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Studies on some Aspects of Biology with Special References to Induced Spawning of Thai pangas (*Pangasius sutchi* Fowler,1937)

Asiful Islam

Email: asifuli@yahoo.com,aislam@soros.ksu.ru

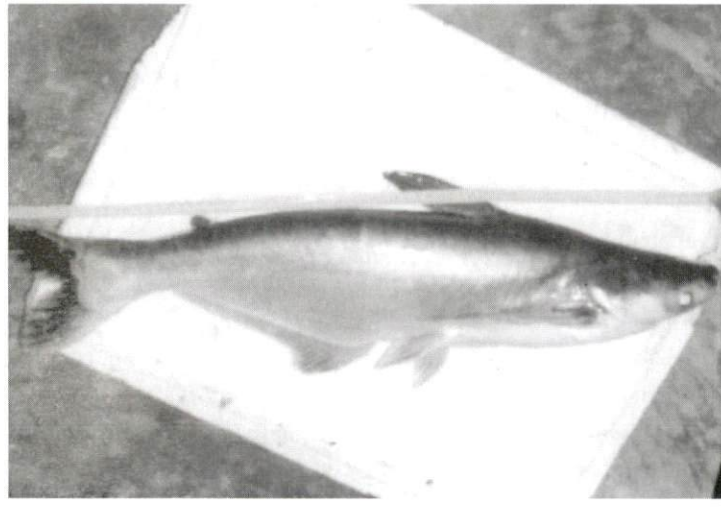
Department of Vertebrate Zoology, Kazan State University, Kazan, Russia 420008

Abstract: A total number of 88 fishes Thai pangas were conducted for induced spawning experiments. Among them, 30 mature *Pangasius sutchi* were conducted for the length-weight relationship, 25 matured females for the fecundity and 33 fishes (12 males and 21 females) for induced spawning experiments. The total-standard length relationship curve shows a straight line with a strong correlation (r = 0.986 and 0.987). The length-weight relationship was best expressed in the logarithmic scale and follows the cube law. The absolute fecundity was ranged from 122000 to 241900 oocytes with an average of 181950 oocytes per female. In the single-dose injection pituitary extract (PG), the average number of eggs release was 182075 $\pm$ 95136. The rate of fertilization was 69 to 95%. The average rate of hatching was 70.04 $\pm$ 34.73%, which was higher in the peak-spawning season with PG treatment. In the double-dose experiment with HCG, the number of eggs released was 150,000 to 200,000 and the fertilization rate was 73.00 $\pm$ 40.99% and the hatching rate was 58.33 $\pm$ 32.78%. With the double dose of PG, the number of eggs released was 160000 to 260000. The fertilization rate was 76.50 $\pm$ 42.68 % and the hatching rate was 58.75 $\pm$ 32.83% with the double dose PG extract. In these experiments, it was established that the PG was more suitable and economical than HCG.

Key Words: Biology, induced spawning, length-weight relationship, fecundity, PG, HCG, Thai pangas, *Pangasius sutchi*, Pangasiidae.

Introduction

Pangasius sutchi is a large catfish (Family: Pangasiidae), which is commonly known as a shark catfish, Thai pangas or pangas fish (Pic. 1). It is a fresh water species found usually in the south and south-eastern countries of Asia. Thai pangas is the most important fish among all of catfishes for their high contents of protein and suitable taste (Azadi, 1985).



Picture 1: A brood Thai pangas (*Pangasius sutchi*)

Though *P. sutchi* are riverine fish, but are extensively cultured in the earthen ponds and floating cages in Thailand, Singapore, Malaysia, Indonesia, Combodia, Vietnam, Myanmar, China, India, Bangladesh and some other countries of Asia. It may reach up to maximum of 15 kg in weight and 150 cm in length (Bardach *et al.*, 1972).

