Original Research Article

Estimation of Fecundity and GSI of Pahari Gutum, *Somileptes Gongota* (Hamilton, 1822) From the Padma River in Rajshahi District, Bangladesh

Abstract

Fecundity and GSI of Gongota Loach, *Somileptes gongota* were studied from April 2019 to March 2020. The fecundity of *S. gongota* varied from 3375 to 73459.75. From total 36 specimen, 16 were male and 20 were female. The standard length of female specimen ranges from 5.4 cm to 12.5 cm while body weight of female specimen ranges from 3.72g to 19.52g. The mean GSI values of twelve months from April to March recorded were 0.158,0.231,0.225,0.242,0.176,0.00,0.00,0.13,0.00,0.00,0.00 and 0.134 respectively. Lowest mean GSI (0.00) found in September, October, December, January, February and highest mean GSI (0.242) found in July. Based on monthly mean GSI of female the spawning season of this species was April to July over the study period and the peak season July. In case of fecundity recorded highest (73459.75) in July and lowest (3375) in August. The relationship between fecundity and body weight was found as F=4.51BW-40115(r^2=0.835). The calculated fecundity ranged from 3375 to 73459.75 along with the body weight 3.72g to 19.52g. The relationship between fecundity and standard length was as F=0.012 $SL^{3.628}$ (r^2=0.794). The regression analysis indicated there was cubic relationship between fecundity and standard length and linear relationship between fecundity and body weight. Knowledge of fecundity and GSI would be very necessary for proper management of this fish.

Keywords: Fecundity, Gonado somatic index (GSI), *Somileptes gongota*

Introduction

Bangladesh is a riverine country. About 700 rivers both small and large are dispersed throughout the country. Water bodies are the quarry of resources which are spread all over the country. These water bodies include rivers, haors, baors, beels, lakes, ponds, canals, and estuaries. The Padma, the Meghna, the Jamuna and the Brahmaputra are the largest river of our country. These rivers are the biodiversity of various fisheries resources and they acts as breeding ground of various commercially important fishes. Besides many of the endangered and threatened species are somewhat found in these types of water bodies. It is a matter of regret that the biodiversity of these water bodies is declining day by day due to various anthropogenic and natural reasons. Over-exploitation, habitat degradation, ecological changes of breeding and feeding ground, aquaculture, unplanned dam construction that hampers the migration pattern of migratory fish like Hilsa (*Tenualosa ilisha)* etc. are some of the anthropogenic causes for the loss of aquatic biodiversity. The natural causes behind this includes volcanic eruption, river erosion, natural climate which abrupt the water quality parameters in such a pattern that result in severely biodiversity reduction of the habitat.

From the fisheries point of view, the water bodies are categorized into i.e., inland open water bodies (rivers, beels, haors, floodplains etc.); inland close waters (ponds, baors, coastal shrimp farms etc.) and marine water bodies (Kabir et al., 1998). These water bodies constitute enriched fisheries resources (Miah and Dewan, 1984). The reproductive cycle of fishes is largely influenced by these water bodies (Mustafa et al., 1980). Some of the water bodies are suitable for pelagic fishes, some are demersal fishes and some of them are exotic and indigenous fishes. There are 293 freshwater fishes, among them 30 are exotic species and 475 marine species are available in our water territory. Many species are threatened or endangered condition while some are already extinct. Many research works are ongoing to improve the quality of water and environment. The commercial prospects of the resources are increasing in a positive way. Every year fish production is increasing in Bangladesh. In inland close water fish production Bangladesh ranked of 5^{th} position in the world (DoF, 2023). Contribution of total production has been decreased by about 50 percent which is alarming in the last few decades.

