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# Secondary productivity of small Crustacea, *Neosesarma* sp. in Bintan Island waters, Riau Islands

**M Krisanti[1], A Sofirma[1], A A Hakim[1], A Farajallah[2], Y Wardiatno[1,3,4] and A Mashar[1,*]**

[1]Department of Aquatic Resources Management, Faculty of Fisheries and Marine Science, IPB University (Bogor Agricultural University), Kampus IPB Dramaga, Bogor 16680, West Java, Indonesia
[2]Department of Biology, Faculty of Mathematics and Natural Sciences, IPB University (Bogor Agricultural University), Kampus IPB Dramaga, Bogor 16680, West Java, Indonesia.
[3]Center for Coastal and Marine Resources Studies, IPB University (Bogor Agricultural University), IPB Baranangsiang Jl. Raya Pajajaran, Bogor 16143, West Java, Indonesia
[4]Environmental Research Center (PPLH), IPB University (Bogor Agricultural University), IPB Dramaga, Bogor 16680, West Java, Indonesia

*Corresponding author: alimashar75@gmail.com

**Abstract.** *Neosesarma* sp. is a species of Decapods from a family of Sesarmidae. *Neosesarma* sp. that has an important role in a food chain. The research aimed to estimate secondary productivity of *Neosesarma* sp. based on ratio of production and biomass. The research was conducted in 3 stations in Bintan Bay, Bintan Island, Riau Islands. Preliminary research was conducted in August, and the main research was conducted in September, October, and November 2018. *Neosesarma* sp. was obtained by using modification of artificial substrate. Length and weight were measured and were analyzed to obtain length frequency distribution, length-weight relationship, and estimation of secondary productivity. The length frequency distribution of *Neosesarma* sp. ranged from 1.2 to 5.2 mm; both males and female had growth pattern of negative allometric; and the highest secondary productivity (1.5392 $gm^{-2}$ $y^{-1}$) was in Station 2 located near mangrove ecosystem as original habitat. The lowest secondary productivity (0.0730 $gm^{-2}$ $y^{-1}$) was in Station 3 (offshore ecosystem). The conclusion of this study is *Neosesarma* sp. that found in mangrove ecosystem has the highest secondary productivity of another coastal ecosystem in Bintan Island waters.

## 1. Introduction

*Neosesarma* sp. is a species of Decapoda which has not been studied and included in the family of Sesarmidae. *Neosesarma* sp. has a size range of 17.7 up to 23.8 mm, so that these species can be categorized as small crustaceans. According to The North European and Baltic Network on Invasive Alien Species [1], small crustaceans are group of crustaceans that measure less than 25 mm. Ecological and economical functions of small crustaceans are not yet known in detail, but some species are parasites. Another species, such as *Daphnia* sp. and *Artemia* sp. often used as fish and shrimp larvae feed [2]. *Neosesarma* sp. life in the marine habitat [3] and another reference states that this species is found in brackish water habitat [4]. Secondary productivity of *Neosesarma* sp. is essential as a food supply for the next trophic level.

Secondary productivity is the level of chemical energy and biomass production of organic material by heterotrophic organisms at a certain location and time [5]. Factors affecting secondary productivity are light, temperature, salinity, and the feeding behavior of these organisms [5]. Secondary productivity value may change as a result of death, reproduction, and migration that occurs within the population [6]. Secondary productivity changes can also be caused by anthropogenic activities, such as pollution, construction, and others [5]. Secondary productivity can be used to look at the dynamics of a population, as an assessment of the environmental stress, and to know the availability of food and energy flow in the ecosystem. The parameters used to determine the secondary productivity and recruitment patterns of *Neosesarma* sp. are biomass, production, and P/B (ratio of production and biomass).

