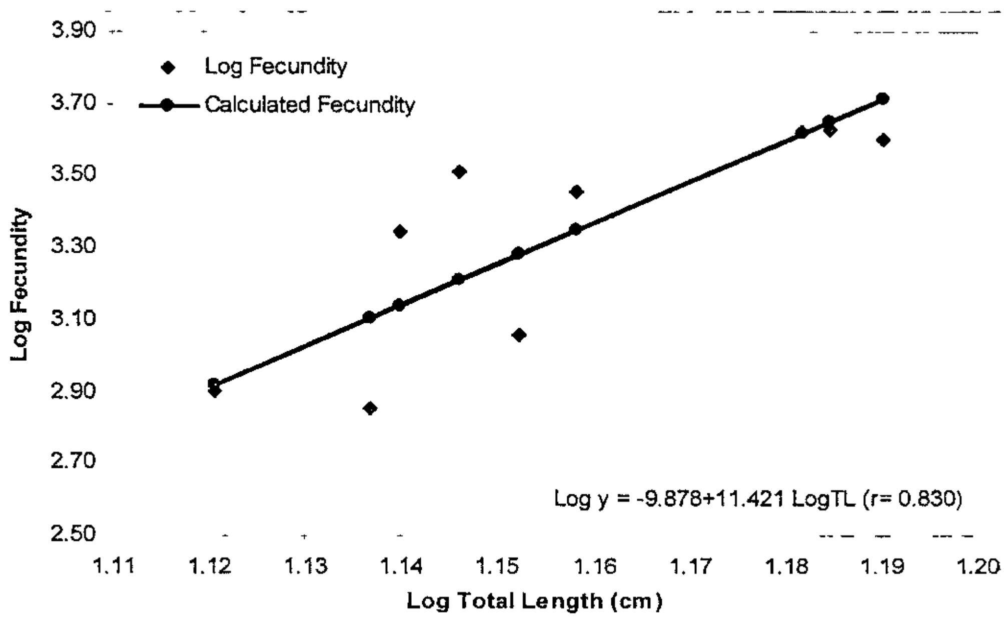

Fig 9: Logarithmic relationship between log total length and log fecundity.

2. 4.2.3: Total Body weight – Fecundity Relationship

The scatter diagram revealed the presence of a linear relationship between total body weight and fecundity. The regression line of fecundity on body weight was found to be linear and positive (Fig-10). So the relationship can be expressed as Y = a + b TBW

Therefore Y = - 7052.1 + 464.29 TBW (r = 0.439 and F_{cal} = 1.671)

The co-efficient of correlation (r = 0.439) was tested by F test and found to be insignificance at 5 % level of insignificance ($t_{0.05}$ = 5.59) with 8 d.f (Appendix-A)

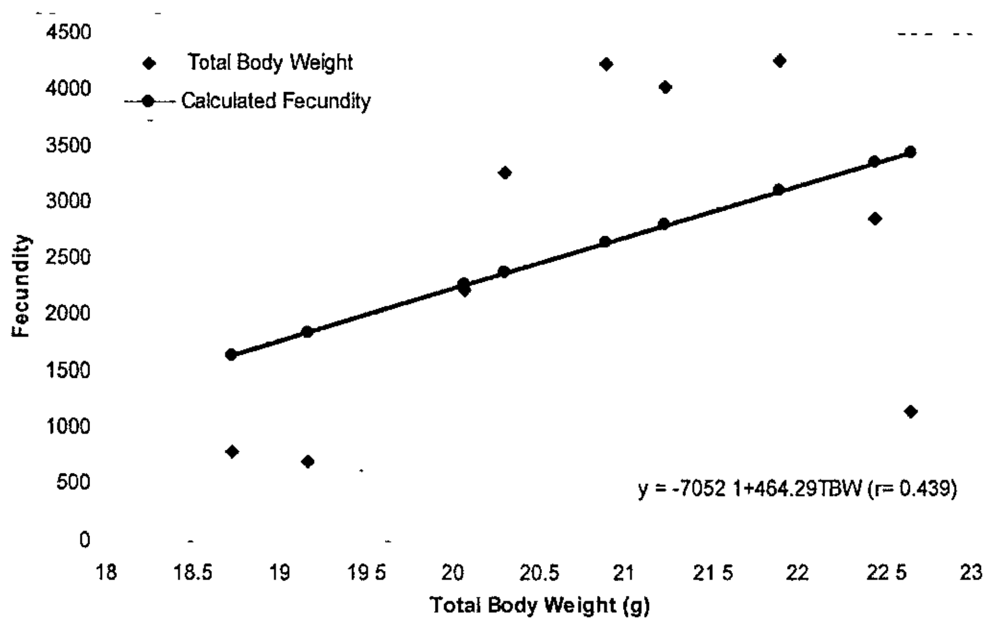

Fig 10: Arithmetic relationship between total body weight and fecundity.

2.4.2.4: Log Total Body weight – Log Fecundity Relationship

The scatter diagram revealed the presence of a linear relationship between log total body weight and log fecundity. The regression line of log fecundity on log total body weight was found to be linear and positive (Fig-11). So the relationship can be expressed as

Log Y = Log a + b Log TBW Therefore,

$$\text{Log } Y = -5.065 + 6.377 \text{ TBW } (r = 0.589 \quad F_{cal} = 3.727)$$

The co-efficient of correlation (r = 0.589) was tested by F test and found to be insignificance at 5 % level of significance ($F_{0.05} = 5.59$) with 8 d.f (Appendix-A)

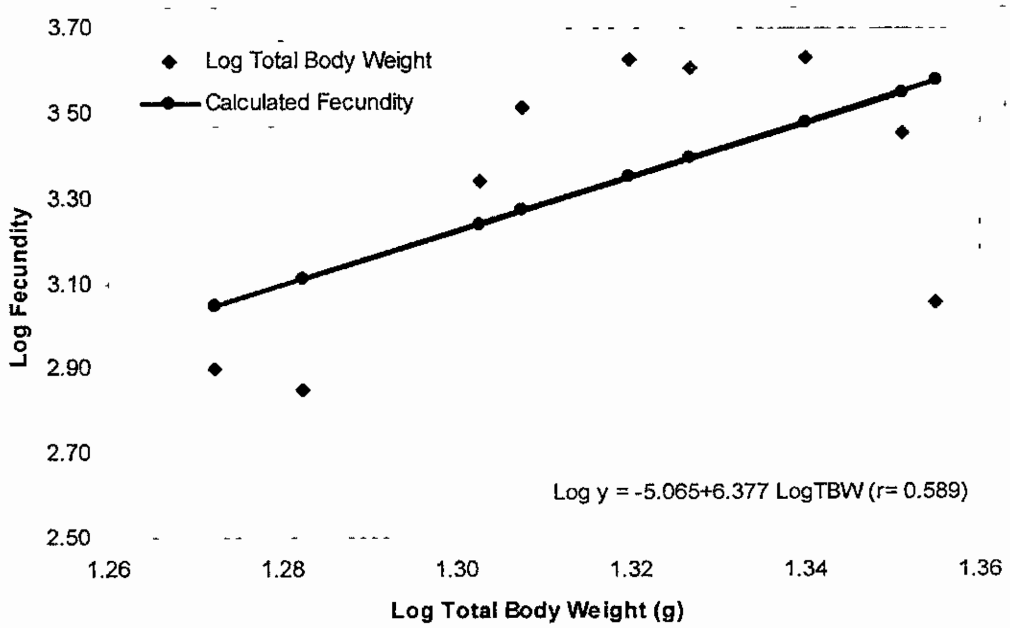

Fig 11: Logarithmic relationship between log total body weight and log fecundity.

2.4.2.5: Gonad weight – Fecundity Relationship

The scatter diagram revealed the presence of a linear relationship between gonad weight and fecundity. The regression line of fecundity on gonad weight was found to be linear and positive (Fig-12). So the relationship can be expressed as Y = a + b GW Therefore,

$$Y = -631.152 + 1275.231 \text{ GW } (r = 0.919 \text{ and } F_{cal} = 37.917)$$

The co-efficient of correlation (r = 0.919) was tested by F test and found to be significance at 5 % level of significance ($F_{0.05} = 5.59$) with 8 d.f (Appendix-A)

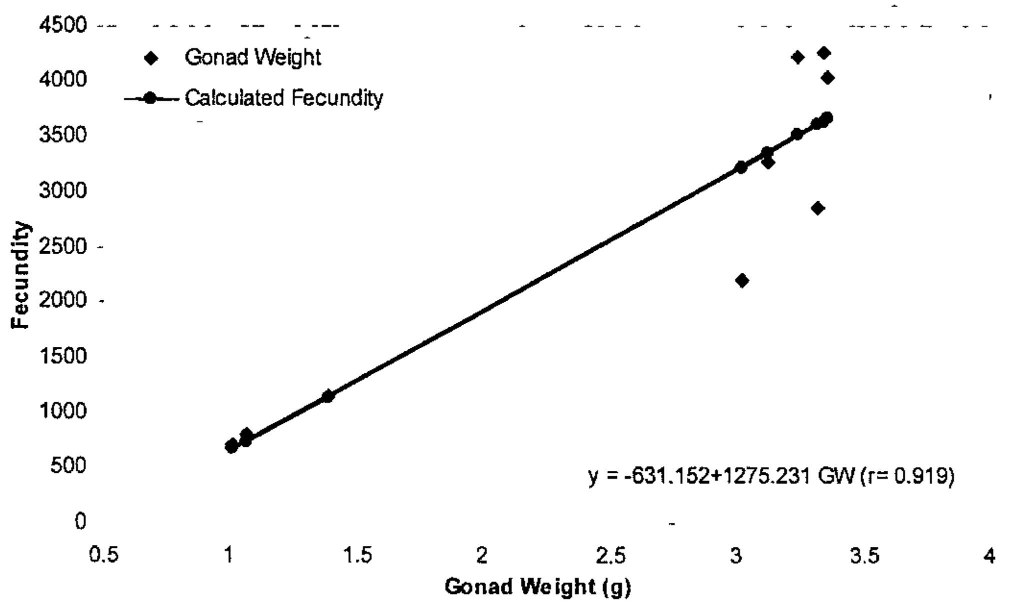

Fig 12: Arithmetic relationship between gonad weight and fecundity.

