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The dynamic of spiny lobster larvae abundance in Awang Bay waters of Lombok Island, Indonesia

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Abstract. The activity of catching the lobster larvae that has been increased for the long term will bring a negative effect to the lobster population on earth. Therefore, the main aim of this research is to get a better knowledge about the dynamic of spiny lobster larvae abundance and its relation to the condition of the waters spatially and temporally in Awang Bay Waters of Lombok Island, Indonesia. The data collection covered the lobster larvae abundance and the quality of waters which included the physical parameter, chemistry, and phytoplankton. There were 5 random stations collected in research location. The observation of lobster larvae abundance did by installing the collector tools where the collection of the larvae is the amount of the whole collector in each station. The measurement of the waters parameter quality did directly on location and the analysis did on the laboratory. The result of the research shows that lobster larvae consist of 2 species which were *Panulirus homarus* (82,9%) and *Panulirus ornatus* (17,1%). Lobster larvae were found dominantly on January and February with the abundance 62-76 ind./unit and found more around the bay side and influenced by the condition of the water's quality. The lobster larvae abundance were positively correlated to the phytoplankton abundance, salinity, brightness, temperature, flow, turbidity, nitrate, and phosphate. Meanwhile, the larvae abundance were negatively correlated to the pH and dissolved oxygen.

1. Introduction

The waters of South Lombok especially Gerupuk Bay, Bumbang Bay, and Awang Bay are the fishing ground of lobster seeds and larvae. It has been developed since 2000 where at that time many seeds and larvae are found stick to the buoys and the other materials that related to the seaweed and grouper seafarming [1]. Those seeds and larvae are maintained in floating cage so that the on-growing sea-farming of lobster becoming the main business for coastal society which replacing the business of catching the lobster from nature. But in the latest 5 years, the business of lobster cultivation in floating cage faced some failures caused by the high level of mortality because of the disease attacked and the quality of the waters was not supported the aquaculture development [2], [4] .

The lobster seeds and larvae that mostly found in Awang Bay were sands lobster (*Panulirus homarus*) and pearl lobster (*Panulirus ornatus*). The lobster life cycle consists of 5 phases started with the mature one that products the sperm or ovum then it hatches out into a filosoma (larvae), changed into puerulus (post larvae), and grow up into juvenile and then being adult [5]. Every stage of lobster life is associated with the specific ecology condition and shows the actual adaptation power. The filosoma larvae floats on the water surface and carried away by the wave, current, and wind. The puelurus larvae move to the shallow area and protected by the seaweed and coral which are provide the food and could be spared from predator [6].

The low productivity of the lobster sea-farming in floating cage and its obstacles make the people prefer to keep sale the haul rather than to do the lobster cultivation business. The puelurus larvae which is still transparent have size 2-3 cm with price reached to IDR 3000 per lobster. So this is very profitable for the catcher and the collector of the seeds. The floating cage that used for the lobster and grouper sea-farming now has a new function as the media to install the collector of the lobster seeds and larvae which is popularly called as ”pocong” [7]. The business of catching the lobster seeds and larvae with using “pocong” which increased in long term will bring the negative effect to the lobster population on earth and cause the damage for the lobster life cycle. And at certain point, the lobster will run into vulnerable or even extinct as what happened in the west of Mindanao Island, Philippine [8], equal with the condition of the waters in south Lombok. Therefore, this research is aimed to know about the dynamic of spiny lobster larvae abundance and its relation to the condition of the waters spatially and temporally. Hopefully this research can be useful for the lobster farming and to keep their preservation.