Estimation of secondary productivity of *Neosesarma* sp. requires sample without disturb the balance of the ecosystem. Therefore, the usage of artificial substrates was needed for sampling. The use of artificial substrates is intended to reduce the variations of the physical and avoid damage to the native habitat of the organisms in the region [7]. In addition, the determination of the mesh size needs to be adjusted to the *Neosesarma* sp. size which will be taken as a specimen. It is intended to take the specimen of a more selective so as not to disturb another biota.

Research on the productivity of small crustaceans, especially *Neosesarma* sp. has never been conducted in Indonesia. Previous research on secondary productivity includes sand crabs [8], larval Chironomidae [7], and the growth and productivity of mangrove crab (*Scylla serrata*) [9]. Small crustaceans as heterotrophic organisms contribute to preserving environmental balance. Bintan Island is the biggest island in the Riau Islands and has a great natural resource [10]. Some regions have the characteristics of a quiet beach and have a mangrove and seagrass habitats which are still pristine. This habitat supports the organism *Neosesarma* sp. Therefore, research on secondary productivity of *Neosesarma* sp. in Bintan Bay, Bintan Island needs to be conducted. The aim of this research is to estimates secondary productivity of *Neosesarma* sp. based on ratio of production and biomass.

## 2. Materials and methods

### *2.1. Data Collection*

The preliminary study was conducted in August 2018, followed by sampling in September, October, and November 2018 in Bintan Island waters (Figure 1). The process of species identification and further analysis were conducted in Laboratory of Micro Biology 1, Department of Aquatic Resource Management, IPB University. The data collection included carapace length and weight of the biota.

Small crustacean specimens were biota that attached to artificial substrates. Artificial substrate served as a medium of live small crustaceans. Artificial substrates were formed from a net with a mesh size 2 mm. Elements smooth substrate was effective to obtain invertebrates [11]. Creation of artificial substrates referred to any larval Chironomidae [8], which was modified in accordance with the target organism. Frame of artificial substrates were made from PVC with size of 45x45 $cm^2$ and were divided into nine parts. Five of them were given the net with a size of 15x15 $cm^2$ [12]. Three transects of artificial substrates were used at each station. Artificial substrates were placed vertically in the water column with weighted and float, to avoid drifting (Figure 2). Preliminary test was conducted in the first months of research to ensure the functioning of artificial substrates that have been modified.

Artificial substrates were placed in three different stations (ST 1 = KJA or floating cage, ST 2 = Seagrass, ST 3 = offshore) with three substrates at every month. Sampling was conducted once a month for three months. All small crustaceans attached to the substrate were sorted and preserved using 96% alcohol. Then the samples were analyzed in the laboratory.

