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Original Article

Some reproductive biological aspects of gray-eel catfish, *Plotosus canius* Hamilton, 1822 spawner in Pattani Bay, Thailand

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Abstract

Reproductive biology of gray-eel catfish, *Plotosus canius* was studied at Pattani Bay by determining its year round changes of gonadosomatic index (GSI). Results show that the GSI was maximum in October (8.4 %), and minimum in April (0.24 %). The sampled size of sexually matured female fishes ranged from 40.9 to 60.5 cm in total length, and between 367.56 to 1,159.37 g in body weight. The average total length of the female fish is 51.9 cm, with an average body weight of 788.8 g. The average fecundity was 1,842.14 egg/fish. The average GSI was 10.87 % (n=14).The fish total length (TL) and body weight (BW) of the matured fish were linearly related, and could be represented by the linear regression as: BW = 32.295 TL – 887.52. The relationship between body weight (BW) and fecundity (Fe) could also be represented by the linear regression as Fe = 398.67+1.83BW. The eggs were adhesive demersal egg type, and rounded. The distribution of egg's diameter could be categorized into five groups i.e. group1 (3.3%), group2 (6.9%), group3 (11.0%), group4 (54.1 %), and group5 (24.6 %), with values of 2.89± 0.19 mm, 3.44±0.36 mm, 4.65±0.28 mm, 5.65±0.26 mm, and 6.38±0.25 mm respectively. The spawning ground is made of silty clay soil, with sediment's pH of 7.16±0.47and water salinity of 12.06 ± 0.78 ppt. We also found that the sperms activity was most active in the 0.9 % sodium chloride's concentration level.

Keywords: reproductive biology, Pattani Bay, GSI, gray-eel catfish, *Plotosus canius*

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1. Introduction

The gray-eel catfish, *Plotosus canius*, is a commercially important species for brackish water fisheries. This species is one of the main species currently being cultured, and is in great demand by the aquaculture industry. Unfortunately, the commercial scale propagation of this fish in hatchery is yet to be standardized. Specifically, there is insufficient information on the propagation procedures of the fish such as type of breeding, stimulating the gonad, larval rearing, and the spawner preparation (Tarnchalanukit *et al*., 1982). Recently, several studies focusing on this species have been published, dealing with the maturity characteristic of the male and female fish (Siritanawong, 2001), fecundity and egg (Khan *et al*., 2002; Trueman, 2006), ovarian development (Laurenson *et al.*, 1993), density of spermatozoa (Runsirikul *et al.*, 2007), and study on the gonadosomatic index (GSI) for the female and male in Songkhla Lake, Thailand (Runsirikul *et al.*, 2007).

The aim of this study were to investigate the fecundity, the egg diameter, gonadosomatic index (GSI) of mature female fish, sperm activity, and physio-chemical sediment parameters of the spawning ground. These parameters will provide useful baseline information for optimazation of fry production, and ultimately for the culture management of this fish in the future.

2. Materials and Methods

Reproductive biology of the *P. canius* was studied for a one-year cycle, starting from October 1st, 2010 to September 30th, 2011 at Pattani Bay, Thailand. Field experiments were carried out using complete randomized design method, and data analyzed using SPSS/PC+ program. The *Plotosus canius* sexual dimorphism of male fish and female fish are shown in Figure 1 and 2, respectively. Ten samples of female fish were collected per month for the reproductive study. Eleven sampling stations around at Pattani Bay were used in order to determine physio-chemical parameters of sediment, and the water salinity at the spawning ground. All sampling were done in triplicate.

a b

Figure 1. Sexual dimorphism of male fish, a) Head of male fish, b) Urogenital papillae of male fish.

a b

Figure 2. Sexual dimorphism of female fish, a) Head of female fish, b) Urogenital papillae of female fish.

