DOI <https://doi.org/10.18551/rjoas.2018-09.66>

REPRODUCTIVE PERFORMANCE BASED ON MORPHOMETRIC CRITERIA OF PISANG SHRIMP (*PENAEUS* SP.) AS ENDEMIC SPECIES IN WEST COASTAL ACEH

Saripuddin*, Johannes Hutabarat, Suradi Wijaya Saputra

Faculty of Fisheries and Marine Science, University of Diponegoro, Indonesia

*E-mail: dhaenk_echa@yahoo.co.id

ABSTRACT

Pisang shrimp (*Penaeus* sp.) is an endemic species of Aceh coastal region. This shrimp could be found on the west coast in Aceh. The aims of this study were to determine the reproductive performance of pisang shrimp based on morphometric criteria. Shrimps with the 3rd level of gonad maturity (LGM) were collected from fisherman's caught in Meulaboh, West Aceh. The broodstock sampling were done by three times repetition in the same location. In each sampling, 10 shrimps with the 2nd-3rd level of gonad maturity were selected. Female broodstocks with the 2nd-3rd gonad maturity level were acclimated in a 5 m³ tank. Shrimps with complete organ were selected to be the broodstock then the total length, length of the carapace and body weight were measured. The broodstocks were transferred into a cone tank in size 250 L with a density of 1 shrimp /tank for maturation. The shrimps's eggs were collected in the morning to obtain the fecundity of the each broodstock. Data were analyzed by linear regression then the correlation values between fecundity with weight, total length and the carapace length were determined. The results showed that the weight, total length and length of the carapace of Pisang shrimp had a close relationship with the fecundity. The highest correlation values was shown by the weight variable ($R^2 = 0.961$) then followed by the length of carapace ($R^2 = 0.895$). The weight variable explained the fecundity better than total length variables and the carapace length. On the other hand, the carapace length variable explained the fecundity better than the total length variable. The lowest values for absolute and relative fecundity were produced by broodstock in weight of 50.5 g with a total of fecundity of 73.500 eggs, while the highest values were produced by the broodstock in weight of 123.5 g with highest fecundity was 413.139 eggs.

KEY WORDS

Pisang shrimp, broodstock, reproductive, morphometrics, fecundity.

Aceh Province, Indonesia, is located on the western end of Sumatera Island. It has a vast sea water area, namely the Malacca Strait waters in the eastern region and Indian Ocean waters in the western region. The vast sea waters greatly support the potential for marine biodiversity. Therefore, Aceh is one of the provinces in Indonesia that has a relatively high biodiversity source, especially from the crustaceans either crabs or shrimps. The sea waters in Aceh are famous for the best source of tiger shrimp (*Penaeus monodon*) and highly in demand by shrimp producing countries. This tiger shrimp are found in the eastern part of Aceh. Tiger shrimps are generally caught in the regency of Aceh Timur and Aceh Tamiang. There are numerous and various potential of shrimp in Aceh, including the endemic type of shrimp species found in the western Aceh waters that have the potential to be developed. Aside from the tiger shrimp, Aceh also has the potential of the pisang shrimp which are native to Aceh and are thought to be endemic species on the west coast of Aceh (Novita *et al.*, 2015). Pisang shrimp are widely spread and appear seasonally along the waters of the western region of Aceh from Lamno (Aceh Besar) to the coast of South Aceh. Its size is similar to the tiger shrimp type (BPBAP, 2014). People on the west coast of Aceh call it in its local name "*udeung pisang*" and some regions call it "*udeung hitam*" with the word *udeung* means shrimp. Pisang shrimp has a relatively large size compared to other types of white shrimp such as *Penaeus marginatus* and *Penaeus indicus*. In general, pisang shrimp in Aceh is similar to tiger shrimp in terms of morphology and behavior (BPBAP 2014).

