Study on reproductive biology of blue swimming crab *Portunus pelagicus* (Cuvier, 1816) from Ayeyarwady Delta Region

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Abstract

Aspects of reproduction in the blue swimming crab *Portunus pelagicus* (Linnaeus, 1758) were studied. The crab specimens were obtained from Shwezinyaw Hein Jetty where commercial fishing vessels, carrying catches of various species of marine fishes and crabs captured from Ayeyarwady delta region, were docked. The study period lasted from July, 2017 to February, 2018. The overall sex ratio of males and females was (1:1.8). Gonad maturation based on GSI in both sexes showed two peaks (November and January) during the study period Ovigerous females of *Portunus pelagicus* first appeared in October and reached peak during November and another small peak appeared in January. In the present investigation, the fecundity of *P. pelagicus* was found to be ranging from 165785 to 598500 eggs. It has been found that the number of egg increased linearly with the increase of carapace width, body weight and egg mass weight.

Keywords : sexratio, gonadosomatic index, ovigerous females, fecundity, *Portunus pelagius*

Introduction

Blue swimming crab (*Portunus pelagicus*) is one of the important commodities in the world's fisheries. Crabs are valuable seafood in great demand both for domestic markets and export industry. They are found in tropical region and distributed in Indo Pacific Ocean, Mediterranean Sea and east coast of Africa. Crabs live in a wide range of inshore and continental shelf areas, including sandy, muddy, or algal and seagrass habitats, from the intertidal zone to at least 50m depth (FAO, 2014). Because of its good flavor, blue swimming crab is in high demand in the market (Sudtongkong, 2006).

Portunus pelagicus is one of the commercially important crabs along the Rakhine, Ayeyarwady and Gulf of Moattama and Tanintharyi Regions in Myanmar. It is an important economic fishery resource with high demand for export, but the production is solely done from catches in the wild and categorized as one of the threatened marine crab species in Myanmar (Myanmar Biodiversity, 2014). At present, *Scylla serrata*, *Charybdis feriatus*, *Portunus pelagicus* and *P. sanguinolentus* are exported to China and *S. bidens* is exported to Thailand (Theint Zarchi Nway, 2017). Exports of crustaceans represent both shrimps and crabs in Myanmar, crabs took account for about 30% while shrimp accounted for over 70% (Sea Food Trade Intelligence Portal, 2014).

Reproductive biology is the main mechanism to maintain species proliferation and continuity. For proper conservation and management of portunid crab, a proper knowledge on its biology is crucial. Study of gonads, size at first maturity, fecundity and breeding season are important aspects of reproductive biology of crabs. There are few studies on the reproductive biology of blue swimming crab, *Portunus pelagicus* in Myanmar. The reproductive biology information gathered from this study on gonad maturation is important to understand the behavior and characteristic of *Portunus*

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pelagicus for the management portunid crab resources exploitation for capture fishery and aquaculture purpose. The objectives of this study were:

- to investigate the sex ratio, gonadosomatic index (GSI) and spawning season of the species
- to assess the relationships between fecundity and total body weight, carapace width, abdomen width and egg weight

Materials and Methods

Study area and site

Samples of studied species *Portunus pelagicus* were collected from Shwezinyaw Hein jetty, Hlaing Township, Yangon Region. Fishing vessels captured various species of marine crab species including the studied species, *Portunus pelagicus*, from offshore fishing grounds in Ayeyarwady delta Region located at Latitude 15º 10´ 200″ E and Longitude 95º 15´ 500″ N and transported them to the jetty. Crabs were captured using bottom trawl net and shore seine from the study area.

Study period

Monthly collections were carried out for eight months from July, 2017 to February, 2018.

Specimen collection and sampling

A total of 240 crabs randomly sampled of various sizes were collected monthly and preserved in deep freezer until further analysis. Sexes were determined by examining the abdominal morphology. Females were characterized with their triangle-shaped abdomen while males, their inverted “T” shaped abdomens.

Gonad development and spawning season

A total of 50 ovigerous females in various sizes were sampled to determine the crab fecundity and embryonic stages while 103 non-ovigerous females and males 87 were sampled to determine the gonadal development stages through only macroscopic study.

