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INDONESIAN FISHERIES RESEARCH JOURNAL
Volume 25 Nomor 1 June 2019
p-ISSN: 0853-8980
e-ISSN: 2502-6569
Accreditation Number RISTEKDIKTI: 21/E/KPT/2018

POPULATION PARAMETERS OF ENDEAVOUR SHRIMP (*Metapenaeus ensis* de Haan) IN BINUANGEUN AND ADJACENT WATERS, WEST JAVA

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Received; January 02-2019 Received in revised from February 26-2019; Accepted February 28-2019

ABSTRACT

Study on the population dynamic of endeavour shrimp (*Metapenaus ensis*) was conducted in Binuangeun waters based on data collected during period of survey, January to November 2016. The purpose of the study was to identify population parameters of the endeavour shrimp. Result showed that the endeavor shrimp growth pattern in Binuangeun waters was negative allometric and sex ratio of males and females was 1.0 : 2.7. The chi square test indicated that comparison of male and female of the endeavour shrimp was significantly different. It mean that there was imbalance in number between males and females. The length at first capture (L_c) of endeavour shrimp was 28.9 mm (carapace length), smaller than the length at first maturity (L_m) at 37.7 mm (carapace length). The growth parameter of endeavour shrimp was 1.33/year with maximum carapace length (Loo) of 51.45 mm. Instantenous total mortality (Z) and natural mortality (M) were 7.74/year and 1.88/year, respectively. While fishing mortality (F) and exploitation rate (E) respectively were 5.86/year and 0.76/year. The exploitation rate of endeavour shrimp in Binuangeun and adjacent waters was high. It was, therefore, recommended that fishing effort of the endeavour shrimp in that waters should be reduced about 52 % in the next year.

Keywords: Population dynamic; endeavour shrimp; Binuangeun waters; FMA 573

INTRODUCTION

Endeavour shrimp (*Metapenaeus ensis*) is one of penaeid shrimp species which is dominantly caught in south coast waters of Java include in Binuangeun and adjacent waters. Catch of endeavour shrimp was the second highest after others shrimp (*Parapenaeopsis* spp.) (Suman, 2004; RIMF, 2016).

Exploitation of the endeavour shrimp in Binuangeun and adjacent waters has taken place since long time ago (Van Zalinge & Naamin, 1975) and become more intensive in the recent years due to an increase of local and or foreign market demand (RIMF, 2016). If this situation continues to occur, sustainability of the shrimp stock will be disturbed in the future. Therefore comprehensive research is needed to reach rational utilization in order to maintain sustainability of the stock for prosperity purpose in the future (Naamin *et al*., 1992; Suman *et al*., 2014).

This paper discussed population parameters of the endeavour shrimp (*M. ensis*) in Binuangeun and adjacent waters. It is hoped that the result can be used as basic and important information for sustainable management of the endeavour shrimp and other endeavor studies in Binuangeun and adjacent waters.

MATERIALS AND METHODS

Samples of the endeavour shrimp were taken from field research in Binuamgeun and adjacent waters (Figure 1) from January 2016 to November 2016. Biometric studies (carapace length, sex and gonad maturity identifications) were done for 1,548 samples. The relationship between the endeavour carapace length and weight follows the cubic law (Bal & Rao,1984; King, 1995): $W = aL^b$, with W as the weight (gram); L as the carapace length (mm) and a, b as constants. The sex ratio was calculated by comparing the number of male and female and analyzed to know whether the sex ratio is balance or not by using the Chi-square test (Walpole, 1993).