In order to maintain the normal flow of protein requirement and enhance the fisheries production and biodiversity of fisheries, it is crying need to protect and conserve the endangered and threatened species of our country. The Pahari Gutum *(Somileptus gongota*) is such a species which is in the endangered situation according to the IUCN red list category (2015). Estimation of fecundity and Gonadosomatic Index/Gonadosomatic Index (GSI) of the species is very necessary to protect the species from extinct (Hossain et al., 1992). Fecundity may be expressed in terms of the number of eggs produced per brood fish in a breeding season (Lagler,1956). It is sometimes referred to as total or absolute fecundity. When we can know about the number of eggs produced by the species, we can get proper steps for viable offspring production (Islam and Hossain, 1990). The English name of the species is Gongota Loach. The life cycle pattern of the species is also necessary to protect the species. They can be chunky and heavy, worm-like, or even eel-like. Some of the loach species are *Somileptus gongota, Botia Dario,Syncrossus berdmorei, Yasuhikotakia nigrolineata, Sinibotia robusta, Pangio oblonga, Leptobotia guilinensis, Botia almorhae etc.* The Phahari gutum is collected from the Padma river of Rajshahi district. The species also found in the old Brahmaputra river of Mymensingh, the Kangsha river of Netrokona district, the Korotoa river of Bogura district and other water bodies of Bangladesh. Although the species is in these water bodies, the supply of the species is very limited. That is why the species is considered the endangered species of Bangladesh.

This species widely distributed in the Rajshahi area in the rainy season (Bhuiyan et al., 1992). This species reared in aquarium. Not available in the markets of Rajshahi area. This fish plays an important role in controlling the insect population (Rahman, 1989). This species is found in its habitats throughout Bangladesh but not abundant anywhere (Akter et al., 2007; Sarker et al., 2002; Shafi et al., 1978) and not listed as threatened in IUCN Red book of threatened fish of Bangladesh by IUCN Bangladesh (IUCN Bangladesh, 2000).

The population biology and its trend for this species remain much unknown. Therefore, it is currently assessed as near threatened in the red list category (IUCN,2015). The abundance of the Pahari Gutum or pahari puiya is significantly declining over last few years (Alam et al., 2006). The fish is also very tasty but limited in supply. Proper conservation measure can be taken from this study to increase the production of the fish which ultimately increase the total fish production of our country (Banu and Bhakta, 1984). The nutritional value of the species is also high (Das et al.,

1989). This will increase the income of fishermen that can bring about the positive change of the poor fishermen. This species is valuable source of animal protein and can meet up the requirement of protein of the people of Bangladesh. For sustainable management of the species, estimation of fecundity and GSI is the main step. Immediate steps to protect the species should be taken otherwise it will be extinct within the near future. Considering the above facts, the main objectives of the research work was the estimation of fecundity and GSI of the Gongota Loach, *Somileptes gongota* (Hamilton, 1822). The main objectives of the research were to determine the fecundity, Gonado somatic Index and spawning season to provide a concrete recommendation for the management of the species.

Materials and Methods

Site of Sampling

The research work was conducted with the Gongota Loach *Somileptus gongota* collected from the Padma river. It is located in the Rajshahi district in Bangladesh. It is originated from the Gongotri himbaha of the Himalay mountain. In India the river is known as the Ganga river and flows through the Chapainawabganj district into Bangladesh and named as the river Padma. Among the four largest rivers of Bangladesh, it is one of them. The river is full of fisheries resources. Many of the endangered and vulnerable species of Bangladesh are available in the river. The river acts as the breeding ground of Hilsa and many of the commercially important and nutritious fish species. *Somileptes gongota* is one of them although the species is now in the endangered situation.

Fig.1: The sampling site of the Padma river in Rajshahi district, Bangladesh

Collection of samples

Total thirty-six (36) number of *Somileptes gongota* both male and female were collected from the Padma river in each month over the year round. Sample collection started from April 2019 and ended in March 2020. The loaches were caught by cast net from the Padma river randomly. The collected samples are transported in polybag filling in the oxygen from the study area to BAU campus. Then they are preserved in the refrigerator. Each month the sample were collected and mentioned the collection date, month name, number of species and then they were compiled in the refrigerator. During the collection of samples some caution were taken to avoid injury. Our honorable guide teacher has helped us providing the necessary knowledge about the research topics.

Recoding length-weight data

The distance from tip of the snout to the end of the longer lob of caudal fin is known as Total Length (TL). Again, the distance from tip of the snout to the end of the caudal fork or end of the last vertebra is known as Standard Length (SL). By using a measuring scale, the Total Length and Standard Length were measured. By using potable weighting machine weight of each sample were recorded. All of the length data were recorded in cm and the body weight

was taken with the help of a portable weighting balance in g. Length weight data of every month were recorded carefully.