Pisang shrimp is not widely known in Indonesia by shrimp farmers. However, farmers in Aceh are very familiar cultivating this type of shrimp, especially on the west coast of Aceh. The fishermen are even routinely catching this them for sale, both for local consumption needs and seafood restaurant needs in Medan, North Sumatera. In 2014, the Pisang shrimp was sold at IDR 60,000 – 80,000 per kg in Aceh market with the size of 40 – 60 shrimps per kg. Meanwhile, it was sold at IDR 120,000 – 160,000 per kg in Medan market with the size of 15 – 20 shrimps per kg. The high market price and the increasing public demand make the pisang shrimp as the candidate of one of the leading commodities in Aceh in the aquaculture sector. The pisang shrimp in western Aceh waters are found mainly in August – March and the peak are around September – November. They are caught at a depth of 10 – 40 meters (BPBAP 2014).

The morphometric criteria of the shrimp are characteristics related to the number of body parts and body size, which is the indicator of taxonomy characteristics in identifying the shrimp. The tiger shrimp morphometric measured includes total length, carapace length, rostrum length, antenna length, antenullary length, uropod length, telson length, body weight and body parts of the shrimp (Riani 2000).

This study aimed to determine the reproductive performance of Pisang shrimp based on the morphometric criteria. This study only measured the total length, carapace length, and weight which were thought to affect the amount of fecundity in reproduction performance.

MATERIALS AND METHODS OF RESEARCH

The Pisang shrimp broodstock as the test sample was collected directly from fishermen at the location identified as the main source of the shrimp on the west coast of Aceh, Meulaboh. The relationship between morphometric characters was used to obtain information about the promotion of certain characters to others (Parenrengi *et al.* 2007). The selection of several morphometric criteria was based on the consideration that the morphometric relationship will be able to explain the reproductive performance of the pisang shrimp broodstock where gonads was mature naturally. To represent the distribution of total length, carapace length, and weight, samples were collected and then selected which include gonad maturity, complete organ or without defect and physiological conditions. Thirty samples were collected and from each collection 10 shrimps were selected with 3 times collection period.

This study was conducted descriptively (qualitative) while fecundity analysis, Hatching Rate (%), Survival Rate (SR %) were analyzed using formulas from several literature sources. The handling of broodstocks, maturation, egg handling and larvae maintenance were referred to the Standard Operational Procedure (SOP) for tiger shrimp hatchery.

Morphometric data measurement related to the reproductive performance in this study includes total length, carapace length, and body weight of pisang shrimp broodstock. The measurement for broodstock length and carapace length was using a ruler in millimeter or centimeter unit, while the weight was measured using a digital scale in gram unit.

The relationship between total length, carapace length and weight with fecundity productivity was analyzed using SPSS (regression). Simple linear regression analysis is one of the regression methods that can be used as a statistical interference tool to determine the effect of an independent variable on the dependent variable. The simple linear regression test and multiple linear regressions have several objectives, namely:

- Calculate the average estimation value and the dependent variable value based on the independent variable value;
- Test the hypothesis of dependency characteristics;
- Predict the average independent variable value based on the independent variable value outside the sample reach.

Linear regression is also a statistic that serves to test the extent to which the causal relationship between the causative factor variables (X) and the effect variable. The causative factor is generally denoted with X or also called as the predictor, while the effect variable is denoted with Y or also called as the response. Simple linear regression (SLR) is also one of

the statistical methods used in production to forecast or predict the quality and quantity characteristics.

The formula of Simple Linear Regression model is as follow:

$$Y = a + bX$$

Where: Y = response variable or effect variable (Dependent); X = predictor variable or cause variable (Independent); a = Constants; b = Regression coefficient (slope); amount of response caused by the predictor.

RESULTS AND DISCUSSION

Hatching Rate and Survival Rate (%) of Larvae. After the eggs hatched into nauplii, the hatching rate was calculated based on the eggs hatched into nauplii. During the study, the hatching rate did not have a positive correlation with morphometric criteria such as total length, weight and carapace length, and it was not found that the higher fecundity value will increase the eggs hatching rate. On the contrary, based on the results of the study, it was found that the low average value of fecundity was in the broodstock weighing between 50,5 – 53,8 grams/shrimp with fecundity value between 73,500 – 91,353 eggs. However, the eggs hatching rate value is very high between 85.7 – 89.9 %, meaning that fecundity highly contributes to the hatching rate. This is presumably because a large number of eggs will reduce the changes of eggs being fertilized by sperms. Additionally, it is strongly suspected that more eggs mean that they are more likely to stick to each other. If it is rarely stirred, the eggs will stay at the bottom of the tank and make it rot which lead to low hatching rate. Riangi (2000), reports that the increasing fecundity resulted in a low degree of hatching rate, or the increase of one variable will be followed by a decrease of other variables. The average hatching rate of eggs during the study was obtained between 76 – 78.8%. Primavera states that good eggs have an average hatching rate of more than 58%. Therefore, it can be concluded that the eggs produced from natural broodstocks are categorized as very good.

