

# The growth model composition of giant prawns (*Macrobrachium rosenbergii*) In Muara Tepian Sembakung, Nunukan

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## The growth model composition of giant prawns (*Macrobrachium rosenbergii*) In Muara Tepian Sembakung, Nunukan

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**Abstract.** Giant prawns (*Macrobrachium rosenbergii*) has high economic value with a price range between IDR. 40,000 to IDR. 75,000 that it was one of the main catches of fishing gear used by the society in Muara Tepian Sembakung. This research aims to analyze the growth model composition of giant prawns (*M. rosenbergii*) in Muara Tepian Sembakung, Nunukan. The objective was conducted for 5 months from October 2019 to February 2020. The research was designed by using quantitative descriptive with a case study approach. The determination of the study location was applied with a purposive random sampling method by following the fishermen who used the bottom fish pots catch. The sampling of giant prawns at Muara Tepian Sembakung was done by taking a survey method adhered to a fisherman with repetition as 10 times of sampling at a different time. The data of Giant prawns that were collected involved sex, total weight, and total length using a laboratory-scale method in the Laboratory of fisheries biology, Fisheries and marine science faculty, Universitas Borneo Tarakan. The research variable was the von Bertalanffy model and age structure of male and female giant prawns. The results obtained that the sex ratio of giant prawns (*Macrobrachium rosenbergii*) between males and females was 1: 1.83 with a percentage of a male was 35.33% and female was 78.6%. The growth of Von Bertalanffy model in getting the infinitive growth for male giant prawns was 24.185 cm at 132 days then T<sub>0</sub> was -1.1088 and growth rate was 0.0877 cm/day with correlation value was 0.88431 (88.431% = very strong correlation) and female giant prawns amounted to 18.470 cm at 101 days while T<sub>0</sub> was -1.0734 days and the growth



rate was 0.1019 cm/day with a correlation value was 0.90626 (90.626% = very strong correlation).

## 1. Introduction

Indonesia is the largest archipelago country in the world [1] cause its location in the equatorial region with tropical / seawater with a diversity of marine biological resources [2]. There are two levels of marine water resources, they are deep sea and shallow sea waters, where shallow marine waters have abundant biological resources for pelagic and benthic biota which are used as a habitat looking for food or dodge from predators. One of the habitats that has a large number of biological resources is in the Estuary area of Muara Tepian Sembakung, Nunukan Regency.

Habitat in Estuaria of Tepian Sembakung has a variety of biota; they are mangrove crabs (*Scylla serrata*), catfish (*Pangasius hypophthalmus*), chopsticks (*Toxotes jaculatrix*), cross-fish (*Plotosus canius*) and giant prawns. According to De Man (1879) [3], giant prawns in Indonesia are known as *Macrobrachium rosenbergii* species. According to Hadie & Hadie (2002) [4] explained that giant prawns (*M. rosenbergii*) are one of the crustacea species that has the largest size. Hadie & Supriatna (1988) [4] added that the special features of giant prawns are the long and curved shape of the shrimp-like as shrimp with 12 + 1 segment and 11 + 3 segment. In giant prawns (*M. rosenbergii*) the adult male sex has a pair of 2nd walks growing very long and large that can reach 1.5 times its body length.

Giant prawns (*M. rosenbergii*) is one of the biotas that have quite high economic value compared to other biotas because giant prawns (*M. rosenbergii*) have a price value that is quite variable based on the size in the Tepian Sembakung Village area. The society renders giant prawns (*M. rosenbergii*) as the main catch using bottom fish pots where the price for size 2 (medium shrimp) and size 3 (small shrimp) are IDR. 55,000 + 25,000 / kg, then size 1 (large shrimp) has a price of IDR. 92,500 + 7,500 / kg. According to Solo Pos (2013) in Pramana, Agustono, & Nurhajati, (2019) [5] giant prawns (*M. rosenbergii*) has a market price in Indonesia reached to IDR. 75,000 / kg and an export about IDR 90,000 / kg.

Giant prawns (*M. rosenbergii*) in Muara Tepian Sembakung have a salinity level around 6.5 + 0.5 ppt. This is consistent with the statement of Ipandri, Wardiyanto, & Tarsim (2016) [6] that giant prawns (*M. rosenbergii*) can live up to 15 ppt salinity and New (2002) [7] adds that giant prawns (*M. rosenbergii*) live up to 20 ppt. Waluyo, Mulyana, & Ali (2018) [8] explained that giant prawns (*M. rosenbergii*) have a living adaptation of the Euryhaline salinity range.

