



Research Article – Fisheries

Spawning and mortality of eggs and larvae produced by different brood sizes of Walking Catfish (*Clarias batrachus* L.)

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Abstract

An experiment was carried out on the spawning and mortality of eggs and larvae of Magur, *Clarias batrachus* collected from brood-stock pond during the study period. The lowest spawn production (3774 eggs) was recorded in the fish having 23 cm total length and 115 g total body weight and the highest spawn production (10102 eggs) was recorded in the fish having 26.4 cm total length and 230 g total body weight. The spawn production was found to increase with the increase of total length, standard length and total body weight following the equations, $Y = -13921 + 833.7X$, $r = 0.685$, $Y = 13965 + 909.8X$, $r = 0.667$ and $Y = 1326 + 33.02X$, $r = 0.810$, respectively. The relationships between spawn production with total length, standard length and total body weight of the fish were found to be linear and significant ($p < 0.01$). The lowest mortality rate (30.41%) was recorded in the fish having 26.4 cm total length and 224 g total body weight and the highest mortality rate (42.76%) was recorded in the fish having 23 cm total length and 125 g total body weight. The mortality rate of eggs and larvae was found to decrease with the increase of total length, standard length and total body weight of female brood following the equations, $Y = 108.6 - 2.878X$, $r = -0.865$, $Y = 110.4 - 3.214X$, $r = -0.862$ and $Y = 54.99 - 0.108X$, $r = -0.970$, respectively. The relationships between mortality rate of eggs and larvae with total length, standard length and total body weight of the fish were found to be linear and significant ($p < 0.01$).

Keywords: *Clarias batrachus*, spawn production, mortality rate, linear relationship

Introduction

Bangladesh is an agro-based South Asian developing country. Fish is the second important export item of this country. Bangladesh has achieved the 4th place based on fish production in the world in 2014. The total production value of fish in our GNP is Tk. 19567.90 crore (DoF, 2012). Total fishermen are 12.80 lakh including 7.70 lakh inland fishermen and 5.10 lakh marine fishermen. Fish farmers are also great in numbers as 42.30 lakh in which fish farmers are about 30.80 lakh and shrimp farmers are about 11.50 lakh (DoF, 2012). The inland capture fisheries contributes about 35.53% where inland culture fisheries contributes about 46.62% of the total fish production and remaining 17.85% comes from marine fisheries (DoF, 2012). Fisheries play a vital role in our national economy. The contribution of fisheries sector in Bangladesh is 4.37% of GDP and 23.37% in agriculture (DoF, 2014).

The walking catfish *Clarias batrachus* (L.) popularly called “Magur” is commercially as well as aquaculturally an important species in many Asian countries. This catfish has both the high nutritive value and high market price. Productions of this species are also considerable such as 5043 kg/ha obtained from farm pond of 0.1 ha (Khanom, 2010; Talwar and Jhingran, 1991). Beside this, it has delicious taste and nutritive properties, for this physician prescribe it for the convalescents. This fish contains 80.74% moisture, 0.95% minerals, 15.22% protein and 3.08% lipid (Ahmed *et al.*, 2012). Spawning of fish occurs during a particular phase of

the reproductive cycle. Some of them breed once a year while some at regular intervals throughout the year. *C. batrachus* species has a short spawning period during July–August, coinciding the south-west monsoons (Talwar and Jhingran, 1991). Its attain maturity at the end of the first year of its life; at 20 cm length (Siddiqui and Choudhury, 1996). The brood fish of 100–150 g size can be employed for successful spawning. For the purpose, they should be well fed with feed containing 30% protein diet daily, at least three months prior to breeding season. They prefer inundated paddy fields and similar water body most for spawning. Also breeds in confined waters like ponds and tanks. Builds nest prior to breed (Shafi and Quddus, 2001).

