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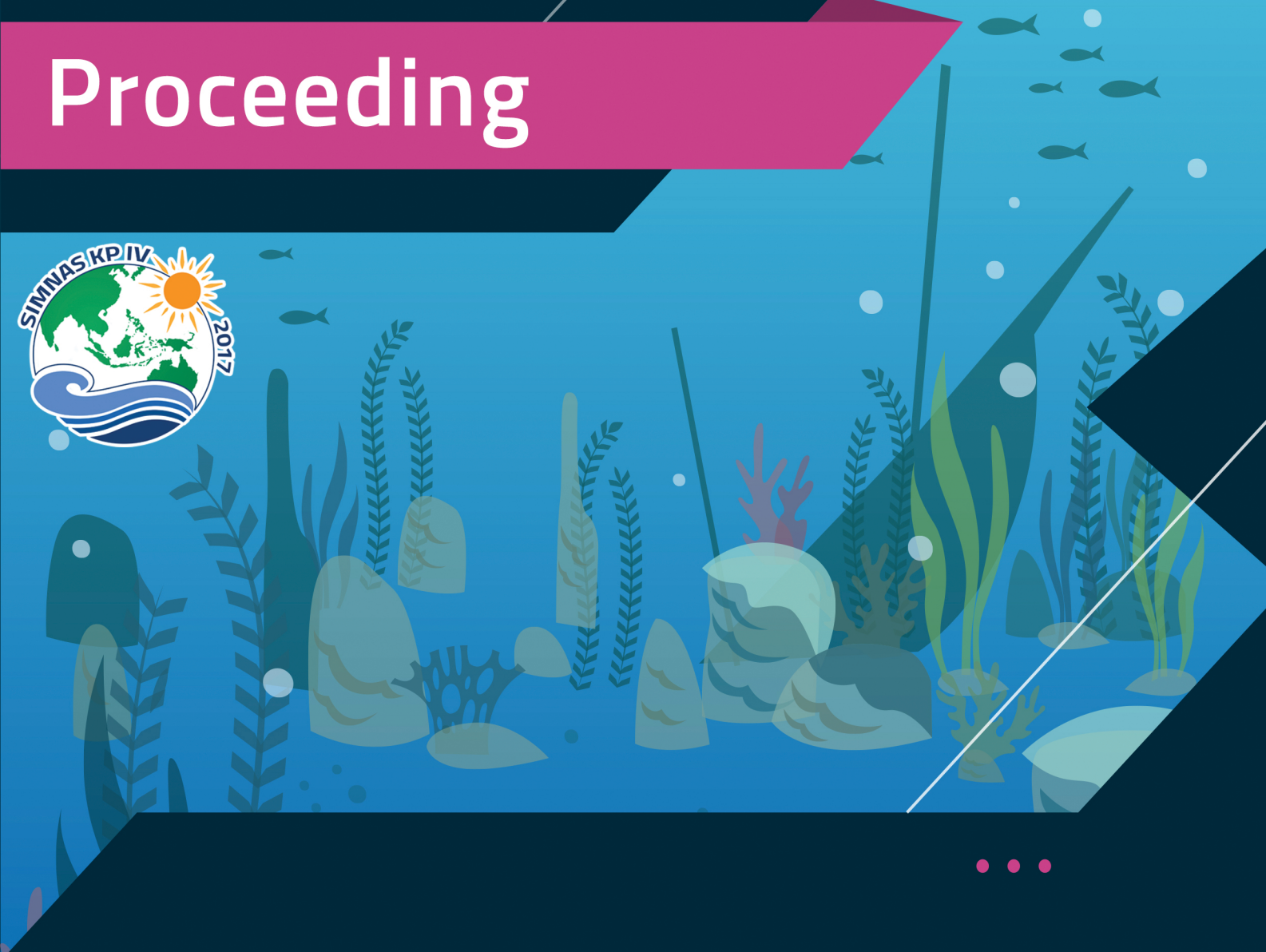
THE 4TH INTERNATIONAL MARINE AND FISHERIES SYMPOSIUM 2017

Proceeding



"Towards Resilient and Sustainable Maritime Economic in The Era of Globalization and Climate Change"

PROCEEDING
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Theme: Towards Resilient and Sustainable Maritime Economic in The Era of Globalization and Climate Change

Makassar, Mei 20, 2017

Keynote Speaker:
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Marine Science and Fisheries Faculty
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PREFACE

Might thanks to Allah SWT who given a blessing to us, so the proceedings of 4th International Fisheries and Marine Symposium have been finished on time. This proceedings contents 18.articles that have been presented at the symposium with the theme of symposium was "Towards resilient and sustainable maritime economic in the era of globalization and climate change" that have been held at Harper Hotel Makassar on 20 May 2017.

All manuscript that published in this proceedings have been selected and reviewed by reputable reviewers. We noted that there was 102.articles were selected to be presented in the symposium, which are 86 articles have been presented as oral presentation and 16 articles have been presented as poster presentation. For increasing quality of articles, we have made an assessment and reviewed by pointed participant during a presentation. Questions and suggestions for improving their articles have been given back to the author. The revised article then sent back to OC to be reviewed by pointed internal reviewers. Minor correction was not substantial and could be revised by our editors, while major correction of article have to be revised by the author.

This proceedings could be finished by supporting and contributing many parties. For this reason, we would like to thanks to all parties who have been assisted since collecting, editing and publishing this proceedings. We also would like to apologize for our weakness in this proceedings, so we really appreciated for a positive feedback from readers for improving our symposium in the future.

Hopefully, our proceeding could be a significant contribution for global marine economic development.

Makassar, 1 September 2017

Coordinator of organizing committee

Prof. Dr. Ir. Yushinta Fujaya, M.Si

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The Analysis System of Profit Sharing for The Fishermen a Boat at Bontosunggu Village Bontoharu District of Selayar Archipelago

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ABSTRACT

This research was carried out during February-March 2016 in Bontosunggu Village, District Bontoharu, Regency of Selayar Archipelago. This research was conducted to determine: (1) the system of profit sharing for the fishermen a boat, and (2) the income of fishermen a boat in Bontosunggu Village. Data collect by the survey with observations using the techniques of sampling cluster random sampling by categories of Punggawa and Sawi. The system applied to fishermen a boat in Bontosunggu Village was ¾ parts. The Punggawa got three parts with the details of one of the fishing gear, one part as the skipper and the last for the machine. The sawi got ¼ of the way. The total revenue on average fishermen a boat in one month the arrest operation was equal to Rp.198.950.000,- where total costs amounting to Rp.13.087.664,- and the total income received of Rp.185.862.336,- Then it can be known if the amount of income punggawa was Rp.123.908.224,- (parts of the ship, the skipper and the machine), or about 66, 67 % and sawi got each part of Rp 15.488.528,- (33,34%). The Sawi was sixth on the details, four for Sawi, add a punggawa one part of Sawi and one part of it again to the machine, to the machine was given to the fishing master (punggawa).

Keywords :income, system of profit sharing, Punggawa, Sawi.

Introduction

A profit-sharing system in a business involving multiple components greatly affects income levels that not only result in different welfare, but there is also a sense of fairness in economic gain. Profit sharing shows that the proportion of fisherman's income (ABK) is always smaller than the retainer's income as the owner of the vessel, the Punggawa always positions that the fisherman should bear the cost of depreciation of vessel investment. Problems that have occurred during the bargaining position of the fishermen in front of the lower Punggawa. Sawi is powerless to make changes to the habits of the results that have been valid and always follow and accept every decision in the Punggawa deal. On the other hand, the retainer acts as the party in control in determining a decision, whose results tend to favor the retainer as the owner of capital. Fishermen (ABK) are always in a disadvantaged position where their income is not worth the hard effort that has been sacrificed.

One way that can be done to increase the income of fishermen, among others, by increasing the production of catches and commercialize a productive fishing unit. The way is done in an effort to catch them by using a tool of arrest. Types of fishing gear commonly used in Selayar District are payang, purse seine, drifting gill net, trolling fishing, fishing line, trap, step chart, seaweed collection tool and boat chart using light aids. One form of fishing technology that is considered successful and growing rapidly in the fishing industry to date is a boat chart that uses light aids to attract the attention of fish in the process of catching (Baskoro and Suherman, 2007). This fishing gear is a source of income for fishermen in Bontosunggu Village, District Bontoharu of Selayar Archipelago which is widely used.

Research Methods

This research was carried out during February - March 2016 in Bontosunggu Village, District Bontoharu, Regency of Selayar Archipelago. Data were collected by the field observations using the techniques of sampling cluster random sampling by categories of Punggawa and Sawi (Table 1).

Table 1. Sampling Research

Number	Units	Amount	Percentage	Number of Samples
1	Punggawa	35	30	11
2	Sawi	152	30	46
Total		187		57

Source: Primary data after being processed 2016

Data analysis

In the present study, the fishery sharing system used a descriptive analysis. This descriptive analysis was used to explore in-depth information about the social aspect in the form of a picture of the form of cooperation of the Punggawa with Sawi and how to share the profit between the punggawa and sawi.

The amount of income earned in fishing activities can be calculated by the formula (Passaribu dkk, 2005):

$$\pi = TR - TC$$

where :

$\boldsymbol{\pi}$ = Income (Rp)
TR =Total Revenue
TC = Total Cost

Total revenue earned in fishing activities can be calculated by the formula:

$$TR = P\,X\,Q$$

where:

TR = Total Revenue
P = Price
Q = Quantity of catch

The total cost incurred in the activity Fishing can be calculated by the formula:

$$TC = TFC + TVC$$

where :

TC = Total Cost (Rp)
TFV = Total Fixed Cost (Rp)
TVC = Total Variabel Cost (Rp)

Results and Discussion

The charting tool has long been used by fishing communities in the Selayar Archipelago. The boat chart capture unit is a technical entity in fishing operations.

The boat charts in Bontosunggu village consist of boats equipped with house charts, net frames, lamps, rollers, power plants, and other aids such as bucket, cool-box, basket and others. All of these components determine whether a capture operation is successful, so the weakness of a unit component can affect the smoothness of the fishing operations. The size of the boat chart used Punggawa can be seen in Table 2.

Table 2. The size of the boat chart

The size of the boat	Amount of Punggawa (people)
15m x 15m	3
16m x 16m	1
16,5m x 16m	2
17m x 16m	3
18m x 17m	1
19m x 16m	1
25m x 18m	0
Total	11

Source: Primary data after being processed, 2016

The profit-sharing system applied by the retainer in Bontosunggu Village was after the net income from the boat bag business was divided into two parts (the Punggawa and the Sawi), where the punggawa got 50% and the Sawi also get 50% of the distributed proceeds, the Sawi income has been divided by two with The Punggawa will be divided by the number of Sawi members (Figure 1). Total income of the Punggawa was up to 66.67% and Sawi only got 33.34% (excluding machinery and Juragan).

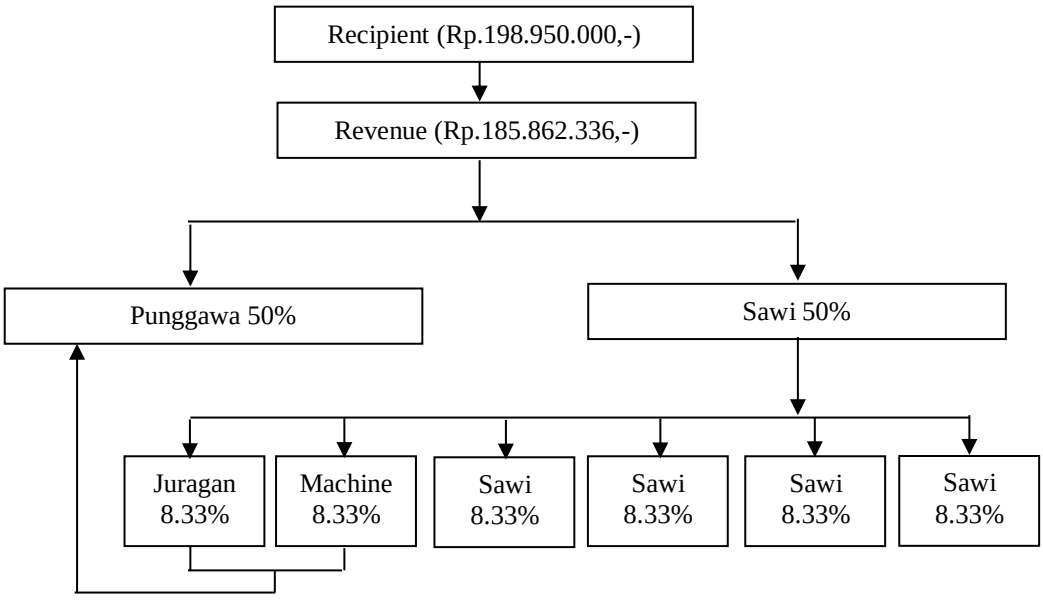

Figure 1. Profit sharing for the fishermen a boat at Bontosunggu District

The reception was the number of catches multiplied by the prevailing fish price at that time. The number of recipient of fishing gear unit in the Bontosunggu Village is presented in Table 3.