The great potential of giant prawns (*M. rosenbergii*) making these organisms as the main income for the fishing community to fulfill their daily needs, however, it has an impact to size degradation of the population. That's why this research is needed to analyze the composition of growth models using the Von Bertalanffy model. The benefits, according to Indarjo et al., (2020) [9] stated that it could be used as knowledge and insight information that is important to describe growth patterns of giant prawns in ecosystem habitats of Muara Tepian Sembakung.

The research objective was to analyze the composition of giant prawns (*M. rosenbergii*) growth model in Muara Tepian Sembakung.

## 2. Materials and methods

### 2.1. Time and place

Research on giant prawns (*M. rosenbergii*) was conducted for 5 months, from October 2019 to February 2020. The determination of the location was designed by using purposive random sampling in Muara Tepian Sembakung.

### 2.2. Research methods

The research method used a quantitative descriptive with a case study approach. The sampling used the experimental fishing method, which is repeated 10 times from the catches of bottom fish pots at different times by surveying in the field. The determination of sampling points using purposive

random sampling and data collection used laboratory-scale methods included total length, sex, and total weight of giant prawns (*M. rosenbergii*) at the Laboratory of Fisheries biology, Fisheries and Marine Sciences Faculty, University of Borneo Tarakan.

### 2.3. Research Parameters

The parameters are regarding the composition of the growth model based on three variables, i.e. von bertalanffy model, the age structure, and the sex ratio of giant prawns (*M. rosenbergii*).

### 2.4. Growth Parameters

2.4.1. *Variable of Von Bertalanffy Model.* The variables of the growth composition are von Bertalanffy model based on growth curves that can describe the range of giant prawns (*M. rosenbergii*) (1938); Sparre & Venema, (1998) using an approach based on Gulland and Holt Plot (1959) in Sparre, Siebrean, & Venema (1999); Salim & Firdaus, (2012); Firdaus, Salim, Mawardhy, & Abdiani (2013); (A. N. Salim, Sumardianto, & <sup>1</sup>malia, 2018); Salim & Kelen, (2018); Firdaus, Lelono, et al., (2018); Indarjo et al., (2020) [10–14] as follows :

$$L_t = L_{\infty}(1 - e^{-k(t-t_0)}) \quad (1)$$

Note :

- L<sub>t</sub> = Length of the giant prawns (*M. rosenbergii*) with age t (unit of time);
- L<sub>∞</sub> = Maximum length of the giant prawns (*M. rosenbergii*) theoretically (asymptotic length);
- K = Coefficient growth of the giant prawns (*M. rosenbergii*) (per unit of time);
- t<sub>0</sub> = Theoretical age of the giant prawns (*M. rosenbergii*) when the length is zero.

2.4.2. *Variable of Age Structure.* The growth composition model based on the <sup>1</sup> von Bertalanffy calculates to class ranges using an age structure that is still integrated with it (Sparre et al. 1999) as follows:

$$(\Delta L / \Delta t) = (L_2 - L_1) / (t_2 - t_1) \quad (2)$$

$$L_{(t)} = (L_2 + L_1) \quad (3)$$

- Note :
- $\Delta L / \Delta t$  = Relative growth;
  - $\Delta L$  = Length of the *M. rosenbergii* ;
  - $\Delta t$  = Difference of sampling time;
  - L<sub>(t)</sub> = Modus of average length

The regression equation used in the age structure variable was comparative approach between the average length (L (t)) mode and the relative growth ( $\Delta L / \Delta t$ ) value to obtain the following linear line equation:

$$Y = a + bx \quad (4)$$

- Note :
- a =  $((\sum y/n) - (b(\sum x/n)))$ ;
  - b =  $(n\sum(xy) - (\sum x)(\sum y)) / (n\sum x^2 - (\sum x)^2)$

**Table 1.** Correlation criteria by Sarwono (2006)

No	Correlation value	Correlation criteria
3	0	: No correlation
2	> 0 – 0,25	: Very weak correlation
3	> 0,25 – 0,5	: Sufficient correlation
4	> 0,5 – 0,75	: Strong correlation
5	> 0,75 – 0,99	: Very strong correlation
6	1	: Perfect correlation