The attribute of Thai pangas of its relevance to culture in the ponds or other inland water bodies is very significant. It is tolerant to changes in salinity, pH, dissolved oxygen content, turbidity, temperature or even pollution in the water bodies. *P. sutchi* is non-predacious in nature, so polyculture with carp is feasible. The culture of this species is economical because it is quite resistant to various pathogenic diseases. It has a suitable reproductive strategy and behavior, i.e. high fecundity and potential for year round induction of final maturation. It also has a

high tolerance to dense culture and has easy culture possibility in large or small water bodies, stagnant ponds, lakes or other inland water reservoir.

There are few studies on the reproductive biology and strategies of the fishes of family Pangasiidae. The literatures on the techniques of fry production, fecundity, maturation, developmental stages and effect of food in the larval periods of Thai pangas are scarce. Although, there are some works on *P. sutchi* available, e.g. transportation problem of patin fry, *P. pangasius* (Sunarno *et al.*, 1989); growth, reproduction and breeding of *P. sutchi* (Manat *et al.*, 1990); hybrid breeding with *Clarias* (Na-Nakron *et al.*, 1993a,b,c&d). Asiful (2002) described the early embryological development of Thai pangas. Wanpen (1984) studied the taxonomical and behavioral differences of *P. sutchi* and *Pangasianodon gigas* (Chevey). Arifin (1990) described the rearing of patin fry (*P. pangasius*) in different salinities. Although, the induced breeding study of this species has been carried on since 1990s, there has not been so much success gained by this time for the development of the reproduction of Thai pangas.

In the present study, an attempt has been made to detect the essential factors and techniques to produce a higher rate of fry and fingerlings by induced spawning techniques. The length-weight relationship has been studied to know the maturation and other biological aspects of the investigated fishes. In case of induced breeding, it is a compulsory task to know the fecundity of the brood fishes. The fecundity of fish has the direct relationship with the total length, body weight and ovary weight of females. It can be used as an indicator for the selection of healthy, disease free, strong and mature brood fishes for the induced stripping.

The aspect of this study is to describe the induced breeding of *P. sutchi* with relation to their biological parameters. The aim will be successful, if the artificial propagation and mass production of fry and fingerlings of Thai pangas could be increased satisfactorily to meet the scarcity of this species in different fresh water bodies.

Materials and methods

A total number of 88 fishes were conducted for this experiment. Brood fishes were collected by gill nets from the stocking ponds of a brood fish multiplication farm (Tongi farm), which is situated about 15 km north of Dhaka city of

Bangladesh. Strong and disease free fishes were reared in the stocking ponds for one year. Brood fishes were reared with regular supply of artificial food at the rate of 5-10% of the body weight.

Length-weight relationship and fecundity study of Thai pangas were done in the Fisheries laboratory of the Department of Zoology of Dhaka University, Bangladesh. The induced spawning experiments were done at a fish seed multiplication farm (Warsi Aquatech) in Dhaka. Aerators were used for supplying the dissolved oxygen in the tanks. Centigrade thermometer was used to measure the temperature of the water of stocking ponds and rearing trays and tanks. Siphoning tube was used for washing the unnecessary foodstuff and waste products from the hatching trays and cisterns.

For the length-weight relationship study, 20 mature females and 10 fertile males were conducted. The ratio of the female to male fish was 2:1. For the estimation of fecundity, 25 females were investigated. The dissected ovaries were weighted and preserved in 5% formalin for the fecundity estimation. The fecundity of fish was distinguished by direct counting method. For the artificial insemination, 33 mature fishes (12 males and 21 females) were used. Thai pangas were induced to breed, three times in a year: early spawning (March - April), peak spawning (May - July) and late spawning (August - October), during 1995.

Pituitary gland (PG) extracts and human chorionic gonadotropin (HCG) were used as the inducing agents for the artificial breeding of Thai pangas. The induction of ovulation was done by using two methods, e.g. single injection method and decisive double dose method. In the single dose method, the 100% calculated dose was applied, and both the male and female were injected at the same time. Sometimes the males were matured enough and did not need to be injected by the extracts. In the double dose method, the preparatory dose consiste of ⅓ of the calculated dose and applied only to the females for the development of gonads. The decisive dose consisted of ⅔ of the total dose and was given after 6 hours from the preparatory dose to the females. If the sperms of the male did not come out by the gentle pressure on the lower abdomen, the 100% of the calculated dose was injected to the males at the same time of decisive dose to the females. In this experimental study, the females were injected with double doses for two times with PG extracts and HCG in the peak spawning period. For the first dose, 30-40%

