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Some biological aspects of Thai koi *Anabas testudineus* (Bloch)

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Abstract

A study was conducted from January-May 2007 to know some biological aspects i.e. gonadosomatic index (GSI), gamete sizes (egg diameter and sperm-head length), fecundity, condition factor (CF), relationship of body weight-fecundity and ovary weight-fecundity of Thai koi *Anabas testudineus*. The highest gonadosomatic index (19.50 ± 0.54), ova diameter (654.10 ± 6.37 µm) and sperm head-length (3.18 ± 0.08 µm) were found in 17th April. The mean fecundity was estimated to be 5,53,708 ± 41,041/kg with a range between 1,13,285 and 10,25,423/kg. The ovary weight ranged from 2.86 to 20.50g/100g with a mean of 11.16 ± 0.696g/100g, whereas the average numbers of eggs/g body and ovary weight were 526 and 4480 respectively. The highest condition factor (CF) 1.005 ± 0.12 indicated good health condition of fish in April than in the other months. The regression analysis showed that the relationship between body weight-fecundity and ovary weight-fecundity were linear. Co-efficient of correlation (r) of ovary weight-fecundity was highly significant ($P<0.01$) and stronger than the correlation (r) of body weight-fecundity. From the results it can be concluded that the peak spawning period of Thai koi might be in April.

Keywords: Thai koi, Fecundity, GSI, Ova and Spawning period

Introduction

Thai koi (*Anabas testudineus*), an important climbing perch in Bangladesh is becoming a highly demanded fish day by day due to its high nutrition, taste, faster growth and having ability to withstand harsh environmental condition (Alam *et al.*, 2006). In 2002, it was introduced into Bangladesh from Thailand. It looks like our indigenous koi. The high growth rate and bigger size of Thai koi make the people enthusiastic to its artificial breeding and culture in Bangladesh. Marginal farmers are very much interested to culture it due to its higher growth rate and better return compared to other species. However the main impediment to the extension of Thai koi farming is the scarcity of quality seeds. For mass production of quality seeds of Thai koi, the biological aspects such as peak breeding time, maturity of ova and sperm should be properly analyzed and evaluated.

Fish species has good relation to its fecundity for mass production of fries and fingerlings (Azadi and Siddique, 1986). Therefore, it is very important to study the dynamics of the fecundity of this species to evaluate its commercial culture potentialities. Furthermore, it is important to know the number of eggs, fry and fingerling that could be produced from an individual female brood fish. The number of eggs produced by a fish has also obvious significance in aquaculture, as this is related with size of brood stock, dependent on the quality of broods and the size of breeders. The information on the fecundity of Thai koi is scarce in Bangladesh. The information on different aspects of biology i.e. gonadosomatic index (GSI), egg sizes (egg diameter and sperm-head length), fecundity and condition factor of this species is of great importance for successful breeding programme. Therefore, the present study was undertaken to determine the GSI, gamete sizes (egg diameter and sperm-head length), fecundity, condition factor, the relationship of body weight-fecundity and ovary weight-fecundity of this important fish.

Materials and Methods

The experiment was conducted for 113 days from 23rd January to 15th May, 2007 in Fish Genetics Laboratory, Faculty of Fisheries, Bangladesh Agricultural University and Genetics Laboratory, Bangladesh Fisheries Research Institute (BFRI), Mymensingh. Ten live gravid female and male fish of Thai koi were collected from the stocking pond of Fisheries Field Laboratory Complex, Bangladesh Agricultural University, Mymensingh at fortnightly interval for subsequent studies. The breeders were selected on the basis of external features such as soft and swollen abdomen for female and slim for male, respectively.

At first the fish were killed by piercing a pin on the head and kept on a tray. Then the fish were dissected out by a scissors. The belly was opened from anus to lower jaw. The whole mass (stomach, intestine and the ovary) were removed carefully and placed on a petridish. Ovary was washed and cleaned with distilled water. Excess moisture was removed from the surface of the ovary with blotting paper. Weight and length of ovaries were taken. Ovary was then kept into boiling water for 10 minutes and finally preserved in 10% buffered formalin.

Sperm was collected from male in an eppendorf tube containing 10% formalin by gentle pressure of the lower region of caudal fin to the vent.