The average value of modus length obtained from the regression equation method is used to calculate the asymptotic length ( $L_{\infty}$ ) =  $-a/b$ , then the growth coefficient is  $-b$ . Age theoretical of *M. rosenbergii* when the length is zero can be expected separately by empirical equation Pauly (1984); Pauly in Sparre and Venema, (1998) ; Sparre et al., (1999) ; Indarjo et al., (2020) ; Firdaus et al., (2020); [10,17,18,26,27]

$$\text{Log } (-t_0) = 0,3922 - 0,275(\text{Log } L_{\infty} - 1,038 (\text{Log } K)) \quad (5)$$

Note :  $L_{\infty}$  = asymptotic length of *M. rosenbergii* (cm);  
 $K$  = growth rate coefficient of *M. rosenbergii* ;  
 $t_0$  = Age theoretical of *M. rosenbergii* when the length is zero (year)

2.4.3. *Variable of Sex Ratio.* The composition of the growth model uses differences based on the sex ratio of giant prawns (*M. rosenbergii*). The method in determining sex ratio based on a laboratory scale with direct observation of giant prawn samples (*M. rosenbergii*) uses gender identification guidelines. Variable of sex ratio by comparing the amount of male and female giant prawns using the Chi-square test model [19].

Note:  $O_i$  = Frequency of male and female giant prawns (*M. rosenbergii*) observed  
 $e_i$  = Expectation frequency, the frequency of giant prawns (*M. rosenbergii*) plus females divided by two  
 $\chi^2$  = value for the random variable  $\chi^2$  whose distribution is, for example, approaching the distribution  $\chi^2$

### 3. Results and Discussion

#### 3.1. Growth Variable of Von Bertalanffy

The research of giant prawns (*M. rosenbergii*) was conducted in Muara Tepian Sembakung, it was obtained 53 males and 97 females giant prawns (*M. rosenbergii*) with a total was 150 of giant prawns (*M. rosenbergii*). The smallest size of male giant prawns length was 8 cm and the largest was 21.1 cm with the average length was  $14.55 \pm 6.55$  cm, while the smallest size of the female was 7.8 cm and the largest was 17 cm with an average range between  $12.4 \pm 4.6$  cm.

The research of giant prawns (*M. rosenbergii*) used many variables, one of them was sex ratio, where to get a comparison between male and female shrimp, using the chi-square test method [19] and the results showed that male and female sex ratio was 1: 1.83. This comparison explained that the population of giant prawns (*M. rosenbergii*) in nature from every 1 (one) male shrimp, there are 1.83 female giant prawns. It means that the number of the female sex was greater than male, this is based on the percentage for female sex was 64.67% and the male was 35.33% (Figure 1).

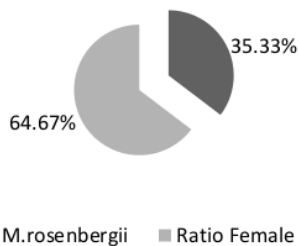


Figure 1. Sex ratio of *M. rosenbergii* in Muara Tepian Sembakung

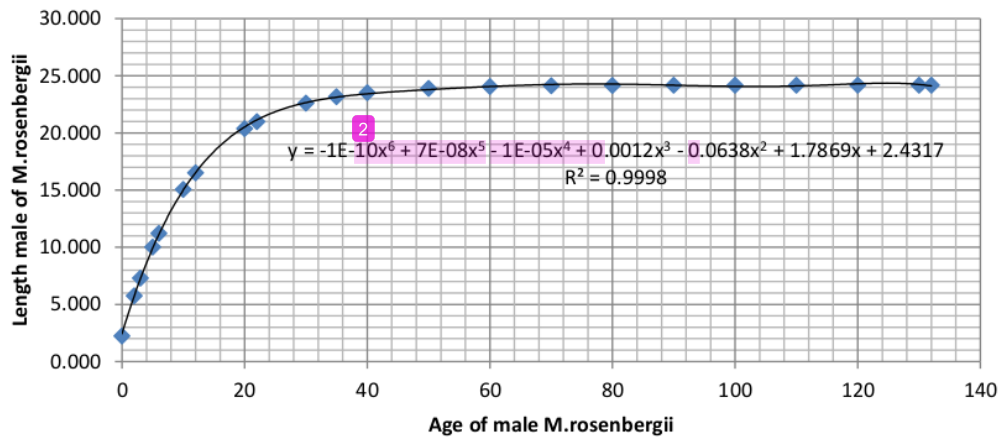


The results of the sex ratio explained that the amount of male shrimp was smaller than females, so this research was needed to do.

