



Sex Ratio and Spawning Season of Blue Swimming Crab (*Portunus pelagicus*, Linnaeus, 1758) in North Java Sea, Indonesia

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Abstract: High value economy of blue swimming crab (*Portunus pelagicus*) increases its capture in nature done continuously without regard to biological phases, so that it might overfishing occurrence. This study aimed to analyze the sex ratio and spawning season of blue swimming crab (*Portunus pelagicus*) in the North Java Sea of Indonesia. The research sampling was collected during October 2016 to September 2017. The total sample obtained was 424 males and 790 females of blue swimming crab. The sex ratio of *P. pelagicus* was 1:1.86 (males: females) where the amount of female was higher than male, the result of chi square test of ratio for overall samples of blue swimming crab (*P. pelagicus*) was significantly different from the expected 1:1 value. The spawning season occurred throughout the year, ovigerous females were every month except in July, and the highest percentage of ovigerous females was in February (30.2%).

Keywords: *Portunus pelagicus*, Sex ratio, Spawning season, Ovigerous female, North Java sea

Blue swimming crab, *Portunus pelagicus* (Crustacea: Decapoda: Brachyura: Portunidae), is widespread throughout the coastal regions and tropical estuaries of the Western Pacific and the East Indian Ocean (Xiao and Kumar 2004). The essential areas in Indonesia for blue swimming crab fisheries are in the northern part of the Java Sea, South Sulawesi, the eastern part of Sumatra, and the Malacca Strait (USAID 2015). Paciran is a coastal area of the North Java Sea. It is located in Lamongan, East Java, where the majority of the population works as fishermen, one of the mainstay fisheries commodities is crab. Its export is currently in between third and fourth rank after tuna, shrimp, and seaweed (BPBAP 2013). The *Portunus pelagicus* export value increased by 6.15% per year during the period of 2012-2017 and export value of *P. pelagicus* increased by 27.81% during the period of 2016-2017 (KKP 2018). The National Commission for the Assessment of Marine Fish Resource Stocks also states that there are difficulties in collecting data on fisheries commodities. It causes difficulties to know potential conservation, one of which is crab. The decrease in the blue swimming crab population in nature is because of the fishing fleet and its high economic value that makes fishery continuously without regard to biological phases. It is necessary to maintain the blue swimming crab population in nature by maintaining and preserving its resources through fisheries management. It is not only oriented to produce results but also to ecosystem preservation. Several biological processes, such reproduction and migration of ovigerous females may influence distribution in crabs (Rohmayani et al 2018). Sex ratio and proportion of ovigerous females will give

information about productivity, spawning season and sustainability of crabs in nature. Research on the sex ratio and spawning season of blue swimming sea was rarely conducted primarily in the North Java Sea. The sea was one of the crucial waters in Indonesia. Thus, it was necessary to research the sex ratio and spawning season of blue swimming crab in the Java Sea (North of Lamongan).

MATERIAL AND METHODS

Study site: This research was conducted in the Java North Sea of at Paciran Lamongan with the eastern boundary of S 6° 54'13.1688 "and E 112° 27'16.9596", the western boundary of S 6° 52'58.3356 "and 112° 16'7.6116".

Data collection: The method used in this study was the observational method. The sampling was done by using a random sample method. Sampling was carried by local fishermen. The sample for study was collected for one year from October 2016 to September 2017. Sampling was carried by using the bubu net, which contained 0.5 inch (width 32 cm, length 49 cm and height 19 cm).

After that was identified on the sample, sex ratio identified by looking at the morphological characteristics of abdomen (Fig. 1), while ovigerous females crabs are females who carry fertilized eegs in the abdomen that attach to their pelopod (Romimohtarto and Juwana 2009). The Ovigerous females can be divided in three stages (Fig. 2).

Data analysis: The sex ratio was analyzed using the *Chi-square* test (Walpole 1993) at a significant level of 0.05 (Steel and Torrie 1992).

$$X^2 \text{ count} = \sum_{i=1} \frac{(o_i - e_i)^2}{e_i}$$

Explanation:

χ^2 value: Chi-square value

O_i : frequency to-i

e_i : expectation frequency to-i.