Gonadosomatic index (GSI) is expressed as percentage of gonad weight to the total weight of the fish. The GSI of the collected fish was calculated fortnightly using the following formula:

$$GSI = \frac{\text{Weight of ovary}}{\text{Weight of fish}} \times 100 \text{ (Nikolsky, 1963)}$$

The preserved ovary of each fish was taken from the 10% formalin and washed with distilled water. Excess moisture was removed as much as possible from the surface of the ovaries with blotting paper. Then the ovary was weighed to the nearest gram by an electric balance. 0.1g eggs were weighed and placed on a petridish containing 10 ml of water. The eggs were then separated from each other using a soft brush. Diameter of the eggs was measured from each of the anterior, central and posterior portions of the ovaries of the individual fish in micrometer using a compound microscope. The randomly selected eggs were put on the micrometer and the measurement was recorded along with the longest axis by moving the eggs with a fine needle whenever necessary. The extra moisture of the eggs was removed with blotting paper and the weight was recorded randomly.

The preserved sperm was placed on the slide and covered by a cover slip. Then the slide was placed under a compound microscope and measured the sperm-head length by adjusting magnification. Diameter of eggs and sperm-head length were measured at 10 × 10 and 10 × 40 magnification respectively using the method of Amy (1983) and Rahman *et al.* (2003).

The gravimetric method was used for counting the eggs. The counted number of eggs of the samples (0.1g) was multiplied by the total weight of both parts of the ovaries. Thus the total number of eggs i.e. fecundity was calculated for a particular fish. In this way fecundity of fishes were obtained by using the following formula:

$$F = \frac{N \times \text{Gonad weight}}{\text{Sample weight}}$$

Where F is the fecundity and N is the number of eggs in sample.

The value of 'q' in the equation $W = qL^b$ was used as an index of well-being or condition factor (CF) of an individual fish. CF was calculated from fortnightly samples using the following equation:

$$CF = W/L^b \quad \text{(Le Cren, 1951)}$$

Where,

W = weight of fish in g
L = Length of fish in cm
b = Calculated exponent value.

The relationship of different parameters such as fortnightly body weight-fecundity and ovary weight-fecundity were estimated as simple linear relationship with the help of Microsoft Excel Programme Version. Co-efficient of correlation (r) and regression co-efficient (b) were also determined.

Results and Discussion

In the present study, the mean highest GSI (19.50 ± 0.54) was recorded in 17th April and the lowest (3.96 ± 0.19) was in 23rd January (Table 1 & Fig. 1).

The highest average ova diameter was recorded 654.10 ± 6.37 μm with ranged from 628.00 to 685.00 μm in 17th April and the lowest was 139.70 ± 3.14 μm with ranged from 125 to 155 μm in 23rd January (Table 2 & Fig. 2). Simultaneously, the highest sperm-head length was found 3.18 ± 0.08 μm in 17th April with ranged from 2.97 to 3.60 μm and the lowest was 2.18 ± 0.05 μm with ranged from 2.0 to 2.30 μm in 23rd January (Table 2).

The highest mean fecundity estimated was 52,088 ± 2066 (ranged from 40,950 to 60,500) in 17th April and the lowest was 5,722 ± 437 (ranged from 3,965 to 8,250) in 23rd January. The highest average numbers of eggs/g of body and ovary weight were 991 (ranged from 902 to 1,040) and 5,140 (ranged from 4,797 to 6,300) respectively in 17th April. The lowest average numbers of eggs/g body and ovary weight were 137 (ranged from 100 to 183) and 3,487 (ranged from 2,666 to 3,965) respectively in 23rd January (Table 1).The overall condition factor (CF) of fish among all the samplings was similar. The highest average CF was 1.01 ± 0.12 in 3rd April and the lowest was 1.00 ± 0.01 in 20th February (Table 1).

The fecundity of the fish was increasing with the increase of body weight following equation of

Fecundity = 1952.16 weight – 67043.

Table 1. Total length, body weight, condition factor, ovary weight, gonadosomatic index (GSI), estimated fecundity and ova diameter of Thai koi (*A. testudineus*). Ten fishes were examined for each sampling in each parameter. Mean ± SE with ranges in parameters