The results research based on the growth patterns using Von Bertalanffy model explains the growth patterns started from the zero days to maximum growth, so it was able to analyze the age of giant prawns in nature. The Von model according to [9] explained that this growth used to analyze the estimation of zero-days age by having a long growth at the beginning of its life cycle; analyzing fish age estimation with correlating it with the first gonad size measurement method [14]; analyzed the age estimation of fish by getting the maximum length size of fish/shrimp/bivalves.

The male giant prawns (*M.rosenbergii*) were tested with two different variables, namely the age variable and the variable of length, so it uses orthogonal polynomial equations to get the Von Bertalanffy model. According to Draper & Smith (1981) [20] that the use of orthogonal polynomial coefficient group methods is used to get the matrix transformation into a matrix with other orthogonal columns. The orthogonal polynomial methods are used to get the optimum point of treatment for maximum response. The optimization problem by applying the differential concept to the regression model obtained, so the orthogonal polynomial regression model must meet the requirements, it was:  $dy / dx = 0$  (necessary condition) and  $d^2y / dx^2 < 0$  (sufficient condition) [21].

The results of the Von Bertalanffy model using orthogonal polynomial equations of type 6, obtained value of the equation was  $y = -1E-10x^6 + 7E-08x^5 - 1E-05x^4 + 0.0012x^3 - 0.0638x^2 + 1.7869x + 2.4317$  where there are r square values of 0.9998 with a correlation value of 0.9999 (99.99%). It gets a correlation level of 0.9999 (99.99%) which, according to Sarwono (2006) [15], explained that the correlation value was 0.9999 (99.99%) derived from two age and length variables of male giant prawns. The results showed that they have a very strong correlation.

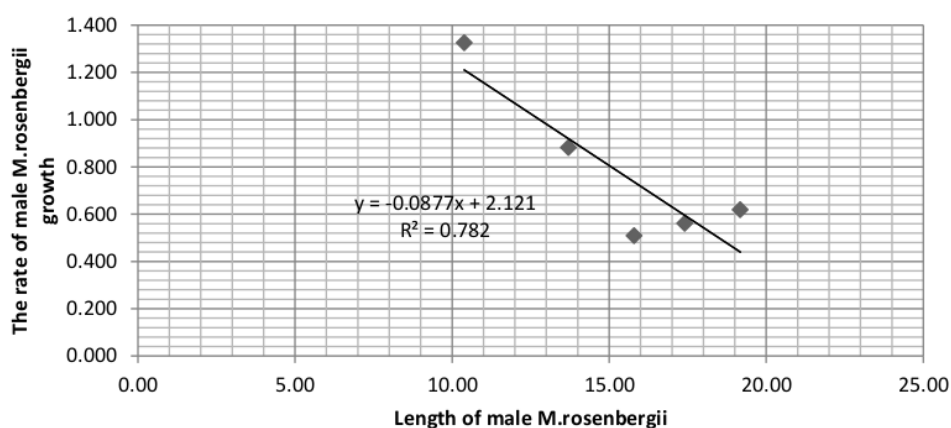


**Figure 2.** Von Bertalanffy polynomial orthogonal type 6 model of male *M.rosenbergii*

The results of research in processing data used the type 6 orthogonal polynomial equation of the von Bertalanffy model variable contained in Figure 2, get the maximum growth or optimal point on the x-axis of 132 days and the y-axis has a number in the amount of 24,185. It was explained that the x-axis is the age of giant prawns (*M.rosenbergii*) and the y-axis is the length of male giant prawns (*M.rosenbergii*) where the growth of giant prawns reaches the optimum or maximum point at 24,185 cm in length over 132 days. This is showed that giant prawns at the age of 132 days can not reach the highest point in length and only reach a maximum length growth of 24,185 cm and correspond to a very strong correlation between the two variables of age and length male giant prawns (*M.rosenbergii*).