Morphological differences in male and female crab were in Figure 1 as follows:

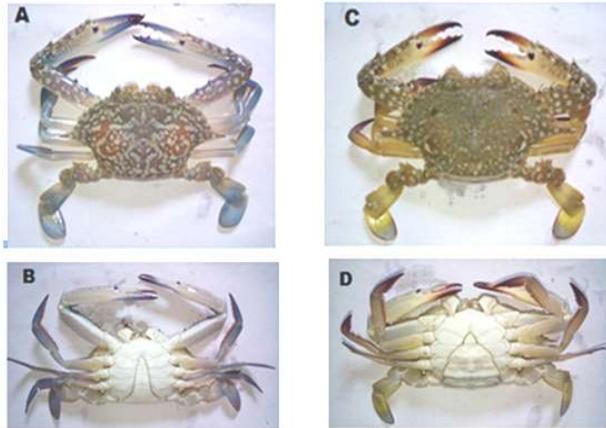


Fig. 1. Morphological Differences in male and female *Portunus pelagicus*. A: appearance from male crab, B: an appearance from male crab, C: an appearance from female crab, D: appearance from female crab

Spawning season of blue swimming crab: The spawning season was through the presence of *ovigerous* female crabs. The equation formula for determining the proportion of *ovigerous* female is as follows:

$$\text{Percentage ovigerous female} = \frac{\text{The number of ovigeous female}}{\text{Number of female overall}} \times 100$$

Ovigerous female crabs can be divided into three stages, as shown below:

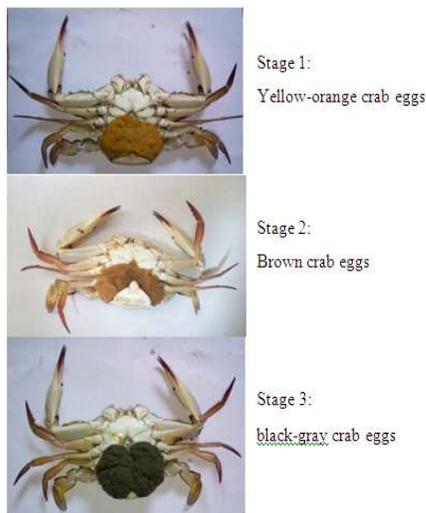


Fig. 2. Morphology of egg development of *Portunus pelagicus ovigerous*

RESULT AND DISCUSSION

Sex ratio: The total crab sample of 1214 tails, 424 were males and 790 females (34.9:65.1% males: females) with male to female was 1:1.86 (Table 1) Test results χ^2 overall sex ratio of the blue swimming crab (*Portunus pelagicus*) for one year was significantly different from the 1:1 ratio ($p < 0.05$). This result is similar to the research conducted in Brebes and Betahwalang waters (Sunarto 2012, Ningrum et al 2015). They were different from the observation in Iran (Hosseini et al 2012) and in Lasongko Bay in Southeast Sulawesi (Hamid et al 2016), where were males more than females. The sex ratio imbalance because the presence of different habitat preferences (salinity characteristics and temperature distribution) between males and females, and tended to form the aggregation of sex segregation (Xiao and Kumar 2004). Mature females usually migrate in several periods of the year (Kamrani et al 2010).

Spawning season: there were 128 *ovigerous* females, the highest percentage of female *ovigerous* was in February, which was 30.2%. Sampling is during in the bright moon conditions, except in july sampling obtained in the drak moon conditions. In july the proportion of females obtained was high, but not find any *ovigerous* females (Table 3). There were two hypotheses related to the absence of *ovigerous* females that occurred in July. The first hypothesis was that all egg might be released because it coincided with a dark moon in July. While the second hypothesis, it might be in every July, there was no female *ovigerous* since, at that time, there was a seasonal change from rainy to summer. Osaka and Takemura (2019) report that in the *Coenobita rugosius* species in Okinawa Japan shows that larval release is related to the lunar cycle, he also stated that ovarian development and larval release influenced by external factory, such as habitat change over several periods.

The absence of *ovigerous* females was not only observed in blue swimming crabs, but also in *Portunus sanguinolentus* in Honghai Bay, South China Sea, (Ping Yang et al 2014) and also found in the *Varuna litterata* in cochin backwater, Kerala, India (Devi et al 2013). In present study, percentage of *ovigerous* females fluctuates (Fig. 3) based on the difference of egg development stage and did not show mutually sustainable fluctuations between stages 1, 2, and 3. It occurred due to *ovigerous* female eggs hatching occurred in less than 1 month. Susanto et al (2005) observed that *ovigerous* females need about 5-8 days, depending on the stage of embryonic development. The blue swimming crab with yellow eggs took longer to hatch than those with brown and black eggs. The *ovigerous* females were generally found throughout the year indicating that this species was spawning continuously. The difference in the