Spawning refers to the process of releasing the eggs by the gravid female at a time and sperm by brood male (Moyle and Cech, 2004). Most aquatic animals, apart from aquatic mammals, reproduce through a process of spawning. The eggs of *C. Batrachus* are adhesive and shining brown in color (Shafi and Quddus, 2001). However, it is an useful working index for the farmer because it allows egg production capability to be directly related to stocking density, feeding rates, water supply, the age and number of brood fish. Mortality of eggs and fry is also an important aspect of biology because the production of fish is usually higher when mortality of eggs and fry is lower (Ahmed *et al.*, 1985). Higher survivability of eggs and fry increases fish production if the mortality is minimum. Thus, the economical success of fish culture depends on low mortality and higher survival.

A comparatively simple culture characteristic with efficient food conversion & excellent nutritional profile makes *C. batrachus* very suitable for commercial intensive culture. A common perception of easily digestible high grade protein, high concentration of iron and beneficial lipid content may be instrumental towards its high acceptance as medicinal fish. In every 100 g flesh- 32.0 g protein, 2.0 g fat, 0.7 g iron, 172 mg calcium, 300 mg phosphorus and 66.3 g water are available (Siddiqui and Choudhury, 1996). According to FAO estimates the demand for catfishes throughout the world is increasing and *C. batrachus* with its several beneficial aspects remain as a hit among the Asians in particular. Considering its high market price and high consumer's demand fish farmers often show considerable interest in its culture but the non-availability of fry is the biggest constraint. In our country fry of magur produced in natural water is not sufficient to meet the demand of fry requirement for its culture. Therefore, proper technique of induced breeding and larval rearing for large scale production of fry are the most crucial factors in expanding culture practice for this species. The aim of the study to determine the egg production capacity using gravimetric method for the successful breeding, the mortality rate of eggs and larvae of *C. batrachus* and to study different relationships between different parameters such as total length, standard length, total body weight, spawn production, mortality of fish, eggs and larvae.

Materials and Methods

The experiment was carried out on the spawning and mortality of eggs and larvae of 100 female and 10 male Magur, *Clarias batrachus* L. at Reliance Aqua Farms located at Ukilbari, Trishal, Mymensingh during the period from April to August, 2016. Conditioning and spawning tank were used for conditioning of the brood fishes and spawning purpose, respectively.

Maintenance of brood fish

The brood fishes were collected from different ponds of this hatchery which was cultured last two or three years and reared in the earthen ponds at the stocking density of 250–300 fish/dec. The fish was supplied with balanced nutritious feed (produced in the farm containing 30% protein) at the rate of 3–5% body weight/day until maturity came.

Collection of brood fish

For the estimation of spawning and mortality (eggs and sac fry), the broods of *C. batrachus* (male and female) were collected from these brood stock pond in the late morning and were kept in large plastic bucket or steel pot. Then the fishes were selected carefully for further use. The collection of broods was done at every seven days interval. A total number of 100 females and 10 males were collected for the estimation of spawn production and mortality (eggs and larvae) of Magur.

Measurements of experimental fish

The total length, standard length, and the body weight of each specimen were recorded separately to the nearest cm scale and g, respectively.

Collection of Milt and Eggs

For collection of milt and eggs, the males and females were injected with HCG hormone solution intra-muscularly

before 17-19 hours at 1000 IU/Kg and 2500 IU/Kg body weight, respectively. Milt and eggs were kept on same plate or pot for fertilizing eggs. The testes were cut and pulverized with blade or cloth for mixing with eggs for fertilization. Then, slightly salty water (0.9%) was added to it for keeping the freshness of milt and eggs. After adding salty water, it was shaken well with a feather for fertilizing eggs.

Estimation of spawn production

Gravimetric method was used to estimate spawn production. This was done by the following formula: $\text{Spawn production} = (\text{Number of eggs in sample} \times \text{Weight of eggs}) / (\text{Sample weight})$

Estimation of survival rate of eggs and fry

The survival rate of eggs and larvae was calculated using the formula: $\text{Survival rate (\%)} = \text{Live fry collected} \times 100 / \text{Number of eggs released}$

Estimation of mortality rate

The mortality rate was calculated by counting of dead eggs and larvae till the end of the experiment. According to Samad (2010) the mortality rate (%) of eggs and larvae was counted by the following formula: $\text{Mortality Rate (\%)} = \text{Number of eggs released} - \text{Live fry collected} / \text{Number of eggs released} \times 100$

Data processing

The relationship between different parameters such as total length and spawning, standard length and spawning, body weight and spawning, total length and mortality, standard length and mortality, body weight and mortality were calculated both as simple linear relationship with the help of Microsoft Excel Program. The coefficient of correlation co-efficient (r), regression co-efficient (b) and regression equation were also calculated and expressed.