Fig.2: Measuring weight of *Somileptes gongota* (g) through an electronic balance

Fig.3: Recoding length of *Somileptes gongota*(cm) through a measuring scale

Gonad sampling

The ventral side of the samples were cut and opened from the anus toward the lower jaw by using scissors carefully and the belly is opened. Then the muscle of the abdomen was cut from the anus toward the ventral column vertically. Muscles, fat tissue, digestive organs and blood vessels were removed in a proper way. After this the ovary were taken out by using forceps. The weight of ovary was measured very carefully with the help of a portable electronic balance in g and recorded length in cm. For estimation of fecundity, small portion of the gonad was taken weighed that is known as sub sample weight.

Preservation of the collected samples

After taken the weight and length of the ovary and immediately after collection the fishes were preserved carefully with 10% formalin in order to cease further digestion of food materials and to stop the enzymatic activity of gut content. The containers were labeled, which included the date of collection and gender. Afterwards, the fishes were brought to the laboratory and kept in a safe place.

Study on Gonado Somatic Index (GSI)

Sexually maturity attains in peak breeding season. After spawning they spawns several times in their life spawn. With the increase of the body mass the gonad increases in size. GSI is frequently applied to determine the reproductive cycle of a fish species over the year at monthly or less interval. Most of the fishes become mature in the same year of birth when favorable conditions are available. GSI assumes that a gonad increases in size with increasing development comparing with the mass of the gonad (GW) to the total mass of the animal (BW). The gonado somatic index of each *Somileptes gongota* was calculated by the following formula:

$$GSI=100\times GW/BW$$

Where, GW=Gonad weight

BW=Body weight

Study on Fecundity

The fish samples were collected every month. The preserved samples were brought in laboratory and washed properly. The gonads from each specimen were removed out by dissecting the samples. Moisture from gonad was thoroughly wiped out with tissue paper. To collect eggs sample, fishes were handled properly. Only the matured ovaries were selected for fecundity analysis. The matured ovaries were weighed by using portable electronic balance in g. These ovaries were then spilt longitudinally and kept in petri-dish. Three samples, each were taken from the anterior, middle and posterior region of each ovary. Weight of each sample was measured by the electronic balance. All the ovaries were preserved in 10% formalin solution which helped in preserving the ovaries as well as made it much easier to separate the eggs from wall of ovary. After some hours, eggs become large and small amount of water added to separate from each other with the help of needles. All the eggs were not equal in size. Some were larger and some of them were tiny in size. The number of eggs in each of the sub sample were counted and mean value of eggs were calculated. The average number in sub sample were multiplied by the weight of the ovary, and calculated the value of fecundity of the gonad. The number of eggs of the sub sample was multiplied by the ratio of gonad weight (GW) to the weight of the sub sample which gives the fecundity of the species.

F=N× Gonad weight/Sub sample weight

F= Fecundity of fish

N= Number of eggs in the sub sample

Standard length-fecundity relationship

The relationship between fecundity and standard length are as follows: -

$F = a\ SL^b$ (Bagenal and Cochran)

Where,

F=Fecundity

SL=Standard Length

Logarithm transformation of the equation becomes the following: -

$$\ln F = a + b \ln SL$$

Body weight –fecundity relationship

The relationship between body weight and fecundity is as follows: -

$$F = a + b\ BW$$

Where,

F=Fecundity

BW=Body Weight

b = Slope of the regression line

a = Intercept of the regression with the y – axis.

RESULTS

Fish Size

Total 36 specimen of *Somileptes gongota* were collected for the experiment. Among the specimen of *S. gongota*, 16 specimens were males and 20 specimens were females. Over the 12 months study period male lowest standard length was recorded 5.4 cm and highest standard length was recorded 10.6 cm. Again, for the female lowest standard length was recorded 6.4 cm and highest standard length was recorded 12.5 cm. In case of body weight of male lowest point was 2.25 g and highest point was 16.92 g. Again, the lowest body weight of female was 3.72 g and highest body weight was 19.52 g recorded from 12-month sample.

Standard Length

The experiment was conducted from April 2019 to March 2020. Whole 12 months various sizes of female specimens were collected and recorded the data. The lowest standard length was 5.4 cm found in September and highest standard length was 12.5 cm found in April. The standard length of female varied 10.6-12.5 cm,9-9.6 cm,8.9 cm,8.7-10.2 cm,8-9.2 cm,7.2 cm,6.4 cm,8.6-10.7 cm,8.5 cm,8.8-9.7 cm,7.2-8.5 cm,9.2-10.1cm respectively during April 2019 to March 2020 (Table 1).