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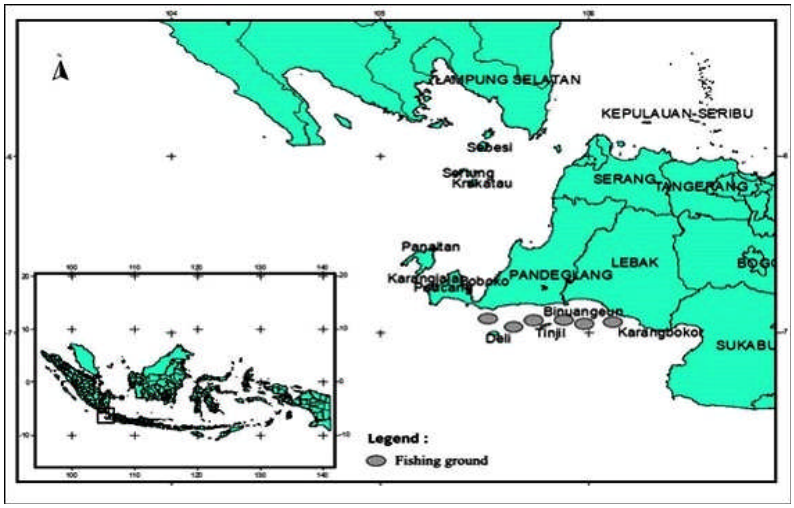

Figure 1. The fishing ground of endeavour shrimp (*M. ensis*) in the Binuangeun and adjacent waters.

The calculation of the length at first capture (Lc) was done using the equation as follows (Sparre & Venema, 1992) :

$$S_L = \frac{1}{1+\exp(S1 - S2xC)}; Ln\left[\left(\frac{1}{S_L}\right)-1\right] = S1 - S2xL \quad ....(1)$$

where SL is the logistic curve and S1 and S2 are constants in the logistic curve equation.

Spearman-Karber method (Udupa, 1986) was applied to identify the size at first maturity with assumption that average size of first maturity occurs when 50 % of the endeavour shrimp is already mature. Logarithmic size of the first sex mature (m) was calculated based on equation below:

$$m = x.k + \frac{X}{2} - \left(x\sum pi\right) \quad .....(2)$$

where:
m : logarithmic size of first sex mature,
xk : logarithmic size of mean value of 100 % mature,
X : logarithmic different of mean value, and
pi : comparison of sex maturity of each length class

In this classification, gonad maturity stage (GMS) I and II are classified as immature while GMS III, IV and V are mature. The GMS was morphologically identified based on sex maturity stage of the shrimp (Tuma, 1967 *vide* Naamin, 1984) namely: I = quiescent/undeveloped, II = developing, III = early maturity, IV = ripe, and V = spent. Growth rate (K) and maximum carapace length (Loo) were analysed by tracing modus of monthly carapace length distribution using ELEFAN program (Sparre & Venema, 1992; Gayanilo *et al*., 2005). Total mortality (Z) was calculated from catch curve (Sparre & Venema, 1992; Gayanilo *et al*., 2005) and natural mortality (M) was predicted using combination of Pauly empiric equation (Pauly,1985) and fishing mortality rate (F) = Z – M, while exploitation rate (E) = F/Z (Sparre & Venema, 1992).

RESULT AND DISCUSSION

Result

The Relationship Between Length-Weight and Sex Ratio

The growth pattern of male and female of endeavour shrimp was allometric negative (Figure 2), indicating the carapace length increase in endeavour shrimp was faster than the body weight gain.

Chi-square test informed that value of male and female was imbalance, it was also identified that sex ratio of the endeavour shrimp in Binuangeun and adjacent waters was found to be 1.0 : 2.7.

The Length at First Capture (Lc) and the Length At First Maturity (Lm)

From the analysis using a logistic curve of endeavour shrimp, it shows that the Lc was found at a carapace length (CL) of 28.9 mm (Figure 3).