Of the total 30 mature pisang shrimp broodstocks, they produced eggs, nauplii, zoea, mysis and postlarvae (PL) with varying degrees of average survival. Based on Table 2, the average survival was 65.3% in nauplii – zoea, 70.5% in zoea – mysis, 73.1% in mysis – PL₁, 75.9% in PL₁ – PL₁₂, and 38,9% in PL₁ – PL₁₂. The larvae life degree from nauplii to mysis showed that the increasing stadium of shrimp will increase the degree of life. In PL₁-PL₁₂ stadium, the average larvae degree of life was 38%. Kurata (1975) in Rianni (2000) states that the larvae degree of life during PL stadium range from 30% to 60%.

Table 1 – SR (%) of Larvae and Metamorphosis based on Stadium

Cycle	Σ Nauplii	SR (%) larvae stadium				
		Naupli- Zoea	Zoea - Mysis	Mysis -PL ₁	PL ₁ -PL ₁₂	Nauplii - PL ₁₂
1	936.150	62.3	67.1	72.7	79.3	31.5
2	747.200	70.4	72.0	79.4	79.9	50.5
3	812.050	63.2	72.5	69.1	68.7	34.9
Mean		65.3	70.5	73.7	75.9	38.9

Parameter of water quality during the study. Water quality is one of the components that determine the larval life during breeding. Seawater used through a physical filtration process using charcoal is then put into a reservoir as a settling tank. After it was settled for 2 days, it was then sterilized using chlorine. 2-3 days later, the water can be distributed to the breeding tank through waterco (physical filter). Waterco is equipment commonly used in filtration installation in shrimp hatchery unit, made of fiber and contain silica sand. The measurement and observation of water quality were conducted continuously. During the study, the quality of media water measured was temperature, salinity, dissolved oxygen (DO), ammonia and pH. Water quality measurement was performed 2 times a day

continuously, at 8.00 – 9.00 WIB and afternoon at 17.00 – 18.00 WIB. The larvae breeding water quality is presented in Table 2.

Table 2 – Water Quality Parameters during Larval Breeding

No	Parameter	Larvae breeding cycle			Unit
		1	2	3	
1	Temperature	28-30	29-31	28-30	Degrees Celcius
2	Salinity	28-32	30-34	27-32	ppt
3	DO	5-6.5	5.0-6.5	5.5-6.7	ppm
4	pH	7.3-8.5	7.5-8.5	7.5-8.5	-
5	Ammonia	0.08-0.40	0.09-0.82	0.09-0.57	ppm

The table above shows the range of water quality parameters as a result of measurement in the breeding tank during the study were: temperature of 28-31 °C, salinity of 27-32 ppt, dissolved oxygen of 5.0-6.7 ppm, pH of 7.3-8.5 and ammonia of 0.08-0.82 ppm.

According to Kokarkin *et al.* (1986), the optimal water quality in shrimp larvae breeding is a temperature ranging from 28-29 °C, salinity of 28-32 ppt, pH of 7.8-8.3 and dissolved oxygen of 4.5-7.0 ppm. Dissolved oxygen of 5.5-6.5 ppm and salinity of 25-35 ppt is a good quality for shrimp breeding in the hatchery (Chamberlain 1982). Referring to the above literature, the water quality in the breeding tank for 3 cycles shows that it was relatively ideal for the breeding of pisang shrimp larvae.