Gonadosomatic index (GSI)

Gonadosomatic index (GSI) of male and female was calculated based on the ratio of gonad wet weight to total body wet weight of crab (Sukumaran, 1995).

$$GSI = \frac{WWG}{WWC} \times 100$$

Where,

GSI = Gonadosomatic index (%)

WWG =Wet weight gonad (g)

WWC =Wet weight crab (g)

The spawning season was estimated based on the average monthly GSI of both male and female crabs, and was supported by the percentage of ovary stage 4 and the presence of ovigerous female crabs and gonad maturity stage 3 in male in each month during the study as reported by Hamid *et al.*, (2015).

Fecundity

Fecundity was made on the basis of the extruded eggs on pleopods as suggested by Sukumaran and Neelakantan, 1996.

$$N = W \times \frac{n}{w}$$

Where,

W = total weight of the egg mass only;

w = average weight of the three egg samples;

n = average number of eggs in the samples;

N = total number of eggs that is fecundity

The relationships between fecundity and carapace/abdomen width; fecundity and total weight/egg mass weight; were all determined by regression analysis (Wootton,1990).

$$F = aX^b$$

Transformed into logarithmic from using the equation:

$$\log F = \log a + b \log X$$

Where Log F was the fecundity, a and b were constants and Log X the variable (carapace width, carapace length, body weight, abdomen width or egg mass). Data were analyzed using the statistical package (SPSS version 23). Pearson's correlation analysis level of significance was selected as $p < 0.01$ and $p < 0.05$. Chi-squared test was carries out on the observed male and female specimens to show the level or proportion of differentiation from the expected 1:1 ratio. The correlation coefficient (r) was determined to know the strength and pattern of association between the two variables. The mean and standard deviation (±SD) value of each data was calculated.

Identification

The studied species was identified by FAO (1988)

Results

Sex ratio

The overall sex ratio of crab male and female is 1: 1.76 or 36.25% male and 63.75% female. The number of female crab was significantly more abundant than males in the months of November, December and February. Most of the months with higher occurrence of female crabs were within the peak spawning period. The monthly variation in sex ratio was presented in table 1.

Monthly proportion of gonadal maturity stages of male *P. pelagicus*

A total of 87 male crabs were dissected to observe the gonadal development through macroscopic examination. Carapace width ranged from 110.00 mm to 190 mm and body weight ranged from 85.53 from 413.01 g of crab samples were used to determine the gonadal development. All three stages of gonad development were observed during the study period in fig. 1 and plate 1.

Monthly proportion of gonadal maturity stages of female *P. pelagicus*

A total of 153 female crabs were dissected to observe the ovarian development through macroscopic examination. Carapace width range from 116.5 mm to 188.7 mm and body weight range from 90.54 from 374.80 g of crab samples were used to determine

the ovarian development. All five stages of gonad development were presented in fig. 2 and plate 1.

Variations in gonadosomatic index (GSI) of *P. pelagicus*

During the ovarian maturation, the GSI increased with the ovarian development. The gonadosomatic index of the male and female crabs was studied according to the size and weight of the crab. GSI mean values monthly in male crabs were smaller than those in female crabs and presented in fig. 3.

Relationship between fecundity and body morphometric parameters of ovigerous female *P. pelagicus*

The carapace width of the fifty ovigerous females, used for the fecundity estimates, ranged between 125.00 and 178.90 mm and their weight ranged 115.75-355.25 g. The mean number of eggs, produced by females of different sizes, ranged from 430492±108849 eggs and the mean carapace width was 153.60±14.50 mm and the mean body weight was 199.88±65.49 g. Regression analysis showed that there was significant ($p<0.01$) relationship between the number of berried eggs and fecundity in figs. 4 and 5. Linear regression for carapace/abdomen width and fecundity could be expressed as:

$\log F = -0.188 + 2.658 \log CW$, $R^2 = 0.769$, $r = 0.896$, $p < 0.01$

$\log F = 3.111 + 1.484 \log AW$, $R^2 = 0.521$, $r = 0.720$, $p < 0.01$

Similarly, the relationship between fecundity and egg mass/body weight was determined by plotting the observed values in a scattered diagram (Figs 6 and 7).