2.4.2.6: Log Gonad weight – Log Fecundity Relationship

The scatter diagram revealed the presence of a linear relationship between log gonad weight and log fecundity. The regression line of log fecundity on log gonad weight was found to be linear and positive (Fig-13). So the relationship can be expressed as

Log Y = Log a + b Log GW Therefore,

$$\text{Log } Y = 2.850 + 1.342 \text{ Log } GW \ (r = 0.968 \text{ and } F_{cal} = 103.310)$$

The co-efficient of correlation (r = 0.968) was tested by F test and found to be significance at 5 % level of significance ($F_{0.05} = 5.59$) with 8 d.f (Appendix-A)

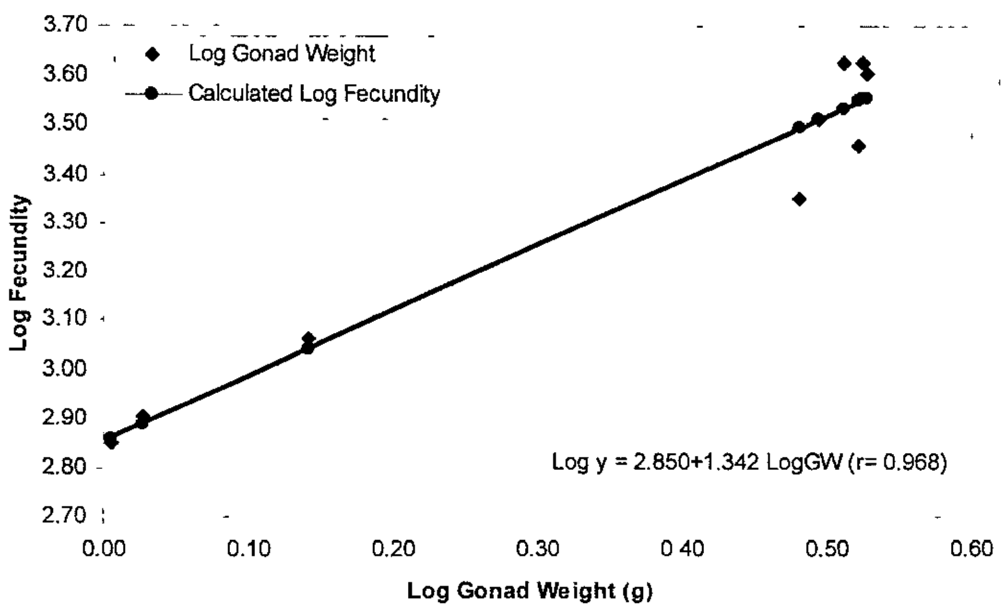

Fig 13: Logarithmic relationship between log gonad weight and log fecundity.

2.4.3: Gonado – Somatic Index:

In the present study, 9 male and female *Labeo gonius* were examined to determine the GSI. Calculating the mean GSI for each sex in each sample followed the seasonal cycle of gonad development. The gonado-somatic index, which is indicative of breeding season in fish, has been calculated month wise and to establish spawning season of *Labeo gonius* has been plotted against months.

Table 3: GSI of *Labeo gonius* for combined sex.

Months	Male		Female	
	GSI ± SD	Average GSI ± SD	GSI ± SD	Average GSI ± SD
September	0.075 ± 0.016	0.067 ± 0.016	0.293 ± 0.069	0.260 ± 0.069
	0.049 ± 0.016		0.306 ± 0.069	
	0.077 ± 0.016		0.181 ± 0.069	
October	0.020 ± 0.012	0.027 ± 0.012	0.373 ± 0.068	0.390 ± 0.068
	0.041 ± 0.012		0.332 ± 0.068	
	0.019 ± 0.012		0.464 ± 0.068	
November	0.034 ± 0.005	0.039 ± 0.005	0.314 ± 0.220	0.308 ± 0.220
	0.041 ± 0.005		0.328 ± 0.220	
	0.043 ± 0.005		0.284 ± 0.220	
December	0.041 ± 0.008	0.032 ± 0.008	0.251 ± 0.168	0.413 ± 0.168
	0.028 ± 0.008		0.586 ± 0.168	
	0.025 ± 0.008		0.401 ± 0.168	
January	0.085 ± 0.039	0.040 ± 0.039	0.166 ± 0.010	0.154 ± 0.010
	0.019 ± 0.039		0.150 ± 0.010	
	0.016 ± 0.039		0.148 ± 0.010	
February	0.024 ± 0.019	0.046 ± 0.019	3.098 ± 0.484	2.539 ± 0.484
	0.055 ± 0.019		2.272 ± 0.484	
	0.058 ±0.019		2.247 ± 0.484	
March	0.026 ± 0.010	0.029 ± 0.010	1.350 ± 0.618	1.880 ± 0.618
	0.020 ± 0.010		2.559 ± 0.618	
	0.040 ± 0.010		1.731 ± 0.618	
April	0.040 ± 0.011	0.027 ± 0.011	2.855 ± 0.285	2.943 ± 0.285
	0.019 ± 0.011		3.262 ± 0.285	
	0.024 ± 0.011		2.713 ± 0.285	
May	0.851 ± 0.383	0.881 ± 0.383	5.693 ± 0.424	5.704 ± 0.424
	1.278 ± 0.383		6.134 ± 0.424	
	0.514 ± 0.383		5.286 ± 0.424	
June	0.326 ± 0.122	0.448 ± 0.122	14.817 ± 0.283	15.085 ± 0.283
	0.449 ± 0.122		15.381 ± 0.283	
	0.570 ± 0.122		15.056 ± 0.283	

July	0.466 ± 0.159	0.653 ± 0.159	15.534 ± 0.289	15.552 ± 0.289
	0.782 ± 0.159		15.894 ± 0.289	
	0.656 ± 0.159		15.272 ± 0.289	
August	0.075 ± 0.001	0.073 ± 0.001	4.023 ± 0.965	4.098 ± 0.965
	0.073 ± 0.001		5.099 ± 0.965	
	0.072 ± 0.001		3.173 ± 0.965	

2.4.3.1: Male:

Monthly average GSI values of males are graphically represented in Fig 14. GSI values of male ranged from 0.027 ± 0.012 to 0.881 ± 0.383. The GSI values generally found peak in May (0.881 ± 0.383). GSI value falls steeply in August.

2.4.3.2: Female:

Monthly average GSI values of females are graphically represented in Fig 14. GSI values of female ranged from 0.260 ± 0.069 to 15.552 ± 0.289. The GSI values generally found peak in July (15.552 ± 0.289). GSI value falls steeply in August.

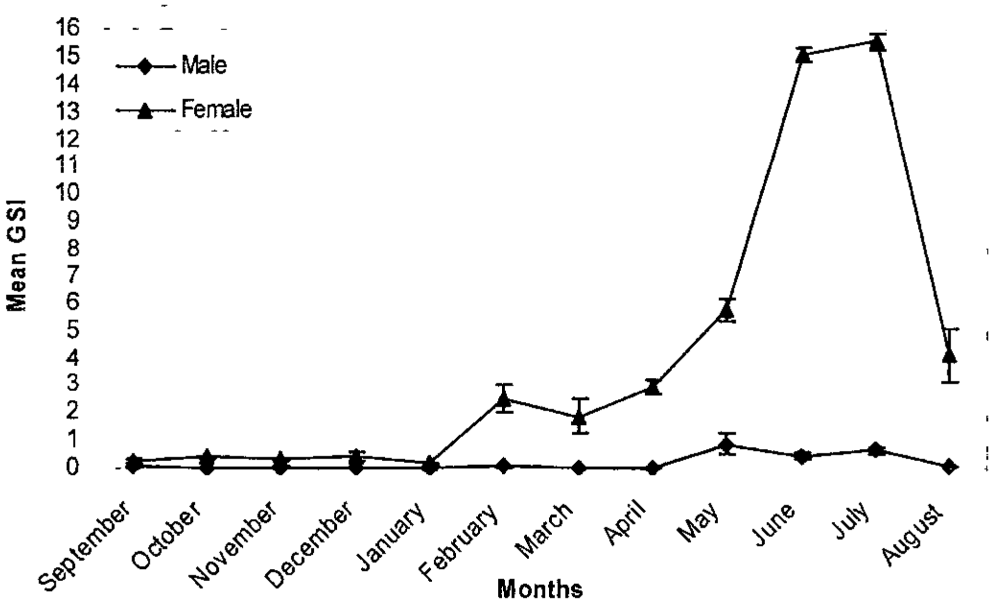

Fig 14: Seasonal variation in GSI of *Labeo gonius*. Error bar indicates standard deviation.

Table 4: GSI of male *Labeo gonius* in different months. Each value represents Mean ± SD.