Table 3. Average recipient of fishermen a boat at Bontosunggu

No	Type of Fish	Basket/Kg	Total Basket (Q)	Price/Basket(P)	Recipient
1	Anchovy	50	57	450,000.-	25,650,000.-
2	Decapterus spp (Layang)	25	100	450,000.-	50,000,000.-
3	Rastelliger spp (Tembang)	50	91	450,000.-	40,950,000.-
4	Squid	30	78	600,000.-	46,800,000.-
5	Sardine	50	79	450,000.-	35,550,000.-
Total			405		198,950,000.-

Source: Primary data after being processed, *2016.*

Revenue is the proceeds of income less the cost incurred during the process of capture. The income obtained by fishermen unit boat chart in Bontosunggu village is presented in Table 4.

Table 4. Revenue of fishermen a boat at Bontosunggu

Number	Uraian	Total
1	Recipient (Rp)	198,950,000.-
2	Cost (Rp)	13,087,664.-
Revenue		185,862,336.-

Source: Primary data after being processed, *2016.*

Distribution of income for both Punggawa and Sawi can be seen in Table 5.

Table 5. The average revenue distribution after profit sharing on the boat chart unit

Number	Component	Amount	Sharing Results	Revenue (Rp)
1	Punggawa	1	92,931,168.-	92,931,168.-
2	Sawi	6	15,488,528.-	92,931,168.-
Total				185,862,336.-

Source: Primary data after being processed, *2016.*

Profit sharing of fisherman boat chart refer to the previously agreed sharing system (Figure 1). That Punggawa got 3 parts with details of one piece of fishing gear, one part as Sawi and one part for machine. While the Sawi gets one part of the division. The income of the Sawi will be divided into six, this is because the Punggawa obtain an additional share which is the same amount as the common Sawi. The average total Punggawa income in one month amounted to Rp. 123,908,244.- and total income of Sawi in one month amounted to Rp 15,488,528.- The distribution of catches between Sawi and Punggawa that tends to burdensome for Sawi. However, Sawi have no alternative other than follow the Punggawa so do not want to question it even considered it is fair for the Sawi and Punggawa also consider it appropriate because the Punggawa have a greater burden when compared with the Sawi.

Conclusion

The system for the results that was applied to the fishermen a boat in Bontosunggu Village was ¾ parts. The Punggawa got three parts with the details of one of the fishing gear, one part as skipper and one of the machine. The sawi get ¼

of the way. The total revenue on average fishermen a boat in one month the arrest operation was equal to Rp.198.950.000,- where total costs amounting to Rp.13.087.664,- and the total income received of Rp.185.862.336,- Then it can be known if the amount of income punggawa was Rp.123.908.224,- (parts of the ship, the skipper and the machine), or about 66, 67 % and sawi get each part of Rp 15.488.528,- (33,34%). The Sawi was sixth on the details, four of Sawi, add a Punggawa one part of Sawi and one part of it again to the machine, to the machine was given to the fishing master.

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Evalution of Giving Commercial Probiotic and Molasses to Seabass (*Lates calcarifer*) Growth

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ABSTRACT

Seabass (*Lates calcarifer*) is a consumption fish which has a high economic value. Probiotics and molasses are ingredient that can increase the fish growth performance. The main purpose of this research was to evaluate commercial probiotics and molasses in feed on the growth and survival rate *seabass* larvae. This research was conducted at BPBAP Ujung Batee from September to October 2016. The research used six treatments with four replications, consisted without probiotics content (A); probiotics 131 ml/kg (B); molasses 131 ml/kg (C); probiotics 65,5 ml/kg + molasses 65,5 ml/kg (D); probiotics 98,25 ml/kg + molasses 32,75 ml/kg (E); probiotics 32,75 ml/kg + molasses 98,25 ml/kg (F). The fish fed twice a day with 5% of the biomass for 45 days. The ANOVA test showed that added of probiotics commercial and molasses significantly affected the growth and survival rate of *seabass* larvae (P<0,05). The result of this research showed the highest value on the growth rate in the added molasses 131 ml/kg with increasing absolute length (2,47 cm); weight gain (3,29 gr); SGR (32,91 %), and survival rate (70%).

Keywords: *Lates calcarifer*, probiotics, molasses, growth rate.

Introduction

Seabass or Asian sea bass (*Lates calcarifer*) is a consumed fish which has a high economic value, to fulfill the requirement in domestic and overseas market. *Seabass* is one of export commodities with a high market demand. The increasing of *Seabass* production should be done in quality, quantity, and size. This matter provides an opportunity for cultivators to develop fish farming commercially whether on a small scale or large scale (Chan, 1982). *Seabass* grows relatively fast, maintain easier and has a high tolerance for environmental change. Fish cultivation spends as much as 60% of the expense on feed (Arief *et al*., 2014). One problem in *Seabass* cultivation in Indonesia is the use of artificial feed with the quality of feed (Mudjiman, 2004). Feed price is affected by the high protein content in feed.

Therefore, the effort to increase the growth and suppress feeding are conducted by adding probiotics and molasses in fish feed. Probiotics are microbes which beneficially affect the host because they can increase nutritional value in feed and respond to the host immunity against diseases (Verschuere *et al*., 2000). The addition of probiotics in fish feed can affect the digestibility and speed of nutrient decomposition in feed, thus helping the process of nutrients absorption by intestine.

Tangko *et al*. (2007) stated that the benefit of using probiotics in cultivation were for disease control, maintenance of microorganisms balance in fish digestive tract, and enhancement of fish digestibility through a good water quality. Chiu *et al*. (2010) stated that added probiotic bacteria with different levels in feed of orange-spotted grouper (*Epinephelus coioides*) gave a significant effect on survival rate (56.6%) compared with the control (20%) for 144 hours after the treatment.

Probiotics are very beneficial in increasing population of bioremediation agent bacteria. One source of carbohydrate which can be used as a supplement to encourage the growth of friendly microorganisms is molasses (Avnimelech, 1999). Molasses is a waste of industrial sugar cane (*Saccharum officanarum*) manufacturing in a form of thick blackish brown liquid. Molasses consist of 37% carbon, 31% sucrose and 32% of several kinds of amino and mineral acids. All of these compounds have a role in maintaining fertility and maintaining stability of water quality (Suastuti, 1998).

Aslianti *et al*. (2014) stated that the use of molasses in cultivation media of milkfish larvae (*Chanos chanos*) showed a positive and better effect on growth and survival rate compared with media without addition of molasses. Based on literatures, the addition of probiotics and molasses into *Seabass* feed has not been studied yet. So it is necessary to study on the effect of probiotics and molasses addition in feed on the growth and survival rate *Seabass*.

Methods

Experimental Design

This study was conducted from September to October 2016 at Balai Perikanan Budidaya Air Payau (BPBAP) Ujung Batee, Aceh Besar district, Aceh Province.

This study was conducted using Completely Randomized Design (CRD) method. This study consisted of 6 treatment levels with 4 replications. The following treatments were the treatment conducted in this study.

Treatment A = feed without probiotic and molasses (control)
Treatment B = feed + 100% probiotic (131 ml/kg)
Treatment C = feed + 100% molasses (131 ml/kg)
Treatment D = feed + 50% probiotic (65,5 ml/kg) + 50% molasses (65,5 ml/kg)
Treatment E = feed + 75% probiotic (98.25 ml/kg) + 25% molasses (32.75 ml/kg)
Treatment F = feed + 25% probiotic (32.75 ml/kg) + 75% molasses (98.25 ml/kg)

Research Procedure

Container Preparation

The container used in this study was a net with a diameter of 55 cm. Installation of the net was performed randomly in the pond. The net used was tied to the sides of the pond and weighed at the bottom of the net to allow the net to sink into the water. Stones (the weight) were tied into 4 pieces/nets using a rope. The water level in each cultivation net was 66 cm. The containers and equipments were sterilized by washing with detergent and chlorine with a dose of 100 ppm, then dried in the sun. The net was placed in 4 rows randomly, the water was deposited in the pond for 1 day and aeration was given in each container as oxygen supplier.

Feed Preparation, Probiotics and Molasses

The feed used in this study was feed containing 39-41% protein. The feed was mashed and mixed with probiotics and molasses, then the feed was re-formed

manually in accordance with the opening mouth of the fish. Preparation commercial probiotic was performed by mixing 6 ml of probiotics into 125 ml of water, added with ½ spoon of sugar then stirred evenly. Furthermore, probiotic treatment was conducted according to the treatment and it was conducted by mixing probiotic into the feed evenly. Molasses preparation was conduced by mixing 50 ml of molasses into 150 ml of water (1:3). Molasses were prepared at the beginning of the study for 45 days of cultivation and storage cover was opened every day to remove the gas of fermentation. Mixing of the materials was conducted once a day for twice a day feeding (morning and afternoon). Cultivation of *Seabass* larvae was performed in the net for 45 days. A total of 10 *Seabass* larvae were used in each container, at the aged of 30 days with a length around 3-5 cm. Feed was a commercial dry feed (pellet) given as much as 5% of its body weight with the size adjusted to the opening mouth of *Seabass* larvae. Feeding was performed twice a day at 08.00 and 18.00 WIB.

Measured parameters

a. The weight gain was calculated as follow :

$$Wg = Wt - Wo,$$

where Wg= weight gain during the experiment (g), Wo= weight of fish at the start of the experiment (g), Wt= weight of fish at the end of the experiment (g)

b. The daily growth rate was calculated as follow:

$$DGR= Wg/t,$$

where Wg= weight gain during the experiment (g), t= duration time of the experiment (day).

c. The specific growth rate is the percentage of weight gain per day.

$$SGR\ (\%\ day^{-1}) = (Ln\ Wt - Ln\ Wo) / t \times 100,$$

where Ln= Logarithm natural, t = experiment duration (day)

d. The Feed Efficiency is the total weight gain produced per total weight of feed consumed,

$$FE\ (\%)= (1/\ FCR) \times 100.$$

Data Collection

Data were taken once a week for 6 weeks by taking *Seabass* larvae then placed in the tray. Thereafter, the growth of *Seabass* larvae was measured, including length and weight. Measurement of the length was performed using a ruler, and weighing of the weight was performed using digital scale.

Results

The study about the effect of commercial probiotic and molasses to *Seabass* larvae growth has been done for 45 days with 6 treatment levels i.e. (A) control; (B) probiotics 131vml/kg; (C) molasses 131 ml/kg; (D) probiotics 65.5 ml/kg +

molasses 65.5 ml/kg; (E) probiotics 98.25 ml/kg + molasses 32.75 ml/kg; (F) probiotics 32.75 ml/kg + molasses 98.25 ml/kg. The results showed that average value of absolute length increase ranged from 1.27 to 2.47 cm, weight gain ranged from 1.49 to 3.28 gr, specific growth rate ranged from 14.95 to 32.91%, the ratio of feed conversion ranged from 4,00 to 6,36, feed efficiency ranged from 15,88 to 25,68% and survival rate (SR) ranged from 50 to 70%.

Table 4.1 The results of treatment to absolute length increase, weight gain, feed conversion ratio, feed efficiency and survival rate of Seabass larvae (*Lates calcarifer*).

Treatment	Absolute Length Increase (cm)	Weight Gain (gr)	Specific Growth Rate (%/day)	Feed Conversion Ratio (gr)	Feed Efficiency (%)	Survival Rate (SR) (%)
A	1,27±0,17^{a}	1,49±0,29^{a}	14,95±2,86^{a}	6,33±0,57^{b}	15,88±1,52^{a}	50,00±0,00^{a}
B	1,67±0,37^{a}	1,89±0,44^{a}	19,00±4,48^{a}	5,42±1,33^{b}	19,37±5,06^{a}	57,50±9,57^{a}
C	2,47±0,99^{b}	3,28±1,05^{b}	32,91±10,50^{b}	4,00±0,73^{a}	25,68±5,13^{b}	70,00±8,16^{b}
D	1,40±0,39^{a}	1,66±0,64^{a}	16,73±6,45^{a}	6,36±0,99^{b}	16,03±2,66^{a}	55,00±5,77^{a}
E	1,75±0,28^{ab}	1,89±0,58^{a}	18,99±5,81^{a}	5,03±0,49^{ab}	20,01±1,99^{a}	57,50±9,57^{a}
F	1,80±0,25^{ab}	1,93±0,40^{a}	19,40±4,04^{a}	5,25±0,82^{ab}	19,39±3,14^{a}	60,00±8,16^{ab}

Note : The mean values (±SD) at the same column with similar superscripts are not significantlydifferent (P<0.05)

The growth of Seabass larvae in all treatments increased variably at the 6th week. The highest yield of absolute length increase showed in treatment C that is 5.12 cm, and the lowest yield showed in treatment A (control) that is 3.92 cm. The highest average yield of Seabass larvaes weight showed in treatment C that is 3.99 gr, and the lowest avarage yield showed in treatment A (control) that is 2.50 gr.