The sexual maturity of *P. canius* was studied by determining its fecundity, egg's diameter, and GSI. Fecundity estimation was made by using a gravimetric method (Tarnchalanukit *et al.*, 1982). Egg's diameter was measured using ocular microscope (Amornsakun *et al.*, 2011). GSI was calculated by using the formula (weight of ovary/ weight of body) x 100 (Tarnchalanukit *et al.*, 1982). The sperm motility of the male fish were also studied, by investigating the saline solution's effect on sperm motility. Three samples of matured male fish obtained from Pattani Bay were injected with suprefact acetate (Buserline) 10 µg/kg mixed with motilium (Domperidone) 10 mg/kg (Amornsakun, 1999).The fish abdomen was dissected after 12 hours of injection to take the test is. Later, the sperm were mixed with sodium chloride solution at different concentration levels such as 0, 0.7, 0.8, 0.9 and 1 % for 60 seconds (Westin & Nissling, 1991).The movement of sperm was observed and then recorded. Data were then subjected to the analysis of variance for movement percentage of sperm in each sodium chloride solution, and followed by study on differences in each sodium chloride solution using the Duncan's new multiple range test (Walpole & Myers, 1978).

3. Results

Gonadosomatic index (GSI) is a strong indicator of a fish maturity that strongly relate to the fish reproductive potential. The result of this work indicate that the GSI of *Plotosus canius* was at the maximum level in October (8.4 %), and was at the minimum level in April (0.24 %) as shown in Table 1 and Figure 3. The sampled size of sexually matured female fishes used in this work ranged from 40.9 to 60.5 cm in total length, and between 367.56 to 1,159.37 g in body weight. The average total length of the female fish is 51.9 cm, with an average body weight of 788.8 g. The average fecundity was 1,842.14 egg/fish. The average GSI was 10.87 % (n=14) as in Table 2 and Figure 4.The total length (TL) and body weight (BW) of matured fish were linearly related, and could be represented by the linear regression as (Figure 5):

$BW = 32.295\ TL - 887.52$, $R^2 = 0.82$, n= 14

Meanwhile the relationship between body weight (BW) and fecundity (Fe) could also be represented by the linear regression as (Figure 6):

$Fe = 398.67 + 1.83BW$, $R^2 = 0.34$, n= 14.

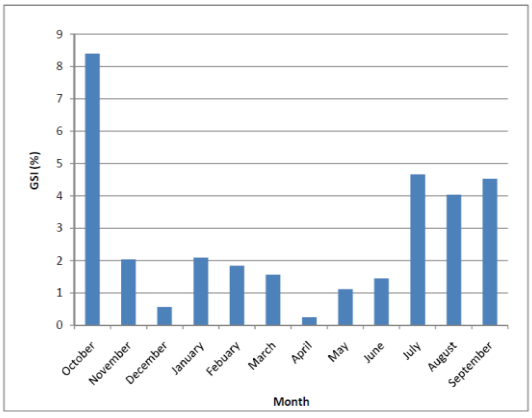

Figure 3. Gonadosomatic index (GSI, %) of the gray eel-catfish in year round.

Table 1. Gonadosomatic index (%) of gray-eel catfish in year round at Pattani Bay, Thailand.

Sample	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
1	0.17	0.15	0.17	0.75	0.21	0.2	5.53	22.35	0.16	22.95	0.22	0.24
2	0.14	0.18	0.17	0.24	0.16	0.15	11.67	0.22	0.27	17.82	0.15	0.26
3	0.2	0.22	0.13	0.16	0.14	0.21	0.24	0.03	2.14	0.12	0.18	0.14
4	0.17	0.18	0.13	0.2	9.5	0.15	1.32	0.26	5.21	0.13	0.15	0.28
5	7.11	16.82	0.14	0.25	0.17	0.18	0.24	0.73	0.21	23.04	0.15	0.3
6	0.12	0.14	0.13	0.16	0.16	12.78	0.13	0.18	0.39	15.75	0.34	0.14
7	0.2	0.15	0.27	0.17	0.32	0.15	12.56	10.22	0.23	3.65	0.24	3.63
8	12.44	0.25	0.16	0.15	0.14	0.16	0.18	0.3	0.21	0.14	0.18	0.17
9	0.14	0.16	14.12	0.19	0.19	0.23	14.6	0.19	22.17	0.23	18.52	0.24
10	0.17	0.18	0.14	0.15	0.16	0.22	0.18	5.91	14.35	0.16	0.21	0.21
Mean	2.09[a]	1.84[a]	1.56[a]	0.24[a]	1.11[a]	1.44[a]	4.66[b]	4.04[b]	4.53[b]	8.4[c]	2.03[a]	0.56[a]
SD	4.24	5.26	4.41	0.18	2.94	3.98	5.98	7.27	7.63	10.17	5.79	1.07