Results

Morphology of experimental fish

The body of *C. batrachus* L. was elongated, head moderately depressed and covered by osseous plates. Eyes small, mouth terminal and barbels four pairs of maxillary barbels extended to middle or end of pectoral fins and mandibular pairs were shorter. Dorsal fin was inserted slightly anterior tip of pectoral fins. Males and females were distinguished by their secondary sexual characters. During breeding season the broods were found to be fully matured and were ready to spawn. The body color of the male was prominent but the female was comparatively dull in color. The abdomen of the female was swollen and soft due to presence of mature bulky eggs. The genital aperture of the male was normal while the genital aperture of the female was protruded.

Morphology of eggs of the experimental fish

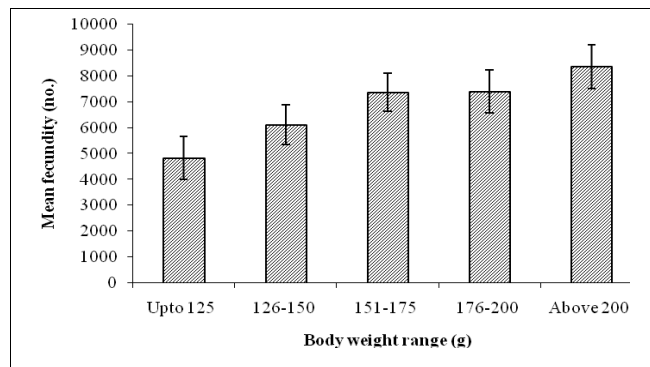
Magur, *C. batrachus* attained maturity at the end of the first year of its life; at 20 cm length. The eggs of *C. batrachus* were adhesive and shining brown or green in color. The egg size of Magur was small but easily visible and countable by naked eyes. But the problem is that the eggs were very sticky. To minimize stickiness the eggs were mixed with slightly salty water (usually 0.90%) and frequently shake with bird's feather.

Table 1. Mean \pm SD of total length, standard length, total body weight, weight of eggs, spawning, live fry collected, survival rate and mortality rate as obtained for *C. batrachus* during the study period

Range of weight (g)	No. of Fish	Total Length (cm)	Standard Length (cm)	Body Weight(g)	Eggs Weight(g)	No. of Eggs	No. of Larvae	Survival Rate (%)	Mean of Mortality Rate (%)
Up to 125 g	18	23.14 \pm 3.0	21.29 \pm 2.9	120.97 \pm 4.19	21.76 \pm 3.71	4831.3 \pm 824.74	2800 \pm 472.1	57.97 \pm 4.2	42.03 \pm 3.6
126 to 150 g	24	24.41 \pm 4.0	22.43 \pm 4.4	139.79 \pm 7.02	27.58 \pm 3.46	6124.1 \pm 768.19	3664.5 \pm 479.2	59.8 \pm 5.8	40.2 \pm 0.58
151 to 175 g	21	24.9 \pm 4.5	22.89 \pm 4.0	166.86 \pm 9.51	33.24 \pm 3.34	7380.8 \pm 741.04	4637.5 \pm 465.2	62.84 \pm 4.2	31.16 \pm 4.2
176 to 200 g	21	25.43 \pm 6.4	23.31 \pm 5.9	187.24 \pm 7.61	33.31 \pm 3.74	7396.7 \pm 830.81	4878.1 \pm 545.5	65.95 \pm 4.1	34.05 \pm 4.0
Above 200 g	16	26.49 \pm 7.0	24.29 \pm 5.0	222.06 \pm 6.53	37.72 \pm 3.8	8374.6 \pm 843.5	5769.3 \pm 563.3	68.91 \pm 4.2	31.09 \pm 4.1

Estimation of spawn production

The results of the studies on the estimation of spawning of 100 gravid fishes collected from brood stock pond of Reliance Aqua Farm. The spawning of fish was found to be ranged from 3774 eggs to 10102 eggs in the fish of 23 cm total length, 115 g total body weight and 26.4 cm total length, 230 g total body weight, respectively with average spawning was 6720 eggs during the period of study. The spawning showed a variation for different total body weight which was higher in the fish group of higher total body weight and lower in the fish group of lower total body weight (Fig. 1 and Table 1).