Discussion

The results showed that the growth of Seabass larvae fed with the addition of molasses had better growth compared with Seabass larvae fed with control feed, probiotic-added feed or combination of probiotics and molasses. Based on ANOVA test, the use of commercial probiotic and molasses in cutivation of Seabass larvae with different doses significsantly affected the growth and survival rate of Seabass larvae (P <0.05).

Duncan test results for weight gain, specific growth rate and feed efficiency parameters in treatment C (addition of 131 ml/kg molasses) significantly different from other treatments. However, on absolute length and feed conversion ratio parameters, the treament with the addition of molasses only was not significantly different compared with the treatment with combination of probiotic and molasses. This was probably due to both of these ingredients contained bacteria which able to increase the growth of Seabass larvae. Anvimelech (1999), said that molasses is one source of carbohydrate which can be utilized to increase C/N ratio in effort to accelerate the growth of microorganisms, especially heterotrophic bacteria (biofloc) in the water. Furthermore, heterotrophic bacteria will develop well with the availability of C-carbohydrate sources such as sucrose, molasses. Then, heterotrophic bacteria will absorb the pollutants, especially ammonia then synthesized it into proteins which can be utilized by aquatic animals (Avnimelech, 2007).

Commercial probiotic is one of Indonesian probiotic isolates which mostly contains Lactobacillus bacteria (Arief et al., 2014). This bacterium derived from genus Bacillus which is include in heterotrophic bacteria (Radhiyufa, 2011). Lactobacillus could convert carbohydrates into lactic acid, then lactic acid would create an acidic or low pH atmosphere. In acidic condition, Lactobacillus had the ability to inhibit pathogenic bacteria and bacteria decomposition (Delgado et al., 2001). Lactobacillus is one of probiotic bacteria (Feliatra et al., 2004). According to Tangko et al. (2007) the benefits of using probiotic bacteria in cultivation were to control disease, maintain the balance of microorganisms in fish digestive tract, and improve fish digestibility through good water quality.

The results shown in growth rate graph (Figure 4.1) showed that the treatment with adding molasses into Seabass larvae showed a very significant results. Aslianti et al. (2014) stated that the use of molasses in cultivation media of milkfish larvae (Chanos chanos) showed a positive and better effect on growth and survival compared with media without the addition of molasses. This result is in line with the study of Sartika et al. (2012), which reported that daily growth rate of goldfish seed (Cyprinus carpio) differed in the treatment with (0.11 g/day) and without molasses (0.06 gr/day) (Sartika et al., 2012). According to Avnimelech (1999), the addition of carbon-rich materials would increase metabolism and growth of bacteria, immobilization of inorganic nitrogen, and it was a potential way to control water quality. According to de Schryver et al. (2008), in a balanced C and N condition in water, heterotrophic bacteria would utilize N, both in organic and inorganic form, which present in the water for biomass formation so that N concentration in the water would reduce.

The results showed that in treatment B, adding 131 ml/kg probiotics did not give effect in Seabass larvae growth. This was probably due to Raja Lele probiotics was not suitable for Seabass larvae growth. Raja Lele probiotics contain Lactobacillus, Acetobacter and yeast, while probiotic obtained from isolation of Seabass larvae was Lactobacillus plantarum (Situmeang et al., 2016). Probiotic would work more effectively if it used microorganisms derived from gastrointestinal tract and microorganisms that lived in the same environment as their host (Yulvizar et al., 2014).

This was allegedly due to both of these ingredients contain bacteria which could increase the growth of Seabass larvae. Anvimelech (1999), said that molasses is one source of carbohydrate which can be utilized to increase C/N ratio in effort to accelerate the growth of microorganisms, especially heterotrophic bacteria (biofloc) in the water. Lactobacillus plantarum was able to break down complex compounds into simple compounds with lactic acid as the next result, then lactic acid could produce acidic pH atmosphere. Lactobacillus plantarum could increase the acidity by 1.5-2.0% on substrate, and in acidic state this bacterial was able to inhibit bacterial pathogens and bacterial decay in the host (Delgado et al., 2001). Febriani (2011) stated that Lactobacillus plantarum was able to digest protein into

amino acids and could reduce the levels of crude fiber so that it could improve digestibility.

The results showed that three parameters i.e. weight gain, specific growth rate, and feed efficiency (Table 4.1), the highest increase were obtained in treatment C. Treatment A, B, D, E, F obtained lower growth increase, probably because the fish did not utilize the feed optimally, resulting in uneven growth. Uneven growth would cause the rate of predation increased. Kordi et al. (2002) stated that predation rate in fish was influenced by the size of the feed in accordance to the opening mouth and also by the appeal of feed to the fish.

Seabass larvae growth in all treatments from the beginning of the study to the 3rd week was slow, it was assumed due to Seabass larvae has not adapted to feed containing probiotics and molasses. At the 4th to 6th week, the growth increased vary in all treatments, this was because Seabass larvae has already familiar with the feed given. Aggraeni and Nurlita (2013) stated that marble goby (Oxyeleotris marmorata) took a long time to adapt to artificial feed (pellet), this could be seen from the low response of this fish in consuming the pellets given.

Survival rate is a crucial factor to success in fish farming. The survival rate of Seabass larvae cultivated for 45 days with a total of 10 seeds per container showed different results, where in C treatment (addition of 131 ml/kg molasses) had the highest survival rate among the treatments that is 70%. This was due to the maintenance of water quality in cultivation media. Suastuti (1998) stated that molasses contain 37% carbon, 31% sucrose and 32% of several kinds of amino and mineral acids, and all of these compounds which contained in molasses have a role in maintaining fertility and maintaining stability of water quality.

The best feed conversion ratio was obtained in treatment C (131 ml/kg molasses) that is 4.00. Feed efficiency in treatment C was 25,68%, the efficiency in this treatment wass the highest compared with other treatments. According to Torang (2013), the size of the feed conversion described the feed efficiency achieved, the lower the value of feed conversion the more qualified the feed was. Putri (2012) said that fish would not efficiently utilize the feed if the value of feed efficiency was low.

Conclusions

Based on the results, it could be concluded that giving commercial probiotics and molasses significantly affected Seabass larvae growth. The results showed that the highest value in growth rate was obtained in treatment C (131 ml/kg molasses) with an absolute length increase (2.47 cm), weight gain (3.29 gr), specific growth rate (32.91%), and survival rate (70%).

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Economic Valuation of Mangrove Forest Ecosystem in Untia Area For Sustainable Use and Management in Makassar

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ABSTRACT

This study aimed to identify the type and function of ecosystems of mangrove forests, calculate the total economic value of mangrove ecosystems, and to explain what factors affect the willingness to pay. The analytical method used was economic valuation and willingness to pay the community. The results showed that mangrove species in Untia Makassar City was dominated by Avicennia marina and Bruguiera gymnorrhiza with formation thicknesses ranging from 2 to 60 meters. The total economic value of mangrove forests in Untia region of Makassar was Rp. 14.616.988.100, - contribution was greater than the value of the direct use. Revenue level was the most influential variable on the willingness to pay the community. This is because the value of the equation used gives a positive value to the income of the local people to the willingness to pay, while other variables include: respondent's age, Respondents 'Respondents' and respondent's education had a negative effect. This indicates that the higher income of respondent will give very high contribution value to the mangrove ecosystem.

Keywords: economic valuation, environmental services, mangrove, Makassar,

Introduction

As one of the coastal ecosystems, mangrove forest is a unique and prone ecosystem. This ecosystem has ecological and economic functions. Ecological functions of mangrove forests include: shoreline protection, preventing sea water intrusion, habitat, feeding ground, nursery ground, spawning ground for various aquatic biota, Tsunami disaster mitigation, as well as micro climate regulator. While the economic functions, among others, as a producer of household needs (charcoal) and industrial purposes, and seed producers.

The mangrove area of Makassar City is around 149.5 Ha and the area of nipah tree is 378.4 Ha. The thickness of mangrove vegetation ranges from 2-5 meters and is dominated by Avicennia marina and Rhizopora. The mangroves in Biringkanaya sub-district are still well preserved, while in the coastal areas of Tamalate and Mariso sub-districts the mangrove ecosystem is diminished due to the high development activities in the region. This mangrove forest has a big role for the surrounding ecosystem. The fruit can be used as food, the tree can withstand coastal abrasion, habitat of various species of fish and other ecological functions. However, these ecosystems begin to experience development pressures both directly and indirectly. Therefore, its management should be an integral part of integrated coastal zone management and watershed management (watershed) as a whole.

The purposes of this research are:

1. To identify the type and function of ecosystem from mangrove forest in coastal city of Makassar.
2. To analyze the amount of total economic value (total economic value) mangrove ecosystem of Makassar city

3. To describe what factors affect the community's willingness to benefit the existence of mangrove ecosystems in the coastal city of Makassar?

Methods

Research sites

The research was carried out in the Coastal Coastal Area of Makasaar which is overgrown with mangroves and the communities around the mangrove forest are doing a lot of activities utilizing the function of mangrove forest resources.

Sampling Method

Methods of collecting socioeconomic data were done by using the sampling technique Non-Probability sampling where sampling techniques were found or determined by the researchers themselves or according to expert considerations. This method aims to know the behavior, interaction, and level of welfare of the community around the study site

Data analysis

To meet with the objectives of the research, the analysis model used are as follows:

Economic Assessment Analysis

The total economic value of the mangrove forest ecosystem under study is formulated as follows:

$$NET = ML + MTL + MP + MK + MW$$

where : ML: Direct benefits; MTL: Indirect Benefits; MP: Benefits of Choice; MK: Benefits of Existence; MW: Inheritance Benefits

Each of these values was identified by virtue of all the benefits gained in the mangrove ecosystem under study. Each of these values is as follows:

a. Direct Benefit or Direct Use Value (DUV)

The formula used to get the total value of direct benefits are:

$$TML = ML1 + ML2 + ML3 + \ldots + MLn$$

where : TML = Total Direct Benefits; ML1 = Direct Benefits of Fish; ML2 = Direct Benefits of Mangrove Crab (Scylla serrata); ML3 = Direct Benefits of Mussels; ML4 = Direct Benefits of Mangrove Wood

b. Indirect Benefits

The immediate benefits of mangrove forests as a coastal abrasion retainer can be determined from the cost of making breakwater along the coastline adjacent to the conservation area.

c. Benefits of Choice

The value of this preferred benefit is obtained by the equation:

OV = US $ 15 per ha. X mangrove forest area
OV = option value.

d. Benefits of Existence

These benefits can be formulated as follows (Ruitenbeek, 1992):

$$ME = \sum_{i=1}^{n} (MEi) / n$$

where: ME = Benefit of Existence; MEi = Ecosystem benefits from the i-th respondent; N = Number of respondents

e. Inherited Benefits

The value of inheritance is defined as the value given by the present generation by providing or inheriting resources for future generations. The inheritance value of mangrove ecosystems can not be assessed by a market value approach, therefore, inheritance values can be calculated by an approximate approach. Accordingly, it is estimated that the inheritance value is not less than 10% of the direct benefit value of the mangroves (Ruitenbeek, 1992).

Values Contingency Analysis

To know the willingness to pay the community (WTP), this study used an approach analysis of Contingent valuation Method (CVM) with the following formula:

$$WTPi = f(X1, X2, X3, X4)$$

where: X1 = Age; X2 = Revenue Rate of Respondents; X3 = Respondents 'Respondents' Family; X4 = Education Level of Respondents

The analysis model was done by the stepwise regression which is assumed to have influence variable, that were the respondent's age variable (X1), respondent's income level (X2), dependent of respondent's family (X3), education level of respondent (X4).

Results

Mangrove Vegetation Condition

The coastal city of Makassar was an "emergence" beach or coastal slopes formed from the mainland that was originally dominated by mangrove cover or a relatively thin mangrove community along the coast, but has been transformed into an open beach and largely utilized for the benefit of settlements, trade and Services. However, some locations, especially Biringkanaya Subdistrict, Tamalanrea Subdistrict, Pannakukang Subdistrict and Tamalate Sub District still have mangorve vegetation.

The results indicated that mangroves grown on the coast of Makassar City including in Untia region were dominated by the type of Nypa fruticans, which

mostly grow and develop along the watershed, then Rhizophora apiculata type which is the result of planting of mangrove rehabilitation program. The remaining natural mangrove and still found in this area were: Avicenia marina, Bruguiera gymnorrhiza and Bruguiera cylindrica. While mangrove follow-up which is generally included in coastal plants or a collection of mangroves that live behind natural mangroves (land vegetation) is dominated by Ipomoea pescaprae. The thickness of the mangrove formation that extends along the coastal area of Makassar City is quite varied. Results of satellite image interpretation and field measurements found that the thickness of the formation ranged from 2 to 60 meters, the thickest formation was found in along the coast of Biringkanaya Sub-district. The thickness of mangrove fornation at this location was the result of mangrove rehabilitation from existing government programs.