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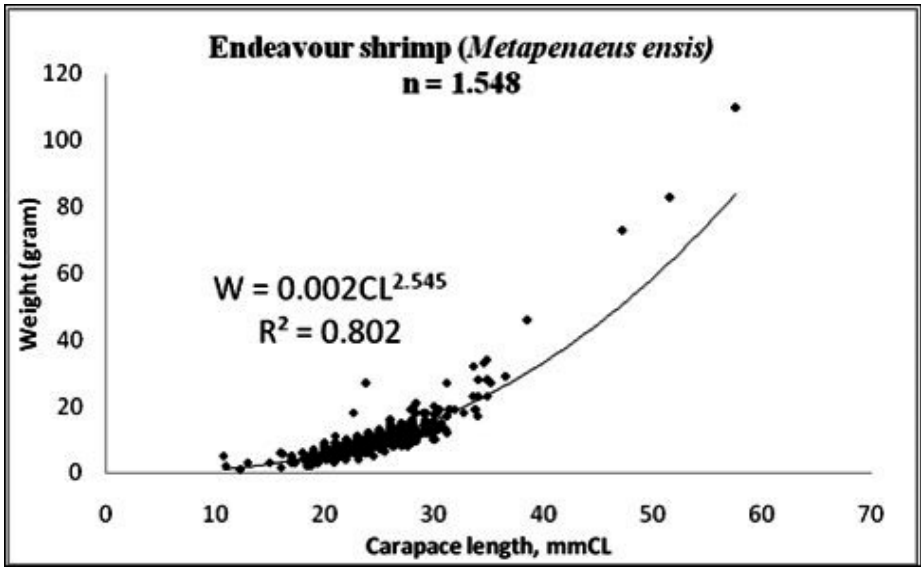

Figure 2. The relationship between length-weight of endeavour shrimp (*M. ensis*) in Binuangeun and adjacent waters.

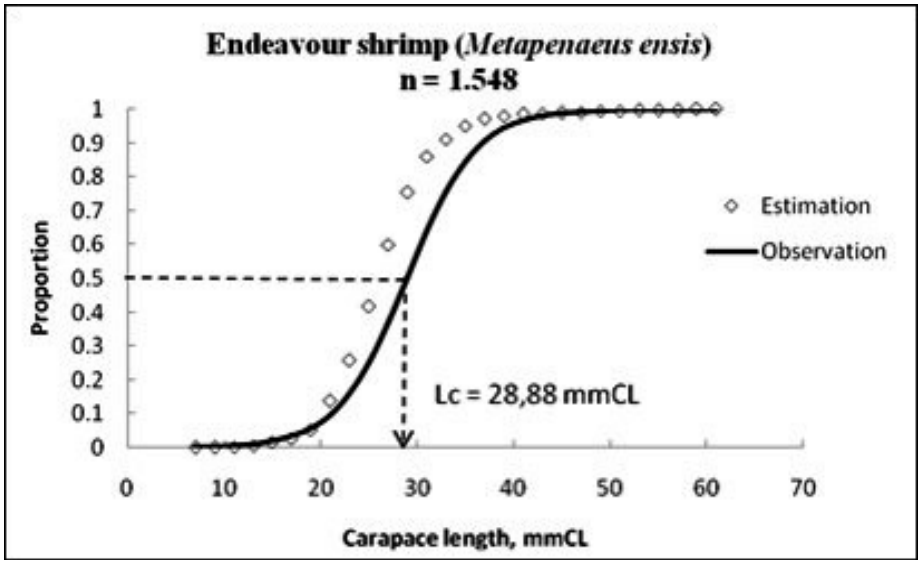

Figure 3. Length at first capture of endeavour shrimp (*M. ensis*) in Binuangeun and adjacent waters.

Meanwhile, the endeavour shrimp analyzed using a Spearman-Karber method reaching at the length at first maturity (Lm) was in average at 37.7 mm (carapace length).

Growth Parameter

Basically, ELEFAN program is applied to interpret carapace length in time series data adjusted with von Bertalanffy growth curve. Value of growth rate (K) and maximum carapace length (Loo) of endeavor shrimp was recorded by identifying monthly carapace length frequency (Figure 4) namely 1.33/year and 51.45 mm.