$\log F = 3.815 + 0.790 \log BW$, $R^2 = 0.734$, $r = 0.863$, $p < 0.01$

$\log F = 5.008 + 0.707 \log EW$, $R^2 = 0.826$, $r = 0.878$, $p < 0.01$

The relationship between fecundity and egg mass/body weight was found linear. It was found that fecundity generally increased with increased in ovary weight.

Table1. Monthly variation in sex ratio of *P. pelagicus* during the study period

Months	Total	Male (n)	Female (n)	M:F	% of female	X^2	Remark
July, 2017	30	13	17	1:1.31	56.66	0.533	NS
Aug, 2017	30	14	16	1:1.14	53.33	0.133	NS
Sept, 2017	30	15	15	1:10	50.00	0.000	NS
Oct, 2017	30	12	18	1:1.5	60.00	1.200	NS
Nov, 2017	30	7	23	1:3.3	76.67	8.533	S
Dec, 2017	30	9	21	1:2.3	70.00	4.800	S
Jan, 2018	30	10	20	1:2	66.67	3.333	NS
Feb, 2018	30	7	23	1:3.3	76.67	8.533	S
Total	240	87	153	1:1.8	63.75	18.150	S

n = sample size, M:F = male:female, X^2 = chi square, S = significant, NS = not significant