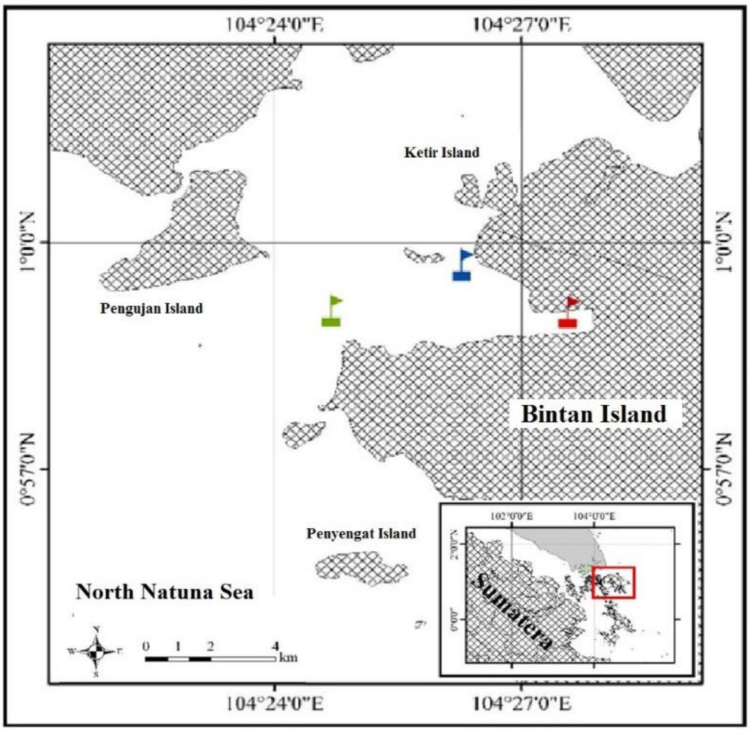


**Figure 1.** Maps of three different stations for artificial substrate in Bintan Island.

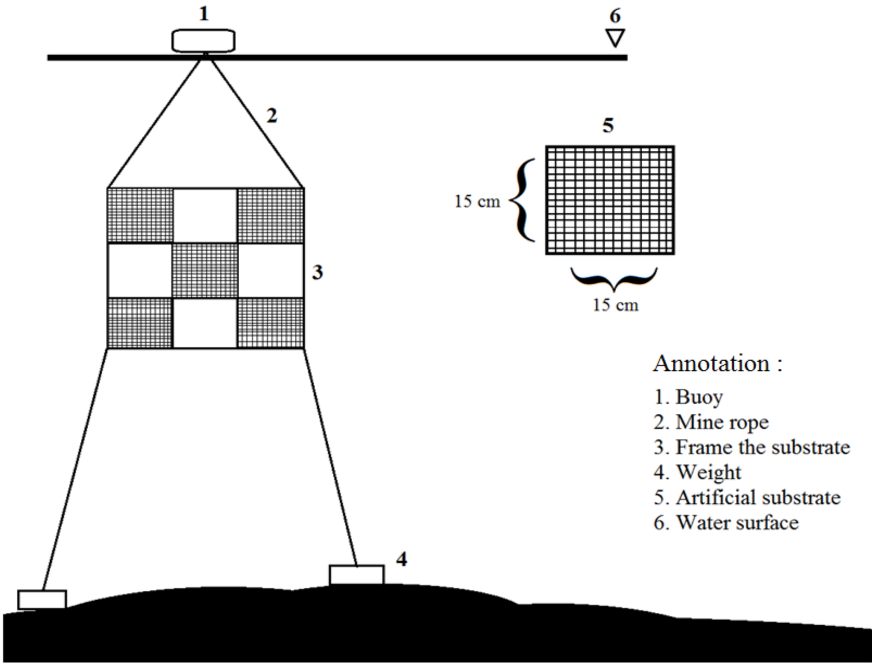


**Figure 2.** Visualization of artificial substrates.

Morphological identification was observed using a stereo microscope in Laboratory of Micro Biology 1. Identification of small crustaceans referred to identification book Marine invertebrates of the Pacific Northwest [13]. All specimens were documented using View 3.7 Beta camera connected to the microscope to facilitate the measurement process. Length measurements were performed using Image J and the weight was measured using a digital analytic. Estimation of secondary productivity was obtained by calculating the ratio of production and biomass.

### *2.2. Data analysis*

The data were analyzed and were obtained length frequency distribution, length-weight relationship, and estimation of secondary productivity. The secondary productivity for a year was called annual productivity. Secondary productivity was stated as biomass per area and per time ($gm^{-2}\ y^{-1}$) or energy ($kJm^{-2}\ y^{-1}$). The secondary productivity was estimated using size-frequency method, and was calculated based on the ratio of production (P) and biomass (B). The equation for calculating biomass was as follows [14]:

$$B = N_i \times W_i$$

Where,
B = Biomass of *Neosesarma* sp.
$N_i$ = Density at each class
$W_i$ = Average wet weight at each class
To estimate the production of *Neosesarma* sp. used the following equation:

$$P = \sum \left( \overline{W_i} \times \Delta N_i \right) \times JK$$

Where,
$\overline{W_i}$ = Wet weight lost at each class (g)
$\Delta N_i$ = Density lost at each class (ind. $m^{-2}$)
JK = Number of classes

## 3. Results and discussion

### *3.1. Results*

*3.1.1. Length frequency distribution.* Length frequency distribution was analyzed to determine the age group of *Neosesarma* sp. by length data. The total specimens of *Neosesarma* sp. were found 61 individuals with a length range of 1.2000-5.1999 mm. The artificial substrate in ST 1 was only found *Neosesarma* sp. at the second and third months (Figure 3). The ST 3 has the highest specimen with total of 36 individuals.