2. Material and Methods

This research was done from October 2018 to February 2019 in Awang Bay, Central Lombok, West Nusa Tenggara (Figure 1), 5 stations which are used as the simple random sampling had collected in research location [9,10]. The main data of this research is lobster larvae abundance while its supporting data included physical parameter, chemistry, and phytoplankton. The observation of the lobster seeds and larvae abundance did by installed the collector tools called “pocong” which is made by the cement paper bag and nets. A unit of raft sized 6x3m is used to hang 6 collectors. The collector operation did on evening so that the raft was completed by the generator and 6 electric lights with 50 watts power in each light. The amount of the lobster larvae which are found at every station in every month was counted to know about the fluctuations of its abundance. The larvae collection is the amount of whole collector for each station. The measurement of the physical parameter, chemistry and aquatic biology cover the temperature, salinity, brightness, pH, dissolved oxygen, current speed, turbidity, nitrate (NO_3-N), phosphate (PO_4-P), and phytoplankton. The sample of phytoplankton was taken by filtering the surface of water layer as much 100 L by using the bucket which has 10l of volume capacity. The identification of plankton did by taking 1 ml of it by using pipette and observed by using Sedgewick Rafter Cell (SRC) dan microscope. The identification did until it reached the genus level and it was supported by the book of Newell and Newell, and Yamaji [11,12]. The laboratory analysis did in Laboratorium Penguji Balai Budidaya Laut Lombok, and Laboratorium Bioekologi Perairan Universitas Mataram. The sampling method, preservation, and water sample analysis referred to APHA standard method [13].

The calculation of phytoplankton abundance did base on APHA modification (2005). Beside the phytoplankton abundance, the calculation of some ecology index is also done. This calculation covers the diversity index (*Shannon-Wiener Index*, H’), similarity index (*Evenness Index*, E) and domination index (*Simpson's Index*, D). That index calculation refers to Odum and Barrent [14]. The data collection was analyzed by the statistic method. The data of lobster abundance in every station and observation and the data of waters quality parameter were analyzed descriptively and shown as graph and thematic map. The analysis of correlation statistic with SPSS v 16 tools is used to know about the relation between lobster larvae abundance, phytoplankton abundance, and waters quality.

Figure 1. Research sites location (red dots)

3. Result and Discussion

3.1. The abundance and the distribution of lobster larvae

The abundance and the distribution of lobster larvae are shown in Table 1 and Figure 2. Based on the result of identification, the lobster larvae consists of 2 species which are called *Panulirus homarus* (82,9%) and *Panulirus ornatus* (17,1%). The lobster larvae are dominantly found on January and February. According to Erlania *et al*. [7], the species of lobster larvae that mostly found in Gerupuk Bay and Awang Bay are kind of *P. homarus* (sands lobster) and *P. ornatus* (pearl lobster). The lobster larvae abundance that relatively high is mostly found in period of June-July and decreased on August-September. It was happened because May is the season for fingerling which has size 6-8cm that make possible for the availability of yuwana larvae being relatively low at around that period. After the month of September, the larvae abundance started to be decreased. It was supported by the study result of Jones [15] which shows that many lobster found at Puerulus stage around Gerupuk Bay on period of November.

Table 1. The abundance (ind./unit) and the distribution of lobster larvae in Awang Bay

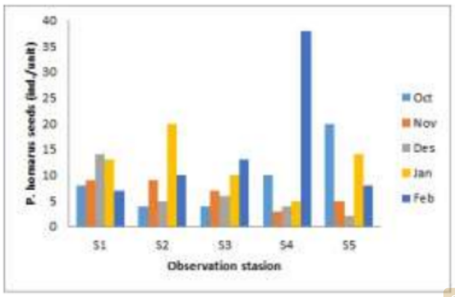
Species	Month					Total	Freq. (%)
	Oct.	Nov.	Dec.	Jan.	Feb.		
Panulirus homarus	46	33	31	62	76	248	82.9
Panulirus ornatus	18	11	8	8	6	51	17.1
Total	64	44	39	70	82	299	

The *P. homarus* lobster larvae abundance is dominantly found in station 1 (bay side), and station 4 (near the port) with the range between 10-12 ind./unit, while *P. ornatus* is dominantly found in station 1. This phenomenon indicates that lobster larvae are moved into the bay to find the spot to stick to the collector before do the metamorphosis into *fingerling*. At filosoma stage, the larvae becomes so weak to swim horizontally but stronger when swim vertically [16]. The larvae vertical migration is controlled by the light which is influenced by the photoperiod and the depth [17].