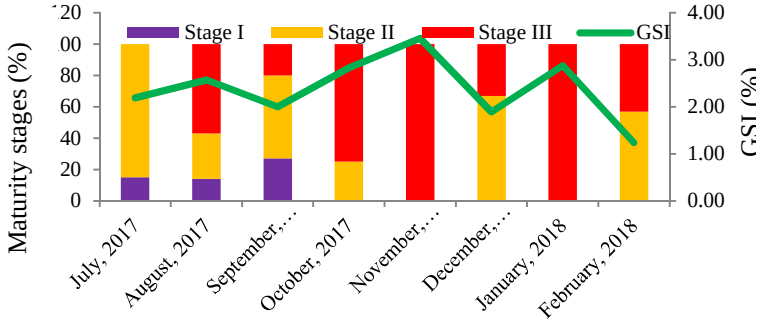


Fig. 1 Monthly proportion of gonad stages and GSI of male crab *P. pelagicus*

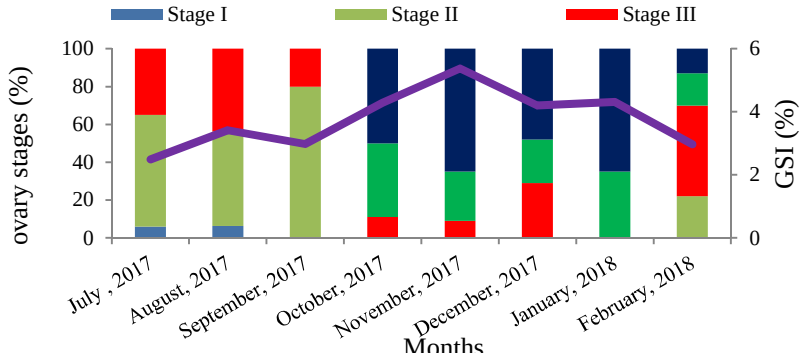


Fig. 2 Monthly proportion of gonad stages and GSI of female crab *P. pelagicus*

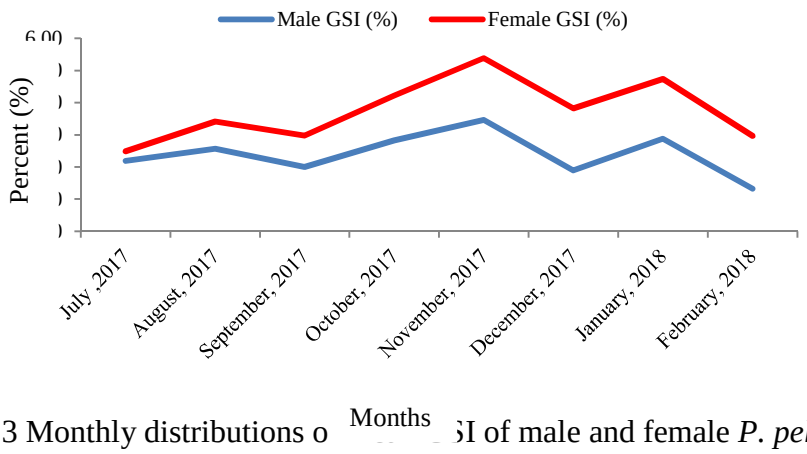


Fig. 3 Monthly distributions o GSI of male and female *P. pelagicus*

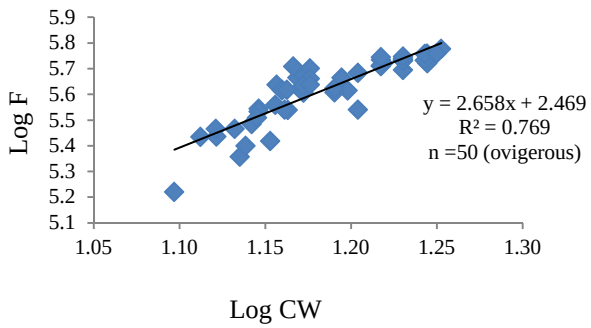


Fig. 4 Relationship between carapace width and fecundity of ovigerous female *P. pelagicus* (log value)