Months	TL (cm)	TBW (gm)	GW (gm)	GSI	Mean GSI
September	1.5	4.12	0.003	0.075	0.067 ± 0.016
	1.7	3.271	0.002	0.049	
	1.9	4.521	0.004	0.077	
October	5.5	4.983	0.001	0.020	0.027 ± 0.012
	6	4.923	0.002	0.041	
	6.7	5.261	0.001	0.019	

November	9.5	5.953	0.002	0.034	0.039 ± 0.005
	10.5	7.391	0.003	0.041	
	12	11.762	0.005	0.043	
December	10.5	7.261	0.003	0.041	0.032 ± 0.008
	10.6	7.058	0.002	0.028	
	10.8	7.871	0.002	0.025	
January	13.7	20.112	0.017	0.085	0.040 ± 0.039
	14	21.596	0.004	0.019	
	13.1	18.890	0.003	0.016	
February	13.25	20.580	0.005	0.024	0.046 ± 0.019
	14	21.988	0.012	0.055	
	14.21	24.132	0.014	0.058	
March	14.8	26.815	0.007	0.026	0.029 ± 0.010
	17.7	39.142	0.008	0.020	
	14.1	22.245	0.009	0.040	
April	13.2	17.500	0.007	0.040	0.027 ± 0.011
	13.8	21.500	0.004	0.019	
	14.2	25.450	0.006	0.024	
May	14.9	23.256	0.198	0.851	0.881 ± 0.383
	13.7	20.960	0..268	1.278	
	15.3	28.157	0.145	0.514	
June	13.8	19.927	0.065	0.326	0.448 ± 0.122
	13.7	20.685	0.093	0.449	
	13.1	16.486	0.094	0.570	
July	14.9	20.364	0.095	0.466	0.653 ± 0.159
	19.4	53.550	2.039	0.782	
	18.6	48.205	0.316	0.656	
August	14.7	20.12	0.015	0.075	0.073 ± 0.001
	15.3	21.88	0.016	0.073	
	16.1	19.40	0.014	0.072	

Table 5: GSI of female *Labeo gonius* in different months. Each value represents Mean ± SD.

Months	TL (cm)	TBW (gm)	GW (gm)	GSI	Mean GSI
September	1.3	4.091	0.012	0.293	0.260 ± 0.069
	1.6	4.243	0.013	0.306	
	1.8	3.324	0.006	0.181	
October	5.1	4.822	0.018	0.373	0.390 ± 0.068
	6	4.219	0.014	0.332	
	4.5	4.523	0.021	0.464	
November	10	6.370	0.020	0.314	0.308 ± 0.220
	9.5	5.494	0.018	0.328	
	10	5.287	0.015	0.284	

December	10.5	6.779	0.017	0.251	0.413 ± 0.168
	10	6.657	0.039	0.586	
	10.3	6.981	0.028	0.401	
January	12.6	21.720	0.036	0.166	0.154 ± 0.010
	13.5	19.396	0.029	0.150	
	13.6	20.976	0.031	0.148	
February	13	18.756	0.581	3.098	2.539 ± 0.484
	13.58	21.520	0.489	2.272	
	14.18	23.272	0.523	2.247	
March	18.3	45.558	0.615	1.350	1.880 ± 0.618
	14.5	24.812	0.635	2.559	
	17.5	38.414	0.665	1.731	
April	15.4	27.150	0.775	2.855	2.943 ± 0.285
	14.1	22.380	0.730	3.262	
	14.9	27.790	0.754	2.713	
May	13.2	18.724	1.066	5.693	5.704 ± 0.424
	14.2	22.643	1.389	6.134	
	13.7	19.162	1.013	5.286	
June	14.4	22.441	3.325	14.817	15.085 ± 0.283
	14.0	20.297	3.122	15.381	
	13.8	20.075	3.023	15.056	
July	15.2	20.882	3.244	15.534	15.552 ± 0.289
	15.5	21.225	3.364	15.849	
	15.3	21.883	3.342	15.272	
August	15.2	20.88	0.840	4.023	4.098 ± 0.965
	15.7	18.14	0.925	5.099	
	19.2	52.25	1.658	3.173	

DISCUSSION

2.5.1: Length – Weight relationship

The arithmetic values of total length are plotted against corresponding weight of fishes and the regression lines drawn showed a curvilinear relationship. The relationship indicates that weight of fish is directly related with the length of the species. A highly significant length – weight relationship was found (r= 0.895) in respect to total length of *Labeo gonius.* This indicates that they are positively correlated. The significant coefficient of correlation between the measurements of total length and body weight of *Labeo gonius* in the present study agreed well with the results reported for *Labeo gonius* (Chondar, 1972) and for *Labeo bata* where r = 0.88398 and r = 0.99 respectively.

In fish the value of 'n' generally varies between 2.5 to 4 (Hile, 1936). Only an ideal fish maintains the value of 'n' at 3 when there is no significant changes in form and specific gravity during its life time (Martin, 1949). In most fishes, the value of 'n' has been reported more or less than 3 (Le Cren, 1951). It has been found in certain species that 'n' has values characteristically lower or higher than 3.0 and has been reported by Bashirullah and Kader (1970) on *Trichiurus savala* where the values of 'n' were 0.09351 and 2.19460 for male and female fish respectively. The value of 'n' will be exactly 3 there is no significant changes in form and specific gravity of the species during its life time. This 'isometric' growth has been observed in certain ideal fishes by Ricker (1975). The cube relationship however, hardly expected, as most of the species do changes their shape.

Similar result was found in *Labeo gonius* during the present study. The values of regression coefficient 'n' obtained for *Labeo gonius* was 1.0418. So the value of 'n' in this study was below 3 which indicated that the growth of *Labeo gonius* was isometric. The equation derived from *Labeo gonius* indicates that the value of 'n' was found to close to 3, thus satisfy the cube law. But according to the present study the value of 'n' of *Labeo gonius* in case of total length follow the cube law certainly.

The cube law relationship between length and weight also reported by Chondar (1972) and Parameswaran *et al.* (1974) on *Labeo gonius* where 'n' values were found 3.1586 and

3.0865 respectively and by Azadi and Naser (1996) on *Labeo bata* where 'n' values are 3.1856 for combined sex in total length weight relationship.

2.5.1.1: Condition Factor

The condition factor, however, is not constant in great majority of fishes. In nature it has been found to vary in individual, a species of population. It fluctuates periodically with season of the year which may be due to heavy feeding, spawning and rebuilding of reproductive system. The peak condition factor (K) value was found in (18 – 19.9) cm size group of fishes. The condition factor of the species increased gradually throughout the study period.

2. 5. 1. 2: Relative condition Factor

The peak relative condition factor (K_n) values was found in (2 – 3.9) cm average sizes group of fishes in *Labeo gonius*. In this study the values of K_n were not stable to certain length class; it varies gradually. Relative condition factor (K_n) showed certain variation with total length. The variation might be associated with the smaller sample size or different stages of maturity or spawning variation in the weight of food contents in the stomach. Variation in the K_n values due to three above mentioned causes were also reported by many workers. (Dewan and Doha, 1967; Bashirullah and Kader, 1970; Shafi and Mustafa, 1976; Das, 1977; Kader, 1984).

Hossain (2003) found variation in K_n values in different locations may be due to size, different maturity stages, sex, partial spawning, food and feeding. In high saline zone male and female become mature early than low saline zone as the higher K_n values were recorded for male and female crabs. The condition of female crabs varied a little in comparison with the males. In his study the variation may be due to salinity, sex and spawning periodicity.

The relative condition for (K_n) for male, female and combined sexes ranged from 0.96 (for 16-17 cm length range) to 1.08 (9-10 cm length range) (mean 1.001 ± SD 0.0256), 0.96 (length range 15-16 cm) to 1.06 (length range 9-10 cm) (mean 1.0007 ± SD 0.0228) and 0.97 (length range 15-16 cm) to 1.07 (length range 9-10 cm) (mean 1.007 ± SD 0.0225) respectively.

The highest K_n value was found in smaller fishes, which agreed with Shafi and Quddus (1974) for *Catla catla* and *Cirrhinus mrigala*. The highest values of K_n during spawning months (April to July) were mainly due to maturity of gonads while in other months it was due to the availability of foods.

2.5.2: Fecundity

During the twelve months observation it is revealed that the fecundity of *Labeo gonius* varied from 799.02 (for a fish for total length 13.2 cm, body weight 18.724 gm and gonad weight 1.066 gm) to 4260.3 (for a fish for total length 15.3 cm, body weight 21.883 gm and gonad weight 3.342 gm). The average number of eggs was found 2611.90 for a female fish with an average total length, total body weight and gonad weight of 14.4 ± 0.080 cm, 20.815 ± 1.38 gm and 2.543 ± 1.05 gm respectively (Table 2).

The range of fecundity was quite high and maximum fecundity recorded in July clearly indicates its peak spawning time. The numbers of egg produced by the fish was dependent on the size of the fish (Thakur, 1978, Shafi and Quddus, 1974 and Rishi and Kaul, 1982). The average fecundity varied among the months except in breeding season. In all the fishes the number of eggs increased with the increase in their length (Dewan and Doha, 1979) that agreed with present study. For the difference in the fecundity such as factors viz. nutritional state (body weight, body length), time of spawning, maturity stages and racial characteristics may be responsible (Hearly, 1971 & Bagenal, 1966).

Latifa, (2001) mentioned that the relationship between fecundity – length, fecundity – ovary weight and fecundity – body weight were linear and positive. Present study supported Latifa's findings.

In the present investigation, a linear and positive relationship was found between total length and fecundity. This agrees with the result of Parameswaran *et al.* (1974) on the species *L. gonius*, Ali *et al.*, (1994) on the species *Clarias batrachus*, Kader *et al.* (1982), Afroza and Hossain (1983) and Miller (1984) reported linear positive relationship between total length and fecundity in various fish species.

A positive relationship between fecundity and body weight was observed in the experiment that supports with the result done by Parameswaran *et al.* (1974) on the species *L. gonius*, Ali *et al.*, (1992 - 1994) in case of *Clarias batrachus*.