In Figure 2 explained the lowest point obtained from the von Bertalanffy model were the x-axis (age) has a zero value or zero-day age and the y-axis (length) was 2,241. This showed that giant prawns (*M.rosenbergii*) length at zero days was 2,241 cm. This is in accordance with the opinion of Effendie (2002) [22] explained the growth of fish with zero-age already has a size of both length and weight.

The results of research from Von Bertalanffy's model can explain growth characteristics described by Effendie (2002) [22] regarding autocatalytic growth. This is evidenced in Figure 2 explains that the growth in the early life of male giant prawns during the initial 10 days had a long growth of male giant prawns around 15,056 cm, at 20 days the length was 20,387 cm and at 132 days of age, the length size was 24.185 cm. Autocatalytic growth, according to Effendie (1997) [23] stated that the velocity in the early life of giant prawns experiences to rapid display size, but it slows down in length until zero so that it has reached the maximum point.



**Figure 3.** Von Bertalanffy model to growth rate and length of male *M.rosenbergii*

The results research of age structure variable (figure 3) for the growth composition of male giant prawns (*M.rosenbergii*) uses a linear regression equation, which compares between two different variables, they are the length and the growth speed of male giant prawns. The age variable obtained by the linear regression equation,  $y = -0.0877x + 2.121$  with a  $r$  square value of 0.782 (78.2%) and a correlation value of 0.8843 (88.43%).

In Figure 3 showed the linear regression equation downward until it meets the x-axis (length variable of *M.rosenbergii* male) where on the y-axis has a zero value (speed growth variable), this showed that if the linear line meets the x-axis, then the velocity growth in male giant prawns has zero growth speed (no growth), so that the maximum length growth of male giant prawns (*M.rosenbergii*) was 24.185 cm. This was supported by the correlation value of the linear regression equation of 0.782 (78.2%). According to Sarwono (2006) [24] explained that if the correlation value was 0.782 (78.2%), it has a strong relationship between the length and speed growth variable of male giant prawns.

Based on Pauly (1984) [18], which uses a linear regression equation derived from age structure variables (figure 3) explained that the growth rate of male giant prawns (*M.rosenbergii*) derived from the -b value. The value of the average speed growth of male giant prawns obtained at 0.0877cm / day, but if the linear lines meet with the x-axis, then the average speed growth was zero.

Figure 4 is the percentage of male giant prawns (*M.rosenbergii*) length structure, where the results from 10 classes of the size structure was 53 male tails. The results in Figure 4 explained that the size distribution of male giant prawns varies according to the results of data processing. The longest structure size of male giant prawns found in Muara Tepian Sembakung was  $12.34 \pm 0.55$  cm,



with a percentage of 34% of the total shrimp sample from 53 individuals, while the fewest of male giant prawns length was  $9.21 \pm 0.4$  cm and  $20.12 \pm 0.98$  cm in 1.9% of 53 male giant prawns found.

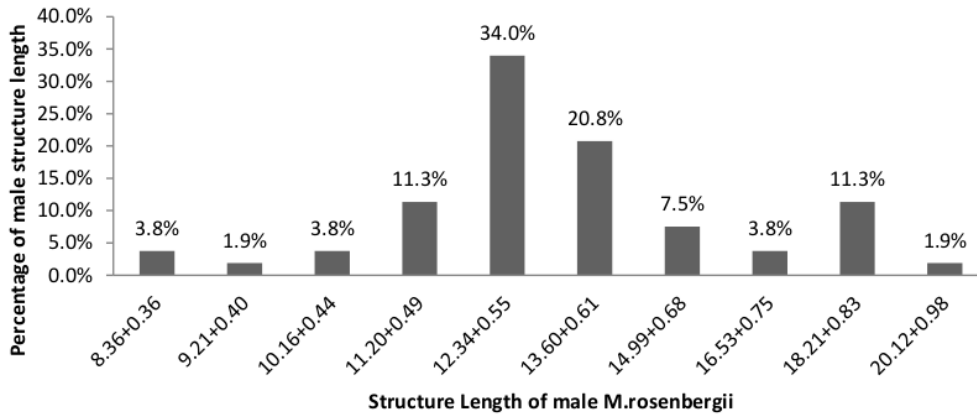


Figure 4. Percentage of male *M.rosenbergii* structure length

The structure length size of 10 classes in Figure 4 explained that each class found giant male giant prawns so it has a normal distribution, where the smallest size at  $8.36 \pm 0.36$  cm as much as 3.8% and the largest at  $20.12 \pm 0.98$  cm as much as 1.9% from 53 male giant prawns. The variations in the average size of male prawns (*M.rosenbergii*) are more complete with a range of  $14.55 \pm 6.55$  cm so that the population is quite abundant in nature.