Mortality Rate and Exploitation Rate

Value of total mortality (Z) represented by value of slope (b) between Ln N/t and relative age (Figure 5) was 7.74/year. Meanwhile value of natural mortality (M) and fishing mortality (F) were 1.88/year and 5.86/ year, respectively.

Using exploitation rate equation (E) = F/Z, it was obtained that E of endeavour shrimp in Binuangeun and adjacent waters was 0.76/year.

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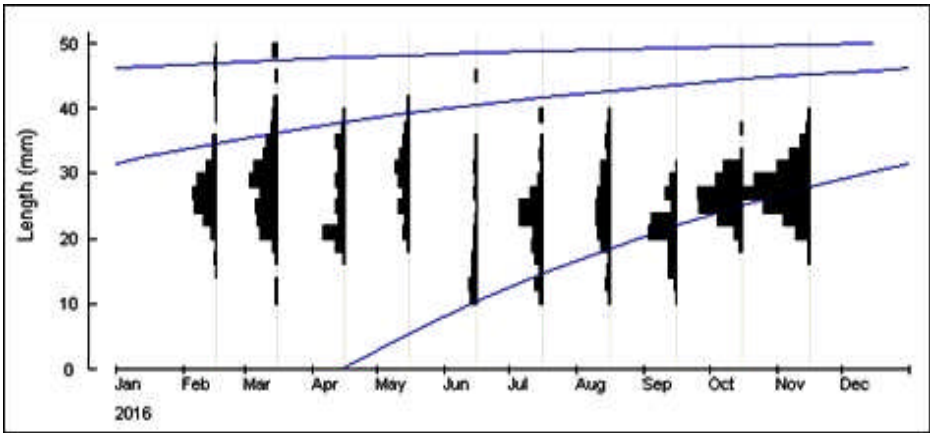

Figure 4. Carapace length distribution of endeavour shrimp (*M. ensis*) in Binuangeun and adjacent waters.

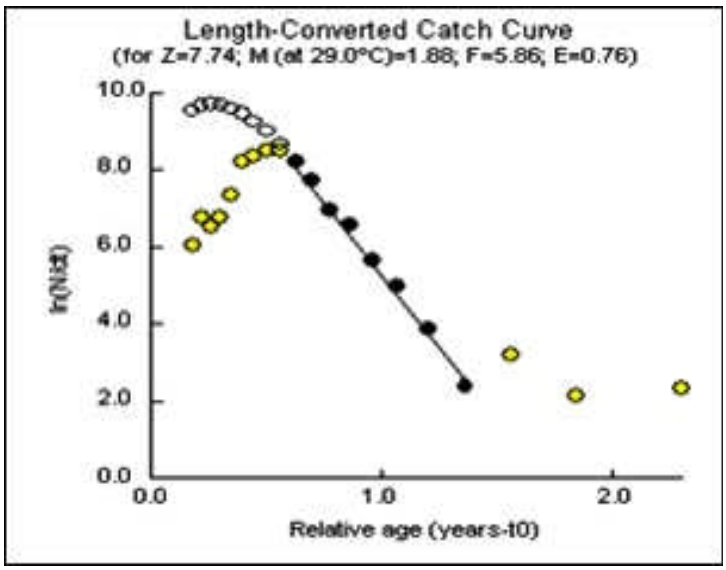

Figure 5. The value of total mortality (Z) of endeavour shrimp (*M. ensis*) in Binuangeun and adjacent waters.

Discussion

The analysis of the relationship between carapace length and weight was used to discover the growth pattern of endeavor shrimp in Binuangeun and adjacent waters. The result of the t-test showed that the endeavour shrimp growth pattern was negative allometric. This growth pattern suggested that the increase in carapace length was faster than the weight gain. This same from the results obtained by Herdianto & Riswanto. (2014) who found that the growth pattern of endeavour shrimp in the waters of Kubu Raya was negative allometric. This growth pattern depends on the availability of food and the water temperature (Monterio, 2002 *in* Fauzi *et al.*, 2013). Differences in length increase could also be caused by differences in external and internal factors. According to Effendie (2002), internal factors are factors that are difficult to control such as genetics, sex, age, and diseases. On the other hand, the main external factors that influence fish growth are temperature and food.