*3.1.2. Length-weight relationship*. Length-weight relationships were constructed to determine the growth pattern. The *Neosesarma* sp. male and female showed growth patterns of negative allometric in all three ecosystems (Figures 4a, 4b, and 4c). The determination coefficient of male in the KJA, seagrass, and offshore ecosystems were 83.17%, 88.39%, and 75.31%. While, the female had the determination of 87.95%, 91.93%, and 81.53%.

*3.1.3. Estimated Secondary Productivity*. Estimations of secondary productivity of *Neosesarma* sp. in three different ecosystems were shown in Table 1. Based on Table 1, the average density of *Neosesarma* sp. for the KJA, sea grass, and offshore ecosystems were 10, 18, and 40 ind/$m^2$. The average weight for each ecosystem was 1.1138, 2.9297, and 2.5259 mg. Before estimating the secondary productivity, annual production was calculated for each ecosystem. The offshore ecosystem had the highest production with value of 1539.1559 $gm^{-2}\ y^{-1}$. The P/B ratio was obtained in KJA, seagrass, and offshore ecosystems were 2.9424, 0.9045, and 10.8020.

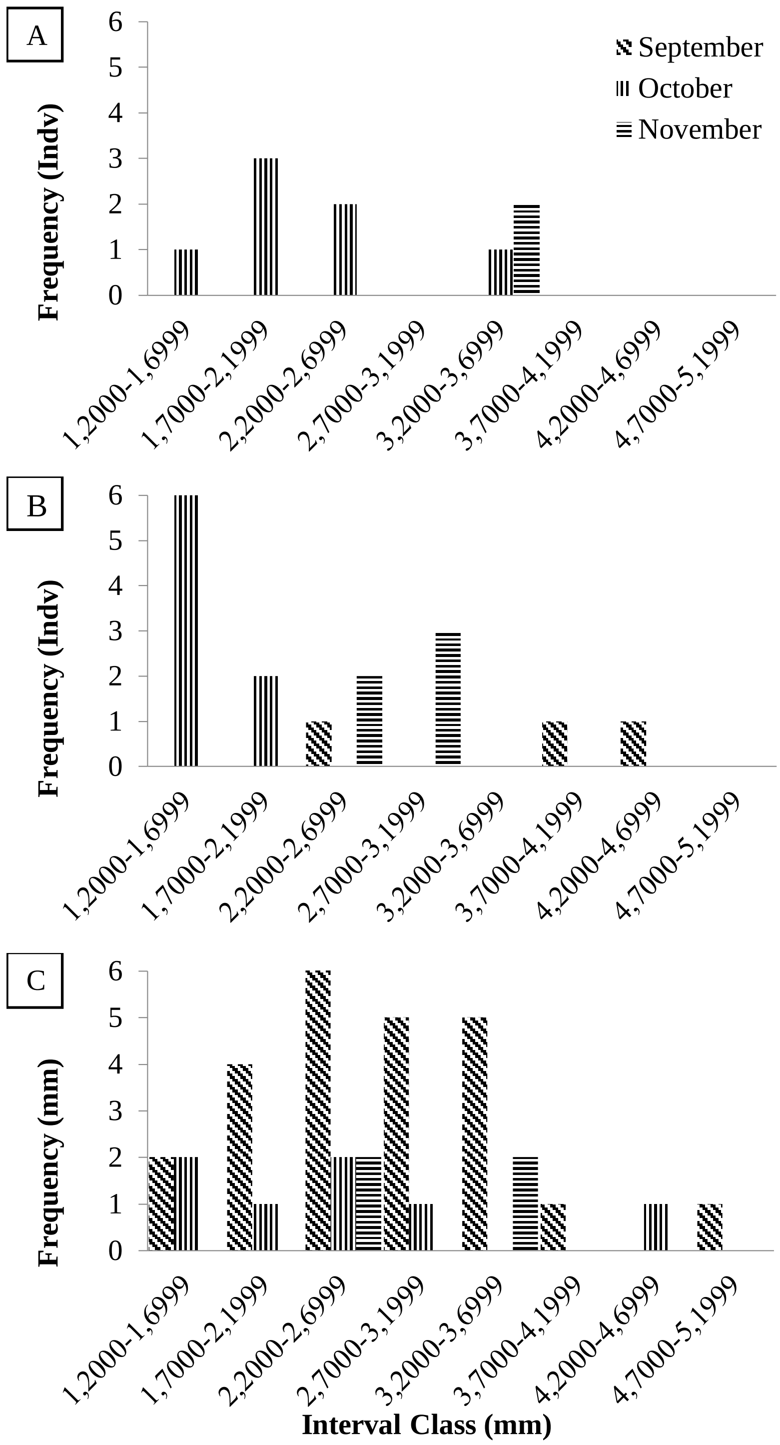


**Figure 3.** Histogram of the long frequency distribution of *Neosesarma* sp. in the three different stations (A) KJA, (B) seagrass, and (C) offshore.