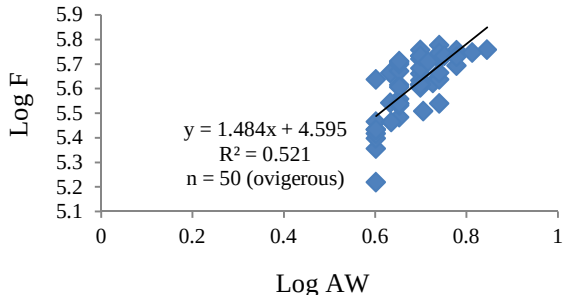


Fig. 5 Relationship between abdomen width and fecundity of ovigerous female

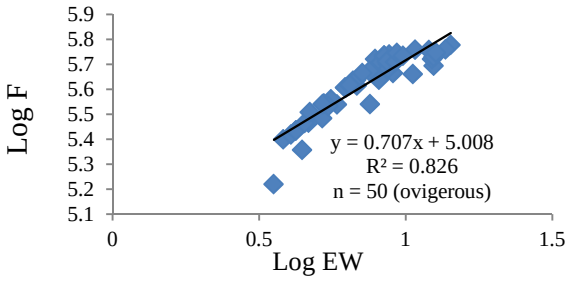


Fig. 6 Relationship between egg weight and fecundity of ovigerous female

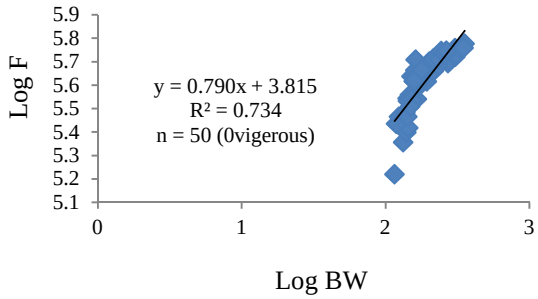
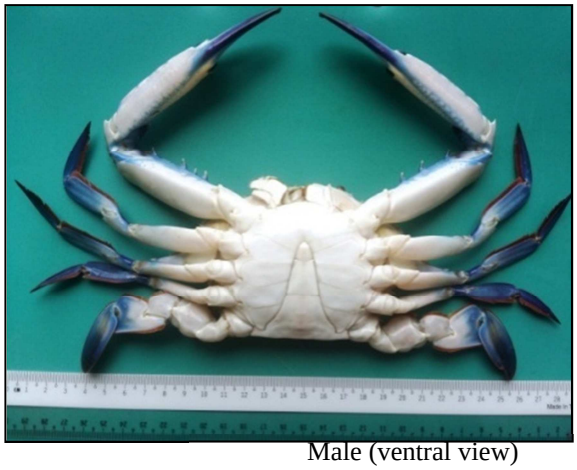
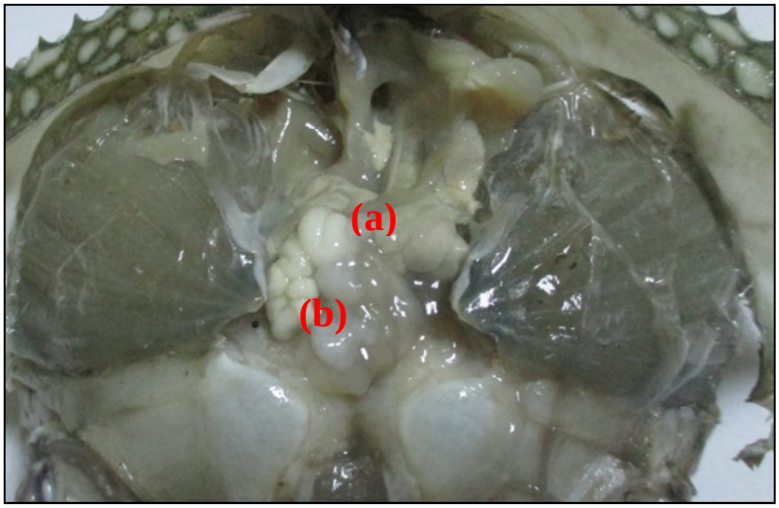


Fig. 7 Relationship between body weight and fecundity of ovigerous female

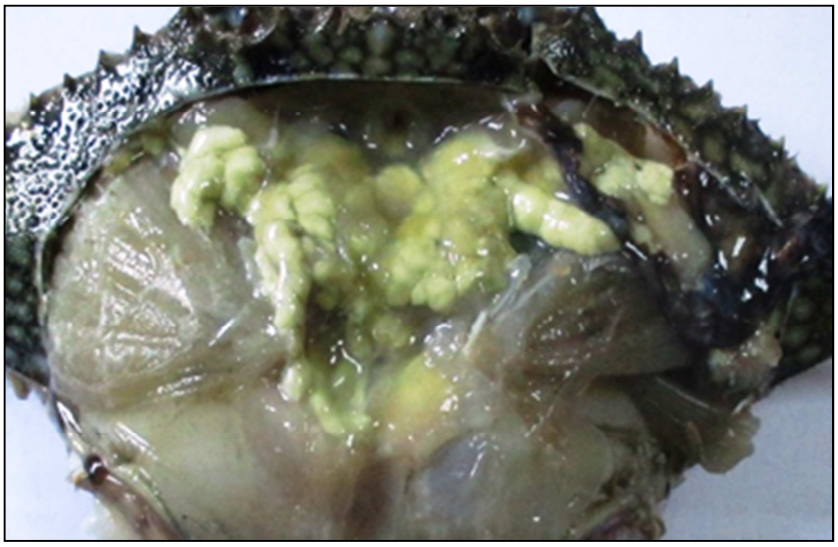
Male (dorsal view)



Male (ventral view)



Male testes (a); vas deferens (b)



Mature testes (stage III)

Female (dorsal view)

Female (ventral view)

Late maturing (stage III); hepatic region (a)

Plate 1. External morphology and gonadal development of male and female *P. pelagicus*

Discussion

The present study aimed to examine the reproductive aspects of blue swimming crab, *Portunus pelagicus* including the determination of sex ratio, gonadosomatic index, relationship of fecundity and body parameters, from Ayeyarwady fishing grounds from July, 2017 to February, 2018.

In this study, the number of female crab was significantly more abundant than males (1: 1.76) during the study period. Sukumaran (1995) reported that the average sex ratio of *P. pelagicus* was 0.84:1 in Karwar, India and 1.06: 1 in southeast Sulawesi, Indonesia (Hamid *et al*., 2015).