Table 2. Body weight (g) total length (cm) fecundity (egg) and gonadosomatic index (GSI, %) of matured gray-eel catfish.

Sample	Body weight (g)	Total length (cm)	Fecundity (egg)	GSI (%)
1	1159.37	60.5	2942	12.5
2	882.19	56.3	2417	12.2
3	367.56	40.9	1252	8.9
4	770.14	53.3	2009	12.3
5	864.52	49.4	1506	10.6
6	741.96	46.7	2934	11.5
7	704.2	51.8	1499	9.5
8	830.68	55.5	1652	10.4
9	859.78	54	1941	11.2
10	584.4	46.5	1380	10.8
11	779.25	53.1	1744	11.5
12	938.2	56.7	1648	9.5
13	879.64	54	1710	10.8
14	681.39	48	1156	10.5
Mean	788.8	51.9	1842.14	10.87
SD	175.19	4.92	543.41	1.09
Min	367.56	40.9	1156	8.9
Max	1159.37	60.5	2942	12.5

Figure 4. Ovary of gray eel-catfish.

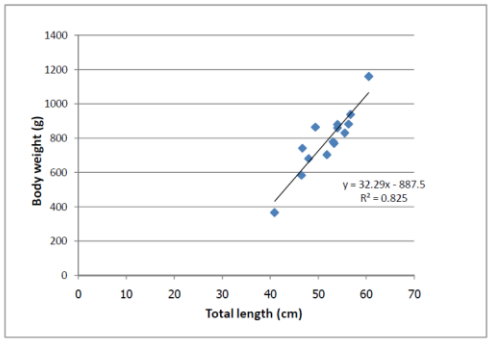

Figure 5. Body weight-total length relationship.

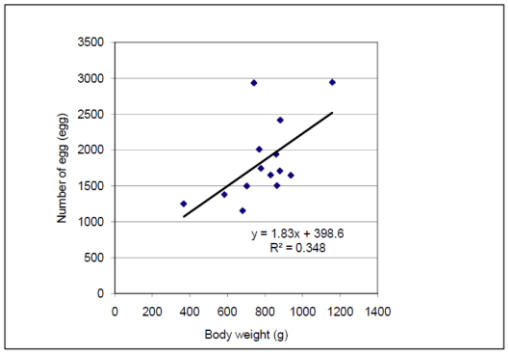

Figure 6. Fecundity-body weight relationship.

The egg types were adhesive demersal egg and rounded. The distribution of the fish egg's diameter could be categorized into five groups i.e. group 1 (3.3%), group 2 (6.9%), group 3 (11.0%), group 4 (54.1 %), and group 5 (24.6 %), with values of 2.89± 0.19 mm, 3.44±0.36 mm, 4.65±0.28 mm, 5.65±0.26 mm, and 6.38±0.25 mm respectively (mean± SD, n=510) (Table 3). By observing the egg's diameter of group 3, 4 and 5, lead us to conclude that the fish is ready for spawning.

Table 3. Diameter of gray-eel catfish egg (mm) (N=510).