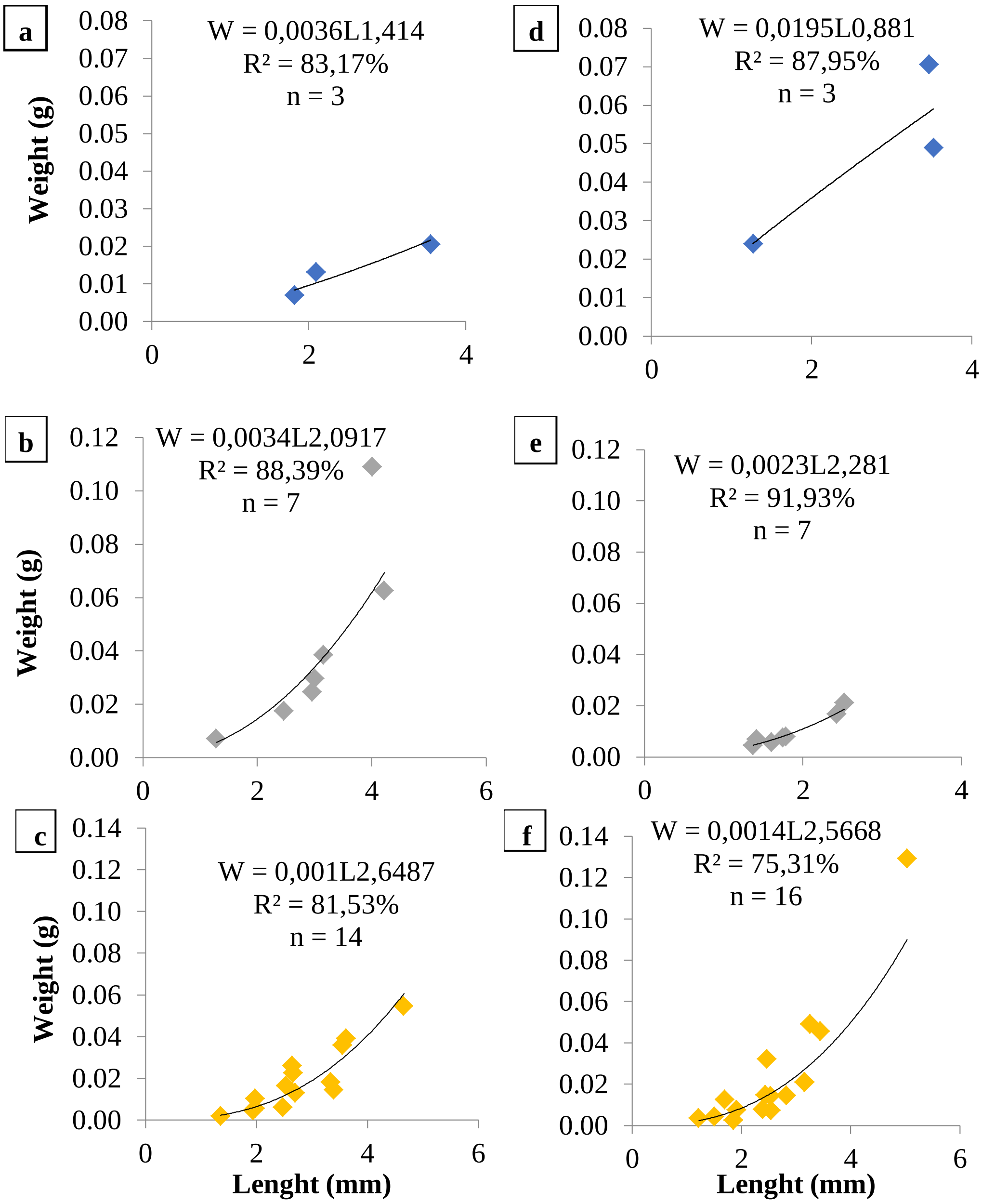


**Figure 4.** Length-weight relationships of *Neosesarma* sp. males and females in the KJA (a and d), seagrass (b and e), and offshore (c and f).

**Table 1.** Secondary productivity of *Neosesarma* sp. in three different stations.

| | KJA (ST 1) | Seagrass (ST 2) | *Offshore* (ST 3) |
|---|---|---|---|
| Average Density (ind/m$^{-2}$) | 6.7500 | 15.7500 | 40.3750 |
| Average Weight (mg) | 1.1138 | 2.9297 | 2.5259 |
| Annual Production (mg.m$^{-2}$y$^{-1}$) | 132.9600 | 72.9600 | 1539.1559 |
| Annual P/B | 2.9424 | 0.9045 | 10.8020 |

### *3.2. Discussion*

Estimation of secondary productivity was conducted on the species that most commonly found in artificial substrate. Artificial substrates were placed in a vertical condition to get a small crustacean that lived in the water column without damage and disturb the ecosystem. In addition, the condition reduced the environmental and physical variation of organisms [14]. The highest number of small crustaceans that obtained was *Neosesarma* sp. from family Sesarmidae [15]. *Neosesarma* species were often found in coastal waters that were still influenced by the mainland [4]. This species was generally an herbivore and detritivore [16]. Some literature suggested that the organisms in Sesarmidae groups had an important role within the ecology, i.e. recycle organic matter (mangrove and seagrass leaves) [17]. Moreover, members of Sesarmidae groups could be an indicator of an environment change [18].

*Neosesarma* was obtained for three months and the frequency distribution was created to determine the size range of *Neosesarma* in Bintan Island. *Neosesarma* were captured during three months in three stations with a total 50 individuals. The important things to consider in determining the length frequency distribution was determining the number of classes, the class width, and length data accordance with the interval class. The length distribution of *Neosesarma* ranged from 1.2 to 5.2 mm. The minimum and maximum of carapace length were 1.2730 mm and 5.0350 mm.

Based on t test analysis (partial test), both males and females had growth pattern of negative allometric. Negative allometric indicated that the growth pattern of length was more dominant than the growth pattern of weight [19]. Analysis of length-weight relationship was used to determine the growth pattern. An effective growth pattern was important for the management of fish stocks, including crustaceans [20].