Previous study showed that sex ratio in blue swimming crab population varied by location. The variation of sex ratio was believed to be related to the behavior of crab, environmental conditions and collection methods (Sukumaran, 1995). The composition of crab size and type of fishing gear may also affect sex ratio (Potter & Lestang, 2000).

In the present study, female GSI value was higher than the male GSI value, probably caused by the increase in the ovaries weight larger than the growth of testes. Gonad maturation and GSI in both sexes showed two peaks (November and January) during the study period .The GSI values for the 153 female crabs ranged from 0.68-9.56% with a mean of 7.87%. This indicated that *P. pelagicus* on the average used 7.87% of its body weight for egg production. Nikolsky (1963) said that the ovaries weight was around 15% from the body weight but Scott (1979) reported the values between 15 and 30%.

Based upon observation of macroscopic studies, the presence of male in the third stage also indicated that this period was known as the spawning season. Maturity stage III, IV and V occurred from October to February during the study period, indicating that mature females were actively spawning throughout the winter season. The variation of the proportion of gonad development and GSI of blue swimming crab among different locations is probably related to habitat conditions, seawater condition, body size and weight of the crabs (Potter & Lestang, 2001).

Ovigerous females were first appeared in October and reached peak during November and few were found during February. Another small peak appeared in January. In India, Pillay and Nair (1976) reported that spawning peaks varied annually and geographically. From Philippine, Ingles and Braum (1989) have observed the occurrence of ovigerous females of *Portunus pelagicus* throughout the whole year with two spawning periods one from February to April and the other from July to October. For the same species from China, Song *et al*., (1988) reported on spawning period extend from April to March.

The present study is in disagree with most of the above mentioned trend in the timing of spawning and peak of occurrence of ovigerous females. This is probably incidental observation, geographical differences or a reflection of the migratory behavior of the crabs (Kumar *et al*., 2003).

In the present investigation, the fecundity of *P. pelagicus* was found to be ranging from (165,785 to 598,500 eggs) whereas, the previous reports on the fecundity of the portunid species were reported to be more or less similar. Prasad and Neelakantan (1989) reported the fecundity of this species was ranged from 52,025 to 202, 250 eggs in India. Pillai and Nair (1971) recorded the fecundity of this species was ranged from 318,720 to 521,450 eggs in southwest coast of India.

Fecundity of crabs varies from species to species and also varies within the same species, due to different factors, such as age, size, nourishment, ecological conditions of the

water body (Hines, 1982). Through this study, it has been found that the number of egg increased linearly with the increase of carapace width, body weight and egg mass weight. These positive significant correlations between fecundity and carapace width and body weight were the same as the result by Kumar *et al*., (2000) on *Portunus pelagicus*.

The present study showed that the spawning season seems to occur in October to February. Indeed, the peaks of spawning period coincide with the period of high GSI's for both males and females. Based on the distribution of GSI mean values monthly in female crab, ovarian maturation stages and the proportion of the ovigerous female, the peak spawning season of crab during the study period occurred in November and January. The present findings also could be concluded that the occurrence and timing of the developmental stages of gonads (stage IV and V) in females and males (stage III) might determine the two peaks of spawning season to occur in November and January. As soft shelled females were not found in the present study, the mating period could not be estimated.

Conclusion

The present observations on some aspects of reproductive biology of blue swimming crab, *Portunus pelagicus*, in Ayeyarwady delta region provided useful information for the management of this species such as prohibition on the capture of ovigerous female crabs and on catching female with a minimum size limit to allow them to reach maturity and produce eggs and zoeae in order to sustain their populations; and prohibition on fishing the crabs in the spawning season should be instituted in this area. Consequently, this study will be probably helpful for future studies on the same species in other coastal regions and the data could be used for comparative studies with the data obtained in other countries on the same species.

Acknowledgements

The author is grateful to Dr. Lu Lu Aung, Professor and Head, Zoology Department, Dagon University for her permission to present this paper and also thankful to Dr. khin Maung Saing, Senior Advisor (Rtd), Ministry of Science and Technology for his valuable suggestion and criticism of the manuscript.

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