of the total PG or HCG (2-3 mg PG/kg or 1-1.5 IU/gm HCG) was injected to the female and the rest of the PG extracts or HCG was injected in the second dose after 10-12 hours of the first injection. When the second dose was injected to the female, the male fish was also injected at the rate of 6 mg/kg of the body weight of PG extract or 3 IU/ gm of HCG. The response of ovulation of the fish was usually observed after 6-8 hours of the second dose injection. For the single dose PG injection, both the male and female were injected at the rate of 6 - 8 mg/kg of the body weight. The single dose HCG hormone was applied to the females at the rate of 3-4 IU/gm and to the males at the rate of 1-1.5 IU/gm. In the peak-spawning season, the females usually released eggs after first injection. PG extracts and HCG were injected to the brood fishes intramuscularly by a disposable hypodermic syringe at the soft muscles in between the dorsal fin and the lateral line or the caudal peduncle region above the lateral line.

Females were observed for latency, every one-hour after 6-7 hours of the second injection. The females were taken out for stripping and the eggs were fertilized with sperms. In the present study, 25 ovaries of the matured females were collected for the fecundity estimation. The fertilized eggs were stirred by adding 5-10 ml of physiological solution to ensure maximum fertilization. The excess milt and the testicular tissues were removed by using dropper or forceps. The fertilized eggs were spread out in the hatching tray ($200\times60\times20$ cm^3) within 1-2 minutes of fertilization for avoiding the adhesion. The hatching troughs were made up of galvanised G. I. sheets and were continuously supplied with water showering. The frame of the trays is made up of iron rod with fine or micro-porous cloth or nylon net for the infrastructure. The 6-8 cm of blank space was present in the surrounding sides of the trays, which helped the hatchlings to move easily from the net after hatching. The dead, unfertilized and decomposed eggs were removed from the trays at intervals of 4 hours, using the siphoning tube for the prevention of fungal and bacterial infection of the fertilized eggs. After the removal of dead eggs from the tray, fecundity of the fish was estimated by the random selection. When all the eggs were hatched out, the frame nets were lifted out from the troughs. The hatchlings were remained in the trays for 2-5 days.

Results

Length-weight relationship and data of total length, standard length and body weight of 30 brood fishes (20 females and 10 males) were conducted.

The arithmetic and logarithmic relationship between the total and standard length was found to be highly correlated (Table 1) and the regression equations were:

SL= -4.261770 + 0.945865 TL (r = 0.98582) ; Log SL = -0.157000+ 1.05498 Log TL (r = 0.986621)

In both the cases, the values of the correlation-coefficient 'r' was nearer to 1, which indicated that the total and standard length was strongly related with each other.

The arithmetic and logarithmic relationship between the total length and body weight was also found to be strongly correlated and the regression equations are:

W= -2382.840978 + 79.141085 TL (r = 0.988513); Log W =0.512559+1.619814 log TL (r = 0.988411)

The 'b' value in the logarithmic scale was nearer to 2, which indicated that the fish growth was more or less isometric. The 'r' value also showed strong and significant relationship in the curve.

The arithmetic and logarithmic relationship of standard length and body weight was calculated and the regression equation was obtained. In both cases, the 'r' value indicated that the relationship between standard length and body weight was highly significant and represented graphically a strong relationship (Table 2).

W= -1855.383872 + 81.244506 SL (r = 0.973549); Log W =0.835981+1.488396 log TL (r = 0.972544).