3.2. The waters quality condition

The waters quality condition is very important for the existence, growth, reproduction, and migration of the lobster larvae. The growth variability and the development of lobster is generally related to the heterogeneous environment [5]. The value of the waters quality parameter in Awang Bay has the significantly difference between the observation station and the observation period (Figure 3). The value of waters pH on November varied from 7.8–8.5 ppm, it is higher than on October which has range at 6.2–7.6 ppm, and on December to February (6.8–7.5 ppm). The salinity range on October (34-35ppt) is narrower than on February which has range at 31-37 ppt. The value of waters brightness on December (2–9m) is lower than on October, November, January, and February with range 3.5-21m.

The condition of the dissolved oxygen on October to January is relatively homogeneous which varied between 4.5-6.3 mg/l, while on February it is more heterogeneous which varied in the range of 3.3-8.6mg/l. The waters temperature on October to December were between 28.3–29.9 ˚C, it is relatively higher than on January to February in the range of 30.3–31.7˚C. The current speed on November (0.05-0.25 m/second) is higher than October, November, December, January, and February which has range between 0.01-0.03 m/second). The value of the waters turbidity on October (4.1-4.9 NTU) is higher than on February which varied from 4.5-7.0 NTU. The nitrate value on December especially in station 1 and 2 is high which varied between 0.024 mg/l and 0.034 mg/l, while on October, November, January, and February varied from 0.001-0.008 mg/l. So does the phosphate value, it is increased on December which varied between 0.08-0.21 mg/l while on October, November, January, and February were between 0.02-0.15 mg/l. Generally, the waters quality parameter which has been observed is still on the Ministerial Decrees threshold about the waters quality condition for the marine biota.



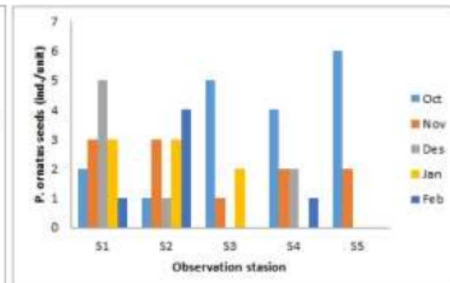


Figure 2. Lobster larvae abundance (ind./unit) that collected from installed lobster collector at each observation stations in Awang Bay

3.3. Community of phytoplankton

Based on the result of identification and the phytoplankton enumeration, there are 21 genus consists of 10 families such as Bacillariaceae (1 genus), Ceratiaceae (1 genus), Chaetocerotaceae (2 genus), Dinophyceae (3 genus), Hemiaulaceae (1 genus), Leptocylindraceae (1 genus), Naviculaceae (2 genus), Rhizosoleniaceae (4 genus), Thalassionemataceae (2 genus), dan Thalassiosiraceae (5 genus) are found in observation location. The abundance of each phytoplankton family can be seen in Table 2. The phytoplankton includes the filum Bacillariophyta (Diatom) is mostly found. The equal condition is found in North Lombok waters [18]. This thing is suitable to the Nountji [19] statement that generally, the phytoplankton in the sea waters is the kind of diatom (Bacillariophyceae, Fragilariophyceae and Coscinodiscophyceae)., followed with dinoflagellata (Dinophyceae) and blue algae (Cyanophyceae). From all the kind of phytoplankton which is found, there are some kinds that when they appeared with high abundance , it will endanger the other organism such as *Nitzschia* sp. and *Ceratium* sp. [20,21].

The highest phytoplankton abundance is found on December with range between 1.183 – 2.117 cel/l, while the lowest abundance is found on February which has range 467-967 cel/l. There are some things that influence the phytoplankton abundance on December such as the environment parameter which supporting the growth and the development of phytoplankton in this month is on the right condition. The main factors that influence the growth and the development of phytoplankton is nutrient and light. The value of nitrate and phosphate are high where the nitrate value on December especially in station 1 and 2 is 0.024 mg/l and 0.034 mg/l. So does the phosphate value that increased on December which varied between 0.08-0.021 mg/l. As a matter of fact, the nutrient value is still minimum to fulfill the growth needs and the development of the phytoplankton according to Mackenthun [22] which said that to get the optimal growth, the phytoplankton needs the nitrate value between 0.9-3.5 mg/l and the phosphate value between 0.09-1.80 mg/l. Furthermore, found that the