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	3.39	3.18	3.28	2.96	3.28	3.60	3.39	3.18	3.39	3.49	3.39	3.18	3.39	3.18	3.28
2	6.25	6.36	6.36	6.46	6.25	5.40	6.25	5.30	5.19	5.72	6.36	6.36	6.36	6.46	6.25
3	5.51	5.30	5.30	5.19	4.77	5.40	5.51	5.08	5.72	5.51	5.30	5.30	5.51	5.19	4.87
4	5.72	5.83	6.04	5.61	5.83	5.93	5.83	5.51	5.61	5.72	5.61	5.83	5.83	5.61	5.83
5	5.30	5.93	6.04	6.14	6.14	6.14	5.93	5.83	6.25	5.61	6.04	5.93	5.83	5.83	6.04
6	7.10	6.57	6.99	6.89	6.89	6.67	7.10	6.89	6.57	6.99	6.89	7.10	6.99	7.10	6.67
7	6.78	6.46	6.25	6.46	6.36	6.36	6.36	6.25	6.67	6.36	6.78	6.67	6.57	6.57	6.57
8	6.78	6.67	6.57	6.36	6.36	6.67	6.57	6.36	6.36	6.46	7.10	6.67	6.67	6.36	6.57
9	5.93	6.14	6.14	6.36	6.36	6.46	6.46	6.36	6.57	6.14	6.25	6.46	6.36	6.14	6.25
10	6.14	6.36	5.83	6.25	6.25	6.14	6.14	5.93	5.51	5.51	6.25	6.04	6.14	6.57	6.36
11	6.67	7.20	6.78	6.67	7.31	7.31	7.20	6.89	7.10	6.67	6.89	7.20	7.20	7.10	7.20
12	4.66	4.77	4.24	4.66	4.98	4.02	4.66	3.92	4.24	4.98	4.45	4.24	4.77	4.45	4.66
13	5.51	6.57	5.51	6.04	5.72	5.93	6.67	6.57	5.93	5.83	5.93	5.83	6.25	5.93	5.83
14	6.14	6.25	6.25	6.46	6.04	6.14	5.61	6.14	6.04	6.04	6.04	6.25	6.36	6.14	6.14
15	6.04	5.83	5.93	5.93	5.83	5.51	5.83	5.83	5.61	5.72	5.72	5.83	5.83	5.93	5.93
16	5.93	6.25	6.14	6.04	6.04	5.93	6.14	6.25	6.14	6.04	6.04	6.36	6.14	6.36	5.93
17	4.24	4.34	4.02	4.34	4.34	3.81	4.34	4.34	3.71	4.34	4.24	4.02	4.34	4.55	4.55