The age structure of male giant prawns (*M.rosenbergii*) has a normal size distribution, that the size of giant prawns in Muara Tepian Sembakung has a variety of different size and all components of the shrimp length are available according to the number of shrimps which is in nature thus explains the balance of the giant prawns (*M.rosenbergii*) population in that area.

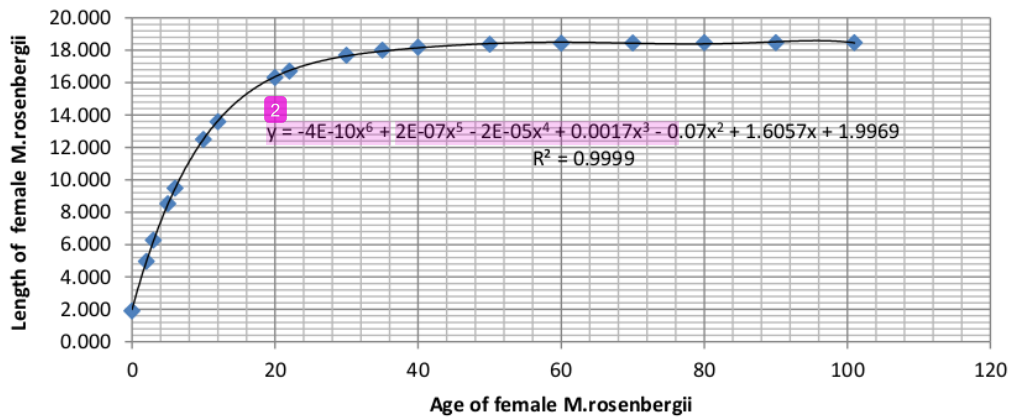


Figure 5. Von Bertalanffy polynomial orthogonal type 6 model of female *M.rosenbergii*

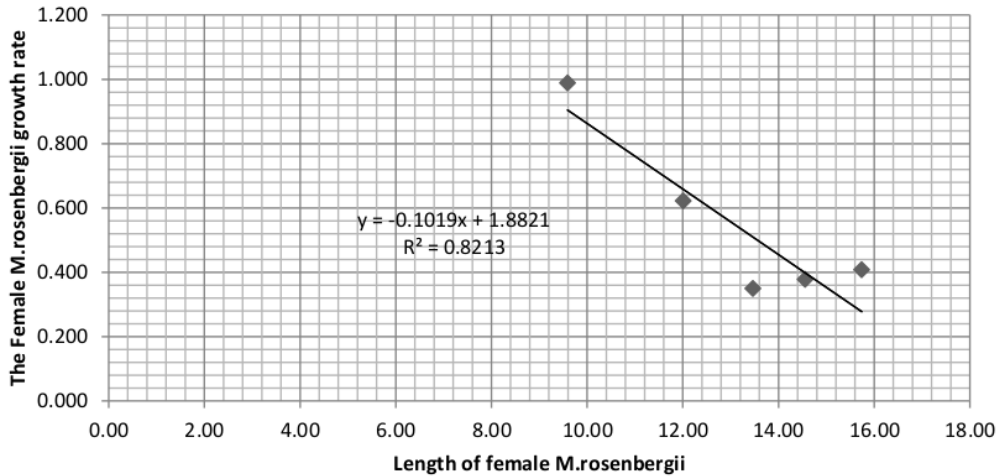
The research results conducted on female giant prawns (*M.rosenbergii*), which were tested using the Von Bertalanffy model with orthogonal polynomial equation type 6 (figure 5). This type are performed by comparing two different variables, they are the age and the length variable of giant

prawns (*M.rosenbergii*) thus that the equation is  $y = -4E-10x^6 + 2E-07x^5 - 2E-05x^4 + 0.0017x^3 - 0.07x^2 + 1.6057x + 1.9969$  with a r square value of 0.9999 and a correlation value of 0.9999 (99.99%). The correlation value was 0.9999 (99.99%), according to Sarwono (2006) that the correlation between age and length variables of giant prawns (*M.rosenbergii*) have a very strong relationship.