Up to now, two of 8 mangrove types in the coastal city of Makassar were the type of Avicennia marina and Bruguiera gymnorrhiza. Mangrove forest management should be very wise because it takes a long time to recover. Due to the destruction and mangrove forest that resulted in the decreasing function of mangrove forest in Makassar City, include as follows:

1. Function as a protector or retainer of abrasion, so that people living around the mangrove area should increase their vigilance against the threat of abrasion that can cause damage and destruction of the house it occupies.
2. The mangrove function as employment has decreased, which has decreased the number of fishermen catch, and decreased the income of local people whose livelihood depends on the mangrove ecosystem.
3. Mangrove function which as a place most of the fish to spawning resulted in the animal threatened extinction.

Assessment of Economic Benefits of Mangrove Ecosystems

a. Direct Benefits

Direct benefits or Direct Use Value (DUV) was a benefit that can be obtained from the mangrove ecosystem directly in the form of fishing, research and tourism (recreation). Direct Benefit Measurement was done by market value approach to quantify the price of various goods obtained. A Direct Benefits of Fish Fishing was done on a shifting basis, the frequency of catching ranges about 1 time / day or an average of 4 - 28 times / month or per year ranges from 54 to 300 times or an average of 216 times. The number of catches by one catch is 3 - 5 kg, so the total catch of fish per year is 648 kg - 1080 kg or the average of 952 kg / year. With the selling price per kg ranging from Rp. 20,000 - Rp. 35,000 or an average of Rp.26.455 / kg. Based on these values, then obtained the total value of fish economy of Rp. 222,423,200, - / year.

b. Direct Benefits of Crabs

This crab has a very high economic value so hunted and captured by people who are in the Village Untia, District biringkanaya, Makassar City using a simple fishing tool that is bubu / rakkang. This tool is operated on a daily basis by the community. The price of mangrove crab (Scylla serrata) is sold between Rp 25.000 - 50.000 / kg. The size of 1 kg is equal to 3 - 5 tail with varying sizes, 1 kg = 3 large size tail + 1 medium size or 3 medium size plus 2 large size tail. This price is still quite cheap when compared with the price in the market of Makassar is between Rp 25,000 - 50.000 / kg. Whereas small-sized communities do not sell it but are consumed for daily needs. Sales of mangrove crabs are usually done in front of the house or offered to neighbors who do not catch, the community also sells it to collectors and not sold to the market. This is because the cost of transport is quite expensive, difficult access to public transportation because the location is far from urban areas. Based on these values, then obtained the total value of crab economy of Rp. 135,680,000, - / year.

c. Direct Benefits of Shellfish

Based on the results of interviews with respondents, the activities of collecting mangrove shells are not routinely performed, but when averaged, the activities are generally done once a month because it depends on their wishes, and usually also from the ordering of people who trade food stalls and restaurants asking them To collect shells. Each time the collection of mangrove shells, the community is able to collect 10 kg to 30 kg at a price of 10,000 - 25.000 / kg. The cost incurred by the community for each time to collect mangrove shells about Rp. 5,000. But the disadvantage is that people do not sell the shells separately but are sold in the form of whole meat and shell. This is because the lack of creativity and community experience in using shell shells to be made crafts / souvenirs such as earrings, necklaces, bracelets, tissue places and so forth. Factors affecting the lack of creativity and community experience are due to low level of education, lack of capital, as well as the lack of specialized training provided by the government and related institutions. Based on these values, the total value of shellfish economy is Rp. 47,150,000, - / year.

d. Direct Benefits of Wood

According to one community in the region that the wood that can be used as firewood was mangrove wood because it can produce high heat and durable. Types of mangroves that are often used as firewood are from Rhizophora sp and Bruguiera sp. Firewood obtained by the community is generally used for domestic consumption and for sale. The people in general routinely take timber, but with the enactment of regulations from the government on the establishment of mangrove forest protection area in Makassar City, causing people are reluctant to search for firewood. Not enforced sanctions if mangrove trees are taken in a state of death. Usually they only look for once a week or even once a month with the number of taking reaching 1-3 bunches. The price set by the local community for each bundle at a price of Rp. 10.000 / ikat. Because the location of mangrove forest adjacent to

their village, but the location for the sale far from where they live in the traditional markets in the urban expenses are also quite a lot. Based on these values, the total value of shellfish economy is Rp. 4,260,000, - / year.

Total Economic Value Direct Benefits

The total economic value of direct benefits of mangrove ecosystem in Kelurahan Untia, Biringkanaya Sub-district, Makassar City is the sum of the four types of direct benefits available and can be seen in Table 1

Table 1. Total Value of Direct Benefit of Mangrove Ecosystem in Kelurahan Untia, Biringkanaya Sub-district, Makassar City.

No.	Direct Benefit	(Rp/year)	(Rp/ha/year)	(%)
1	Fish	222,423,200	22,242,320	54.31
2	Crab	135,680,000	13,568,000	33.13
3	Clams	47,150,000	4,715,000	11.51
4	Firewood	4,260,000	426,000	1.04
	Total	**409,513,200**	**40,951,320**	**100 %**

Source: Primary data analysis, 2015.

Indirect Benefits

Indirect benefits are the perceived benefits indirectly to the goods and services produced by the resource and its environment. Based on the results of identification of the existence of mangrove forest in Untia, Biringkanaya sub-district, Makassar city, the value of indirect benefits is done by approaching the value of the retaining waves. The function and role of mangrove ecosystem as a waves holder is very important to keep the city area from the waves. Direct mangrove naturally can not be measured with market value (marketable) so that to measure the value of physical measurement is done with the approach to the cost of making waves retainer.

The construction of wave retaining requires materials such as cement, mountain rock, sand, and concrete iron. Costs allocated to build waves in the coast of Makassar, Biringkanaya sub-district, kelurahan Untia estimated at Rp. 962.500, -. The average height of Break Water in Kelurahan Untia, Kecamatan Biringkanaya, Makassar City is 2.5 meters. Detailed estimates of the calculation of the construction of the breakwater (Break Water) in West Coast of Makassar City as follows:

• Long coastline overgrown with mangrove forest: 10,000 m2
• Break Water Width: 50 cm
• Average Height: 2.5 m
• Durability: 10 Years
• Break Water Price: Rp. 1.412.500

Indirect Benefit Value = 10,000 m2 x Rp. 1.412.500
= Rp. 14,125,000,000, - or
= Rp. 1,412,500,000 / year

Thus the cost and benefits of the mangrove forest ecosystem as retaining waves in the Village Untia, Biringkanaya Sub-district, Makassar City is Rp.

9.625.000.000, - or Rp. 962.500.000, - / year, with the width of break water 50 cm, average height Break water 2.5 m.

Based on the result of quantification of indirect benefits (carbon sink and wave arrest) mangrove forest ecosystem in Kelurahan of Untia, sub-district of biringkanaya, Kota makassar, total total indirect benefit value is Rp. 962.500.000, - / Year

Option Value

The value of the choice of mangrove ecosystem in Kelurahan Untia is approached with the benefits of biodiversity (biodiversity). The value of the rupiah per dollar is Rp. 12,690. Taking into account the biodiversity value of mangrove, using benefit transfer. Assumed the value of choice = value of mangrove forest biodiversity in Kelurahan Untia, subdistrict biringkanaya, Makassar City is US $ x 15 per ha per year (ruitenbeek, 1992). Value of choice = value of biodiversity x the value of the rupiah against the dollar during the study. ($ 15 per ha per year x Rp 12,690 per US $ = Rp 190,350 per ha per year) it is known that the mangrove forest area is 10 ha, the benefit value of choice per ha per year is Rp 190,350 Per ha per year x 10 ha = Rp 1.903.500 / year.

Exixtence Value

With the same approach and method with inheritance value, but the willingness to pay in question is the willingness to pay the community for the maintenance of the mangrove ecosystem although the community will not use or visit it, then the value of existence can be determined, using valuation techniques in the survey so that WTP obtained by using CVM technique. The value of the existence of mangrove ecosystem can be seen in table 17.

Table 3. Benefits of Mangrove Forest Presence and Respondent Characteristics in Kelurahan Untia, Kecamatan Biringkanaya, Makassar City.

Table 3. Existing value mangrove ecosystem and respondent caracteristic in Untia, Makassar

No	WTP	Respondent	WTP
1	1,000,000	13	13,000,000
2	5,000,000	27	135,000,000
3	10,000,000	10	100,000,000
	Total	**50**	**248,000,000**
	Average		**4,960,000**

Source :Primary Data Analysis, 2015

The table above shows that the willingness to pay the community (WTP) as many as 13 people for Rp.1,000,000, and as many as 20 people for Rp.5,000,000, while the WTP of Rp 10,000,000 as many as 10 people. Then obtained the value of the existence of the existence of Rp. 4.960.000 per ha per year, if multiplied by the area of mangrove forest (10 ha) = Rp 49.600.000, - / year.

Bequest Value

The mangrove ecosystem as an inheritance has a very high value. The heritage value of mangrove ecosystems can not be assessed by market value approach. Therefore, inheritance values can be calculated by approximate approach. Accordingly, it is estimated that the inheritance value is not less than 10% of the direct benefit value of the mangroves (Ruitenbeek, 1992). Thus, in relation to the total value of direct benefits from the mangrove ecosystem, the mangrove heritage value in Kelurahan untia, Biringkanaya sub-district, Makassar City is 10% x 409,513,200 = 40,951,320 / year.

Total Economic Value (TEV) Mangrove Ecosystem in Untia, Biringkanaya Sub-district, Makassar City.

From the results of the assessment that has been done, mangrove ecosystem in Kelurahan Untia, Biringkanaya Sub-district, Makassar City has several benefits, namely direct benefits, indirect benefits, benefits of choice, benefits of existence, and inheritance benefits. Direct benefits include direct benefits of fish, direct benefits of mangrove crab (Scylla serrata), direct benefits of shellfish (Anadara spp.), Direct benefits of firewood. Indirect benefits of mangrove ecosystem function as coastal protection from abrasion with cost approach. Benefits of choice obtained from the identification of the biodiversity value of the mangrove ecosystem. As for other benefits is the existence of ecosystems obtained from the value of paying the respondent / community (WTP), and inheritance benefits are estimated not less than 10% of the benefits directly mangrove.

The total economic value (TEV) is based on the results of the identification of all types of benefits from the mangrove ecosystem in Kelurahan Untia, Biringkanaya sub-district, Kota makassar, then calculated all the benefits. The recapitulation of the total estimated value of the benefits of mangrove ecosystem is presented in the following table:

Tabel 4. Total Economic Value Mangrove ecosistem in Untia, Bringkanaya Makassar

No.	Beneffit	Value (Rp/Tahun)	Value (Rp/ha/Tahun)	Value (%)
A.	Manfaat Langsung			
1.	Direct value of fish	222,423,200	22,242,320	
2.	Direct value of fish Crab	135,680,000	13,568,000	
3.	Direct value of shellfish	47,150,000	4,715,000	
4.	Direct value of wood	4,260,000	426,000	
	Direct Value Total	409,513,200	40,951,320	2.80
B.	Indirect value	14,125,000,000	1,412,500,000	96.63
C.	Option Value	1,903,500	190,350	0.01
D.	Existence Value	49,600,000	4,960,000	0.34
E.	Bequest Value	30,971,400	3,097,140	0.21
	Total Economic Value	14,616,988,100	1,461,698,810	100 %

Source :Primery Data Analysis, 2015

The above results show the Total Economic Value of mangrove ecosystem in Kelurahan Untia, Biringkanaya Sub-district, Makassar City with area of ± 10 ha is Rp. 14,616,988,100, - / year or Rp. 1,461,698,810, - / ha / year. The indirect benefits of mangrove ecosystems around the Kelurahan of Untia Beach, Biringkanaya Sub-district, Makassar City contributed the most with Rp 14,125,000,000. With the results obtained indicate that the community is very dependent on the potential of the mangrove ecosystem and already understand and understand about the role function of the ecosystem as a protector of the beach and their residence from the brunt of the waves.

The value of each benefit of the mangrove ecosystem has a very important role for the environment. The economic value of mangrove direct benefits indicates that people in Untia Sub-district, Biringkanaya Sub-district, Makassar City They have realized that damage to the ecosystem will result in a decrease in their income which will also indirectly affect the level of welfare. For the benefit of inheritance, the benefits of existence, and the benefits of choice that, when combined into one, then have enormous value. The magnitude of benefit value obtained in this study may change in the future because it depends on the change of utilization type.

Contingency valuation analysis

Stepwise regression is one method to get the best method from a regression analysis where with this analysis can be known variable which have significant effect and if there is variable which is not significant then the variable is issued. The analysis model is done by stepwise regression which is assumed to have influence variable, that is age variable of respondent (X1), income level of respondent (X2), Respondent Family Responsibility (X3), and education level of respondent (X4). To see the factors that affect the value of this PAP, SPSS software is used.

From the statistical analysis, the existence value of mangrove ecosystem in Kelurahan Untia, Biringkanaya sub-district, Makassar city given by respondent based on paying (WTP), minimum is Rp 1,000,000 per hectare and maximum is Rp 10,000 Per hectare, while the mean value of willingness to pay for each hectare of coral reef ecosystem is Rp 4,960,000.