Linear positive relationship between gonad weight and fecundity was also reported by the worker Gerking (1959) on *Labeo gonius.* As observed by Gerking (1959) the fecundity is directly related to the size of the ovary and fish weight, rather than fish length. There is no decrease in the number of ova per unit weight of the ovary with increase in size of the ovary in *L. gonius.* Besides Shafi and Mustafa (1976); Shafi *et al.* (1978 & 1979), De and Mitra (1981), Rahman *et al.* (1982) and Nargis *et al.* (1983) Ali *et al.* (1994) also showed linear positive relationship between gonad weight and fecundity in different species of fish. Their investigations agree with the result of present findings.

A comparison of the correlation of total length – fecundity (r = 0.867), total body weight – fecundity (r = 0.439) and gonad weight – fecundity (r = 0.919) indicated much closer relationship of fecundity with gonad weight than other factors like total length, and body weight. Present investigation agrees with the results of Rahman (1989) on *Mystus gulio.* Shafi *et al,* (1978 & 1979), Crivelli (1981), Bhuiyan and Rahman (1983), Nargis *et al.* (1983), and Kader (1984) also reported the relationship between gonad weight and fecundity to be the most significant than that between fecundity and other parameters.

In the present experiment all the F values for different relationship were higher than the calculated values at 5% level of significance except the total body weight – fecundity and Log total body weight – Log fecundity relationship. The F values were found lower than the calculated values and found insignificance relationship.

2.5.3: Ganado – somatic Index (GSI)

The highest mean value of GSI was found in the month of May for male and July for female. The maximum GSI value of male and female were 0.881 ± 0.383 and 15.552 ± 0.289 respectively. The lowest mean value of GSI (0.027 ± 0.0.12) of male was found in the month of October and the lowest value (0.154 ± 0.010) for female was found in January.

2. 5. 3. 1: GSI for Male

The gonado somatic index, which is indicative of the state of the gonadial development and maturity of *L. gonius*, calculated separately for males and females and depicted graphically in figure 14. The male fish had higher proportion of body weight and testes weight in the month of May that was a good indication of its peak maturity. It was evident from the present study the GSI values falls steeply in August month. Increasing in GSI values of male indicates development of gonads during May month. Parameswarn *et al.* (1974) showed that GSI (*L. gonius*) increases steadily from February, reaching the peak in May, which is maintained with a slight decline in June and, thereafter falls gradually from the month of August. His findings were similar to the present study. Pandian (1967) reported spawning of *M. gulio* was found during May to October with a peak in the month of May and June. Hoda and Khan. (1997) observed the male GSI range of *Euryglossa Orientalis* from 0.139 to 0.231. The male fish of *Clarias batrachus* had highest GSI value was in the month of June. This insignificant variation in GSI may be due to the variation of habitat or food availability, size, age, spawning period of fish.

2. 5. 3. 2: GSI for Female

The female fish had higher proportion of body weight and ovary weight in the month of July. It was evident from present study that the GSI values increased steeply from February and reached peak in July (15.552 ± 0.289). The present findings corroborate with result of Parameswarn *et al.* (1974) on the species of *L. gonius.* Ahamed (1944) has reported that *L. gonius* breeds in July in the Punjab. According to Mookerjee and Ganguli (1949) the breeding season of the fish in Bengal is from June to August. In Assam, however, *L. gonius* and other carps mature earlier in ponds and have been successfully induced to breed by late March and early April (paremeswaran *et. al.,* 1970, MS.). The author have recorded that riverine carps also mature by middle of March in this State (Paremswaran *et.al.,* 1970). A probable reason for the early maturation may be the early onset of monsoon in this reason. It may be mentioned in this connection that in Chittagong (Bangladesh), where monsoon begins early, carps begin breeding in the rivers from April to onwards (Hora, 1945; Ahamed, 1948). Barua *et al.,* (1986) stated that *Clarius batrachus* has a single spawning season which last from May to July. Gonado - somatic index varies in both sexes, reaching in peak in the month of June. Sarker *et al.* (2002) observed the GSI value of *Mystus gulio* in the month of July. This variation would be due to spawning season differences. Khan *et al.* (2002) observed the GSI of *Plotosus canius* increases steadily from April reaching in peak in July and becomes least in August. Sarker *et al.* (2002) and Khan *et al.* (2002) results completely agrees with the result of the current study. The slightly variation of GSI in the present study in comparison with others could be due to habitat differentiation, food availability and temperature fluctuation.

CHAPTER THREE

BIOCHEMICAL COMPOSITION

INTRODUCTION

3.1.1 Background of the study:

Increasing in population is creating an alarming situation in terms of 'protein deficiency' and becoming a major hazard in developing countries. Almost 75 % peoples of Bangladesh have been suffering from malnutrition. In this country, per capita annual fish needed 18 kg but per capita annual fish intake only 14.14 kg (DOF, 2002 - 2003). To overcome this problem it is necessary to supply protein rich diet to the people. Fish is a major source of animal protein. Biochemical composition analysis is an index of nutritive value as isolated fractions are correlated with some of the properties of organisms that are nutritionally significant. It provides both quantitative and qualitative information on the uncertain nutritional significance of a particular organism of feed stuff, which are essential for both nutritionalist and to the fishery technologist and it is also essential for the maximum utilization of natural resource.

Biochemistry concerns with the chemical reaction of living organism. Protein, Lipid, Moisture and Ash are the major biochemical constituents of organism. These can be affected by a numerous factors. The chemical composition of fish expected to very largely from one species to another and with in the same species from one individual to another individual and even in the same species. The composition of a fish may vary due to location, size, age, etc. composition may also vary from one part to another part (Stansby, 1962).

Biochemical composition is the most commonly used system for evaluating the nutritional state of organisms or feeds. The composition of food gives its potential value. The normal composition of an animal is a useful base line for comparison in establishing the state of animal's health and nutrition. (Hurwitz and Plavnik, 1986).

Fish is an excellent source of animal protein (Pearson and Muslemuddin, 1976). The main components of fish are protein, fat, ash, moisture and carbohydrate. These components play a vital role in evaluating the quality of the fish. An understanding of the nutritional aspects of fishes can lead to better utilization of their resources.

Chemical composition of fish is affected by numerous factors either of intrinsic in nature or environmental. Sexual stages of development influence the composition of fish

(Legendre, 1938). The chemical composition of fish can be expected to vary largely from one species to another and within the same species from one individual to another (Jaquot, 1961). Variation in composition due to age difference of fish was also observed by Khuda *et al.* (1962). Many authors have recorded the seasonal effects of the chemical composition in fishes (Jaquot, 1961, Jafri, 1969).

Now a day's fish has been widely accepted by the both urban and rural people throughout the world. Biological or nutritional quality of protein contained in various fish species compare very favorable than that of muscle meat. A special advantage of fish is the highest degree of digestibility in comparison of others. The constituents (protein, fat, moisture, ash) play a vital role in evaluating the quality of fish. Fish protein contains favorable amount of all essential amino acids. Fish have been favored in the diet because of high content of essential fatty acids.

Extensive work on biochemical composition of many fishes has been done in our country (Hossain *et al.,* 1999). But few reports have been published (Hossain *et al.*, 1999 and Rahman *et al.,* 2002) on biochemical composition of *Labeo gonius.* Their results revealed only the body flesh in one month rather than monthly variation and other body parts.

Most of the people in our country are ignore about the quality of their daily food intake. They have no idea about the nutrient content of fish. On the basis of the above discussion, the present study was undertaken to obtain measurement of biochemical composition and seasonal changes in body composition of *Labeo gonius* and, in particular, to assess protein, lipid, moisture and ash.

3.1.2 Objectives of the study:

The present investigation was carried out to determine the biochemical composition of *Labeo gonius* with the following objectives:

- To determine the nutrient content in the body flesh.
- To observe the seasonal variation of proximate composition.

MATERIALS AND METHODS

From the present study, a total of 115 random specimens of *Labeo gonius* were collected monthly from September 2004 to August 2005 from the cultured pond, Khulna University Khulna. Live fish were firstly washed and cleaned by blotting paper to dry the specimen. Then the total length (TL) was measured with the help of a centimeter scale. The total body weight was taken with the help of electric balance (B-303S). The length and weight were recorded in the nearest centimeter and gram respectively. The experiment was conducted in the Fish Nutrition Laboratory of Fisheries and Marine Resources Technology Discipline, Khulna University, Khulna.

3.3.1: Biochemical composition

Biochemical composition of fish was determined in two ways i.e. wet weight basis and dry weight basis. In case of wet weight basis fish flesh was taken from species of *Labeo gonius*. The percentage of biochemical composition (protein, fat, ash and moisture) was determined for the species. Then the mean percentage value of biochemical component of the species was calculated.

In case of dry weight basis whole fish were taken and weighed. Then the fishes were placed in an oven (N4OC) at 105^0 C for 24 hrs. After drying they were weighed again and data were recorded. Fish were ground to powder the percentage of biochemical composition (Protein, fat, ash and moisture) was determined for the species. Each experiment represents three replications.

3.3.2: Analytical techniques

3.3.2.1: Protein

Principle:

The protein of the fish body was broken down and the amount of free Nitrogen was determined. The amount of protein was determined by multiplying the value of Nitrogen with a constant. Under mentioned apparatus were used to conduct the experiment.

- Kjeldahl flask.
- Kjeldhal nitrogen digestion apparatus (NDG-50E).
- Kjeldhal nitrogen distillation apparatus (OSK-8416 A).
- Burette.

- Electric balance (B303 S).
- Blender.
- Conical flask.
- Measuring cylinder.
- Mortar.