Figure 5 uses the polynomial orthogonal type 6 equation model because it searches for the optimal or maximum point on two different variables, so the optimal point on the x-axis is 101 days and the y-axis has a value of 18,470 cm. It explains that if the female giant prawns reach the optimal point on maximum length of 18,470 cm at around 101 days of age and correspond to a very strong correlation between length and age variables. In figure 5, the lowest point affected on the y-axis, where it explains that the variable on the x-axis has zero-day age with the variable on the y-axis was 1,914. This explains that at the lowest point (figure 5) in female giant prawns (*M.rosenbergii*) has zero days of age, where it has length size with a value of 18,470 cm. According to Effendie (1997) [23] explained that fish born at zero days had undergone a process of growth in the egg, so when they hatch at zero days the fish already have a size both length or heavy.

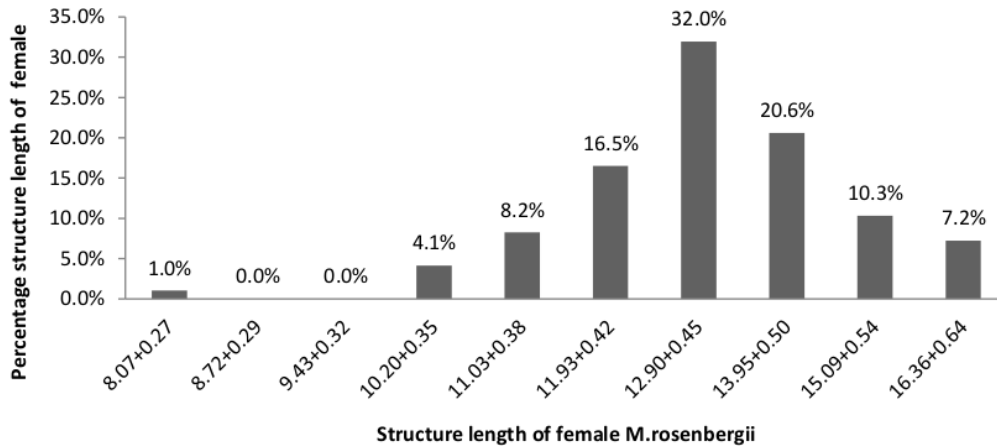
In figure 5, the polynomial orthogonal regression equation type 6 has an explanation that the growth of female giant prawns (*M.rosenbergii*) at 10 days has length growth fastly for 12,494 cm (figure 5) and at 20 days slower with a long growth about 16,313 cm (figure 5). This explains that for 10 days at the beginning of the length growth, the female giant prawns (*M.rosenbergii*) has fast growth rate than in the next 10 days the growth rate slows and the optimal point at 101 days (figure 5) which has a maximum growth rate. This is known as autocatalytic growth. According to Effendie (2002) [22] explains that autocatalytic is rapid growth in early life, then slow back to the optimal point till fixed or zero (no long growth). At the time of zero growth speed, the growth of male giant prawns is not in the direction of the length because it has reached the maximum length, but its growth towards maintenance or toward the bodyweight of male giant prawns. This is in accordance with the opinion of Lagler (1949) [25] explained that the growth of giant prawns (*M.rosenbergii*) if it has reached the optimal or maximum point, then the energy to growth is shifted towards weight or body maintenance.

Figure 6 explains the age structure variable by using a linear regression equation between two different variables are the length and the average growth of the female giant prawns (*M.rosenbergii*). The form of linear regression equation toward the x-axis (the length of the female *M.rosenbergii*) and the y-axis has zero zones, then the gathered between the x-axis and linear regression line is the maximum length of the giant prawns (*M.rosenbergii*) with the equation of  $y = -0.1019x + 1,882$  and r square value of 0.8213 (82.13%), then a correlation value of 0.9063 (90.63%). In Figure 6 explained that the maximum length growth could be known from the junction between the x-axis and linear regression lines; while the y-axis is obtained, the growth rate of female giant prawns is zero. The results in Figure 6 explain that the maximum length growth of female giant prawns is 18,470 cm with the growth rate was zero (no growth), a correlation value of 0.9063 (90.63%), and has an average length of growth of 0.1019 cm/day (figure 6).