Based on the results of stepwise regression education level (X1) and age (X4) of respondents that, there is a tendency that the higher level of education and age level, the greater the value of existence of ecosystems in the coastal city of Makassar. Respondents who have junior high education are 14 people with age range of age of 29 - age 50. A total of 3 people give the value of existence of mangrove ecosystem Rp 1.000.000, - per hectare, 7 people give value Rp 5.000.000, - per hectare, 4 people Respondents gave a value of 10,000,000, - per hectare. For respondents who have elementary education as many as 27 people with age ranges of age 27 - age 68. A total of 8 people provide the value of the existence of mangrove ecosystems of Rp 1.000.000, - per hectare, 13 people provide value Rp 5.000.000, - per hectare, 6 The respondent gave a value of 10,000,000, - per hectare.

While the respondents who do not continue their education as many as 9 people with age range that is age 32 - age 52, giving average value Rp 5.000.000, - per hectare, only 2 people give value Rp 1,000,000, - per hectare.

The result of stepwise regression analysis in the above table shows that the existence value of mangrove ecosystem in Kelurahan of Untia, Biringkanaya Sub-district, Makassar City based on the willingness to pay the community obtained by regression equation as follows:

$$WTP\ (Y) = 0{,}332 - 0{,}021\ (X1) + 0{,}167\ (X2) - 0{,}019\ (X3) - 0{,}019\ (X4)$$

By using the above equation it can be concluded that the income level (X2) is the variable that has the most positive effect on the willingness to pay the community in Kelurahan Untia, Biringkanaya Sub-district, Makassar City. This is because the value of the equation above gives a positive value on the income of the local community to the willingness to pay, while other variables include: age of respondent (X1), Respondent Family Responsibility (X3), and respondent education level (X4) , This indicates the higher income of respondents will give a very high contribution value to mangrove ecosystem. This means that respondents generally realize that the destruction of the mangrove ecosystem will greatly affect the level of income that adversely affects their welfare so that the community or respondents will switch to other livelihoods due to the loss of the main livelihood. Based on the above regression model, it can be interpreted that one's income can positively influence the PAP of coastal community of Makassar.

Conclusion

The conclusion of this results as follows:

1. Type of mangroves in the region of Untia was the type of Avicennia marina and Bruguiera gymnorrhiza with a thickness of the formation ranges from 2 to 60 meters, keeping the shoreline remains stable. Because if the decrease of mangrove forest area decrease its function so that it threatens the survival of the people living in the forest area either from the threat of abrasion, decreasing of income due to decreasing of catch and other livelihoods obtained from mangrove forest.
2. The total economic value produced by mangrove forests in Kelurahan Untia, Kecamatan biringkanaya, Makassar City is Rp. 14.616.988.100, - the contribution was greater than the direct use value (direct use value).
3. Revenue level was the variable that has the most positive effect on the willingness to pay the people of Makassar. This was because the value of the equation used gave positive value to the income of the local people to the willingness to pay, while other variables include: respondent's age, Respondents' Respondents, and respondent's education level negatively, this indicates the higher the respondent's income Provided a very high contribution value to the mangrove ecosystem.

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The Effect of Nitrobacteria on Plankton Abundance And Survival of Larvae Swimming Crab (*Portunus pelagicus*) Megalopa Stage

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ABSTRACT

The aims of this research was to know the effect of nitrobacter addition to phytoplankton abundance (*Chorella sp*) and swimmng crab larvae (*Portunus pelagicus*). This research used Complete Randomized Design (CRD) with 4 treatments nitrobacter 0,25 ppm; 0,5 ppm; 0.75 ppm and control without nitrobacter. The measurement of the daily phytoplankton density by means of haemacytometer and crab survival compared the number of naupli stocked to the megalopa stage. The results showed that the use of nitrobacter 0.75 ppm obtained the average phytoplankton density 67954.55 cells / mil survival rate megalopa 9.73% and the lowest without nitrobacter with the average 29484,85 cells / mil 3.47%. This suggests that nitrobacter affects the abundance of phytoplankton (*Chlorella sp*) and survival swimming crab larvae megalopa stage.

Keywords: Megalopa, Rajungan, Nitrobacter, Phytoplankton

Background

Natural feed is an absolute type of feed that must be provided for all hatchery activities. The type of feed provided varies according to the mouth opening of larvae swimming crab. The giving of rotifer as a natural feed in the hatching of swimming crab has been widely practiced (Brick, 1974, Yunus et al. 1996; Rusdi, 1999).

The problem faced in the hatching of swimming crab is the large of mortality rate of larvae in the early stadia, it is suspected by unsupported environment for the development of stadia and energy needs for the next development. Therefore, one effort that can be done to meet the energy needs is to increase the amount of abundance of natural feed (*Chorella* sp).

Recently, the use of biotechnology like bacteria that are widely used to oxidize ammonia and nitrites to nitrates are nitrobacteria bacteria. Nitrobacteria are widely used because it is environmentally friendly to minimize environmental degradation (Heriati, 1998). In this context, it is necessary to conduct research related to good nitrobacteria concentration to produce optimal plankton abundance in water.

The research is intended to determine the dose of nitrobacteria to increase phytoplankton abundance (*Chorella* sp) and the survival of swimming crab (*Portunus pelagicus*).

Methods

The research was conducted for 30 days from the beginning of October to the end of October 2014. It is located at backyard household scale, Bojo village, Mallusettasi sub-district, Barru district.

Preparation of container

The container used is 10 liters jar as many 12 units.

Figure 7. Placement of jars/treatment container in the tub (side view)

Preparation of test animal

Test animal used in this research is larvae swimming crab (*P. pelagicus*) obtained from the result of eggs hatching in the backyard. Broodstock obtained from the catch of fishermen around the waters of Pinrang district. The newly hatched larvae are maintained with a density of 50/L, so the total per jars is 250 larvae.

Preparation of nitrobacteria

Take nitrobacteria liquid in a bottle using a drop pipette with a dose of 0.5 ppm, 0.25 ppm, and 0.75 ppm in each treatment. Then put it in the fiber glass, then pour it into each treatment container and maintain for 8 hours to decompose in the water. After that, larvae swimming crab is entered with a density of 250/L.

Measurement of water quality such as temperature, salinity, pH, and DO is performed in every stadia turnover in the morning.

The design of experimental was using *Completely Randomized Design* (RAL) with 4 treatments and 3 replications to obtain 12 units of experimental unit.

Parameter of Observation

Calculation of abundance and survival of phytoplankton *Chorella* sp by using equation as follows:

According to Efendy (1979):

$$SR=\frac{Nt}{No} \text{ x } 100\%$$

where: SR: Survival (%); Nt : number of test animals at the end of experiment;

No: number of test animals at the beginning of experiment

Survival was obtained by comparison between the numbers of larval of megalopa stadia that lived at the end of experiment with the number of larvae stocked at the beginning of experiment i.e at the beginning of *zoea* 1 stadia.

According to Isnansetyo (1995):

$$A = \frac{A1+A2+A3+A4}{4} \text{ x } 25 \text{ x } 10^4 \text{sel/mil}$$

where : A: number of cells in the chamber; 4: number of data retrieval; 25: number of large chamber; 10^4sel/mil: volume of chamber density

Result and Discussion

The results of research indicates that the average of survival rate of larvae swilling crab of zoea 1 to zoea 4 in second day the highest is treatment C (0.75 ppm)

of nitrobacteria with an average of 9.73%, followed by treatment B (0.50 ppm) of nitrobacteria with an average of 9.60%, then treatment A (0.25 ppm) of nitrobacteria with an average of 6.93%; and the lowest is treatment D (control without nitrobacteria is 3.47%).

Table 1 shows that the highest value of survival is obtained at treatment C (9.73%), followed by treatment B (9.60%), followed by treatment A (6.93%), and the lowest is treatment D (3.47%). Based on the result of ANOVA analysis showed that the survival of larvae swimming crab in zoea to zoea 4 with the addition of nitrobacteria had significant effect ($p < 0.05$) on the survival of larvae swimming crab. Tukey-test showed that the survival of larvae swimming crab at treatment A was significantly different ($P < 0.05$) to treatments B, C and D. Treatment D was significantly different from B and C. The difference in the survival of larvae swimming crab between treatments was thought to be influenced by the addition of nitrobacteria to maintenance media. This is in accordance with Herlambang and Ruliasih (2003) that nitrobacteria are able to maintain water quality in maintenance media through nitrification process. It is a bacterium that converts or breaks down nitrite into nitrates through a nitrification process. Nitrification is a process of transforming nitrogen compounds from ammonia nitrogen ($N\text{-}NH_4^+$) to nitrogen nitrate ($N\text{-}NO_3^-$). Nitrosomonas oxidize ammonia to nitrites and then oxidized to nitrates by nitrobacteria bacteria under aerobic conditions. Nitrosomonas and nitrobacteria are the most nitrifying bacteria that play a role in the biological process of ammonium oxidation to nitrate.

Table 1. Tukey's test of survival (%) larva crab on zoea stia during treatment

No	Treatment	Mean Survival (%) ± SE
1.	A (0,25 ppm nitrobacteria)	6,93 ± 0,70553 ^{ab}
2.	B (0,5 ppm nitrobacteria)	9,60 ± 0,92376 ^{a}
3.	C (0,75 ppm nitrobacteria)	9,73 ± 1,18509 ^{a}
4.	D (control)	3,47 ± 0,70553 ^{b}

Description: Different letters in the same column show significant differences at 95% level.

Based on Boyd's (1988) observation that nitrosomonas bacteria and nitrobacteria are bacterium that causes the nitrification process in a waters that serves as a bacterium that is able to maintain water quality through cations contained in a waters, the nitric acid was formed and can be changed immediately as nitric salts by nitrobacteria or nitrosomonas, the nitrite salts are further proceed into nitrite salts, in its reaction. The nitrite salts are important as minerals assimilated by green plants to regulate the amino acids back to the body, to form the protoplasm is depend on the nitrite, further the phytoplankton to be feeds for larvae swimming crab, so it can support the survival of the crab and reduce stress conditions that allow the mortality of larvae crab during maintenance. Nurcahyono et.al (2009) for treatment D (without nitrobacteria) showed the lowest survival rate of 3.47%. The decline in survival rates is assumed as water quality exceeds the tolerance limit so that the larvae crab get sick and die.

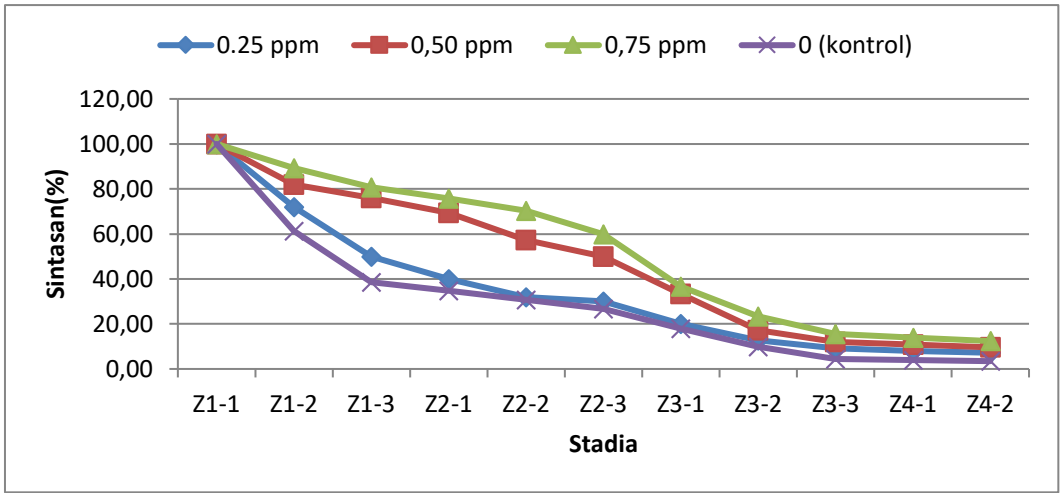

Figure 1. Graph of survival with garlic treatment on the larva swimming crab

The results of research showed the average of highest abundance of phytoplankton (*Chlorella* sp) for treatment C (0.75 ppm nitrobacteria) with an average of 67954.55 ppm, treatment B (0.5 ppm nitrobacteria) with an average of 44772.73 ppm, treatment A (0.25 ppm nitrobacteria) with an average of 38257.58 ppm and treatment D (control without nitrobacteria) of 29484.85 ppm.