Reagents and its preparation:

1. Resolvent: Potasium sulphate and mercuric oxide in the ratio of 10 to 0.7 were mixed and crushed properly and preserved in colored bottle.
2. Concentrated sulfuric acid was taken for the study.
3. 2% Boric acid solution. 20 gm Boric acid crystal was added with 1 liter distilled water.
4. Tashiro's indicator, dissolve 80 gm methyl red and 20 mg methylene blue in 95% ethanol and make up to 100 ml with 95% ethanol.
5. Sandy zinc or zinc powder.
6. 33 – 40% Caustic soda: 400 gm NaOH and 10 gm potassium sulfide was added with 1 liter distilled water.
7. 0.1 (N) HCl Acid: 8.48 ml HCl was added with 1liter distilled water.

Procedure:

Sample preparation:

Incase of body flesh, the flesh of fish was blended with blender machine and then the sample was taken.

Digestion:

0.2 – 0.5 gm of sample was weighed and inserted into a Kjeldhal flask and 2 gm of resolvent and 5 ml concentrated H_2SO_4 were added into the flask. The content of the flask was digested by heating in a Kjeldhal nitrogen digesting apparatus (NDG-50E) for 45 minutes till the clear color appears. After completion of digestion, transferred the flask from digesting apparatus and let it be cooled for 10 minutes until the temperature decreased up to about room temperature.

Distillation:

15 ml of 2% Boric acid (H_3BO_3) were taken in a conical flask and 2 – 3 drops of Tashiro's indicator were added into the flask. The delivery tube of the apparatus was

arranged with its tip below the surface of 15 ml boric acid. Then adding 70 ml of distilled water diluted the digested materials and 0.5 gm of sandy zinc was added in the Kjeldhal flask. About 25 ml of 33 – 40 % Caustic soda (NaOH) solution was poured slowly along the flasks in sidewall. The flask was then connected to the Kjeldhal nitrogen distillation apparatus (OSK-8416 A) and distilled it for about 30 minutes to obtain 25 – 30 ml distilled solution. Distilled solution was stored in the conical flask through delivery tube.

Titration:

The distilled solution stored in the conical flask was taken and titrated against 0.1 (N) HCl solutions.

Calculation:

The percentage of gross portentous nitrogen was calculated out with the following formula (Crampton and Mitchell, 1972; Jacobs, 1973; Pearson, 1976).

$$\%\,N = \frac{\text{Volume of HCl X Normality of HCl X 0.014}}{\text{Weight of sample (gm)}} \text{ X } 100$$

Percentage of protein = % N X 6.25 (Conversion factor)

3.3.2.2: Lipid

Principle:

Fat was extracted with acetone by Soxhlet extraction and the extract thus obtained is weighed after careful recovery of the solvent.

Apparatus:

- Soxhlet fat extractor (SF-6).
- Extracting thimble paper.
- Hot plate (SH-1).
- Electronic balance (B303 S).
- Blender.
- Beaker (250 ml).
- Mortar.

Chemical:

- Acetone.

Procedure:

In case of body flesh, the flesh of fish was blended with blender and then the sample was taken. For whole fish, the whole body of the fish was completely dried in an oven at 105^0 C temperatures. Then the dried fish crushed with a mortar and then the sample was taken for experiment. 2 – 5 gm sample was taken in the thimble paper. First of all weight of the empty thimble was taken. Then it was weighed with the sample. Difference between two weights gave the weight of the sample. Then the sample was placed in Soxhlet fat extractor apparatus. 70 ml of acetone was used and fat extracted with acetone. Fat extracted with acetone was taken in a weighed 250 ml beaker and the apparatus was heated at 105^0 C for about 6 hours. After extraction of fat was placed on the hot plate (SH-1) until the acetone was completely evaporated. Fat weight was found from the difference between two weights.

Calculation:

Calculation was done by using the following formula (Maynard, 1970; Jacobs, 1973 & Pearson, 1976).

$$\% \text{ Fat} = \frac{\text{Weight of extracted fish}}{\text{Weight of sample (gm)}} \text{ X } 100$$

3.3.2.3: Moisture

Principle:

Moisture was determined by complete drying of the sample at 105^0 C. the loss in weight of the sample is the measurement of moisture content.

Apparatus:

- Oven (N40C).
- Porcelain crucibles.
- Electronic balance.
- Blender.

Procedure:

For determining moisture content was cleaned, dried and then the constant weight of the crucible was taken. Sample was placed in the crucible and weight was taken. Difference between two results gave the weigh of the sample. Then the crucible with sample was put in a controlled oven and was dried at 105^0 C and was weighed several times till the constant weight was observed.

Calculation:

The percentage of moisture content was calculated by the following formula (Pearson, 1976).

$$\% \text{ Moisture} = \frac{\text{Weight of the sample (gm)} - \text{Weight of the dried sample (gm)}}{\text{Weight of sample (gm)}} \text{ X } 100$$

3.3.2.4: Ash

Principle:

The ash content is the inorganic residue let after complete removal of the organic residue by muffling at about 550 – 600^0 C in the muffle furnace. The following apparatus were used to conduct the experiment.

Apparatus:

- Muffle furnace (S-336 RB).
- Porcelain crucible and desiccators.
- Electric balance (B303 S).
- Blender.
- Mortar.

Procedure:

The flesh of fish was blended with blender incase of body flesh and then the sample was taken. For whole fish the, the whole body of the fish was completely dried in an oven at 105^0 C temperatures. Then the dried fish done dust with a mortar and then the sample was taken for experiment.

Clean porcelain crucible were heated in a muffle furnace 600^0 C and the crucible were cooled and weight, heating cooling and weighing are repeated until constant weights of the crucible were obtained. The sample with the crucible was weighed and recorded. 2 to 5 gm of sample was taken in each crucible. After that, each crucible with the sample was placed in the muffled furnace. The samples were muffled at 600^0 C for 6 hrs until the color of the residue become uniformly grayish to white. Afterwards the crucible was transferred to the desiccators to cool down at room temperature for a few minutes. Heating, desiccating and weighting were repeated till a constant weight obtained. Finally the constant weight of the crucibles was recorded.

Calculation:

The percentage of ash content was determined by the following formula (Maynard, 1970 and Pearson, 1976).

$$\% \text{ Ash} = \frac{\text{Weight of ash (gm)}}{\text{Weight of sample (gm)}} \times 100$$

RESULTS

The present study was undertaken with a view to study the biochemical composition (protein, lipid, ash and moisture) of *Labeo gonius.* The body flesh of *Labeo gonius* was taken to determine the month wise variation in proximate composition. Seasonal cycles of variation in proximate constituents are generally attributed to complex interaction between environmental parameters, food availability, growth and reproductive activity. The percentage of protein, lipid, ash and moisture were calculated from their body flesh of the fish body at wet weight basis.

3.4.1: Protein

The average protein content (as percent) observed monthly in the body flesh of the *Labeo gonius* is presented in Table 6.

Table 6: Monthly average protein content of *Labeo gonius.*

Months	Average Protein % ± SD
September	10.82 ± 0.509^{d}
October	17.01 ± 0.269^{e}
November	17.54 ± 0.042^{ef}
December	17.64 ± 0.608^{ef}
January	18.38 ± 0.608^{f}
February	20.62 ± 0.509^{g}
March	17.44 ± 0.728^{ef}
April	2.06 ± 1.205^{a}
May	7.28 ± 0.049^{b}
June	10.61 ± 0.481^{d}
July	9.23 ± 0.651^{c}
August	8.13 ± 0.481^{bc}

The data are mean values of two replicates. Values are mean ± SD. Values within the same column having the same superscript shows no significant difference ($P > 0.05$) and different superscript shows significant difference.

The maximum protein content was observed in the month of February (20.62 ± 0.509) and the minimum value was found in the month of April (2.06 ± 1.205) respectively. One way ANOVA is performed to observe the variation of protein percentage among the study period. The table revealed that no significance variation was found among the month of March, November, December and between the month of June and September respectively. However, the average protein content of whole body of *Labeo gonius* is presented graphically in Figure 15.

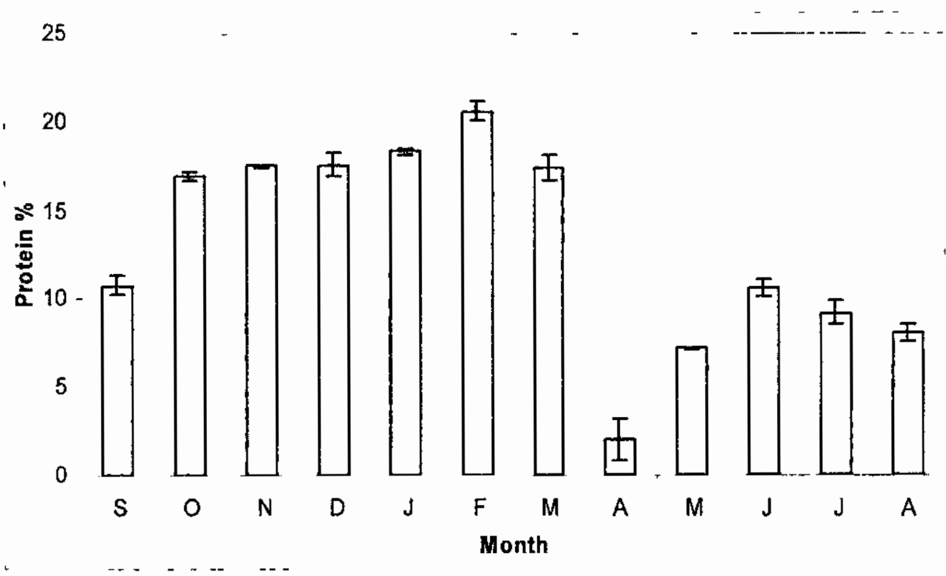

Fig 15: Monthly variation of protein content of body flesh of *Labeo gonius.* Error bar indicates SD.