**Fig. 1.** Showing body weight-wise fluctuation of spawn production for *C. batrachus*.

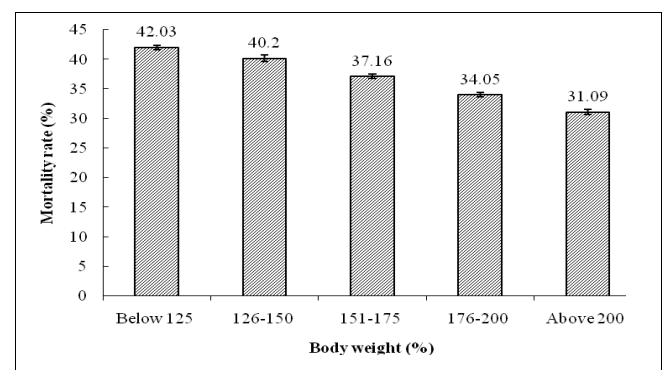
Estimation of Survival Rate (eggs and sac fry)

The survival rate of eggs and fry of Magur was low. The survival rate ranged from 30.41 to 42.76% with an average survival rate of 62.86% (Table 1). The highest survival rate (69.59%) of *C. batrachus* was recorded in fish of 224 g total body weight and 26.8 cm total length. The lowest rate (57.24%) of the same was recorded in the fish of 125 g total body weight and 23 cm total length. Survival rate was higher in the fish group of higher total body weight and lower in the fish group of lower total body weight.

Estimation of Mortality Rate (eggs and sac fry)

The mortality rate of *C. batrachus* was higher than the normal ones. It was ranged from 30.41 to 42.76% with average mortality rate 37.14%. The highest mortality rate (42.76%) of *C. batrachus* was recorded in the fish of 125 g total body weight and 23 cm total length. The lowest (30.41%) of the same was recorded in the case of fish of 224 g total body weight and 26.8 cm total length. The mortality

rate showed a variation for different total body weight. Mortality rate was lower in the fish group of higher total body weight and higher in the fish group of lower total body weight (Fig. 2 and Table 1).

**Fig. 2.** Showing body weight-wise fluctuation of mortality rate for *C. batrachus*.

Different relationships between various parameters

The spawn production (no. of eggs) of the fish was increasing with the increase of total length, standard length and total body weight of *C. batrachus* following the equation $Y = -13921 + 833.7X$, $r = 0.685$, $Y = 13965 + 909.8X$, $r = 0.667$ and $Y = 1326 + 33.02X$, $r = 0.810$, respectively. When this equation was plotted on scatter diagram, a straight line was obtained and the regression line was significantly ($p < 0.01$) fitted (Fig. 3).

The mortality rate of the fish was decreasing with the increase of total length, standard length and total body weight of *C. batrachus* following the equation $Y = 108.6 - 2.878X$, $r = -0.865$, $Y = 110.4 - 3.214X$, $r = -0.862$ and $Y = 54.99 - 0.108X$, $r = -0.970$, respectively. When this equation was plotted on scatter diagram, a straight line was obtained and the regression line was significantly ($p < 0.01$) fitted (Fig. 3).