Table 1: Relationship between total and standard length of *P. sutchi* in the arithmetic scale

No. of Fish	Sex M / F	Sex ratio (F:M)	Total length (cm)	Standard length (observed value) (cm)	Standard length (calculated value) (cm)
1	F		71	63.0	62.89
2	F		75	68.0	66.68
3	F		70	62.0	61.95
4	M		68	60.5	60.06
5	F		73	65.4	64.79
6	M		78	70.9	69.52
7	F		77	69.5	68.57
8	F		80	71.4	71.40
9	F		82	72.5	73.30
10	F		72	64.0	63.84
11	M		84	76.9	75.19
12	F		85	77.4	76.14
13	F		86	76.9	77.08
14	M	2 : 1	81	71.5	72.35
15	F		78	70.1	69.52
16	M		75	65.9	66.68
17	M		76	68.1	67.63
18	F		80	71.0	71.41
19	M		83	74.5	74.25
20	F		78	69.1	69.52
21	F		79	70.2	70.46
22	F		84	73.5	73.19
23	M		75	64.9	66.68
24	F		74	65.1	65.73
25	F		90	81.7	80.87
26	F		91	83.2	81.81
27	M		85	74.9	76.14
28	M		88	77.2	78.97
29	F		79	70.1	70.46
30	F		72	63.5	63.84

$Y = a + bL$; SL = -4.261770 + 0.945865 TL ($r = 0.985929$)

Table 2: The relationship between total length and body weight of *Pangasiu sutchi* in logarithmic scale

No. of fish	Sex M/ F	Sex ratio (F:M)	Log standard Length	Log body weight (observed value)	Log body weight (calculated value)
1	F		1.7993	3.5185	3.5141
2	F		1.8325	3.5440	3.5634
3	F		1.7923	3.5051	3.5037
4	M		1.7817	3.4771	3.4879
5	F		1.8155	3.5314	3.5382
6	M		1.8506	3.5682	3.5904
7	F		1.8419	3.5563	3.5775
8	F		1.8536	3.6020	3.5950
9	F		1.8603	3.6127	3.6049
10	F		1.8061	3.5185	3.5242
11	M		1.8859	3.6232	3.6429
12	F		1.8887	3.6334	3.6471
13	F		1.8859	3.6434	3.6429
14	M	2 : 1	1.8543	3.6020	3.5959
15	F		1.8457	3.5797	3.5831
16	M		1.8188	3.5563	3.5432
17	M		1.8331	3.5563	3.5644
18	F		1.8512	3.6127	3.5913
19	M		1.8721	3.6232	3.6224
20	F		1.8394	3.5910	3.5738
21	F		1.8463	3.5910	3.5840
22	F		1.8662	3.6334	3.6137
23	M		1.8122	3.5440	3.5333
24	F		1.8135	3.5440	3.5353
25	F		1.9122	3.6812	3.6821
26	F		1.9201	3.6902	3.6938
27	M		1.8744	3.6232	3.6259
28	M		1.8876	3.6532	3.6455
29	F		1.8457	3.6020	3.5831
30	F		1.8027	3.5051	3.5192

$Y = a + bL$; Log W = O.835981 + 1.488396 Log SL (r = 0.972544)

The logarithmic equations of regression were statistically done for significance from the theoretical value of 1.70. The value was found to be strongly significant and different at 5% level of degrees of freedom in all cases. The t-test was done for detecting the 'r' value. It was found that the calculated value was more or less higher than the observed value (Table. 2).

The relative condition factor (K_n values) for the total length of Thai pangas ranged from 0.9951 to 1.0054. The maximum and minimum K_n values were observed as 80 cm and 72 cm of length and body weight of 4100 g and 3200 g. In this experiment, it was found that the relative condition factor was more or less approximate.

The maximum and minimum fecundity of fishes were observed as 4250 g and 3200 g of body weights and 78 cm and 70 cm of total lengths. The observed maximum relative fecundity was 61.176 oocytes in relation to 78 cm of length and 4250 g of body weight. While the observed relative fecundity was 38.025 oocytes in relation to 79 cm of length and 4000 g of weight (Table. 3).

In the female fishes, the abdomen becomes bulged up during the breeding season. This phenomenon is supported by the work of sexual dimorphism in certain air breathing teleosts by Dehadrai *et al.* (1973). The male Thai pangas has protruded urino-genital papilla, which is easily separated from the females. Mookerjee *et al.* (1994) in case of Indian carps and Huq (1977) in case of catfishes also reported the similar sexual dimorphisms.