3.4.2: Lipid

The average lipid content (as percent) observed monthly in the body flesh of the *Labeo gonius* is presented in Table 7.

Table 7: Monthly average lipid content of *Labeo gonius.*

Months	Average Lipid % ± SD
September	2.58 ± 0.64^{b}
October	2.28 ± 0.18^{b}
November	2.56 ± 0.18^{b}
December	2.38 ± 0.49^{b}
January	1.28 ± 0.14^{a}
February	3.03 ± 0.16^{b}
March	1.40 ± 0.08^{a}
April	9.55 ± 0.59^{c}
May	1.14 ± 0.03^{a}
June	5.21 ± 0.03^{d}
July	4.23 ± 0.74^{c}
August	4.10 ± 0.94^{cd}

The data are mean values of two replicates. Values are mean ± SD. Values within the same column having the same superscript shows no significant difference (P> 0.05) and different superscript shows significant difference (P> 0.05).

The maximum lipid content was observed in the month of April (9.55 ± 0.59) and the minimum value was found in the month of April (1.14 ± 0.03) respectively. One way ANOVA is performed to observe the variation of lipid percentage among the study period. The table revealed that no significance variation was found among the month of September, October, November, December, February, and among the month of January, March and May respectively. However, the average lipid content of whole body of *Labeo gonius* is presented graphically in Figure 16.

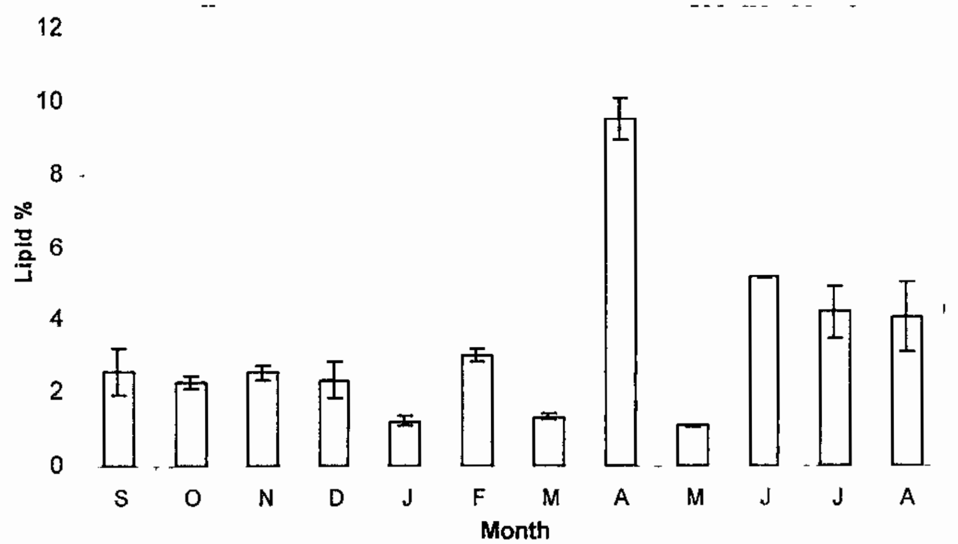

Fig 16: Monthly variation of lipid content of body flesh of *Labeo gonius.* Error bar indicates SD.

3.4.3: Moisture

The average moisture content (as percent) observed monthly in the body flesh of the *Labeo gonius* is presented in Table 8.

Table 8: Monthly average moisture content of *Labeo gonius.*

Months	Average Moisture % ± SD
September	87.31 ± 0.615^{g}
October	77.27 ± 0.325^{ab}
November	78.60 ± 1.300^{bc}
December	78.91 ± 0.805^{c}
January	80.80 ± 1.890^{d}

February	76.88 ± 0.020^{a}
March	81.61 ± 0.550^{d}
April	83.37 ± 0.530^{e}
May	83.44 ± 0.530^{ef}
June	87.92 ± 1.195^{g}
July	84.08 ± 0.215^{ef}
August	84.94 ± 0.111^{f}

The data are mean values of three replicates. Values are mean ± SD. Values within the same column having the same superscript shows no significant difference (P> 0.05) and different superscript shows significant difference.

The maximum moisture content was observed in the month of June (87.92 ± 1.195) and the minimum value was found in the month of February (76.88 ± 0.020) respectively. One way ANOVA is performed to observe the variation of moisture percentage among the study period. The table revealed that no significance variation was found between the month of April, May and July & August, and the rest of the study period showed significant variation of moisture content. However, the average moisture content of whole body of *Labeo gonius* is presented graphically in Figure 17.

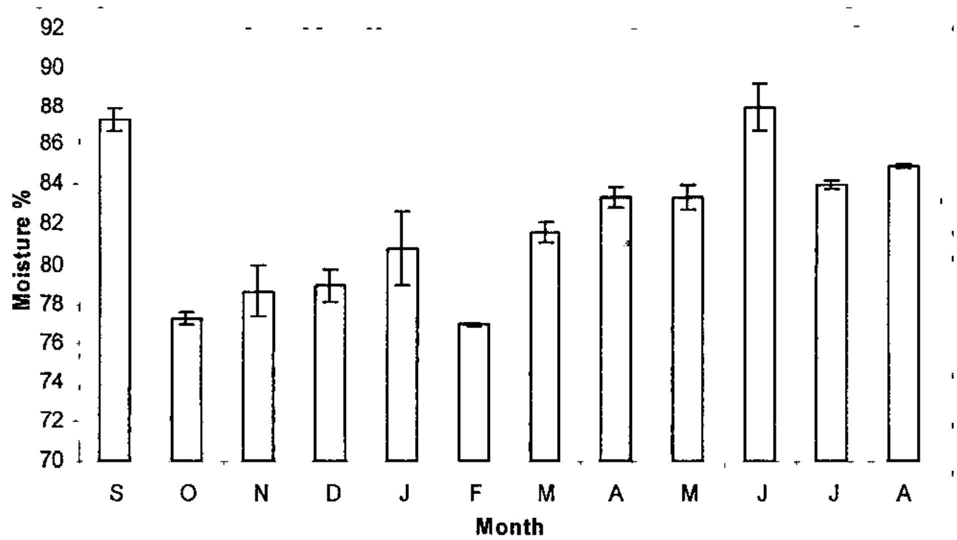

Fig 17: Monthly variation of moisture content of body flesh of *Labeo gonius.* Error bar indicates SD.

3.4.4: Ash

The average ash content (as percent) observed monthly in the body flesh of the *Labeo gonius* is presented in Table 9.

Table 9: Monthly average ash content of *Labeo gonius.*

Months	Average Ash % ± SD
September	1.38 ± 0.053^{a}
October	1.42 ± 0.040^{a}
November	1.40 ± 0.020^{a}
December	1.49 ± 0.056^{a}
January	1.62 ± 0.053^{b}
February	1.74 ± 0.040^{b}
March	2.02 ± 0.053^{c}
April	2.85 ± 0.081^{e}
May	2.93 ± 0.050^{e}
June	2.05 ± 0.133^{c}
July	2.43 ± 0.153^{d}
August	2.82 ± 0.053^{e}

The data are mean values of three replicates. Values are mean ± SD. Values within the same column having the same superscript shows no significant difference (P> 0.05) and different superscript shows significant difference.

The maximum ash content was observed in the month of May (2.93 ± 0.050) and the minimum value was found in September (1.38 ± 0.053) respectively. One way ANOVA is performed to observe the variation of ash percentage among the study period. The table revealed that no significance variation was found among the month of September,

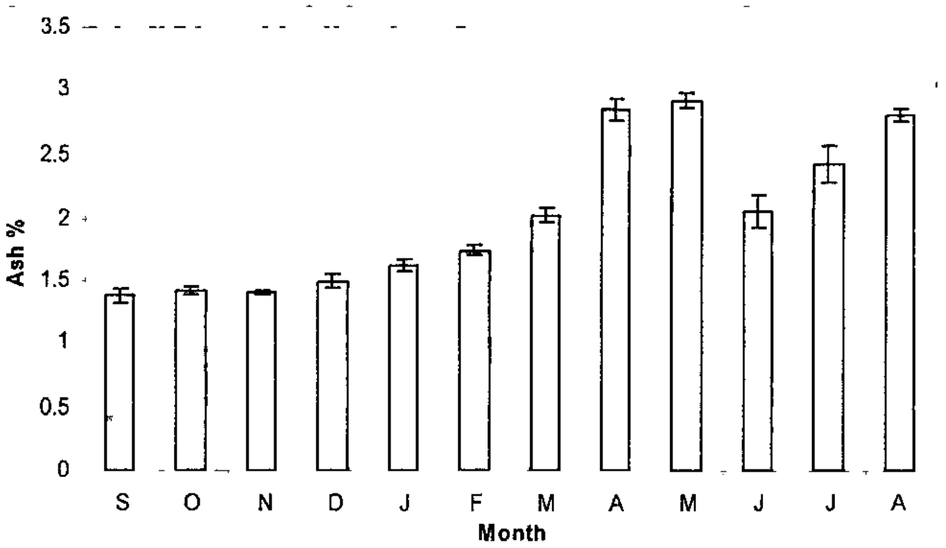

Fig 18: Monthly variation of ash content of body flesh of *Labeo gonius.* Error bar indicates SD.

October, November, December and among the month of April, May and August respectively. However the average ash content of whole body of *Labeo gonius* is presented graphically in Figure 18.

DISCUSSION

3.5.1: Biochemical composition

Biochemical composition of the samples have been undertaken to determine the level of important tissue constituents of *Labeo gonius* viz. protein, moisture, fat and ash. Degani *et al.,* (1986) opined that changes occurred of body composition of fish in relation to size or age. Rao (1969) found that the biological compositions were fluctuated by the influence of breeding and feeding cycles. He also noted that salinity, temperature, diet and seasonal variation change the proximate composition of fishes.