Table 3. Continued

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	3.39	2.96	3.28	3.28	3.28	3.49	3.18	3.39	3.07	3.18	3.49	3.18	3.18	2.96	3.28
2	5.19	6.36	6.46	6.36	6.04	6.46	6.14	6.25	6.46	6.25	5.72	6.46	5.08	6.14	6.36
3	5.19	5.08	5.40	5.30	5.19	4.24	5.51	5.40	5.30	5.08	5.72	5.72	5.30	5.40	5.40
4	5.83	5.51	5.83	5.61	5.61	6.04	5.93	5.83	5.83	6.04	5.61	5.51	5.83	6.04	5.93
5	5.61	5.51	6.04	6.14	5.61	5.61	5.93	5.93	6.14	5.83	6.04	5.83	5.83	6.14	5.72
6	6.99	6.46	6.99	6.89	6.46	6.89	6.57	6.99	6.78	6.78	6.57	7.20	7.10	6.89	6.67
7	6.46	6.46	6.46	6.57	6.67	6.36	6.67	6.67	6.57	6.67	6.57	6.57	6.36	6.46	6.67
8	6.78	6.67	6.78	6.25	6.67	7.31	6.78	6.78	6.78	6.78	6.67	6.89	6.99	6.67	6.57
9	6.57	6.57	6.46	6.36	6.14	6.36	6.46	6.36	6.14	6.25	6.36	6.57	6.25	6.14	6.25
10	6.25	6.25	6.25	6.04	5.30	6.46	6.14	6.14	6.14	6.46	6.25	6.89	6.14	5.83	6.14
11	7.20	7.10	7.20	7.20	6.67	6.99	7.10	7.10	6.99	7.20	6.99	7.10	6.99	7.31	7.10
12	4.55	4.13	4.66	4.45	4.02	4.87	4.24	4.45	4.34	4.77	4.66	3.92	4.77	4.87	4.66
13	6.36	5.83	5.93	5.93	5.61	5.72	5.83	5.83	5.93	5.93	5.72	5.83	5.83	5.72	5.72
14	5.83	6.14	6.25	6.14	6.14	5.93	6.36	6.04	6.14	6.04	5.83	6.25	5.83	6.36	5.83
15	5.72	5.83	5.93	5.72	5.83	5.83	5.61	5.93	5.51	5.61	6.04	5.93	5.93	5.83	5.93
16	6.14	6.14	6.36	6.04	5.83	6.14	6.36	6.25	6.14	6.46	6.36	6.25	6.46	6.14	5.93
17	4.02	4.34	4.55	4.45	4.55	4.34	4.45	3.71	4.24	4.02	3.60	4.55	4.02	4.24	4.45

The physio-chemical parameters of the sediment at the spawning ground (in August through October) such as pH, organic matter, phosphorus, potassium, calcium, magnesium, sand, Silt, and clay were found as follows: 7.16±0.47, 31.39 ±5.06 g kg^{-1}, 134.37±36.81 mg kg^{-1}, 2,017.19±648.53 mg kg^{-1}, 3,932.12±1,446.79 mg kg^{-1}, 334.33±145.94 mg kg^{-1}, 4.09 ±7.16%, 51.01±11.77%, and 44.90±12.75%, respectively. Water salinity was 12.06±0.78 ppt (mean±SD, n=33).Results of physio-chemical sediment, and water salinity were not significantly different (P>0.05) among the eleven stations (Table 4 and Figure 7).

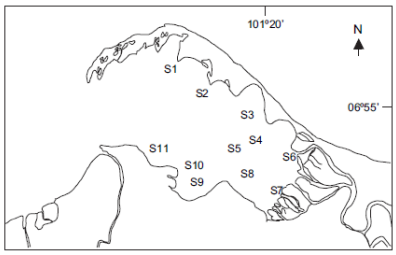

Figure 7. Sampling station in Pattani Bay.

The testis of *P. canius* (Figure 8) was removed in order to study the sperm motility. The average percentage of sperm motility in each treatment were 0 %,24.6 %, 31.0 %, 70.3 % and 33.3 %, respectively. The movement of sperms detected at NaCl concentration level of 0.9 % was signify-cantly higher as compared to other NaCl concentration levels (P<0.05) (Table 5).

4. Discussion

Gray-eel catfish, *Plotosus canius* is a commercially important species for brackish water fisheries. The egg types were adhesive demersal egg and rounded. The female fish size at sexual maturity was 51.9 cm in average total length, with 788.8 g in average body weight, and the average fecundity was 1,842.14 egg/fish. For handling purpose, this fish can be considered as a medium size fish. The relatively low fecundity indicates that the natural behavior of the spawner is to take care of the newly hatched larvae by constructing a nest for spawning (Tarnchalanukit *et al*., 1982).Comparatively, the fecundity of the *P. canius* was lesser than the other species such as Siamese gourami, *Trichogaster pectoralis* which was

Table 4. Average of physio-chemical sediment at the spawning ground in August-October.