Table 1: The 12 months information of *Somileptes gongota*

Date: 05/04/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	14	**12.5**	**19.52**	**3.191**	0.028	403
2	12	10.6	15.12	2.314	0.076	351
3	9	7.5	9.23	-	-	-

Date: 10/05/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	8.4	7.5	4.237	-	-	-
2	9.8	7.2	6.021	-	-	-
3	10.2	8.9	9.031	2.031	0.004	126

Date: 10/06/2019

Fish no.		TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1		10.5	9	10.101	2.755	0.075	674
2		11	9.6	10.412	1.986	0.008	165
3		9	7.6	6.723	-	-	-

Date: 07/07/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	10.3	8.7	9.793	2.401	0.037	486
2	11.6	10.2	9.347	2.231	0.0041	135
3	12	**10.6**	6.342	-	-	-

Date: 15/08/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	9.5	8	6.723	**0.837**	0.031	125
2	10.8	9.2	9.231	2.105	0.126	450
3	7.5	6.4	4.321	-	-	-

Date: 03/09/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	6.2	**5.4**	**2.25**	-	-	-
2	9.7	8.4	7.213	-	-	-
3	8.3	7.2	3.981	0.00	0.00	0.00

Date: 09/10/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	7.5	**6.4**	**3.72**	0.00	0.00	0.00
2	11.2	9.7	8.32	-	-	-
3	9.2	7.8	7.137	-	-	-

Date: 12/11/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	10.5	9	6.917	-	-	-
2	12.2	10.7	13.210	1.379	0.032	327
3	9.8	8.6	6.22	0.972	0.014	129

Date: 13/12/2019

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	10	8.5	8.143	0.00	0.00	0.00
2	11.5	10.1	11.42	-	-	-
3	9.7	8.3	6.025	-	-	-

Date: 02/01/2020

Fish no	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	11.5	9.7	11.760	0.00	0.00	0.00
2	10.3	8.8	7.04	0.00	0.00	0.00
3	8.4	7.3	5.210	-	-	-

Date: 05/02/2020

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	11.2	10	11.113	-	-	-
2	9.7	8.5	10.52	0.00	0.00	0.00
3	8.8	7.2	5.621	0.00	0.00	0.00

Date: 13/03/2020

Fish no.	TL (cm)	SL (cm)	BW(g)	GW(g)	Small part GW(g)	No of eggs in small part
1	12	10.5	**16.919**	-	-	-
2	11.5	10.1	12.972	1.013	0.0052	155
3	10.6	9.2	9.153	1.737	0.0029	115

Body weight

Different body weight of female specimen found over 12 months, 3.720 g is the lowest body weight of female fish found in October and the highest body weight was found 19.52 g in April. Body weight of *S. gongota* female specimen varied from 15.12-19.52 g,10.101-10.412 g,9.031 g,9.347-9.793 g,6.72-9.23 g,3.981 g,3.72 g,6.22-13.21 g,8.143 g,7.04-11.76 g,5.621-10.52 g,9.153-12.972 g respectively from April 2019-March 2020. (Table 1)

Ovary weight

The highest ovary weight was recorded 3.191 g in April and the lowest one was 0.837 g in August and 0.00 g in September, October, December, January and February. Ovary was collected throughout the 12 months from April to March. Only April, May, June and July specimen contain comparatively higher weight than the other months. Ovary weight of female specimen of S. gongota varied from 2.31-3.19 g, 1.99-2.76 g,2.23-2.4 g,0.837-2.105 g,0.00 g, 0.00 g, 0.97-1.389 g, 0.00 g, 0.00 g, 0.00 g, 1.01-1.74 g respectively from April to March. (Table 1)

Table 2: Month wise GSI of female fish *Somileptes gongota*

Month	No of fish examined	GSI ranges	Mean GSI
April-2019	2	0.153-0.163	0.158
May -2019	2	0.272-0.190	0.231
June -2019	1	0.225	0.225
July-2019	2	0.239-0.245	0.242
August-2019	2	0.124-0.228	0.176
September-2019	2	0.00	0.00
October-2019	2	0.00	0.00
November-2019	2	0.104-0.156	0.130
December-2019	3	0.00	0.00
January-2020	2	0.00	0.00
February-2020	2	0.00	0.00
March-2020	2	0.078-0.189	0.134

Gonado Somatic Index (GSI)

The highest GSI value of females was recorded 0.245 in July and lowest was 0.104 in November throughout the sampling period over twelve months. The value ranges of GSI from April to March respectively 0.153-0.163,0.190-0.272,0.225,0.239-0.245,0.124-0.228,0.00,0.00,0.104-0.156,0.00,0.00,0.00,0.078-0.189. September, October, December, January, February shows 0.00 GSI as seemed 0.00 gonad weight. April, May, June, July showed mostly higher GSI than the other month. The mean GSI value of twelve months from April to March was recorded 0.158, 0.231, 0.225, 0.242, 0.176, 0.00, 0.00, 0.130, 0.00, 0.00, 0.00 and 0.134 respectively (Table 2).