Sampling date	Average total length (cm)	Average body weight (g)	Condition factor	Ovary weight (g)	Gonadosomatic index (GSI)	No. of ova/g body weight	No. of ova/g ovary weight	Fecundity
23rd January	11.31 ± 0.321 (9.3-12.4)	41.56 ± 1.13 (35-45)	1.0014±0.007 (0.95-1.03)	1.64 ± 0.11 (1.0-2.1)	3.96 ± 0.19 (2.8-4.7)	137 (100-183)	3487 (2666-3965)	5,722 ± 437 (3,965-8,250)
6th February	12.84 ± 0.89 (12.1-13.6)	44.99 ± 0.31 (44-47)	1.0001±0.003 (0.99-1.02)	1.987 ± 0.2 (1.9-2.1)	4.10 ± 0.32 (1.31-4.61)	146 (143-155)	3314 (3250-3400)	6,585 ± 80 (6,207-7,035)
20 February	13.8 ± 0.16 (13-14.5)	45.57 ± 0.31 (44-47)	1.0000±0.002 (0.99-1.01)	2.45 ± 0.6 (2.1-2.7)	5.47 ± 0.15 (4.8-6.25)	162 (148-171)	3009 (2720-3162)	7,388 ± 177 (6,532-7,943)
6th March	14.26 ± .12 (13.5-14.8)	45.34 ± 0.24 (44-46.3)	1.0000±0.001 (0.99-1.01)	3.12 ± 0.3 (2.99-3.22)	6.89 ± 0.06 (6.64-7.23)	242 (229-258)	3509 (3449-3600)	10,982 ±150 (10,315-11463)
20th March	14.38 ± 0.35 (11.7-16)	46.37 ± 2.69 (25.6-60)	1.0039±0.028 (0.91-1.21)	6.34 ± 0.51 (4.1-10)	13.7 ± 0.67 (9.73-16.66)	587 (389-800)	4252 (3900-5000)	26,837 ± 2150 (18,800-40,000)
3rd April	15.02 ± 0.28 (13.2-16.3)	56.22 ± 3.44 (37.3-77.5)	1.005±0.12 (0.95-1.08)	8.9 ± 0.67 (5-11)	15.72 ± 0.63 (11.72-17.9)	810 (639-940)	5178 (4500-5900)	45283 ± 2655 (29,500-53,000)
17 April	14.09 ± 0.14 (13.2-14.5)	52.4 ± 1.46 (44-59)	1.001±0.011 (0.91-1.05)	10.22 ± 0.51 (6.5-12.1)	19.50 ± 0.54 (14.77-20.7)	991 (902-1040)	5140 (4797-6300)	52,088 ± 2066 (40,950-60,500)
1st May	14.39 ± 0.16 (13.9-15.5)	49.08 ± 0.59 (45.2-50.6)	1.005±0.101 (0.94-1.04)	6.825 ± 0.20 (5.5-7.5)	13.91 ± 0.36 (11.4-15.2)	869 (706-980)	6,262 (5569-7031)	42,700 ± 1415 (34,100-49,600)
15th May	14.43 ± 0.12 (13.9-15.1)	49.98 ± 0.66 (48-53.5)	1.0004±0.008 (0.97-1.06)	6.75 ± 0.20 (5.5-7.4)	13.53 ± 0.47 (11.4-15.4)	792 (426-951)	6,171 (6000-6300)	41,623 ± 1175 (34,100-45,880)

Table 2. Diameter of egg and sperm-head length of female and male fishes of Thai koi (*A. testudineus*) in different months in a year. All values represent mean ± SE with ranges in parentheses

Month	No. of fish examined for each sex	Body weight of male (g)	Body weight of female (g)	Gamete size (μm)	
				Egg diameter	Sperm-head length
23rd January	10	25.68 ± 2.78 (15.50-37.0)	41.56 ± 1.13 (35.0-45.0)	139.70 ± 3.14 (125-155)	2.18 ± 0.05 (2.0-2.30)
6th February	10	25.65 ± 2.37 (15.0-38.0)	44.99 ± 0.31 (44.0-47.0)	143.40 ± 0.94 (140-150)	2.36 ± 0.03 (2.30-2.50)
20th February	10	24.22 ± 2.28 (10.0-34.0)	45.57 ± 0.31 (44.0-47.0)	176.40 ± 2.78 (160-190)	2.73± 0.04 (2.50-2.95)
6th March	10	23.45 ± 1.88 (15.0-32.0)	45.34 ± 0.24 (44.0-46.30)	393.30 ± 14.27 (300-450)	2.98 ± 0.03 (2.86-3.20)
20th March	10	23.71 ± 2.55 (7.30-29.0)	46.37 ± 2.69 (25.60-60.0)	430.80 ± 9.72 (390-500)	3.0 ± 0.17 (2.86-3.50)
3rd April	10	37.0 ± 1.75 (30-45)	56.22 ± 3.44 (37.30-77.50)	551.20 ± 7.21 (525-590)	3.10 ± 0.11 (2.92-3.15)
17th April	10	40.59 ± 1.71 (36.70-50.0)	52.40 ± 1.46 (44.0-59.0)	654.10 ± 6.37 (628-685)	3.18 ± 0.08 (2.97-3.60)
1st May	10	49.85 ± 2.32 (40.0 – 62.0)	49.08 ± 0.59 (45.20-50.60)	607 ± 7.37 (555-635)	3.02 ± 0.03 (2.90-3.20)
15th May	10	49.49 ± 2.30 (13-14.80)	49.98 ± 0.66 (48-53.50)	600.10 ± 7.56 (550-625)	2.99 ± 0.2 (2.90-3.52)