The artificial propagation of Thai pangas was carried on using PG and HCG treatments. In the early spawning period (1st of March to 30th of April 1995) 5 females and 3 males (2:1) were conducted for the artificial breeding study (Table 4). The highest and lowest length and weight of the brood fishes were 78 cm and 69 cm and 4250 g and 3100g, respectively. The average weight was 3243.75$\pm$ 468.61 g. The fecundity varied between 21000-125000 (the average fecundity - 67125$\pm$46997). The average fertilization and hatching rates were 35.40 $\pm$19.44 % and 20.55$\pm$11.17%, respectively. In the last week of March 1995 (30th March), one female spawned easily but most of the eggs died due to low temperature (20°C).

Table 3: Absolut and relative fecundity of Thai panga

No. of fish	Total length (cm)	Body weight (g)	Ovary weight (g)	Absolute fecundity	Relative fecundity	Temperature (^{0}C)
1	71	3300	370.00	166500	50.454	22
2	75	3500	410.00	205000	58.571	20
3	80	4000	410ю00	220000	55.000	24
4	82	4200	430.00	241900	57.595	25
5	70	3200	350.00	122000	38.125	27
6	73	3400	390.50	156200	45.941	26
7	85	4300	430.00	236000	54.883	26
8	90	4800	480.00	228000	47.500	28
9	72	3200	340.00	132678	41.462	25
10	75	3500	400.50	160200	45.771	24
11	78	3800	380.00	152000	40.000	23
12	80	3950	400.00	180000	45.569	24
13	69	3100	300.00	123000	39.677	27
14	83	4150	395.00	162032	39.044	28
15	72	3350	340.00	136000	40.597	30
16	75	3450	345.00	138320	40.093	32
17	79	4000	390.00	152100	38.025	34
18	70	3200	330.00	132000	41.250	32
19	78	4250	410.50	164200	38.635	28
20	88	4550	450.00	210100	46.176	29
21	71	3300	350.00	160000	48.485	32
22	69	3100	340.00	150.000	48.387	33
23	75	3500	400.00	200000	57.143	26
24	72	3200	390.00	195000	60.937	24
25	78	4250	445.00	260000	61.176	25

During the early spawning period, the temperature ranged between 20-26°C. The latency and hatching periods of *P. sutchi* were 26 hours and 36 hours at the temperature of 22°C whereas, when the temperature was 25°C, the latency and hatching periods took 22 and 32 hours. The higher, the temperature the lower the latency and hatching periods (Table 3). The single and double dose of PG extracts and HCG were injected to both the males and females in the peak spawning period (May-July, 1995). A total of 15 brood fishes (5 males and 10 females) (1:2) were used for the single dose experiment. In the double dose experiment, a total of 10 fishes (4 males and 6 females) (1:1.5) were injected both with HCG (2 males and 3 females) (1:1.5) and PG extracts (2 males and 3 females) (1:1.5).

In the HCG treatment, the body weight of the fishes ranged between 2900-3500 g (average body weight - 3160±240.83 g). The total number of eggs was 150000 to 200000 with an average of 170000±94974. Percentage of fertilization rate was ranged from 65 to 85% (average 73±40.99%) and hatching varied between 50-70% (average 58.33±32.78%). The temperature during the spawning period ranged from 31 to 32°C. Latency and hatching periods took 22 and 21.5 hours at 32°C and 28 and 27 hours at 31°C temperature, respectively (Table 5). In the PG treatment, the body weight varied from 3000 to 4250g. Total number of eggs obtained by stripping was 160000 to 260000 (average 210000±120333). Lengths of the fishes were varied from 70.5 to 78 cm. Fertilization rate was 65 to 88 % (average 76.50±42.68%) and hatching rate was 49.5 to 68% (average 58.75±32.83%) (Table 6). In the double dose PG treatment, the temperature was ranged from 26.5 to 28.5°C in the peak spawning season. The latency and hatching periods were 25 and 30 hours at 26.5°C and 23 and 29.5 hours at 28.5°C, respectively. In the induced reproduction of Thai pangas, DO (dissolved oxygen) content, free CO_2 level, pH, free ammonia and nitrite-nitrogen levels in the stocking ponds and rearing tanks and also the average relative humidity (%) had an influence.