Table 1. Sex ratio of *Portunus pelagicus* in the Java Sea (North of Lamongan)

| Year | Month | Proportion (%) | | Sex Ratio J: B | χ^2 value |
|-------|-----------|----------------|-------|-------------------|----------------|
| | | J | B | | |
| 2016 | October | 29.36 | 70.64 | 1: 2.41 | 17.06* |
| | November | 53.47 | 46.53 | 1:0.87 | 0.49 |
| | December | 46.6 | 53.4 | 1: 1.15 | 0.47 |
| 2017 | January | 20.79 | 79.21 | 1: 3.81 | 34.47* |
| | February | 37 | 63 | 1: 1.70 | 6.76* |
| | March | 41 | 59 | 1: 1.44 | 3.24 |
| | April | 48 | 52 | 1: 1.083 | 0.16 |
| | May | 49 | 51 | 1: 1.04 | 0.04 |
| | June | 25 | 75 | 1: 3 | 25* |
| | July | 26 | 74 | 1: 2.85 | 23.04* |
| | August | 36 | 64 | 1: 1.78 | 7.84* |
| | September | 7 | 93 | 1: 13.29 | 73.93* |
| Total | | 34.9 | 65.1 | 1:1.86 | 110.34* |

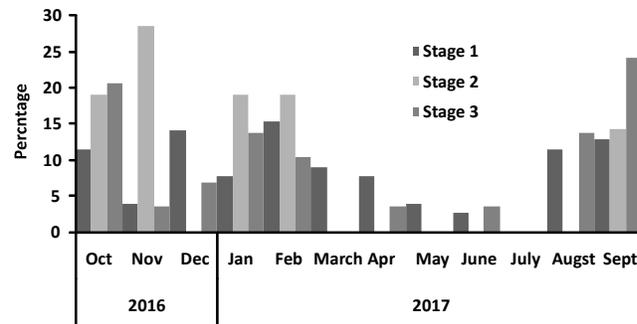
Explanation: Df=1, χ^2 table = 3.84 (p<0.05) *significant = χ^2 value > χ^2 table

Table 2. Sex ratio of *Portunus pelagicus* in various waters location

| Location | Sex ratio J:B | Source |
|------------------------------|------------------|---------------------------|
| Trang Beach, South Thailand | 1:0.85 | Nitiratsuwan et al (2013) |
| Persian Gulf, Iran | 1:0.88 | Hosseini et al (2012) |
| Pati Waters | 1:0.85 | Ernawati (2013) |
| Lasongko Bay | 1:0.94 | Hamid (2015) |
| Brebes Waters | 1:1.22 | Sunarto (2012) |
| Betahwalang Waters | 1:1.10 | Ningrum et al (2015) |
| Java Sea (North of Lamongan) | 1:1.86 | This research |

Table 3. Percentage of *ovigerous* female *P. pelagicus* in the North Java Sea

| Year | Month | Female overall | <i>Ovigerous</i> female | Percentage of <i>ovigerous</i> female (%) |
|-------|-----------|----------------|-------------------------|---|
| 2016 | October | 77 | 19 | 24.7 |
| | November | 47 | 10 | 21.3 |
| | December | 55 | 13 | 23.6 |
| 2017 | January | 80 | 14 | 17.5 |
| | February | 63 | 19 | 30.2* |
| | March | 59 | 7 | 11.9 |
| | April | 52 | 7 | 13.5 |
| | May | 51 | 3 | 5.9 |
| | June | 75 | 3 | 4 |
| | July | 74 | 0 | 0 |
| | August | 64 | 13 | 20.3 |
| | September | 93 | 20 | 21.5 |
| Total | | 790 | 128 | 16.2 |

**Fig. 3.** Percentage of *ovigerous* female *Portunus pelagicus* abundance based on egg maturity stage in the North Java Sea

spawning time was affected by different water locations. It indicated that in every month, there would be copulation and was marked by the presence of *ovigerous* females and also hatching or releasing eggs.

CONCLUSION

The sex ratio of *Portunus pelagicus* in the North Java Sea showed fluctuation. sex ratio was significantly different from the ratio 1:1, where the amount of female was higher than male. *Portunus pelagicus* spawning season occurred throughout the year. Every month a sample of *ovigerous* females was obtained except in July. The highest percentage of *ovigerous* females was in February (30.2%).

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