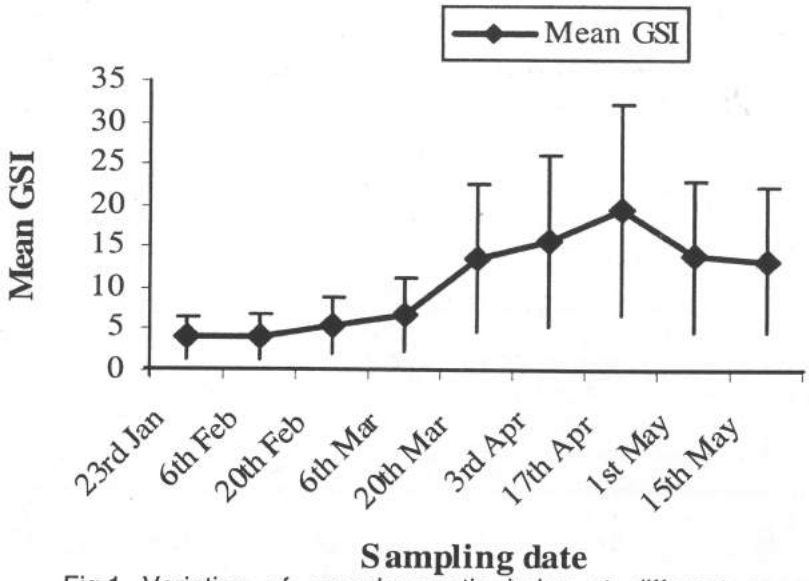

Fig.1. Variation of gonadosomatic index at different sampling dates of Thai koi (*A. testudineus*); Mean ± S.E.

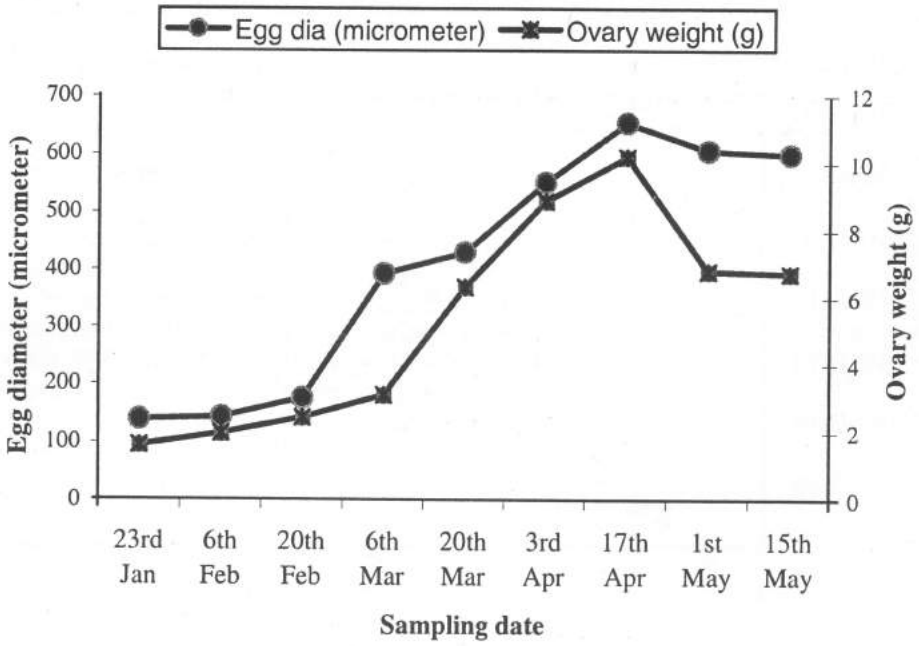

Fig. 2. Variation of ovary weight (g) and egg diameter (μm) of Thai koi (*A. testudineus*) in different sampling dates