Reproduction performance based on Morphometric Relationship pattern between weight and fecundity. In general, the maturity of shrimp reproduction is strongly influenced by morphometric factors, one of which is the weight of each individual shrimp broodstock, which is characterized by the level of reproductive maturity has developed so that the morphometric data for weight size can be used to show the value of the resulting fecundity. Rianni (2000) suggests that morphometrically shrimp broodstock have a positive relationship between body weight and fecundity they produced. This means that the heavier the weight of female shrimp broodstock, the higher the fecundity they produced. The fecundity value based on weight and length is called relative fecundity, while the fecundity based on the number of eggs from each individual is called absolute fecundity.

Figure 1 – Relationship between weight and fecundity

The results of the study showed that the relationship between weight and fecundity is very closely determined. The determination coefficient value, which is represented by R^2 is 0.96. This means that the broodstock weight can explain the diversity in the number of eggs (fecundity) of 96%. This is in accordance with the study results by Rianni (2000) which suggests that the female broodstock weight and the resulting fecundity show that heavier weight will increase the fecundity. Figure 1 shows that female broodstock began to gonad

mature at 50.5 weight with 73500 eggs or 1.455 eggs per gram body weight. The number of eggs per unit of weight continues to increase as the weight increases to 3490 eggs/gram at 123 gram weight of broodstock. This means that with 2.5 times of weight change will increase the eggs production to almost 2.5 times. This change is more significant than the change in the total length and carapace length value to the fecundity of pisang shrimp broodstock.

For efficiency in pisang shrimp hatchery, the data of the relationship between weight-fecundity recommends using female broodstock weighing over 50 grams. In tiger shrimp, the ideal weight for a spawning process to obtain healthy seeds is >217 grams/shrimp (Naca, 2005). Meanwhile, Rianni (2000) suggests that tiger shrimp broodstock from Aceh morphometrically weigh 157 grams/shrimp is capable of producing 565.916 eggs (fecundity). The study results in pisang shrimp broodstock weighing between 85.5 to 123.5 grams/shrimp showed very good reproductive performance with very high fecundity achievements, this size was thought to be the productive period for pisang shrimp broodstock from nature. Broodstock weight of 85.5 grams was able to produce 269,500 eggs or with a fecundity ratio or relative fecundity of 3,152 eggs. Whereas the broodstock weight of 123.5 grams produced 431.139 eggs with a fecundity ratio of 3,491 eggs. The reproductive performance of naturally mature gonad of pisang shrimp began to show the absolute amount of fecundity increased at a weight of 85.5 grams. Therefore, that weight range is thought to have entered a good reproductive period for pisang shrimp broodstock.

Relationship pattern of total length and fecundity. Correlation value or determination coefficient between total length and fecundity denoted by R^2 is 0.844, meaning that the total length of broodstock, the 84% of the fecundity diversity can be explained by total length variable (cm). However, this value is lower than the correlation between weight and carapace length to fecundity. At 16 cm, female broodstock produced 91.352 eggs or 5.700 eggs per total length. This value rises to almost 3 times of the total length 26.7 cm (431.138 eggs or 16.147 per unit total length). This means that with 1.5 times length change will increase the number of eggs up to 3 times.

Figure 2 – Relationship between total length and fecundity

From the relationship pattern between total length and fecundity, it can be concluded that broodstocks with a total length of at least 16 cm can be used for seedlings. Longer the female broodstock will produce more eggs per additional length unit.

Relationship pattern between carapace lengths with fecundity. The morphometric parts of shrimp that can be used as a standard in estimating the amount of fecundity produced by each broodstock are the carapace length. In this case, the size of the prospective spawning shrimp broodstock for female shrimp broodstock is the one with carapace length between 52-

56 mm (Nurjanna M.L, 1986). Based on data analysis (Graph 3), a positive correlation between carapace and fecundity length is 0.895, meaning that 90% of the diversity in fecundity can be explained by the carapace length variable. This value is better than the correlation between total length and fecundity but still below the correlation value between broodstock weight and fecundity. The female broodstock with 7.5 cm carapace length produced 73,500 eggs or 9,800 eggs per cm long carapace. While the female broodstock with 12 cm carapace length produced 431,138 eggs or 35,928 eggs per cm long carapace. This shows that a 1.6 times change in carapace length will increase the number of eggs by 3.7 fold.