Spawning Season

In the experiment monthly mean GSI value for females was higher in April, May, June and July and the highest value was in July (0.242). Based on monthly mean GSI of females the spawning season of this species was assumed from April to July over the study period and the peak season was in July (Fig. 4).

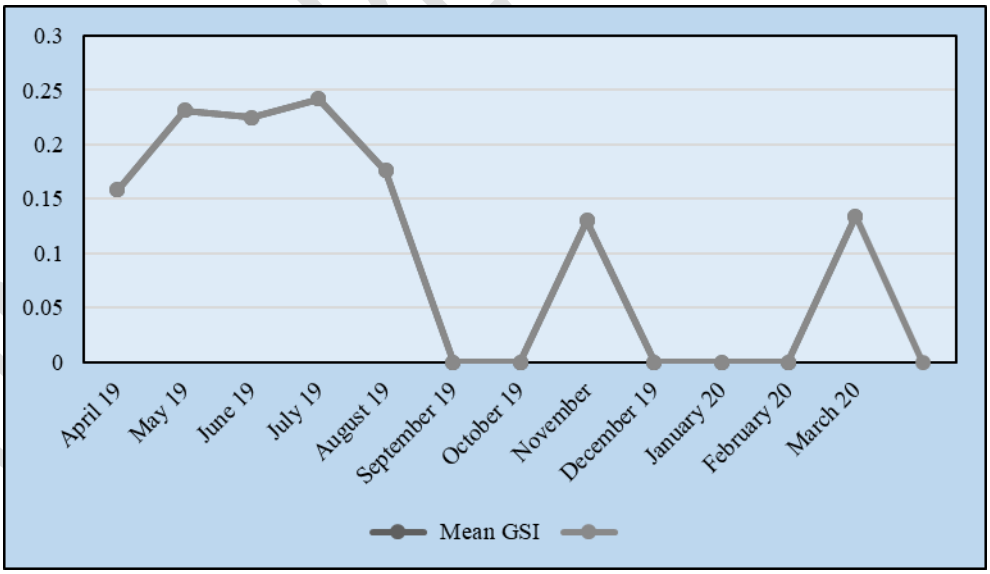

Fig. 4: Highest spawning season in July with highest GSI value

Fecundity

Along with the experiment April, May and July showed mature female specimens of *S. gongota*. From the mature female specimens ,highest fecundity was recorded 73459.75 in July and lowest fecundity was recorded 3375 in August. The highest fecundity was recorded with standard length 10.2 cm and body weight 9.347 g. Again the lowest fecundity recorded with 8 cm standard length and body weight 6.723 g.

Table 3 : Body weight, Gonad weight, GSI and fecundity of female *S. gongota*

Month	Body weight(g)	Gonad weight(g)	GSI	Fecundity
April (2019)	19.52	3.191	0.163	45927.67
April (2019)	15.12	2.314	0.153	10687.02
May (2019)	10.101	2.755	0.272	24758.27
May (2019)	10.412	1.986	0.191	40961.23
June (2019)	9.031	2.031	0.225	63976.5
July (2019)	9.793	2.401	0.245	31537
July (2019)	9.347	2.231	0.239	**73459.75**
August (2019)	6.723	0.837	0.124	**3375**
August (2019)	9.231	2.105	0.228	7517.86
November (2019)	13.210	1.379	0.104	14091.65
November (2019)	6.22	0.972	0.156	8956.29
March (2020)	12.972	1.013	0.079	30195.19
March (2020)	9.153	1.737	0.189	68881.03

Body weight and fecundity of S. gongota

In regression analysis, body weight was taken as independent variable, while fecundity as dependent variable. The scatter diagram found from the fecundity (F) and body weight (BW) yielded a linear relationship. The relationship between the fecundity and body weight was found as, F = 4.51 BW-40115.