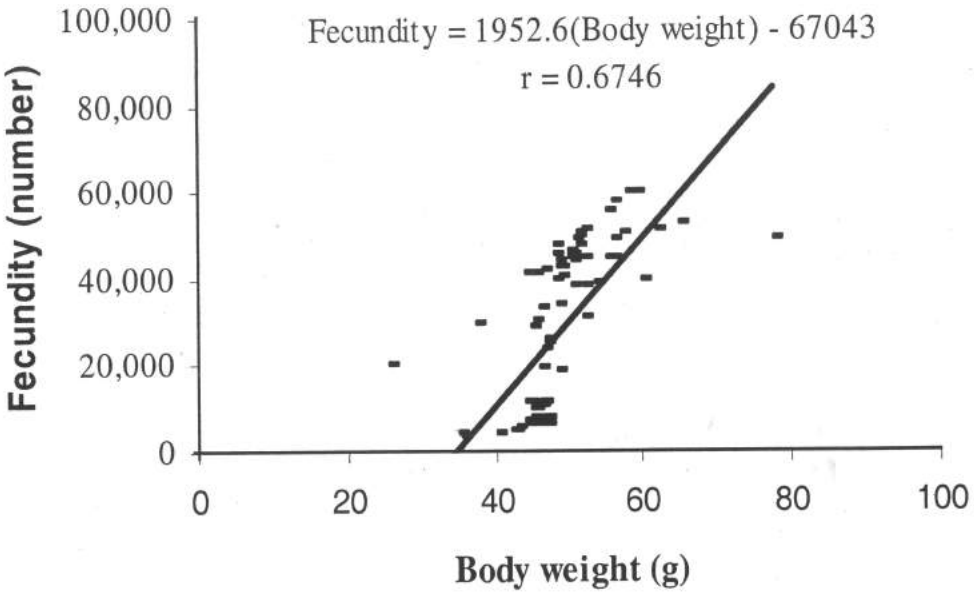

Fig. 3. Linear relationship between body weight (g) and fecundity of Thai koi (*A. testudineus*)

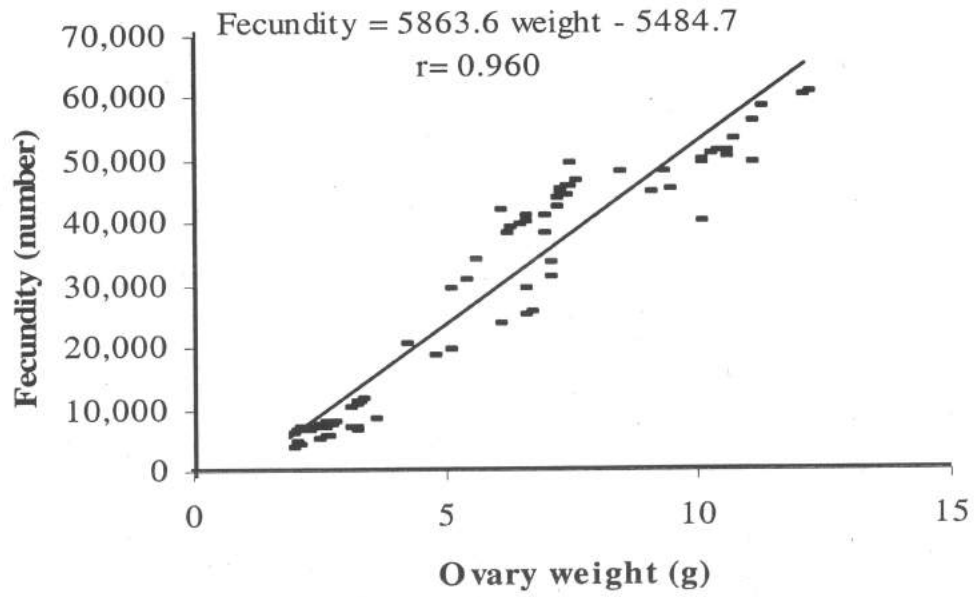

Fig. 4. Linear relationship between ovary weight (g) and fecundity of Thai koi (*A. testudineus*

The value of co-efficient correlation (r) was 0.6746. When this equation was plotted on scatter diagram, a regression line was obtained and this line was significantly fitted ($P<0.01$) (Fig. 3). The fecundity of the fish showed increasing trends with the increase of ovary weight which as calculated using the following equation of

Fecundity = 5863.6 weight - 5484.7

The value of co-efficient correlation (r) was 0.960. When this equation was plotted on a scatter diagram, a straight line was obtained and the regression line was significantly fitted ($P<0.01$) (Fig. 4).