Table 4: Artificial breeding of Thai pangas by inducing singl dose PG extracts in the early spawning period. F (female) and M (male) brood fishes

Sex index	Total length (cm)	Body weight (g)		PG dose injection (mg)		Amount of eggs released in female (g)	No. of eggs released in female	Fertilization rate (%)	Hatching rate (%)	Temperature (°C)	Comments
		Before stripping	After stripping	Required	Applied						
M	69.5	2900	2850	20.30	14.2	-	-	-	-		Male responded well
F	71.0	3300	3299	23.10	15.5	-	-	-	-		Female didn't release eggs (immaturity)
F	69.0	3100	3030	21.70	15.0	70	21000	40	16.5	20	Eggs released but small amount
M	69.2	2800	2715	19.60	15.0	-	-	-	-		Male responded with single dose
F	75.0	3500	3400	24.50	20.5	100	40000	30.0	21.5	18	Eggs were not matured
F	72.0	3200	3000	21.85	20.0	200	82500	32.7	24.0		Spawn easily but maximum no. of eggs were died because of low temperature
M	70.0	2900	2845	20.30	15.0	-	-	-	-		Male responded well in single dose
F	78.0	4250	4005	29.75	25.0	245	125000	40.5	20.2	24	Eggs come out freely, female responded well, immature eggs present
Average±SD	71.1 ± 1.1	3243.75 ± 468.61	3143.0 ± 138.3	22.6 ± 1.1	17.5 ± 1.3	153.8 ± 35.7	67125.0± 46996.53	35.8 ± 19.44	20.55 ± 11.17	20.7 ± 1.4	

Table 5: induced breeding of *P. sutch* by inducing double dose HCG in the peak spawning period in 1995. F (female) and M (male) brood fishes

Sex index	Total length (cm)	Body weight (g)		PG dose injection (mg)			Amount of Eggs released In female (g)	No. of eggs released in female	Fertilization Rate (%)	Hatching rate (%)	Temperature (°C)	Comments
		Before Stripping	After stripping	Total	Preparatory	Decisive						
M	70.0	3000	2890	750	------	750	------	------	------	------		Male responded well
F	69.0	3100	2760	775	259	516	340	150000	71	55	32	Female spawned easily
F	75.0	3500	3100	875	292	583	400	200000	85	70		Large No of eggs were rleased
M	69.5	2900	2785	725	------	725	------	------	-----	------		Male responded with double dos
F	71.0	3300	2950	825	275	500	350	160000	65	50	31	Some eggs were died due to high temperature
Average±SD	7.9±1.0	3160.60± 240.83	2897.0±54.9	790.0±24.1	27.3±7.8	614.8±46.6	363.3±15.2	170000± 94973.68	73.00±40.99	58.33±32.78	31.5±0.4	

Table 6: Induced spawning of *P. sutch* by inducing double dose PG extract in the peak spawning period in 1995. F (female) and M (male) brood fishes

Sex index	Total length (cm)	Body weight (g)		PG dose injection (mg)			Amount of Eggs released In female (g)	No. of eggs released in female	Fertilization Rate (%)	Hatching rate (%)	Temperature (°C)	Comments
		Before Stripping	After stripping	Total	Preparatory	Decisive						
M	74.0	3400	3348	23.80	------	23.80	------	------	------	------		Male survived
F	75.0	3450	-----	24.15	8.05	20.10	------	------	-------	------	30	emale died due to high does application
F	78.0	4250	3805	29.75	9.91	19.84	445	260000	88	68.0		Breed well
M	70.5	3000	2890	21.00	------	21.00	------	------	-----	------		Male responded well with double dos
F	72.0	3200	2810	22.40	7.46	14.93	390	160000	65	49.5	32	Easy stripping but some eggs not come
Average±SD	73.9±1.2	3460.00± 476.18	3213.3±199.3	24.3±1.3	8.05±0.6	19.9±0.3	417.5±19.4	210000± 120332.87	76.50±42.68	58.75±32.83	31.00±0.7	

Discussion

In the present investigation we found that the suitable brood fishes are those of 3-5 years old and being 3-8 kg.