Station	pH	OM (g/kg)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)	Sand (%)	Silt (%)	Clay (%)	Water salinity (ppt)
1	7.15 ^{a}	26.79 ^{abc}	205.12 ^{d}	1394.5^{ab}	4881.11^{bcd}	407.6^{cde}	0.703 ^{a}	49.74 ^{bc}	49.55 ^{bcd}	11.66^{ab}
2	7.27 ^{a}	32.57 ^{bcd}	122.82^{abc}	2285.47 ^{cd}	2724.2 ^{a}	431.02 ^{de}	19.3 ^{b}	40.57 ^{ab}	40.12 ^{b}	12.33^{abc}
3	6.97 ^{a}	32.46 ^{bcd}	85.62 ^{a}	1577.78 ^{abc}	2909.61^{ab}	386.43 ^{cde}	0.55 ^{a}	75.98 ^{d}	23.46 ^{a}	12.33^{abc}
4	7.18 a	33.63 ^{bcd}	125.44^{abc}	2000.62 ^{abcd}	3617.26^{abc}	137.63 ^{ab}	2.94 ^{a}	51.41 ^{bc}	45.64 ^{bc}	11.33 ^{a}
5	7.02 ^{a}	26.39 ^{ab}	124.82^{abc}	2184.76 ^{bcd}	2471.59 ^{a}	310.08 ^{bcde}	14.6 ^{b}	42.65 ^{ab}	42.74^{bc}	12.33 ^{abc}
6	7.54 ^{a}	23.95 ^{a}	95.15 ^{ab}	1356.6 ^{a}	3918.56^{abc}	115.61 ^{a}	19.3 ^{b}	40.57 ^{ab}	40.123 ^{b}	13.00 ^{c}
7	7.65 ^{a}	33.89 ^{cd}	148.11 ^{c}	2193.69^{bc}	4436.431^{abcd}	439.08 ^{de}	1.5 ^{a}	59.88 ^{c}	38.61 ^{b}	12.66 ^{bc}
8	7.13 ^{a}	30.24^{abcd}	147.83 ^{c}	1482.16 ^{abc}	2968.89 ^{ab}	238.87 ^{abc}	1.62 ^{a}	55.63 ^{c}	42.73^{bc}	12.66 ^{bc}
9	7.21 ^{a}	33.45 ^{bcd}	146.72 ^{c}	3252.26 ^{e}	5585.12 ^{cd}	463.74 ^{e}	1.77 ^{a}	47.49 ^{abc}	50.73^{bcd}	11.33 ^{a}
10	6.26 ^{b}	35.23 ^{d}	137.14 ^{b}	1981.04 ^{abcd}	3725.136 ^{abc}	280.93^{abcd}	1.68 ^{a}	41.97 ^{ab}	56.34 ^{cd}	11.33 ^{a}
11	7.37 ^{a}	36.64 ^{d}	139.24 ^{b}	2480.12 ^{d}	6013.37 ^{d}	466.57 ^{e}	0.52 ^{a}	36.67 ^{a}	62.81 ^{d}	11.66 ^{ab}

Means with the same superscript in the same row are not significantly different (P>0.05)

Remark:

1	Lam Nok	6˚53'13.32"N	101˚17'16.62"E
2	Ban Datoa	6˚54'8.82"N	101˚19'12.34"E
3	Ban Talosamilae	6˚55'8.68"N	101˚19'6.26"E
4	Ban Budi	6˚55'39.74"N	101˚18'17.57"E
5	Yamu river mouth	6˚54'5.48"N	101˚19'46.69"
6	Daloa School	6˚54'34.86"N	101˚20'4.69"E
7	Ban TunlongLuloa	6˚53'25.57"N	101˚18'21.51"E
8	Parae	6˚52'39.39"N	101˚19'44.58"E
9	Freezer company	6˚54'17.79"N	101˚15'55.38"E
10	Pattani fishing port	6˚54'27.00"N	101˚14'51.57"E
11	Ban Lam Nok	6˚53'53.49"N	101˚16'22.35"E

Table 5. Percentage of sperm movement in different sodium chloride solution (NaCl).