Thai koi (*A. testudineus*) is comparatively larger than the local koi. Its body colour is whitish to pale and contains two distinct black spots on both caudal base and operculum during the breeding season (Noor, 2005). The highest GSI of the present study was 19.50 ± 0.54 (ranged from 14.77 to 20.7) in 17th April and the lowest 3.96 ± 0.19 (ranged from 2.8 to 4.7) in 23rd January. Although local koi showed maximum GSI in May (Banu and Shaha, 1987), but Thai koi showed maximum GSI in April. It might be due to different strains, size of body, feed composition and other environmental causes. Sarker (2005) found the highest average GSI of 16.12 ± 3.26 in catfishes (*Neotropius atherinoides*) during May. The mean GSI of the present study is higher than the findings of Sarker (2005), might be due to different species and different maturation stages of the species. Present study showed that ova diameter of Thai koi varied from 125 to 685 μm with a mean of 410.66 ± 7.00 which was lower than those of Shafi and Mustafa (1976) who reported that diameter of eggs of local koi varied from 500 to 900 μm with a mean of 710 μm. Sarker (2005) reported that the ova diameter of *N. atherinoides* varied from 340 to 470 μm in Mithamoin haor in Kishoreganj district. It might be due to species variation, life history traits, ontogeny and developmental consequences of gonad. The average sperm-head length of Thai koi varied from 2.00 to 3.60 μm with an average value of 2.83 ± 0.08 μm. Rahman *et al.* (2003) reported that the average value of sperm-head length of *Labeo calbasu* was 3.35 ± 0.32 μm which was higher than the present findings. It might be due to species variation and the lager size of *L. calbasu.*

In the present study, the fecundity of Thai koi varied from 3,965 to 60,500 eggs. Shafi and Mustafa (1976) reported that the fecundity of local koi varied from 6,478 to 44,395 eggs and Khan and Mukhopadhay (1972) found a range of 10,002 to 36,477 eggs in same species. Banu *et al.* (1985) reported that fecundity of local koi varied from 12,355 to 41,820 eggs. However, present findings agree with the findings of above mentioned authors. Faruq *et al.* (1998) reported that the average number of eggs/g body and ovary weight of *Heteropneustis fossilis* were 181 and 873 respectively. In the present study, the results of eggs/g body and ovary weight were 562 and 4480 respectively which is higher than the findings of Faruq *et al.* (1998). It might be due to different species and different times of gonadal maturation stages. Fecundity also varied with seasons, climatic conditions, environmental habitat, nutritional status and genetic potential (Nakaraj and Hossain, 1987; Bromage *et al.*, 1992).

Condition factor may be used to detect seasonal variations in the condition of fish, which may vary with food abundance and the average reproductive stages of fish. Condition factor of Thai koi varied from 0.95 to 1.05. Faruq *et al.* (1998) reported that condition factor of *H. fossilis* varied from 0.59 to 0.79. This variation occurred due to variation in size, time, species, overall feeding and habitat condition. The fecundity depends on the body weight of a fish. The relationship of fecundity with the body weight approximates a straight line. Body weight and fecundity of Thai koi were found to maintain a positive correlation (r = 0.6746). The value of correlation coefficient (r = 0.6746) was an indication of strong relationship between fecundity and body weight of fish. The relationship between body weight and fecundity has also been observed in other fishes by Islam and Das (2006) in *Mystus cavasius*; Faruq *et al.* (1998) in *H. fossilis* and Doha and Hye (1970) in *Tenualosa ilisha.*

The correlation coefficient between ovary weight-fecundity of Thai koi was 0.960. It was observed that fecundity increased with the increase of ovary weight. Similar strong relationship was observed by Islam and Das (2006) in *M. cavasius* and Azadi *et al.* (1987) in *M. vittatus*.

This study represents the first attempt to investigate GSI, egg sizes (egg diameter and sperm-head length), fecundity, CF, relationship between body weight-fecundity and ovary weight-fecundity of Thai koi in laboratory condition. The findings of the present study would be useful for the development of breeding and rearing of fry and fingerlings. However, further studies are needed to be done throughout the year to identify the peak spawning period and to know more information about the gonadal maturation and other biological aspects related to the reproduction and fry and larval development.

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