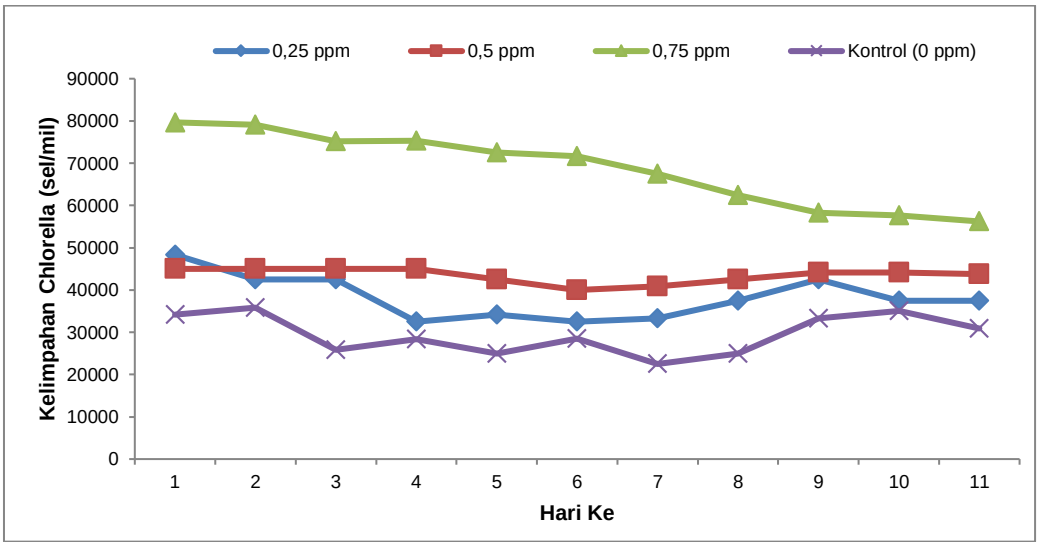

Figure 2. Graph of phytoplankton abundance with nitrobacteria treatment

Based on the result of ANOVA showed that the effect of nitrobacteria in maintenance media has significant effect ($P < 0.05$) on the abundance of phytoplankton (*Chlorella* sp). Tukey-test showed that the abundance of phytoplakton (*Chlorella* sp) in treatment A and B was significantly different ($P < 0.05$) to the treatment C and D, and treatment C was significantly different from treatment A, B, and D. Treatment D was significantly different to treatment A, B, and C. The high level of phytoplankton abundance produced at treatment C with the frequency of nitrobacteria (0.75 ppm) is suspected because the frequency of nitrobacteria is suitable to the need for maintenance media to maintain water quality, especially the increasing DO and the decreasing NH_3 in the maintenance medium. This is supported by Heriati (1989) which states that nitrobacteria is able to produce oxygen through nitrification process, where at the time of NH_4 (nitrate)

changes to NO_3 (nitrate) with the assistance of nitrosomonas and nitrobacteria bacteria, the process will produce O_2 (oxygen). Sudjarwo (2007) and Handayani et al. (2005) explained that phytoplankton plays a very important role in water, its ecological function as a primary producer and the beginning of the food chain of phytoplankton which is often made as measure scale of fertility to waters.

Table 2. Parameters of water quality during the study

Parameter	Treatment			
	A	B	C	D
Salinity (ppt)	29 - 30	29 - 30	29 -30	29 - 30
Temperature (^OC)	30 - 31	30 - 31	30 - 31	30 - 31
DO	4,71 – 4,73	4,81 – 4,95	5,61 – 5,81	4,56 – 4,60
pH	7 - 8	7 - 8	7 - 8	7 - 8
NH_3	0,043 – 0,048	0,033 – 0,038	0,018 – 0,025	0,055 – 0,063

The solubility of measured oxygen content for four treatments during the study ranged from 4.56 to 5.81 ppm. According to Kasry (1985 in Kasmiaty 2005), oxygen solubility shows optimal conditions during maintenance of larvae swimming crab. The dissolved oxygen in the water between 4-6 ppm is considered the most ideal for growing and developing of larvae. According to Nurcahyono, et al (2009), the optimum value of pH from 7.8 to 8.6 on the maintenance of stadia zoea of larvae swimming crab.

As result of water quality measurements above can be concluded that nitrobacteria can maintain water quality. This is in accordance with Heriati's (1998) statement that nitrobacteria is a bacteria that is environmentally friendly because it is able to minimize environmental degradation of a waters. Stated again that nitrobacteria capable of producing oxygen through the process of nitrification, which at the time of NH_4 (nitrites) turned into NO_3 (nitrate) with the assistance of bacteria and nitrosomonas and nitrobacteria the process will produce O_2 (oxygen). It can be seen from the table above that the resulted average of DO measurements ranging from 4.71 to 5.81 ppt and NH_3 ranging from 0.18 to 5.81 proves that nitrobacteria is able to maintain water quality during research with increasing DO and decreasing content of NH3.

Conclusion

Based on the results of this study, it can be concluded that nitrobacteria can affect the abundance of phytoplankton (*Chlorella* sp) and survival rate of larval swimming crab (*Portunus pelagicus*) with an average 67954.55 cells/ml obtained from treatment C (0.75 pm nitrobacteria) and the lowest on treatment D (control/without nitrobacteria) with an average of 29484.85 ppm. Then the highest survival was obtained at treatment C (0.75 ppm nitrobacteria) of 9.73%, and the lowest in treatment D (control/without nitrobacteria) of 3.47%.

The appropriate dose to increase the abundance of phytoplankton and survival of larval crab are obtained from treatment C (0.75 ppm) and the lowest in treatment D (control), this proves that nitrobacteria is capable of affecting the abundance and

survival of phytoplankton and maintaining the quality of the waters and it is seen from the increasing DO and the decreasing NH_3.

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Biodiversity of Marine Macroalgae in The Intertidal Zone of Lhok Bubon Beach, West Aceh, Aceh Province

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ABSTRACT

Intertidal zone was one of the ecosystems with high biodiversity in the world and macroalgae was one producer in that ecosystem. Lhok Bubon Beach (West Aceh Area) has biodiversity of marine biota in the intertidal zone such as marine macroalgae. The sampling site was located in the Lhok Bubon beach, which has been regarded as one of Meulaboh beach tourism destinations. Because of that, this research was done for learning the biodiversity of marine macroalgae in the intertidal zone of Lhok Bubon Beach. Data sampling was taken at low tide from December 2016 to February 2017. The sampling method was free sampling by exploring the intertidal zone of Lhok Bubon Beach to invent biodiversity of marine macroalgae which was founded. The results showed that there were three divisions which consisted of 10 kinds of green algae including Chaetomorpha crassa, Cladophora sp, Codium fragile, Enteromorpha flexuosa, Chlorodesmis fastigiata, Boegeisenia forbesii, Caulerpa racemosa, C. sertulariodes, Halimeda micronesia and H. macroloba whereas brown algae consisted of 11 kinds of algae including *Dictyota dichotoma, D. ciliolata*, *Dictyopteris delicatula*, *Turbinaria ornata*, *Padina australis, P. Minor, Sargasssum ilicifolium*, *S. polycystum*, *S. duplicatum*, *S. vulgare* and *Cystoseira compressa*. Moreover, red algae consisted of 6 kinds of algae including *Haliptilon virgatum*, *Laurencia obtusa*, *L. complanata*, *Gastroclonium subarticulatum*, and *Neogastroclonium subarticulatum* and *Thamnoclonium dichotomum*. Generally, phycho-chemical parameters in the Lhok Bubon beach still supported marine macroalgae growth.

Keywords : biodiversity, intertidal zone, Lhok Bubon Beach, macroalgae

Introduction

Background

Indonesia is a country with highly marine biodiversity. Indonesia is the center of marine biodiversity in the Indo-Pacific (Gray, 1997). Many marine biodiversity of Indonesia is used by local communities. One of marine resources that utilized was marine macroalgae or is known as seaweed. According to Dawes (1967), macroalgae is one of natural resources that possess value added and benefit not only for human being but also our environment. The benefit of macroalgae for human is a foodstuff, cosmetic, and drugs. Macroalga is useful for our neigbourhood because it can produced organic matter through photosynthesis process that is useful for marine ecosystem. A growth of macroalgae influenced by environmental factor the such as temperature, salinity, pH, turbidity and dissolved oxygen (DO).

Intertidal zone is an ecotone between terrestrial and marine ecosystems and is an important habitat for marine life. As an important part of the intertidal ecosystem, benthic macroalgae are primarily composed of Rhodophyta, Phaeophyta and Chlorophyta living on the rocks or gravel. They play an extremely important role in energy flow, circulation of materials, and information transfer in the intertidal zone, and are the most potential community for development of algae resources (Zhang *et al*., 2008).

Macroalgae are generally classified into three main divisions, namely Chlorophyta, Phaeophyta, and Rhodophyta, based on their pigmentation (John *et al*., 2002; Lee, 2008). Most green algae (Chlorophyta) are found in the ocean surface and marine sediments. Phaeophyta, the brown algae can be found mostly on the rocky intertidal shore. The red algae (Rhodophyta) usually inhabit warmer waters and tropical seas. The green algae appear green due to the presence of chlorophyll α and β. All green algae are photosynthetic, including single-celled, sheet like, tubular, filamentous and colonial forms (Starr and Taggart, 2004). The brown algae normally apppear brown or yellowish brown and they contain xanthopyll pigment called fucoxanthin. Some species of Phaeophyta appear olive-green, golden or dark brown depending on pigments (Ismail and Tan, 2002). Brown algae are distributed from the intertidal zone to the open ocean. The red algae appear red due to the dominance of the pigments phycoerythrin and phycocyanin. They are normally found in deep clear waters (Druehl, 2000). Biodiversity studies of tropical macroalgae are currently gaining attention. However, the biodiversity in the West Aceh coastal has not yet investigate intensively.

West Aceh water have coastal line as much as 50.55 km with extent of area 80.88 km^2 with various ecosystem that possess diverse yields (Farah *et al*., 2010). West Aceh regency is a coastal area with rich biodiversity and fisheries that infront of Hindian Ocean. Lhok Bubon beach is one of the beach that located in West Aceh. The main character of Lhok Bubon Beach is to possess substrate that dominated by dead coral and sandy as well as some substrates mixed with muddy. The exposure of sunlight in Intertidal area affected abundance of macroalgae. Macroalgae in this intertidal zone need a sufficient sunlight for photosyntensis. This circumstances of environment and subsrate are precisely habitat for growing macroalgae. The effort has to be made to investigate the diversity of marine macroalgae in the West Aceh area and the data obtained is of much use for future reference and comparison study. This research aimed to record the macroalgae biodiversity in the intertidal zone of Lhok Bubon beach and determined the species composition and distribution on intertidal and subtidal zones.

Research Methods

Study Area Overview

The sampling area was located in the Lhok Bubon beach, approximately 30 km from Meulaboh city, West Aceh (Figure 1). This research was conducted from December 2016 until February 2017. The Lhok Bubon beach located on the west coast of Aceh that infront of Hindian Ocean. Intertidal sediment is primarily rocky and gravel beach with rich marine macroalgae resources. This site also is tourism destination for local community.

Sampling Method

There sampling sites located in the Lhok Bubon Beach based on differences geographic condition and algal growth of subsrate. The sediment of site 1 (latitude 4°11'51.07"N ; longitude 96° 1'42.33"E), Site 2 (latitude 4°11'44.02"N ; longitude

96° 1'37.65"E), site 3 (latitude 4°11'42.64"N ; longitude 96° 1'32.41"E) is rocky, sandy and gravel, rocky substrate. The sites were positioned by using GPS. The marine macroalgae were collected along the coastal area in the Lhok Bubon beach. The intertidal zone and subtidal zone were represented by the three stations.