Sample	Sodium chloride solution (%)				
	0	0.7	0.8	0.9	1
1	0	21	33	75	32
2	0	18	32	62	27
3	0	35	29	74	41
Mean	0^{a}	24.6^{b}	31.3^{b}	70.3^{c}	33.3^{b}
SD	0	9.07	2.08	7.23	7.09

Means with the same superscript in the same row are not significantly different (P>0.05)

reported to have 26,261 egg/fish, and sexually matured size was at 18.07 cm in total length and 94.20 g in average body weight (Amornsakun *et al.*, 2004). In addition Amornsakun *et al.* (2005) reported the size of sexually matured female Climbing perch, *Anabas testudineus*, was 15.20 cm in total length and 61.10 g in body weight, and the fecundity was 24,120.5 egg/fish. Fecundity varies with different species depending on age, length-weight, environmental, and some other parameters. (Ghafari & Jamili, 2010; Shivasanthini *et al.*, 2008; Zalina *et al*., 2012).

We found that the GSI of matured gray-eel catfish was 8.4%, which is comparatively similar to the other fishes. Normally the GSI value of catfish was 8 to 12% (Tarnchalanukit *et al*., 1982).Several studies have reported that the GSI of Siamese gourami was 10.9%, while climbing perch was 10.4% (Amornsakun *et al*., 2004, 2005).

The spawning season of *P. caniusin* Pattani Bay and Songkhla Lake, Thailand are at the same time period, i.e. in October (Runsirikul *et al.*, 2007). Diameters of fish eggs for spawning time were in the range of 4.65-6.38 mm. It size is bigger than various other fish such as red-tail catfish, *Mystus wyckioides* (2.28 mm), Siamese gourami, *Trichogaster pectoralis* (0.91mm), climbing perch, *Anabas testudineus* (0.83 mm), and snake head fish, *Channa striatus* (0.58 mm) (Amornsakun, 1999; Amornsakun *et al.*, 2004, 2005, 2011).

Loya and Fishelson (1969) have suggested that, to be suitable for brackish water fish rearing, the main soil texture environment at spawning ground should be classified as silty clay with the sediment's pH at neutral (Pattani Bay, pH 7.16±0.47), and water salinity not more than 30ppt (Pattani Bay salinity is 12.06 ±0.78ppt).

In order to survive and propagate successfully, the fish's sperm need to be able to tolerate some salt concentration in the water. In this work, it was shown that the movement of sperms in the0.9 % sodium chloride (NaCl) concentration level was higher than the any other sodium chloride (NaCl) concentration levels, which means that the most suitable concentration of sodium chloride solution for sperm dilution is 0.9 %. For a good fertilization rate, the spermatozoa should be able to enter themicropyle of ovary within seconds. Kudo *et al.* (1994) reported that European catfish sperm entered to micropyle of egg within 20-60 seconds after fertilization, and 4 minutes later, the activity of spermatozoa slowed down significantly.

In conclusion, for a sexually matured gray-eel catfish, the average total length and body weight were 51.9 cm and 788.8 g, respectively, while the average fecundity of the fish was 1,842.14 egg/fish. When the fish is ready to spawn, the egg's diameter will ranged from 4.65 to 6.38 mm. The GSI of gray-eel catfish will varyas a function of time. Normally, as the GSI reached 8.4% (in October), the fish is

ready to spawn. Result also show that geographical location is not an important factor, since *P.canius* at Pattani Bay and *P. canius* at Songkhla Lake (Runsirikul *et al.*, 2007) spawned at the same time, which is in October. Concerning the effect of concentration of NaCl solution on the movement of sperm, it was shown that concentration of NaCl solution at 0.9% has higher sperm's movement count than the other concentrations. Especially important for spawning is the environment at the spawning ground which should have neutral sediment's pH (7.16±0.47), and water salinity of 12.06±0.78 ppt. which is considered similar to the other brackish water fish's requirement.

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