Figure 3 – Relationship between carapace length and fecundity

Carapace length changes clearly show changes in fecundity compared to total length. However, because the length change of the carapace is less noticeable than the change in length, it is better to measure the carapace length with a more precise unit of mm rather than cm. The female broodstock with 7.5 cm carapace length is feasible as broodstock ready for the spawning. However, in terms of fecundity, it is not optimum yet, meaning that it is not in the productive size category.

CONCLUSION

The morphometric criteria for pisang shrimp provide different explanation and result between carapace length, total length and weight to the number of fecundities. The total length size to fecundity is no better than the carapace length to the amount of fecundity, while weight has a strong effect compared to carapace length and total length to the amount of fecundity in pisang shrimp broodstock which eggs mature naturally. Based on the regression test results, the correlation value between total length and fecundity, which is denoted with R^2 is 0,844. This means that 84% of fecundity diversity can be explained by total length variable (cm). Meanwhile, the correlation value or determination coefficient between carapace length and fecundity, which is denoted with R^2 is 0.895. This can be explained by carapace length variable (cm) that almost 90%, of diversity in fecundity, can be explained by carapace length variable. Meanwhile, the relationship between weight and fecundity is closely determined by the determination coefficient value denoted with R^2 of 0.961. This means that the broodstock weight can explain the diversity in eggs amount (fecundity) of 96%. The absolute and relatively lowest fecundity in broodstock weighing 50.5 grams with the fecundity of 73.500 eggs and the highest is in broodstock weighing 123.5 grams with the fecundity of 431.139 eggs. In addition to morphometric criteria, another

influence that can be used as a reference in estimating the value of fecundity is environment condition and several other factors.

ACKNOWLEDGEMENTS

This research is funded by the *Pusat Pendidikan dan Pelatihan Kelautan Perikanan Kementerian Kelautan Perikanan* through the program of *Tugas Belajar (Tubel)* in the Universitas Diponegoro, Indonesia. Thank you for Pusdik KKP as the manager of learning tasks, the lecturers in the postgraduate program of Master in Coastal Resources at the University of Diponegoro and the Head of Brachiswater Development Center Ujung Batee in Aceh who have given the opportunity for the learning tasks.

REFERENCES

1. Balai Perikanan Budidaya Air Payau Ujung Batee. 2014. Petunjuk Teknis Pembenihan Udang Pisang.
2. Chamberlain G.W. 1982. Biology and controll of shrimp reproduction. Texas Shrimp Farming Manual. By G.W. Agricultural Extension Service. Texas. 50 p.
3. NACA. 2005. Better Management Practices (BMPs) Manual for Black Tiger Shrimp (*Penaeus monodon*) Hatcheries in Vietnam. Research Report.
4. Novita. D., Ferasyi T.R., Muchlisin Z.A. (2016). Intensitas dan Prevalensi Ektoparasit pada Udang Pisang (*Penaeus spp*) yang Berasal dari Tambak Budidaya di Pantai Barat Aceh. Jurnal Ilmiah Mahasiswa Kelautan dan Perikanan Unsyiah, 1(3), 268-279.
5. Nurdjana M.L. 1986. Pengaruh Ablasi Mata Unilateral terhadap Perkembangan Telur dan Embryo serta Kualitas Larva Udang Windu (*Penaeus monodon* Fab). Unpublished Dissertation. Graduate Progam, Universitas Gajah Mada.
6. Parenrengi, A., Sulaeman, H.W., Tenriulo, A. 2007. Keragaman Morfologi Udang Fama (*Penaeus semisulcatus*) dari Perairan Sulawesi Selatan dan Sulawesi Tenggara. Jurnal Riset Akuakultur, 2(1), 27 -32
7. Primavera J.H. 1983. Review of maturation and reproduction in closed thelycumpenaeids. Proceeding of the First International Conference on the Culture of Penaeid Prawn/Shrimps. Aquaculture Department SoutheastASEAN Fisheries Development Centre. Iloilo. Philippines, 47-64.
8. Riani E. 2000. Kemungkinan penggunaan induk udang windu (*Penaeus monodon* Fab.) Binuangen sebagai pengganti induk Aceh yang sudah mengalami gejala tangkap lebih. Media Konservasi, 7(1), 29 – 36.