Production was a growth measurement or biomass turnover in days or years [21]. Production of *Neosesarma* sp. was estimated at three different stations and the highest production in Station 2, followed by Station 1 and 3. High production at Station 2 was caused by the located near the mangrove ecosystem. The mangrove ecosystem had a positive contribution to the secondary productivity of *Neosesarma*. The group Sesarmidae often found in mangrove ecosystems [16]. Sesarmidae groups ate decaying mangrove leaves. Station 1 had a lower density than Station 3, but the production was higher. The average mass of *Neosesarma* at this station was the smallest among the others (1.1138 mg). This condition showed that production of an organism was affected by masses. Several studies had linked the production of Decapoda organisms that was shown in Table 2.

**Table 2.** Research on production of Decapoda.

| Biota | Production ($gm^{-2}y^{-1}$) | Locations |
|---|---:|---|
| *Chiromantes dehaani* | 293.2067 | Yangtze River, China [23] |
| *Helice tientsinensis* | 29.5133 | Yangtze River, China [23] |
| *Scylla serrata* | 13.9290 | Indramayu, West Java [9] |
| *Emerita emeritus* | 2.4181 | Kebumen, Central Java [8] |
| *Neosesarma* sp. (Station 2) | 1.5392 | Bintan Island, Riau Islands |
| *Neosesarma* sp. (Station 1) | 0.1330 | Bintan Island, Riau Islands |
| *Neosesarma* sp. (Station 3) | 0.0730 | Bintan Island, Riau Islands |

Table 2 showed the value of production in some species of Decapoda. *Chiromantes dehaani* had the highest production with value of 293.2067 $gm^{-2}$ $y^{-1}$ While, *Helice tientsinensis* had production of 29.5133 $gm^{-2}$ $y^{-1}$. Another study on mangrove crabs at a place resulted 13.9290 $gm^{-2}$ $y^{-1}$ for *Scylla serrata* and 2.4181 $gm^{-2}$ $y^{-1}$ for *Emerita emeritus*. The production of *Neosesarma* at the third station was very small when was compared with other Decapoda.

Secondary productivity was biomass produced by the heterotrophic population at a time interval and a specified amount without considering the survival rate of the population. Secondary productivity was obtained by calculating the ratio of production (P) and biomass (B) [5]. Secondary productivity calculation on *Neosesarm*a sp. didn't need to consider the correction factor. Organisms with life cycle less than a year didn't need to calculate a correction factor [23]. The third station had different secondary productivity. Secondary productivity from lowest to highest were Station 2, Station 1, and Station 3. Station 2 was located near the mangrove ecosystem and station 3 was located farthest away from the beach. Station 1 was located near an area that has floating net cages of grouper. The grouper consumed the pellets made from fish meat, while *Neosesarma* was a detritivore that consumed the remainder of mangrove leaves. annual P/B showed their rapid growth.

Based on the calculation of secondary productivity, Station 2 had the highest value that was located near the mangrove ecosystem and was original habitat of *Neosesarma*. *Neosesarma* utilized the remaining mangrove leaves as food. Factors affecting secondary productivity were feeding behavior, light, temperature, and salinity [5]. Feeding behavior played an important role in the process of energy flow. Energy could be moved through the prey-predator process. Secondary productivity measurement was the calculation on which the depiction of the ecosystem dynamics. This family Sesarmidae generally became food for birds. Several countries in Southeast Asia utilized these groups as a source of protein (food) [24].

## 4. Conclusion

The highest secondary productivity of *Neosesarma* sp. was 1.5392 $gm^{-2} y^{-1}$, found in Station 2 that located near mangrove ecosystem as original habitat. The lowest secondary productivity was 0.0730 $gm^{-2} y^{-1}$, found in Station 3 that located in offshore ecosystem.

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