3.5.1.1: Protein

Percentage of protein content in the body flesh was highest in the month of February (20.62 ± 0.509) and the lowest value was found in the month of April (2.06 ± 1.205) respectively. In body flesh the protein contents were more or less similar up to March and in April its falls steeply. From the month of May the protein contents were increasing gradually up to the rest of the month of the study period. One way ANOVA is performed to observe the variation of protein percentage among the study period. The analysis showed that no significance variation was found among the month of March, November, December and between the month of June and September respectively. Monthly variation of protein content in the study may be due to different amount of diet consumption. Besides it may be assumed that the steep changes in protein content was due to physiological changes in fish body as the gonadal development of the fishes was begun to mature, that's why the somatic growth of the fish body become decrease and the protein content of the fishes found lower compare to the other months of experimental period. The increased of protein content in the rest of the three months of the study period indicated the development of somatic growth simultaneously with the development of gonadic growth.

The available reports suggest that extractability of muscle proteins varies from species to species (Shimizu *et al.,* 1976). Mannan (1977) reported that the fish contained generally 18% protein. Banu *et al.* (1985) found 14.03% to 20.12% protein in various fishes and prawns, which corroborate with the present result. Hossain *et al.* (1999) reported that the muscle protein content among some small indigenous fish species of Bangladesh varied widely from 16.16 to 22.28% and *Labeo gonius* contained 20.62% protein. His reports corroborate with the present findings. Berg *et al* .(1998) reported that the protein content of young riverine Atlantic salmon and brown trout declined greatly in winter but were replenished in spring. Rates of decline were slower for the smallest fish, which also had the lowest specific content of protein while the differences in absolute amounts were greatest for the largest fish. Belinsky *et al.* (1996) reported that the protein content of female white fish, lake trout and brook trout was 15 ± 2.85, 15 ± 0.72 and 17.3 gm/100gm respectively. Shearer *et al.* (1994) revealed that the protein was observed to increase with size, but showed a slight decrease in early spring. This was attributed to reduce feeding during winter and early spring. Similar result was found in case of *Labeo gonius* where in early spring (from February) protein content becomes decreases. Jonsson *et al.* (1998) reported that protein concentration did not vary with age in the immature fish, mean protein concentrations being 18, 17.5 and 16.8% in parr in the autumn and spring and in smolts respectively. The variation of protein in the body flesh might be due to season and size of fishes. Rahman *et al.* (1978) worked on the biochemical composition of *L. rohita* and found that the raw whole fish had 19% protein which corroborate with the present findings.

3.5.1.2: Lipid

Percentage of lipid content in the body flesh was highest in the month of April (9.55 ± 0.59) and the lowest value was found in the month of May (1.14 ± 0.03) respectively. Table 7 shows that during spawning season the lipid content is less but the values increases gradually after spawning period. Figure 16 shows that the average lipid content is more or less same throughout the previous month of spawning period. One way ANOVA is performed to observe the variation of lipid percentage among the study period. The analysis showed significance variation of lipid content among the month of April, June, July and August. The lipid content is sharply increased at the month of April; this may due to the reason that fat is stored in the body flesh as the fish was prepared for spawning. But in the next month of May the lipid content was steeply decreased as spawning was occurred in that month.

Shearer *et al.* (1994), who explained that the level of lipid decreased during maturation. He also found that the parameters changed in relation to life cycle stage and fish size were influenced by whether the fish were in salt or fresh water. Rahman *et al.* (1982) reported 1.02 ± 0.05% to 11.69 ± 0.26% crude fat in fresh water zeol fish. His result is nearly similar to the present investigation but the species was different and slight fluctuation occurred. The variation in fat content was influenced by the variation of species, diet, temperature, salinity, selective mobilization and distribution (Lovern, 1950). Berg *et al* (1998) reported that the mean specific fat content was reduced by 45 to 70% during winter, relative to the pre winter period (September) and during spring fat content was replenished rapidly, particularly in smallest salmon fry (a three fold increase from April to June) which also agrees with the present study. The drop in lipid concentration appears to parallel an increased growth rate with a channeling of foods into protein (Haor, 1976). Fat is an easily mobilized energy reserve that can be used for activity during spawning when the energy uptake is extremely low (Jonsson and Graven, 1985). Hossain *et al* (1999) reported that the carcass lipid content of some small indigenous species (SIS) varied between 1.87 to 9.55% and *Labeo gonius* contained (9.55 ± 0.59) % lipid. The present findings agree with the result of Hossain *et al.* (1999). Belinsky *et al.* (1996) reported that the protein content of female white fish, lake trout and brook trout was 15 ± 2.85, 15 ± 0.72 and 17.3 gm/100gm respectively. Rahman *et al.* (1978) worked on biochemical composition of *L. rohita* and found that the whole raw fish had 5.1% lipid content which didn't corroborate with the present findings. Levels of total fat within the samples were quite variable, as expected, since it is known that fat in fish varies by age, sex and reproductive status (Kinsella, 1988). The present findings suggest that the variation of fat content of *Labeo gonius* may be due to the same cases found by Kinsella, 1988.

3.5.1.3: Moisture

Percentage of water content in the body flesh of *Labeo gonius* ranged from (87.92 ± 1.195) to (76.88 ± 0.020). The maximum and minimum moisture contents were found in the month of June and February respectively. Generally lower values observed in the month October, November and December and higher values were observed in the month of June, July and August. Figure 17 shows that the moisture content of body flesh was lower in the winter season and higher in the summer season. One way ANOVA is performed to observe the variation of moisture percentage among the study period. The result revealed that the average values of moisture content of body flesh were artificially vary except the month of April, May, June and August.

Belinsky *et al.* (1996) showed that moisture was quite consistence within fish sample part (i.e. flesh, liver and eggs). Ali (2001) reported that the water content varied from 75.52 ± 0.15 to 79.81 ± 0.04% with maximum in January and minimum in July. A moisture content of 77.24 to 82.12% was recorded by Gheyasuddin *et al.* (1980) in various fresh fishes. It may be due to inter species variation and size of fish. Fluctuation of moisture may also be for the specimen's maturing, gravid and spent stage (Kader, 1984) and also for the growth of fish (Master and Magar, 1954; Setna *et al.,* 1994). The present study agreed with the findings of Gheyasuddin *et al.* (1980) and Ali (2001) where the values of moisture content of *Labeo gonius* was more or less similar to the ranged mentioned by them. Since the moisture has an inverse relation with size of the fish, the fishes in the present study being small showed comparatively higher moisture content than that obtained by Rahman *et al* (1982) is small zeol fishes of Bangladesh (70.60 to 80.44%). Jonsson *et al.* (1998) found the relative water content decreased with age in parr in the autumn and increased with age in smolts, mean values being slightly higher smolts (78%) than in parr (77%). Rahman *et al.* (1978) worked on the biochemical composition of *L. rohita* and found that the raw whole fish had 70.9% moisture content which didn't corroborate with the present findings.

3.5.1.4: Ash

Percentage of ash content in the body flesh was highest in the month of May (2.93 ± 0.050) and the lowest value was found in the month of September (1.38 ± 0.053) respectively. Figure 18 show that there is a little seasonal variation of ash content in body flesh of *Labeo gonius* except April, May and August. During this time higher ash values were observed and it may be due to specimen's were become matured. The figure also revealed that the ash content of *Labeo gonius* was increased gradually throughout the month of May. But in spawning season the ash content was quite vary with the previous months. The values were quite decreases than the last two months but the average values were quite similar compare to the un-spawning season.

CSIR (1962) reported that the ash content of some selected fish species in India ranged between 1.53 and 2.60 %. Rubi *et al.* (1987) found to 0.83 to 1.76% ash in fresh muscle. Their findings were quite similar to the present study. Kader (1984) reported that ash content in *Gobioides rubicundus* was found 3.21 to 3.35%. Shearer *et al.* (1994) reported that the ash level decreased by about 50% by the time the fish reached 250 gm then increased prior to maturation. Rahman *et al.* (1978) worked on the biochemical composition of *L. rohita* and found that the raw whole fish had 2.42% ash content which corroborate with the present findings. Hossain *et al.* (1999) reported that the ash content of *Channa punctatus* was 5.49, which did not support the present study. The variation in proximate composition could be occurred due to the influences of season as well as size or age, breeding and feeding behavior, hydrological parameters, diet etc.

CHAPTER FOUR

CONCLUSION

CONCLUSION

The main objective was to study some aspects of biology (length – weight relationship, condition factor, relative condition factor, fecundity, and GSI) and the biochemical composition (protein, lipid, ash and moisture) of *Labeo gonius*. It is clear from the result of the present study and the discussion made so far that *Labeo gonius* could be indispensable in diet in respect of their nutritive quality. *Labeo gonius* is fall in the category of small indigenous species (SIS). Once this fish was available in the nature, however, changes in the environment and other factors are threatening for their existence. To ensure the continuity of the biodiversity and retain the species for future generation, proper management and culture techniques of this species should be encouraged.

The biological information of any animal has enormous practical utilities in the knowledge generation and in management of the resources. Aquaculture needs precise biological information on the above mentioned aspects. Every animal maintains a ratio among the different parts of its body (e.g. total –length, standard length, fork length, weight etc) when they are developing from young to adult. The determination of a precise mathematical relationship between length and weight of fish has numerous practical applications in fisheries biology.

As the value of 'n' (slope) in all the regression equation for *Labeo gonius* was below 3, the length –weight relation of *Labeo gonius* did nor strictly follow the 'cube law' relationship. As the 'K' values for the species were increased with the corresponding increase in total length, it could be conclude that larger fish were more energetic or physically strong. As the K_n values were higher for lower length of fishes and lower for higher length of fishes, it could be conclude that the variation due to the smaller sample size or different stages of maturity or spawning variation in the weight of food contents in the stomach.