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optimal orthophosphate value for the phytoplankton growth is varied between 0.27-5.51 mg/l and if is less than 0.02 mg/l it can be a limitation factor [23].
To see the level of the waters environment stability, some of phytoplankton ecology index has been counted such as diversity index (*Shannon-Wiener Index*, H'), equality index (*Evenness Index*, E) and domination index (*Simpson's Index*, D). The diversity index is showing many varieties of phytoplankton in some waters. Meanwhile the equality index is showing the balance level of the variety composition, and the domination index is showing any kind of plankton is dominant [14]. The higher equality value of a waters area indicates that the area has stabile equality.

The phytoplankton diversity index on October is varied between 1.69-2.12, on November is between 2.24-2.47, on December is between 1.03-1.49, on January is between 0.82-1.58, and on February is between 0.68-1.33. The phytoplankton equality index on October is varied between 0.81-0.96, on November is between 0.96-0.98, on December is between 0.64-0.73, on January is between 0.59-0.91, and on February is between 0.47-0.98. The phytoplankton domination index on October is varied between 0.20-0.21, on November is between 0.08-0.11, on December is between 0.32-0.42, on January is between 0.27-0.55, and on February is between 0.37-0.54 (figure 6). Refer to [14], the phytoplankton diversity value in this observation includes the low diversity category and having the low stability , while the equality index shows enough value. The domination index value which closer to one shows the dominant variety [14] The high domination index (>0.5) found on January and February.

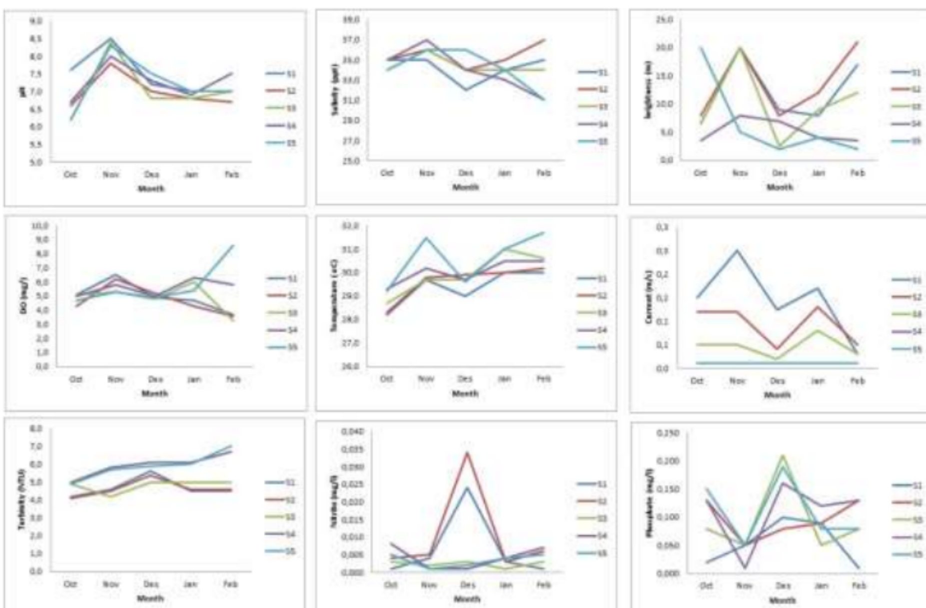

Figure 3. Temporal and spatial water quality variation from October 2018- February 2019 at each observation stations in Awang Bay