The co efficient of determination (r^2) in the regression analysis was 0.835, which suggested that 83.5% of the variation in fecundity was due to the variation of body weight. This indicated that fecundity increased with the increase of the body weight. So, from regression analysis it showed significant relationship between fecundity and body weight. The calculated fecundity ranged from 3375 to 73459.75, along with the body weight 3.72 to 19.52 g of female specimens (Table-3).

Standard length and fecundity of S. gongota

The fecundity (F) and Standard length (SL) of *S. gongota* plotted in the scatter diagram and yielded a nonlinear or power curve equation. In regression analysis Standard length was taken as independent variable, fecundity as dependent variable. As the standard length change a bit fecundity will also change. The relationship between the fecundity and standard length was expressed as $F= 0.012\ SL^{3.628}$. The analysis estimated co efficient of determination (r^2) was 0.794 which suggested that 79.4% of the variation in fecundity is due to variation in standard length. This indicated that the number of eggs per female increased significantly with increasing of the standard length. So, the regression analysis indicated there was strong relation between fecundity and standard length. The calculated fecundity ranged from 3375 to 73459.75, along with the standard length of the female 6.4 to 12.5 cm.

Discussion

According to the result the highest standard length was recorded 12.5 cm in April. Again, the lowest standard length was 6.4 cm in October. In case of body weight 3.72 g was lowest and 19.52 g was highest. GSI is the indicative of the spawning season was found throughout the research session over twelve months. The GSI is the indirect way to find the peak spawning season. The highest GSI value was 0.245 in July and the lowest GSI value in 0.078 in March. September, October, December, January, February showed 0.00 GSI value and their ovary weight was 0.00 g. The rise and fall in the GSI graph showed peak spawning season and July was the highest one. The graph showed gradually rising from April to July and then decrease in August. Gonado somatic index increases with the maturation of fish and reaches to its

maximum at the peak period of maturity. That means the spawning season of *S. gongota* was April, May, June and July was the peak season with maximum GSI. In case of fecundity among 20 female, 13 mature female specimens were taken for the research. From April to August, November and March total 13 female specimens were conducted for fecundity. The highest fecundity was found in July which was 73459.75 and lowest found in August which was 3375.

Standard length of female specimen of *Somileptes gongota* was recorded lowest 6.4 cm in the month of October and highest in 12.5 cm in the month of April. On the other hand, the lowest body weight of female was recorded 3.72 g in October and highest body weight was 19.52 g in April. For male standard length was recorded lowest 5.4 cm in September and highest 10.6 cm in March. Again, body weight of male highest in 16.919 g in March lowest in 2.25 g in September. GSI value was also calculated of all fishes for 12 months. The mean GSI values for female was highest in July (0.242) and lowest in November (0.13). The GSI values for females were become higher from April to July. This indicates that spawning season of that species from April to July and pick in July.

Gravimetric method was followed to estimate the fecundity. From the research work result, it was observed that the number of fecundities varied from 3375 (from a fish with standard length 8 cm, total weight 6.723 g) to 73459.75 (for a fish with standard length 10.2 cm and body weight 9.347 g). Highest fecundity was found in the month of July and lowest fecundity in the month of August.

The regression equation and their relationship between Standard Length (SL) and Body Weight (BW) with fecundity were conducted. During the present experiment, the fecundity was plotted against the standard length and body weight of the fishes. The relationship between body weight and fecundity of *Somileptes gongota* was found linear and the relationship was expressed as F= 4.51 BW- 40115. But there was a nonlinear cubic relationship between Standard Length (SL) and fecundity of *Somileptes gongota* and expressed as $F= 0.012\ SL^{3.628}$. The present research evolved that the relationship between body weight and fecundity was found to be the most significant and it was a linear relationship.

Conclusion

The study on estimation of fecundity and GSI of *Somileptes gongota* will be effective for the conservation of the red listed fish. The reproductive parameters will be useful for the culture of the species. For sustainable fisheries management of *Somileptes gongota* fecundity and GSI estimation are very important. Without complete assessment on fecundity and GSI their reproductive behavior cannot imagine. To establish sustainable management and conserve from threatened condition prerequisites are to evaluate fecundity and GSI of a fish. Therefore, this study conveys premier information about fecundity and GSI. The information of this study can be potentially use as a baseline for the future study on this fish.

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