**Figure 6.** Von Bertalanffy growth model and length of female *M. rosenbergii*

According to Pauly (1984) explained that linear regression equations for the species length growth in achieving maximum has zero growth velocity / has not experienced. Pauly (1984) explained that the average velocity of growth is derived from the linear regression equation of the value of b by adding the formula in front using minus. Sarwono (2006) stated that the correlation value of 0.9063 (figure 6) has an explanation that the relationship between two different variables, namely the length and the growth speed variable, has a very strong correlation.



**Figure 7.** Percentage structure length of female *M. rosenbergii*

The results research in processing data structure length size variables of the female giant prawns (*M. rosenbergii*) was 97, with the smallest size was 7.8 cm and the largest about 17 cm. The structure length size of female giant prawns get the highest percentage, or the amount of female giant prawns dominant found in Muara Tepian Sembakung with the size was 12.90±0.45 cm and the percentage of 32% from a total number of 97 females. The lowest of giant prawns found at 8.07±0.27 cm (figure 7), with a percentage of 1% from the total 97. However, there are two classes/lengths of giant prawns

(*M.rosenbergii*) that are not found in nature, they are the size of  $8.72 \pm 0.29$  cm and  $9.43 \pm 0.32$  cm (figure 7) with an average range of the two long classes was  $9.1 \pm 0.7$  cm.

**Table 2.** Composition of Giant prawns (*M.rosenbergii*) in Muara Tepian Sembakung

No	Crustacea Sex	Growth		Structure age			Structure size	Composition of size growth
		Von bertalanffy Poynomial orthogonal type 6	Lowest length (cm)	length Maximum (cm)	Average growth speed (cm/day)	To (Length at zero age)		
1	Male	$y = -1E-10x^6 + 7E-08x^5 - 1E-05x^4 + 0.0012x^3 + 0.0638x^2 + 1.7869x + 2.4317$	2.241 (0 day)	24.185 (132 days)	0.0877	-1.1088	Normal Distributi on	Complete / varied sizes
2	Female	$y = -4E-10x^6 + 2E-07x^5 - 2E-05x^4 + 0.0017x^3 - 0.07x^2 + 1.6057x + 1.9969$	1.914 (0 day)	18.470 (101 days)	0.1019	-1.0734	Abnormal distributio n	Incomplete / does not varied in size

Figure 7 explains that the size of male giant prawns to the length of -1.1088 days with an average growth rate was 0.0877 cm/day where at zero-days, the size was 2,241 cm and reached a maximum length in 24,185 cm for 132 days, and the length distribution of male giant prawns in Muara Tepian Sembakung was normal and varied (complete) with an average range of male giant prawn lengths around  $14.55 \pm 6.55$  cm. Whereas for female giant prawns have a length of -1.0734 days with an average growth rate reached to 0.1019 cm/day, at zero days the size was 1,914 cm and a maximum length was 18,470 cm for 101 days. The distribution of the female giant prawn's length is not normal or does not vary (complete) in nature with an average of around  $12.4 + 4.6$  cm because it has two long classes that are not found female giant prawns at a length of  $8.72 \pm 0.29$  cm and  $9.43 \pm 0.32$  cm.

#### 4. Conclusion

The conclusion from the research that the composition of von Bertalanffy growth model by comparing the sex of male and female from giant prawns (*M.rosenbergii*) obtained 1 (35.33%); 1.83 (64.67%) so that based on population growth of giant prawns (*M.rosenbergii*) in nature, male giant prawns have a normal and complete distribution of size variations than female giant prawns (*M.rosenbergii*). The growth of male giant prawns (*M.rosenbergii*) (0.0877cm / day) slower than the female growth rate (0.1019 cm/day) with a value for males of -1.1088 days where zero-day age has a measured length of 2,241 cm to 24,185 cm within 132 days. Whereas for female giant prawns has -1.0734 days where at zero days the female was 1,914 cm with a maximum length of 18,470 cm within 101 days.

#### 5. Suggestion

Based on the research results of giant prawns (*M.rosenbergii*) explained that the distribution of female has an abnormal distribution because there are two classes that are not found in Muara Tepian Sembakung that was in size  $9.1 \pm 0.7$  cm; thus it needs to be considered.

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