Table 2. The phytoplankton abundance in Awang Bay

Family of Phytoplanton	October		November		December		January		February	
	Abund (cel/l)	Relat (%)	Abund (cel/l)	Relat (%)	Abund (cel/l)	Relat (%)	Abund (cel/l)	Relat (%)	Abund (cel/l)	Relat (%)
Bacillariaceae	133	2.6	275	5.3	917	6.4	917	28.1	1.117	30.3
Ceratiaceae	375	7.3	242	4.7	-	-	-	-	-	-
Chaetocerotaceae	783	15.2	542	10.5	1.000	7.0	1.067	32.6	33	0.9
Dinophyceae	400	7.8	725	14.0	-	-	-	-	17	0.5
Hemiaulaceae	-	-	-	-	-	-	-	-	83	2.3
Leptocylindraceae	425	8.2	342	6.6	-	-	-	-	-	-
Naviculaceae	383	7.4	667	12.9	267	1.9	267	8.2	150	4.1
Rhizosoleniaceae	300	5.8	710	13.7	7.533	52.9	433	13.3	100	2.7
Thalassionemataceae	-	-	467	9.0	500	3.5	500	15.3	50	1.4
Thalassiosiraceae	2.358	45.7	1.200	23.2	4.017	28.2	83	2.6	2.133	57.9

3.4. The larvae abundance and its relation to the waters quality condition

Based on the correlation between the waters condition with the lobster larvae abundance and phytoplankton abundance (Table 3), it is known that the lobster larvae abundance is positively correlated to the phytoplankton abundance, salinity, brightness, temperature, current, turbidity, nitrate, and phosphate. It is strengthened by Jeffs et al. [24] Puereli is correlated to the frequency of the beach current which heading to the land or the shallow waters. On the post-larva phase, the energy is limited to the movement so that the larvae abundance or post-larva will be more on the beach waters than on the offshore. For the pH parameter and the dissolved oxygen, the larvae abundance is negatively correlated. It shows that Awang Bay waters is a fertile waters and full of phytoplankton. It is suitable for the sustainability of the lobster larvae. Phytoplankton is the food source for the shrimp larvae that is still have the quality of planktonic. The brightness of the waters relates to the phototaxis characteristic of the lobster larvae. The lobster larvae was more interested to get closer to the light, so that they prefer to live in the bright waters condition.

Moreover, the current is also influence the distribution of larvae, because it suspected that the lobster larvae which is spread and developed in Awang Bay came from the larvae that carried away by the current from different location. While the other opinion said that the opposite current could bring the larvae back to its first location [25]. According to Jones [26], the lobster larvae which is catched from nature for the enlargement cultivation is generally on the Juvenile stage sized 2-3cm. It is also known that the spatial distribution and the abundance of some species is influenced by the life cycle from the species itself [25]. The *Puerulus* is a post-larva stage with the shape looks like the grown-up lobster but does not have the pigment and hard exoskeleton yet [15].

Table 3. The correlation matrix between the lobster larvae abundance, plankton abundance, and the waters quality of Awang Bay

Parameters	abund. Larvae (ind./unit)	abund. Phyto (cel/L)	pH	salinity (ppt)	bright. (m)	DO (mg/l)	temp (°C)	current (m/s)	turbi (NTU)	nitrite (mg/l)	phosp. (mg/l)
abund. Larvae (ind./unit)	1										
abund.phyto (cell/L)	0.31	1									
pH	-0.16	0.17	1								
salinity (ppt)	0.43	0.05	0.32	1							
bright (m)	0.16	0.08	0.17	0.44	1						
DO (mg/l)	-0.08	-0.01	0.31	-0.40	-0.27	1					
temp (°C)	0.04	-0.44	0.19	-0.19	-0.16	0.39	1				
current (m/s)	0.10	0.12	0.25	0.11	0.38	0.01	-0.38	1			

turbi (NTU)	0.09	-0.01	0.04	-0.56	-0.61	0.54	0.58	-0.58	1		
nitrite (mg/l)	0.11	0.20	-0.13	-0.31	-0.04	0.01	-0.13	0.04	0.14	1	
phosp. (mg/l)	0.10	0.40	-0.43	-0.22	-0.32	-0.18	-0.16	-0.32	0.24	0.07	1

4. Conclusion

The lobster larvae abundance is dominantly found on January and February and mostly found in bay side. The larvae distribution of lobster larvae spatially and temporally influenced by the waters condition where its abundance is positively correlated with the phytoplankton abundance, salinity, brightness, temperature, current, turbidity, nitrate and phosphate, while with the pH and dissolved oxygen, it is negatively correlated. Due to the larvae potential and the lobster larvae in Awang Bay is large enough, it needs much supports from the stakeholder in this resource maintenance so that it will save the existence of the larvae.

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