In the induced breeding study of Thai pangas, it is revealed that the relationship between the total and standard length of *P. sutchi* is strongly linear and directly correlated. Machiels & Henken (1986) obtained the same results when studying *Clarias gariepinus*. But study on growth rate, i.e. standard length against total length, of *Johnius argentatus* showed a curvi-linear relationship, which was described by Latifa *et al.* (1987). According to Rounsefell and Everhert (1953), the absolute growth curve rises slowly at first with an increasing slope follows by a decreasing slope later. Jana and Das (1980, 1982), Dhamrongrat and Kasesunchi (1981) and Muir (1981) in case of *Clarias batrachus*, Hogendoorn (1979) in case of *C. lazera* fry and fingerlings and Huq *et al.* (1966) in case of channel cat fish showed a linear relationship like the length study on Thai pangas.

In the study of total length-body weight relationship of Thai pangas, the 'b' value was 1.61, but, Ali (1993) in case of *Clarias macrocephalus* showed that the 'b' value is 2.94. Hile (1936) and Martin (1949) reported that 'b' value usually ranges from 2.5 to 4. Furthermore, in the study of standard length-body weight relationship the 'b' value of Thai pangas was 1.48. Banu (1976) described in this relationship the 'b' value of *Cottus gobio* to be 2. Dan (1977) showed the 'b' value of *Tachysurus tennispinis* as 2.78. Clay and Clay (1981) observed b = 3.05 in case of *Clarias lazera.*

The K_n (relative condition factor) values in total length of *P. sutchi* ranges from 0.9951 to 1.0054. Ali (1993) reported that the maximum and minimum K_n values of *C. macrocephalus* ranged from 1.126 ± 0.023 to 0.907 ± 0.016 for females and 1.123 ± 0.030 to 0.817 ± 0.028 for males. This result indicated that the K_n value of *P. sutchi* is nearly similar to that observed by Ali's (1993).

In this study, the absolute fecundity increased in relation to the increment of total length, body weight and ovary weight. In the same length and body weight ranges, fishes may vary in their absolute fecundity. Marichamy (1971) in case of *Herklotsichthys punctatus*, Gibson & Ezzi (1981) in case of Norwegian goby, *Pomatoschistus moruegtcus*, and Kakuda & Nakai (1981) in case of *Nibea albiflora*, described the similar results. In this experiment, it was also established

that, *P. sutchi* is more fecund than other fishes e.g. *Clarias batrachus, C. gariepinus, Oreochromis mossambicus, Heteropneustis fossilis* etc. From these observations, it was established that the relative fecundity depends on the maturation and not on the morphology of fish.

The relative fecundity of *P. sutchi* average was 49.6. But, Ali (1993) found that the relative fecundity of *C. macrocephalus* was 7.1 to 83.5.

The selection of Thai pangas brood fish was done on the basis of their weight, health and maturity. It is the major task to produce a good number of disease free and strong fish seeds. Islam and Chowdhury (1976) in case of major carps and Khan and Mukhopaddhya (1975) in case of some air breathing fishes discussed those criteria.

In this study, it was found that the pre-spawning and spawning behavior for the stripping procedure of *P. sutchi* was usual for the induced spawning. Van Der Wall (1974) described the breeding habits and behavior of *C. gariepinus* which supported the results of our study. In the early spawning period, Thai pangas did not response well because of the fluctuations of temperature to lower degrees (14-18^{0}C). They prefer the higher temperature like 28-32^{0}C because they are warm water fishes. Temperature is a major factor for the induced spawning of Thai pangas. Rsults obtaing by Peteri & Nandi (1992) also supports our results in comparison to *C. gariepinus.*