It was found that considerable variation in the content of the chemical constituents existed within the same species on the fresh weight basis and that the variation was function of their size. It is well recognized that uncontrolled variables such as the geographical location of fish, seasons, sex, feeding habits and reproductive status affect the nutrient composition of fish. It has been observed that large size species had higher amount of moisture and in most cases large size species had higher value of crude protein and fat.

From proximate composition of *Labeo gonius*, it is evident that the nutrient content of this species is more or less equal compared to other small valued species even large fish species.

The present study is a preliminary work even conducted in Bangladesh. The limitation of the present study was small size of sample during the study period. Sufficient amount of fish could not be harvested as the fry of the fish in the experimental pond was affected due to the presence of unwanted species or may be eaten by large predatory species. The major limitation was found in the laboratory, lack of sufficient equipments hampered the proper analysis of the samples. So there should have sufficient equipments facilities in the laboratory for this kind of work.

The investigation, however, will provide basic information on the biology and biochemical composition of *Labeo gonius*. This data can also be used as a guideline for promoting fish consumption and further detailed study.

CHAPTER FIVE

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CHAPTER SIX

APPENDICES

APPENDIX - A

Table 1: One way ANOVA[b] test for Total length – Weight relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1778.160	1	1778.160	32.090	.000[a]
	Residual	443.297	8	55.412		
	Total	2221.457	9			

a Predictors: (Constant), Length
b Dependent Variable: Weight

Table 2: One way ANOVA[b] test for Log Total length – Log Weight relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.000	1	1.100	18.488	.003[a]
	Residual	.476	8	.059		
	Total	1.575	9			

a Predictors: (Constant), Log Total Length
b Dependent Variable: Log Weight

Table 3: One way ANOVA[b] test for Total length – Fecundity relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12791103.012	1	12791103.012	21.171	.002
	Residual	4229254.762	7	604179.252		
	Total	17020357.774	8			

a Predictors: (Constant), Total Length
b Dependent Variable: Fecundity

Table 4: One way ANOVA[b] test for Log Total length – Log Fecundity relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.548	1	.548	15.453	.006
	Residual	.248	7	.035		
	Total	.796	8			

a Predictors: (Constant), Log Total Length
b Dependent Variable: Log Fecundity

Table 5: One way ANOVA[b] test for Total body weight – Fecundity relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3280691.865	1	3280691.865	1.671	.237
	Residual	13739665.909	7	1962809.416		
	Total	17020357.774	8			

a Predictors: (Constant), Total body weight
b Dependent Variable: Fecundity

Table 6: One way ANOVA[b] test for Log Total body weight – Log Fecundity relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.277	1	.277	3.727	.095
	Residual	.519	7	.074		
	Total	.796	8			

a Predictors: (Constant), Log Total body weight
b Dependent Variable: Log Fecundity

Table 7: One way ANOVA[b] test for Gonad weight – Fecundity relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14367840.045	1	14367840.045	37.917	.000
	Residual	2652517.729	7	378931.104		
	Total	17020357.774	8			

a Predictors: (Constant), Gonad Weight
b Dependent Variable: Fecundity

Table 8: One way ANOVA[b] test for Log Gonad weight – Log Fecundity relationship.

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.745	1	.745	103.310	.000
	Residual	.051	7	.007		
	Total	.796	8			

a Predictors: (Constant), Log Gonad Weight
b Dependent Variable: Log Fecundity

Table 9: Monthly observed biochemical composition of *Labeo gonius* is presented in the Table 9.

Months	% Protein ± SD	% Lipid ± SD	% Moisture ± SD	% Ash ± SD
September	10.46 ± 0.509	3.03 ± 0.64	87.92 ± 0.615	1.33 ± 0.053
	11.18 ± 0.509	2.13 ± 0.64	86.69 ± 0.615	1.44 ± 0.053
	-	-	87.31 ± 0.615	1.36 ± 0.053
October	17.20 ± 0.269	2.15 ± 0.18	77.59 ± 0.325	1.46 ± 0.040
	16.82 ± 0.269	2.40 ± 0.18	77.27 ± 0.325	1.43 ± 0.040
	-	-	76.94 ± 0.325	1.38 ± 0.040
November	17.57 ± 0.042	2.43 ± 0.18	78.60 ± 1.300	1.42 ± 0.020
	17.51 ± 0.042	2.69 ± 0.18	77.30 ± 1.300	1.40 ± 0.020
	-	-	79.90 ± 1.300	1.38 ± 0.020
December	17.21± 0.608	2.73 ± 0.49	79.71± 0.805	1.55 ± 0.056
	18.07 ± 0.608	2.03 ± 0.49	78.91 ± 0.805	1.48 ± 0.056
	-	-	78.10 ± 0.805	1.44 ± 0.056
January	18.48 ± 0.608	1.38 ± 0.14	82.69 ± 1.890	1.68 ± 0.053
	18.28 ± 0.608	1.18 ± 0.14	78.91 ± 1.890	1.58 ± 0.053
	-	-	80.80 ± 1.890	1.60 ± 0.053
February	20.98 ± 0.509	3.14 ± 0.16	76.88 ± 0.020	1.70 ± 0.040
	20.26 ± 0.509	2.91 ± 0.16	76.90 ± 0.020	1.78 ± 0.040
	-	-	76.86 ± 0.020	1.75 ± 0.040
March	17.95 ± 0.728	1.46 ± 0.08	82.16 ± 0.550	2.06 ± 0.053
	16.92 ± 0.728	1.34 ± 0.08	81.61 ± 0.550	1.96 ± 0.053
	-	-	81.06 ± 0.550	2.04 ± 0.053
April	2.91 ± 1.205	9.13 ± 0.59	82.84 ± 0.530	2.94 ± 0.081
	1.21 ± 1.205	9.96 ± 0.59	83.90 ± 0.530	2.78 ± 0.081
	-	-	83.37 ± 0.530	2.84 ± 0.081
May	7.29 ± 0.049	1.12 ± 0.03	83.94 ± 0.616	2.98 ± 0.050
	7.36 ± 0.049	1.16 ± 0.03	82.75 ± 0.530	2.88 ± 0.050
	7.19 ± 0.049	-	83.62 ± 0.530	2.92 ± 0.050
June	10.93 ± 0.481	5.19 ± 0.03	88.80 ± 1.195	2.20 ± 0.133
	10.25 ± 0.481	5.23 ± 0.03	86.56 ± 1.195	1.98 ± 0.133
	10.65 ± 0.481	-	88.40 ± 1.195	1.96 ± 0.133
July	10.18 ± 0.651	4.75 ± 0.74	84.33 ± 0.215	2.30 ± 0.153
	9.26 ± 0.651	3.71 ± 0.74	83.90 ± 0.215	2.60 ± 0.153
	8.24 ± 0.651	-	84.12 ± 0.215	2.40 ± 0.153
August	8.11 ± 0.481	4.76 ± 0.94	85.05 ± 0.111	2.88 ± 0.053
	8.79 ± 0.481	4.23 ± 0.94	84.83 ± 0.111	2.78 ± 0.053
	7.49 ± 0.481	-	84.96 ± 0.111	2.80 ± 0.053

Table 10: Homogeneous subsets for the mean protein percentage of *Labeo gonius.*

PROTEIN
Duncan[a,b]

MONTHS	N	Subset for alpha = .05						
		1	2	3	4	5	6	7
April	2	2.0600						
May	3		7.2800					
August	3		8.1300	8.1300				
July	3			9.2267				
June	3				10.6100			
September	2				10.8200			
October	2					17.0100		
March	2					17.4350	17.4350	
November	2					17.5400	17.5400	
December	2					17.6400	17.6400	
January	2						18.3800	
February	2							20.6200
Sig.		**1.000**	**.158**	**.074**	**.719**	**.328**	**.149**	**1.000**

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 2.250.
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table 11: Homogeneous subsets for the mean lipid percentage of *Labeo gonius.*

LIPID
Duncan[a]

MONTHS	N	Subset for alpha = .05				
		1	2	3	4	5
May	2	1.1400				
January	2	1.2800				
May	2	1.4000				
October	2		2.2750			
December	2		2.3800			
November	2		2.5600			
September	2		2.5800			
February	2		3.0250			
July	2			4.2300		
August	2			4.4950	4.4950	
June	2				5.2100	
April	2					9.5450
Sig.		**.535**	**.102**	**.506**	**.089**	**1.000**

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 2.000.

Table 12: Homogeneous subsets for the mean lipid percentage of *Labeo gonius.*

MOISTURE

Duncan[a]

MONTHS	N	Subset for alpha = .05						
		1	2	3	4	5	6	7
February	3	76.8800						
October	3	77.2667	77.2667					
November	3		78.6000	78.6000				
December	3			78.9067				
January	3				80.8000			
March	3				81.6100			
April	3					83.3700		
May	3					83.4367	83.4367	
July	3					84.1167	84.1167	
August	3						84.9467	
September	3							87.3067
June	3							87.9200
Sig.		.586	.069	.666	.259	.325	.051	.390

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 3.000.

Table 13: Homogeneous subsets for the mean lipid percentage of *Labeo gonius.*

ASH

Duncan[a]

MONTHS	N	Subset for alpha = .05				
		1	2	3	4	5
September	3	1.3767				
November	3	1.4000				
October	3	1.4233				
Decemebr	3	1.4900				
January	3		1.6200			
February	3		1.7433			
Mach	3			2.0200		
June	3			2.0467		
July	3				2.4333	
August	3					2.8200
April	3					2.8533
May	3					2.9267
Sig.		.104	.057	.669	1.000	.114

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 3.000.