Data on sex ratio of shrimp stock are important and as basic information for reproduction biology of the stock (Suhendrata & Merta, 1986).Sex ratio of male and females endeavour shrimp was imbalance (1.0 : 2.7) ($p<0.05$). The dominant of female indicates that the recovery of population in these waters will not disturb (Naamin, 1984). This finding is similar to that reported from Kebumen waters (Suparjo, 2005). These data were quite different with data reported by previous researchers. Suman *et al*. (1987) reported that sex ratio of male and female endeavour shrimp in Pangandaran waters was 1.0 : 1.2 while in Kotabaru waters (South Kalimantan), the sex ratio of shrimp was 1.0 : 2.5 (Suman, 1991). This phenomenon possible occurred due to the different analysis of male and female sex ratios done prior to and during spawning season (Nikolsky, 1963).

Shrimp age and the length at first maturity is important for management purpose because exploitation has to let some stocks which have the

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same or bigger size when they reach maturity still life (Sudjastani, 1974). The length at first maturity (Lm) of the endeavour shrimp in Binuangeun waters was 37.7 mm in carapace length. The Lm value found in this study is slightly higher than those reported for endeavour shrimp of Tanjung Krawang was 20 mm (Martosubroto, 1978), South Coast of Java waters was 36,8 mm (Suman, 1990) and Cilacap waters was 31,80 mm (Suman & Boer, 2005). Nikolsky, (1963) stated that Lm value is influenced by some factors, such as: depth and type of habitat in association with food availability, temperature, and light. According to Sivakami *et al*. (2001), the difference in Lm value for each fish is caused by the difference size of samples collected, the maximum and minimum length, and frequency of fish that are gonad-mature. So allegedly that the availability of food and environment condition in Binuangeun waters are better than the some waters.

Further analysis showed that the length at first capture (Lc) of endeavour shrimp in the Binuangeun waters was smaller than the length at first maturity (Lm). This condition is unexpectable in term of fisheries management. It was recommended that Lm value was larger than Lc value. If this condition is left for long period, the stock of endeavour shrimp in Binuangeun waters would continue to decrease until a level in which the endeavour shrimp stock will be disrupted and finally no more endeavour shrimp stock available in the waters enough as a fishery resource. In contrast, if Lc is higher than Lm, it means that the individuals of shrimp have changes to spawn to maintain its population. In order to ensure the sustainability of the resources, the fishing pattern should allow a number of shrimps brood stock to escape (Sudjastani, 1974). To prevent stock degradation in the Binuangeun waters, a regulation for net mesh size is needed in catching of endeavour shrimp.

According to Sparre & Venema (1992), the lower growth coefficient (K) needed the longer time for the species to reach asymptotic length. On the other hand, the higher growth coefficient needed the shorter time by the species to approach the asymptotic length. The growth rate (K) of endeavour shrimp in the Binuangeun waters was 1.33 per year and this showed that the growth rate was considered fast (Sparre & Venema, 1992). Therefore care must be taken when planning the amount of effort allowed to be applied each year for exploiting the shrimp stock in order to obtain rational management of the stock. If value of recommended effort was lower, uncapture shrimp stock would be useless or number of natural mortality would be high because the growth type of the stock was fast growth. It mean that the stock had short life span. In contrast , if value of recommended effort was higher, the stock would be disturbed, even jeopardized because there was no enough time for population members renew the stock which led the decrease of recruitment number and amount of next year stock. This phenomenon differed from the results of other studies in various waters (Table 1).