Discussion

Clarias batrachus L. is one of the most important catfishes in Bangladesh. It has been drawing the attention of fish farmers in Bangladesh day by day due to its high market values, profitable culture and hardy nature. Artificial breeding of this species to obtain good quality fry has become a necessary part of fry production in the hatchery. The present work on spawning and mortality (eggs and larvae) by using HCG single dose application will be helpful in producing good quality fry according to demand and will

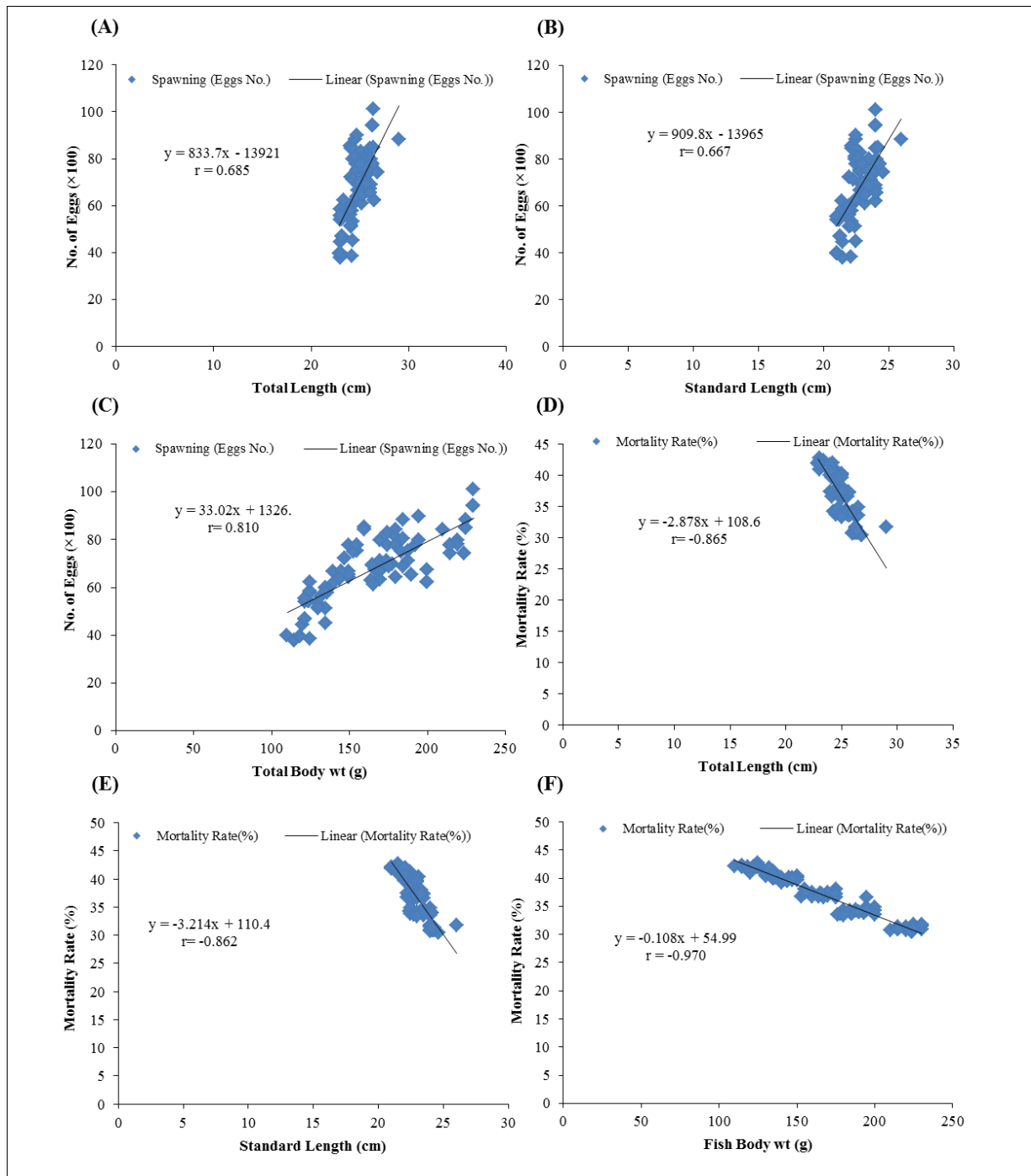


Fig. 3. Showing the relationship between (A) spawn production and total length, (B) spawn production and standard length, (C) spawn production and total body weight, (D) mortality rate and total length, (E) mortality rate and standard length, (F) mortality rate and total body weight of *C. batrachus*.

make easy for the hatchery management. The highest spawn production (10102 eggs) of *C. batrachus* was recorded in the fish of 230 g total body weight and the lowest (3774) of the same was recorded in the fish of 115 g total body weight. This variation might be associated with the increase of body weight. Fishes having higher body weight might have more matured ovary containing more eggs. These findings agreed with the findings of Faruk (1995) and Barua *et al.* (1988) for *C. batrachus*. It was found that spawn production might differ up to 7000 eggs due to body weight variation of female brood of *C. batrachus*.