PG extracts gave a better performance in the artificial breeding of *P. sutchi*, as has been the case for *C. lezera*, Richter & Van Der Hurk, 1976. African cat fish (*C. geriepinus*) Peteri & Nandi, 1992 and Indian major carps Alikunhi *et al.,* 1964. While Carron *et al.* (1976) in case of *C. macrocephalus*, Eding *et al.* (1982) in case of African cat fish (*C. Lazera*), Mollah and Tan (1983) in case of *C. macrocephalus*, Ahmed *et al.* (1985) in case of *C. batrachus*, Clemens and Sneed (1962) in case of warm water fishes, Mustafa *et al.* (1986) in case of *C. batrachus* and Naser *et al.* (1990) in case of *C. batrachus* obtained the best results with HCG. Mustafa *et al.* (1986) studied the induced breeding of *C. batrachus* using both the HCG and PG extracts.

The best dose of PG extract for the breeding of Thai pangas was recorded as 6-8 mg/kg. Peteri *et al.* (1992) obtain satisfactory results of induced breeding of *C. geriepinus* by applying 5-6 mg/kg of PG. Where as, it was successful with the

application of 3-4 IU/gm of HCG in the induced breeding of Thai pangas. Hecht *et al.* (1982) obtained the best result by applying 3-5 IU/gm of HCG in case of *C. geriepinus.*

The male and female fishes responded well with single and double dose of PG extracts and HCG. Male is injected with single dose of PG extract at the time of second dose application to the female. This dose is applied for the increment of the amount of fluidity of sperms of male fishes. This observation was supported by Tang *et al.* (1963) and Wu & Chung (1964) studies on Chinese carps.

The higher rate of out come of fertilization and hatching of *P. sutchi* was found in the trays with controlled treatment. But Ahmed *et al.* (1981) reported that the induced breeding of *C. batrachus* had a good result in the plastic bowl.

In the peak of spawning season, the number of eggs released significantly higher (260000) due to the full maturity of the fishes. The fertilization and hatching rates were also higher with the application of both PG and HCG in the peak of spawning period.

Fertilization and hatching rates varied in different spawning seasons because of temperature fluctuations and physico-chemical parameters of the water bodies. The water condition influenced the induced spawning of Thai pangas and the growth of the fry and fingerlings. The highest and lowest temperature of water was recorded as 34°c in July and 18°c in January 1995. Rao (1955) and Naser *et al.* (1990) described the influence of the fluctuation of water temperature on different cat fishes. But, Shah *et al.* (1957) observed no influence of temperature on the spawning of Indian major carps. The water temperature also had a role in the latency and hatching periods of *P. sutchi*. Bruton (1979a) also has described the role of temperature in the spawning of *Clarias gariepinus.*

In this study, DO (dissolved oxygen) has the specific influenced on the growth of brood fishes and the development of eggs and fry after spawning. The DO content was recorded as 4.8-7.8 ppm in the stocking ponds and rearing tanks which was feasible for the fry and fingerlings. The oxygen content in the water was also related to the fluctuation of temperature. In the experiments, the DO content was higher when the temperature was higher. Lakshmana *et al.* (1967) and Miah et al. (1981) reported that the lower the water temperature, the higher the DO content. Welch (1948) and Ruttner (1963) supported the result of this study. The free CO_2

was recorded as 12.2-23.0 ppm in stocking pond and rearing tanks. The pH of water was 7.1-7.7. The lowest pH of water was observed in September and June 1995 (4.8 and 5 respectively) because of continuous rainfall. Works of Verma (1969) and Naser *et al.* (1990) conformed decrease of pH. The free ammonia (NH_3) and nitrite-nitrogen were directly related to the total rainfall in the study period. Phosphate – phosphorous showed direct relationship with the alkalinity of water. The average relative humidity (%) was found to be directly related to rainfall. Islam *et al.* (1974) also described such results in their study.

Thai pangas is a popular fish with a high content of proteins. By induced spawning, the genetically strong and disease free fish larvae could be introduced. In this context, it can be suggested that the vast production of this fish can meet the overall demand for fish proteins. By induced spawning, the disease resistant and good number of quality fish fry of *P. sutchi* could be reproduce not only in the aquaculture of Asia but also in the whole world. May be Thai pangas could be introduced as an exotic fish in Europe, America, Australia or even Africa in near future.

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