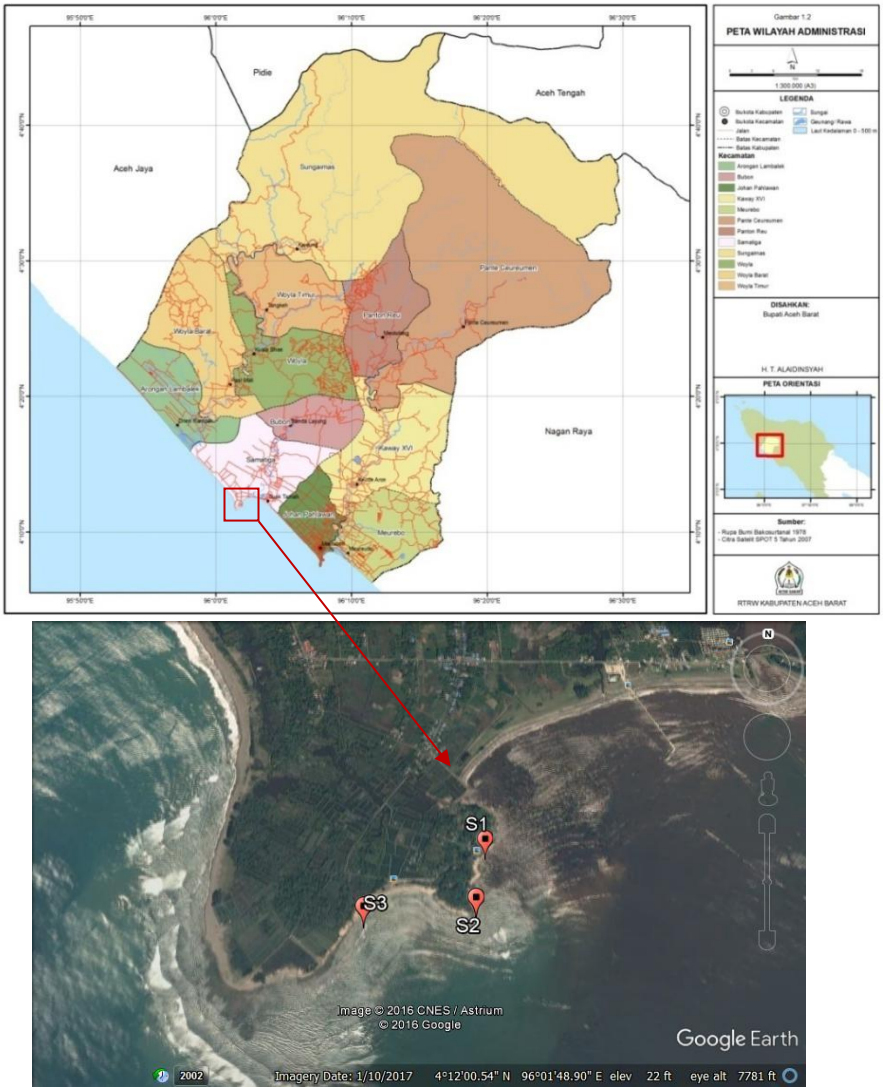

Figure 1. Sampling Site

Specimen Sampling

Macroalgae specimens that collected in the intertidal and subtidal zones by snorkeling and walking through the shallow water. Complete structure of macroalgae specimens was detached from their substratum and put into the plastic bags. Small and fragile specimen were kept in the specimen vials. Our specimen were cleaned by freshwater and removing any attached small debris and epiphytes. Data such as the shape and colour of macroalgae specimen were recorded on site. These data will assist species identification. Images of macroalgae specimen were captured by Canon zoom lens 5x. Identification of marine macroalgae conducted in the Fisheries Laboratory of Teuku Umar University. Specimens were subjected to morphological and anatomical examinations for identification. Identification of

species was based in macroalgae textbook (Kasim, 2016) and Algabase website : www.algaebase.org.

Results and Discussion

Results

Marine macroalgae in the Lhok Bubon beach, coast of western Aceh comprised of three main divisions namely Chlorophyta, Pheophyta and Rhodophyta (Figure 2). The most dominant division with the highest species richness was Phaeophyta, with ten species representing 41% of the total marine marine macroalgae species were recorded (Table 1). This was followed by Chlorophyta with eight species making up 37% of the total species richness. Rhodophyta which was represented by six species contributing 27% of the total species richness. Although, Phaeophyta exhibited the highest species richness in the Lhok Bubon beach area, it was only represented by two families: Dictyotaceae and Sargassaceae. Both families had similar species richness, of which Dictyotaceae was represented by five species and Sargassaceae by five species. *Sargassum* and *Dictyota*, both from the order Fucales and Dictyotales, were the common species of Phaeophyta recorded from the sampling site. Another member of Phaeophyta, *Padina australis* (Sargassaceae, Dictyotales) with a soft thallus with rhizoidal holdfast, was attached mainly to the sandy substrate. However, a small amount of *P. australis* was found on rocky substrate. Whereas the species of *P. minor* is similar to *P. australis* but smaller, with narrow interval of concentric lines and attains a height of 5-6 cm. This species mostly found on dead coral in mid intertidal zone along moderately wave exposed shorelines. Other genera of this division recorded in this study were *Turbinaria*. Chlorophyta was represented by six families, namely, Cladophoraceae, Ulvaceae, Udoteaceae, Caulerpaceae, Halimedaceae and Siphonocladaceae. This division was recorded as moderately diverse in terms of the number of family. Cladophoraceae dominated the green algae with two species while the other families were represented by one or two species. Other genera of Chlorophyta recorded in this area were *Halimeda, Boegeisenia, Chlorodermis, Codium* and *Caulerpa.* The red algae (Rhodophyta) were represented by families Corallinaceae, Champiaceae, Rhodomelaceae and Halymeniaceae. As expected for tropical marine waters, Rhodophiceae was the less diverse class of this division.

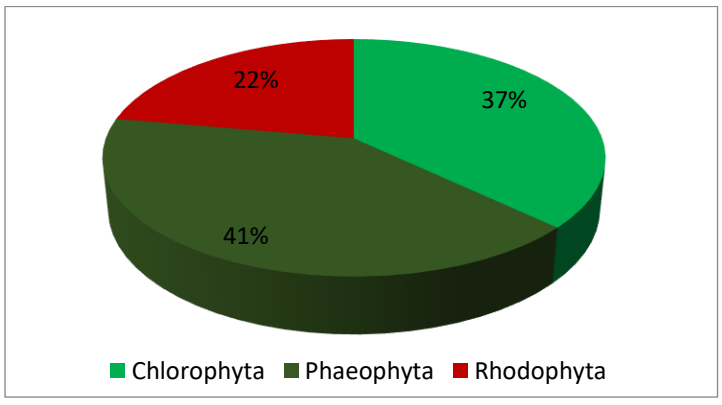

Figure 2. The percentage of marine macroalgae according to the divisions

Table 1. The marine macroalgae composition in the Lhok Bubon beach

Species	Zone	
	Intertidal	Subtidal
Division of Chlorophyta		
Cladophoraceae		
Chaetomorpha crassa	+	-
Cladophora sp	+	-
Ulvaceae		
Enteromorpha flexuosa	+	-
Codiceae		
Codium fragile	-	+
Udoteaceae		
Chlorodesmis fastigiata	+	-
Halimedaceae		
Halimeda macroloba	+	-
H. micronesia	+	-
Siphonocladaceae		
Boegeisenia forbesii	+	-
Caulerpaceae		
Caulerpa racemosa	+	-
C. sertulariodes	+	-
Division of Phaeophyta		
Dictyotaceae		
Dictyota dichotoma	+	+
Dictyota ciliolata	+	-
Dictyopteris delicatula		
Padina australis	+	-
P. minor	+	-
Sargassaceae		
Turbinaria ornata	+	-
Sargasssum ilicifolium	+	-
S. polycystum	-	+
S. duplicatum	+	-
S. vulgare	+	-
Cystoseira compressa	+	-
Division of Rhodophyta		
Corallinaceae		
Haliptilon virgatum	-	+
Champiaceae		
Gastroclonium subarticulatum	+	-
Neogastroclonium subarticulatum	+	-
Rhodomelaceae		
Laurencia obtusa	+	-
Laurencia complanata	+	-
Halymeniaceae		
Thamnoclonium dichotomum	+	-

Note : (+) = Presence (-) = Absence

Discussion

Lhok Bubon Beach, coast of western Aceh is dominated by the brown algae from two genera *Dictyota* and *Sargassum* (Table 1). Alongside the brown algae, the green algae from the family Cladophoraceae also recorded high in abundance. Mostly family Cladophoraceae associated with brown algae in the intertidal zone with attached in the dead coral substrate. According to Subathraa and Poonguzhali (2013), one of the species from family Cladophoraceae namely *Chaetomorpha* sp more significant in phytochemical properties. Beside that, the family Caulerpaceae also distributed with moderately abundance in Lhok Bubon Beach especially *caulerpa racemosa*. Not only the Caulerpaceae widely distributed in tropical seas, the macroalgae have also invaded the Meditteranean (Piazzi *et al*. 2001). Green algae of warmer tropical waters are similar around the world but in colder regions, the northern and southern green algae are markedly different (Costa *et al*., 2002; Tan and Yap, 2006).

The most diverse seaweed division in Lhok Bubon Beach was Phaeophyta, represented by *Sargassum*, *Dictyota* and *Padina*. *Padina* has concentric circles of tiny hairs which bear its reproductive structure in alternate ban between the lines of hairs (Geraldino *et al*. 2005). Strong wave action helps to loosen and distribute their spores. The most diverse and abundant genus was *Sargassum*. They are robust macroalgae with strong stripes and holdfast. These distinctive characteristics make it possible for *Sargassum* to withstand strong wave action and predators contributing to the survival of the taxa. Among the genera known from the west coast include seven genera of Cholorophyta (*Chaetomorpha, Cladophora, Enteromorpha, Chlorodesmis Halimeda, Boegeisenia* and *Caulerpa*). Five genera of Rhodophyta (*Haliptilon, Neogastroclonium, Gastroclonium, Thamnoclonium* and, *Laurencia*). Six genera of Phaeophyta (*Padina, Sargassum, Dictyota, Dictyopteris, Cystoseira* and *Turbinaria*). The differences in species richness between sampling sites could be attributed to the different in sampling frequency and time of collecting, changes in water physicochemical parameters and predator and prey relationship. Most diversity studies of algae in the past did not record the specific location of the sampling sites (with GPS coordinates) but generally marked the sites on a map. Therefore, to conduct a similar biodiversity study in the same location would be challenging. Thus researchers tend to conduct fieldwork in the same general area, although inaccurate, but generally acceptable as representative the study sites. In terms of habitat preference, there are marked differences of seaweed composition between the intertidal and subtidal zones. On a smaller scale, we found that there is a distinctive difference in species composition of the algae of subtidal and intertidal zones in the Lhok Bubon Beach. Chlorophyta was mostly found in the upper intertidal to subtidal zones while Phaeophyta proliferated in the mid-tidal zone. Both divisions are known to thrive in habitats having high light intensity. Naturally, Rhodophyta with phycoerythrin as their pigments grows well in lower light intensity in the subtidal areas where the water is much deeper. We hypothesize that the shift in species composition could be due to many concurrent changes such as water physicochemical components, light intensity and the predator

and prey interactions which need to be tested further. The rapid development within the proximity of the sampling sites has most probably triggered changes to the physicochemical parameters of the adjacent coastal waters.

Conclusion

Lhok Bubon beach was moderately diverse in seaweed diversity. With 25 species of algae comprising three divisions, Lhok Bubon beach can be considered as a highly reputable area. Unlike other places, this location was dominated by brown algae rather than green algae. Even though there was only a slight difference in terms of species richness between the two divisions, the results reflected the character of the habitat. This could be due to high turbidity, an implication from bad weather and sediments. Thus, it may not be the best habitat for the proliferation of green algae, but instead it gives rise to a good number of brown algae. We suggest larger sampling sites in the future to fully understand the species composition of algae in this area. A good systematic method to record the algae should be conducted. Spatial and temporal studies on marine plants in this area will help us to gain insight to this marine macroalgae.

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The Sensory Hedonic Quality and Physical Characteristics Effect of *Kappahycus Alvarezii* Seaweed and Catfish Bone on Traditional Food Ilabulo Catfish (*Pangasius* sp.)

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ABSTRACT

Kappaphycus alvarezii seaweed as an important commodity in Gorontalo Province add elasticity and nutrient to traditional ilabulo food whose raw material is catfish (*Pangasius* sp.). The research aimed to obtain characteristics of the sensory hedonic quality and physical gel strength due to fortification of *K. alvarezii* seaweed and catfish bone. The research method: added *K. alvarezii* 5% (A), 10% (B) and 15% (C)) and 10% (A), 15% (B) and 20% (C) of catfish bone. Organoleptic test used hedonic quality scale based on SNI 01-2346-2006 parameters of appearance, color texture, flavor and taste. Physical analysis used TA-XT2i texture analyzer. The data analysis of hedonic quality sensory used non-parametric statistics *Kruskal Wallis* and if significantly affected continued with *Duncan* test and physical analyzed used descriptive. The Results of hedonic quality was obtained that ilabulo of selected catfish formula is formulation C fortification of *K.alvarezii* 15% seaweed and 20% fish bone flour, exposure of whole criteria, neat, flat surface, average thickness (7,33), texture of chewy, compact, solid (6.87) and a rather clear brown criteria of color (7.07). However, the flavor criteria (7.4) and the taste with the fish flavoring criteria (7.47) were founded in the B fortification of *K. alvarezii* 10% and 15% catfish bone. The results showed that the physical texture of ilabulo catfish fortification with seaweed *K.alvarezii* and catfish bone is average 2149.3/gf and without fortification is an average of 1927 / gf.

Keywords : fortification, catfish bone, ilabulo catfish, , Kappaphycus alvarezii, physic,

Introduction

Kappaphycusalvarezii is an important seaweed commodity in Gorontalo Province which has been widely applied to food products. One food product that can be fortified *K. alvarezii* seaweed is the traditional food ilabulo made from raw material catfish. Fortification of seaweed *K. alvarezii* in addition to as a nutritional addition of fiber also serves to make the product ilabulo catfish become more supple that is in the process of gelatinitationwhen cooking ilabulo. Astawan*et al* (2004) suggested that *K alvarezii* seaweed contain fikokoloid one of them is carrageenan equal to 20,97% which can be added to food which function assist forming gel.

Traditional food of catfish ilabulo besides fortification of *K. alvarezii* seaweed and catfish bone also contain the main ingredient of sago flour which contributed to gel formation. This research was conducted to find out the of hedonic quality of *K. alvarezii* seaweed and catfish bone and physical strength that is fortification gel strength and without fortification of *K. alvarezii* seaweed and catfish bone on traditional food of ilabulo catfish.