From the regression equation and scatter diagram obtained by total length and spawn production, it was evident that the spawn production of *C. Batrachus* had a

linear relationship with different lengths. We can estimate spawn production based on total length by $Y = -13921 + 833.7X$, $r = 0.685$; standard length by $Y = 13965 + 909.8X$, $r = 0.667$; total body weight by $Y = 1326 + 33.02X$, $r = 0.810$. These findings agreed with the findings of Faruk (1995) and Barua *et al.* (1988) for *C. batrachus*. The survival rate of eggs and larvae of *C. batrachus* was lower than that of the findings of Rahmatullah *et al.* (1983) and Naser *et al.* (1990). This difference might be associated with the application of different hormones. Rahmatullah *et al.* (1983) used PG double dose for female and PG single dose for male as inducing agent for *C. batrachus*. On the other hand, HCG single dose was used for both female and male of *C. batrachus* as inducing agent. The highest mortality rate (42.76%) of *C. batrachus* was recorded in the fish of 125 g

total body weight and the lowest (30.41%) of the same was recorded in the fish of 224 g total body weight. This variation might be associated with the degree of body weight variation. As body weight of female brood increased, the maturity of eggs also increased (Thakur and Das, 1985). As a result, the mortality of eggs and sac fry of *C. batrachus* decreased with increase of total body weight. This finding supports with the findings of Shivastava *et al.* (2012) for *C. batrachus*.

It was found that mortality rate might differ up to 12% due to body weight variation of female brood of *C. Batrachus* but 30% mortality of eggs and larvae was common. This mortality might be caused by natural reasons such as poor water quality, poor health of brood fish and poor morphology of eggs and unhealthy feeding etc. So, mortality of eggs and sac fry can be minimized by collection of eggs from larger fish up to 12%. And remaining mortality can be minimized by reducing stress on eggs and fry, proper water quality management, proper feeding etc. From the regression equation obtained by total length and mortality rate, it was evident that the mortality of *C. batrachus* had a linear relationship with the total-length. One can easily estimate the egg and sac fry mortality of *C. batrachus* by the following equation, $Y = 108.6 - 2.878X$, $r = -0.865$.

There is no review available on the total length and mortality of eggs and sac fry relationship of *C. batrachus*. The regression equation and scatter diagram between standard length and mortality rate showed a negative and linear relationship. One can easily estimate the egg and sac fry mortality of *C. batrachus* by the following equation, $Y = 110.4 - 3.214X$, $r = -0.862$. There is also no review available on the standard length and mortality of eggs and sac fry relationship of *C. batrachus*. The regression equation and scatter diagram showed a negative and linear relationship between body-weight and mortality rate. We can estimate mortality rate of eggs and sac fry of *C. batrachus* by putting the value of total body weight in the following equation, $Y = 54.99 - 0.108X$, $r = -0.970$. There is also no review available on the total body weight and mortality of eggs and sac fry relationship of *C. batrachus*.

Conclusion

An experiment was designed to estimate spawning and mortality rate and determination of relationship between various parameters, a total of 100 gravid female fish and 10 brood male fish were collected from brood stock pond during the period from April to August, 2016. The number of eggs ranged from 3774 to 10102 and the highest values 10102 for the brood category of above 200 g with average spawning 6782 eggs. The mortality rate of *C. batrachus* was higher. The mortality rate ranged from 30.41% to 42.45% and the lowest values 30.41 for the brood category of above 200 g with average mortality rate 37.14%. In this study, brood female having higher weight and total length provide more eggs than the female brood fish having lower body weight and total length. The total body weight–spawning relationship and total body weight–mortality relationship were found to be most prominent. The coefficient of correlation (r) of total body weight–spawning and total body weight–mortality was highly significant ($p < 0.01$).

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