Table 1. The growth rate (K) and maximum carapace length (Loo) of endeavour shrimp (*M. ensis*) in some waters area

Waters	K (per year) Loo (mm)	Source
Binuangeun	1.33 51.45	this research
South Coast of Java	1.61-1.63 52.2	Suman (1992)
Cilacap	1.49-1.52 41.5-52.2	Suman & Boer (2005)
Balikpapan	1.60 42.0	Suman & Bintoro (2009)
Arafura Sea	1.33 52.0	Suman *et al*. (2017)
Bangka Strait	1.40-1.45 45.0-49.5	Lestari *et al.* (2018)

Differences in the growth parameter could be caused by differences in the maximum length of the samples collected and differences in the location of the waters (Widodo & Suadi, 2006). Knaepkens *et al*. (2002) and Effendie (2002) stated that differences in the values of K and Loo are caused by internal/ intrinsic and external factors. Internal factors that influential are genetics, parasite infestations, and diseases, while the external factors are temperature and availability of food.

The total mortality rate (Z) is a combination between the natural mortality rate (M) and the fishing mortality rate (F) (Sparre & Venema, 1992). Instantenous total mortality rate (Z), natural mortality rate (M) and fishing mortality rate (F) were 7.74/year, 1.88/year and 5.86/ year, respectively. This phenomenon differed from the results of other studies in various waters (Table 2).

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Table 2. The total mortality (Z), natural mortality rate (M) and fishing mortality rate (F) of endeavour shrimp (*M. ensis*) in some waters area

Waters	Z M F	Sumber (Source)
Binuangeun	7.74 1.88 5.86	this research
South Coast of Java	6.9-7.1 2.2-2.1 4.7-5.0	Suman, (1992)
Cilacap	6.5-8.7 2.0-2.1 4.5-6.6	Suman & Boer (2005)
Balikpapan	4.52 2.18 2.34	Suman & Bintoro (2009)
Arafura Sea	4.79 1.88 2.91	Suman *et al*. (2017)
Bangka Strait	4.0-4.6 2.0 2.0-4.6	Lestari *et al.* (2018)

It was presented that differences in value of shrimp mortality rates in several waters (Table 1) were caused by different level of effort number, predator and environment condition (Pauly *et al*., 1984). The M value of endeavour shrimp in several waters appeared to be smaller than the F value, and this suggests that most of the endeavour shrimp in the Binuangeun waters died due to capture.

Using exploitation rate equation (E) = F/Z, it was obtained that E of endeavour shrimp in the Binuangeun waters was 0.76/year. Based on Pauly criterion (Pauly *et al*., 1984), it was concluded that over fishing of the shrimp stock has occurred in the Binuangeun waters because rational fishing of fish or shrimp stock can be gained if values of E in that waters equals 0.5. If value of E is more than 0.5, the stock will be endangered thus effort has to be decreased in order to sustain the stock. Phenomenon of the endeavour shrimp stock in the Binuangeun waters suggested that fishing effort of the endeavour shrimp stock should be lowered until 52 % of the present status.

CONCLUSION

The growth pattern of endeavour shrimp (*M. ensis*) in Binuangeun and adjacent waters was negative allometric and this suggested that the body width growth was faster than that of the weight gain. The length at first capture (Lc) which is smaller than the length at first maturity (Lm) may disturb endeavour shrimp resource sustainability. The growth rate and the mortality rate of endeavour shrimp (*M. ensis*) were classified as high. The exploitation rate of endeavour shrimp resources in Binuangeun waters was already classified as overfishing category. To ensure the waters sustainability, regulated on the net mesh size and a reduction of approximately 52 % of the current fishing effort is advisable. For determining of the net mesh size, it is still needed further research in these waters. In addition, an assessment of the socio-economic aspect may result to a more accurate stock status of endeavour shrimp in Binuangeun and adjacent waters.

ACKNOWLEDGEMENT

This research was based on the data collected during Stock Assessment of Fisheries Resources in Indian Ocean (Fisheries Management Area 573) in 2016 which was supported by Research Institute for Marine Fisheries (RIMF) and funded by government. The authors should thank to researcher group of shrimp in RIMF for their support and in valuable idea for this paper.

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