Material and Methods

Materials and Tools

The materials used in this research were *K.alvarezii* seaweed meat and catfish bone, sago flour, corn flour, seasoning and coconut milk.

The tool used was scoorsheet of hedonic quality test of SNI 01-2346-2006 and gel strength of TA-XT2i texture analyzer.

Methods Preparation of Catfish (Pangasius sp.)

Catfish preparations include weeding, stomach contents, and fillet preparation. Fried catfish meat based on Lanier method (1992) about the making of fish fillet that is fillet fish washed using cold water temperature between 5-10 ^{o}C as much as 3 times with water ratio: meat = 3: 1 and crushed.

Making Catfish Bone Flour (Pangasiussp.)

The preparation of catfish bone was based on (El Fauziah (2003) &Mulia (2004) modified.Candine bone was cleaned and boiled at 100°C for 30 minutes, washed and steamed for 4 hours, autoclaved 121°C 1 hour, manual pressing, reduced size 5-10 cm, dried with 105°C 90 minutes oven, mashed and sieved 100 mesh.

Kappaphycusalvarezii Seaweed Porridge Based on Harmainet al (2016)

Kappphucusalvarezii seaweed porridge was based on Harmain*et al* (2016) method. *K. alvarezii*seaweed was cleaned and washed using fresh water as much as 3 (three) times, then soaked for 2 days and made two water changes. Furthermore, it was washed again with fresh water and the size of 3 - 5 cm was reduced and blended to produce *K.alvarezii*seaweed porridge.

Making Ilabulo Catfish (Pangasiussp.) Fortification Kappaphycus alvarezii Seaweed and Catfish Bone

The formation stage of catfish ilabulo refers to the formula of Harmain & Yusuf (2012) by modifying the addition of *K. alvarezii* seaweed and catfish bone as a treatment.

The ilabulo formation of catfish fortified *K. alvarezii* seaweed and catfish bone can be seen in Table 1.

Table 1. Formulation of ilabulo for 100 grams of catfish raw meat

Material Treatment	**Composition** (%)		
	A	B	C
*K. alvarezii*seaweed	5	10	15
Catfish bone flour	10	15	20
Sago flour (gr)	50	50	50
Corn flour (gr)	5	5	5
Garlic (gr)	10	10	10
Onion (gr)	30	30	30
Pepper (gr)	1,5	1,5	1,5
Chilli (gr)	1,5	1,5	1,5
Salt (gr)	1,5	1,5	1,5
Sugar (gr)	1,5	1,5	1,5
Coconut Milk (ml)	100	100	100
Onion Leaf (gr)	15	15	15
Cooking Oil (ml)	30	30	30

Based on the formulation, the process of making ilabulo is made. The scheme of ilabulo catfish making fortification of *K. alvarezii* seaweed and catfish bone flour is presented in Figure 1.

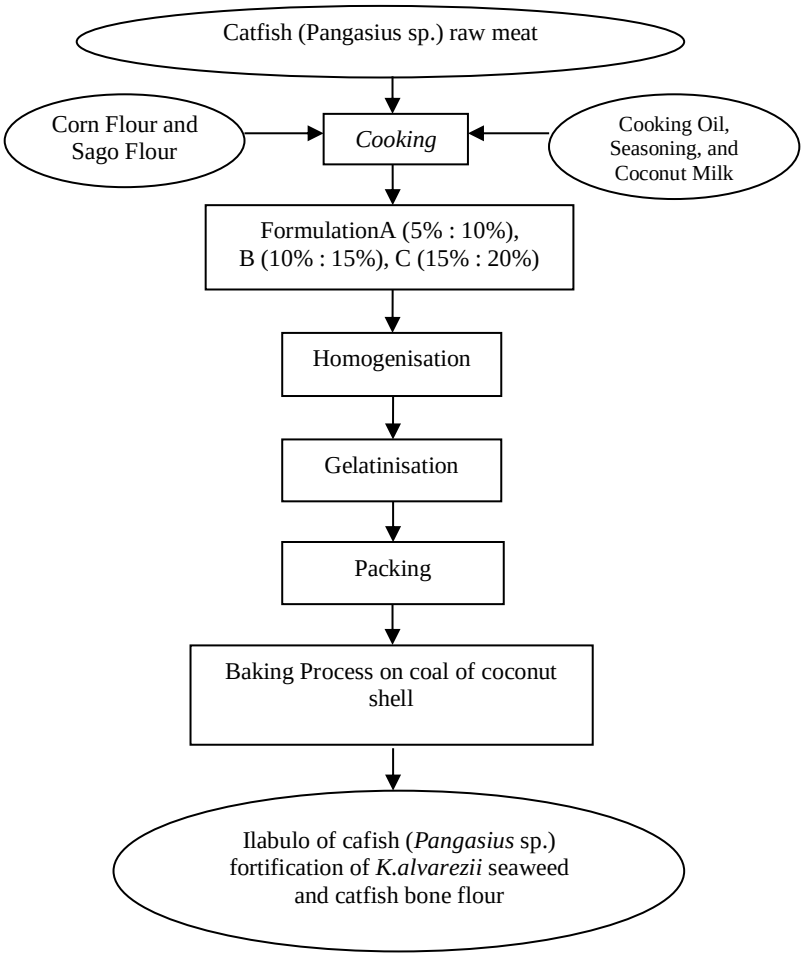

Figure 1. Scheme of ilabulo catfish fortification of *K. alvarezii* seaweed and catfish bone flour

Hedonic Quality Testing) (SNI 01-2346-2006) To Obtain Selected Formulations

Ilabulo catfish fortified *K. alvarezii* seaweed and catfish bone meal was then done hedonic quality test based on non parametric statistic Kruskal Wallis. If it is significantly different then proceed with Duncan test. Analysis of organoleptic testing data using SPSS 16.

Analysis of Gel Strength of Ilabulo Fish Patin (Pangasius sp.) Fortification of K. alvarezii Seaweed and Selected Patin Fish Chip Flour (Chen, et.al. 2013) (Apriyantono et al, 1989)

Analysis of gel strength using TA XTplus type texture analyzer (Chen, *et.al*.2013). The gel strength value was calculated by using the formula:

Gel strength (g cm) = gel force (gf) x distance (cm) (Apriyantono*et al*, 1989).

Result and Discussion

Research Results of Hedonic Quality Ilabulo Catfish (Pangasiussp.) Fortification Seaweed Kappaphycusalvarezii and Catfish Bone Flour

Appearance

The result of the research of hedonic quality of exposure criterion can be seen in Figure 2.

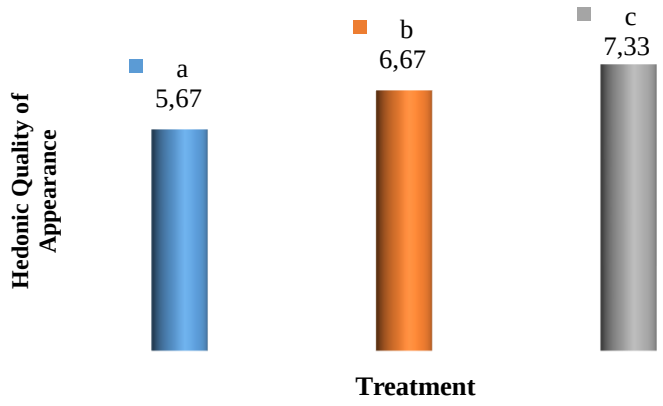

Figure 2. Histogram test results of hedonic quality of appearance

The histogram of figure 2 showed that the hedonic quality value of ilabulo catfish fortification of *K. alvarezii* seaweed and the highest catfish bone was C (15:20) formulated on the whole, neat, flat surface, average thickness of 7, 33 and the hedonic quality value of the lowest visibility of ilabulo catfish fortification *K. alvarezii* seaweed and catfish bone flour was A formulation (5:10) is in the intact criteria, less tidy, uneven surface, the thickness is not flat with a value of 5.47.

The *Kruskal-Wallis* test showed that the removal of catfish fortified *K. alvarezii* and catfish bone showed that the three formulations showed significant results ($p<0,05$). Based on the results of further tests *Duncan* obtained that the formulation of A (5:10) was significantly different from formulation B (10:15) and C (15:20), formulation B (10:15) was significantly different from formulation A (5:10) and C formulations (15:20) as well as C formulations (15:20) were significantly different from formulations A (5:10) and formulation B (10:15).

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Texture

The result of the texture hedonic quality value is shown in Figure 3.

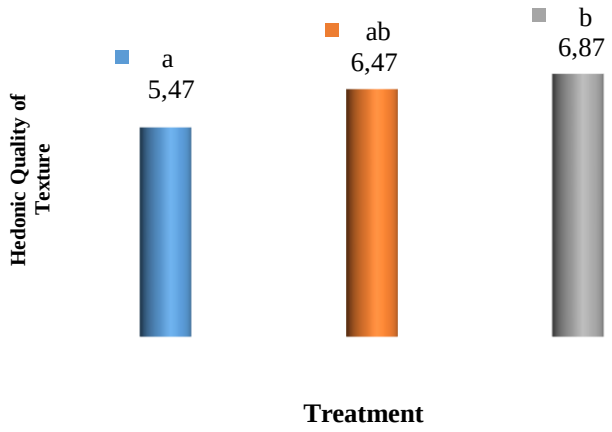

Figure 3. Result of test of hedonic quality test of texture

Histogram in Fig. 3 showed that the value of organoleptic hedonic quality of ilabulo catfish texture fortification of *K. alvarezii* seaweed and the highest catfish bone was B (15:20) formulated on the elastic, compact, solid criteria of 6.87 and the value Organoleptic hedonic quality texture lowest texture ilabulo catfish fortification *K. alvarezii* seaweed and catfish bone flour is cracker was the formulation A (5:10) is in the criteria of chewyness, less compact, less dense with a value of 5.47.

Kruskal-Wallis test showed that the ilabulo catfish texture of fortified *K. alvarezii* seaweed and catfish bone showed that the three formulations showed significant effect ($p<0,05$). Based on the results of further tests it was found that the formulation of A (5:10) was significantly different from the formulation of B (10:15) and C (15:20), formulation B (10:15) was very different from formulation A (5:10) and C formulations (15:20) as well as C formulations (15:20) were significantly different from formulations A (5:10) and formulation B (10:15).

Seaweed *K. alvarezii* fortified on seaweed affects the formation of the patabol of catfish texture in addition to sago flour in each of these formulations. In addition, the gelatinization process during the heating process also affects the texture of catfish ilabulo. This is caused because *K. alvarezii* seaweed contains carrageenan that serves as a formator of elasticity. Sago starch containing amylopectin starch together with the carrageenan properties of *K. alvarezii* seaweed contribute to the texture of ilabulo to be elastic, compact and solid.

Figure 3 showed that panelists prefer formulation B (10:15) which is significantly different because the addition of *K. alvarezii* seaweed and catfish bone meal that is not too little and not too much to form a texture is not too dense and compact. But the addition of seaweed and bone meal of little catfish produce the texture of the catfish ilabulo was not too compact and rather mushy. Corn flour with the same composition in each of these formulations is less likely to cause the texture to be less compact, so with fortification *K. alvarezii* grass helped in forming

elasticity ilabulo catfish besides sago flour. Gelatinization process during heating process is crucial in texture formation.

Color

The result of the hedonic quality colourvalue is shown in Figure. 4

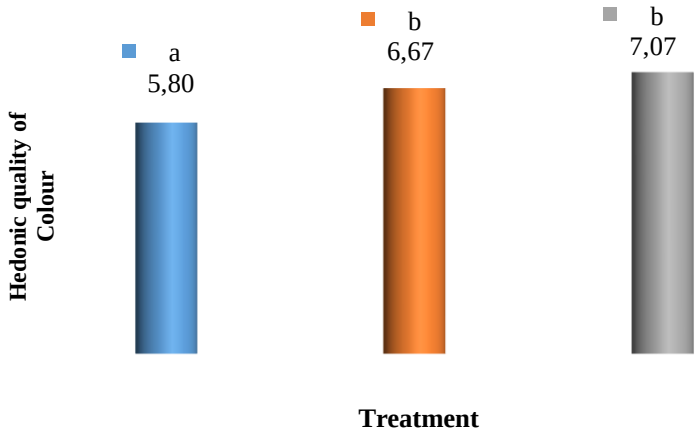

Figure 4. Results of color hedonic quality analysis

Histogram in Figure 4, showed that value of hedonic quality colourilabulo catfish fortification *K. alvarezii*highest seaweed was C formulation (15:20) is in criteria like value 7.07 that is brown rather clear and the lowest colourvalue was formulation A (5:10) ie yellowish brown is in the criteria like the value of 5.80.

Based on *Kruskal-Wallis* test that the colour of ilabulo catfish fortification *K. alvarezii*pada seaweed all three formulations showed no significant effect (p> 0,05) on formulation B (10:15) and C (15:20) but formulation A (5:10) had a marked effect on the formulations of B (10:15) and C (15:20). This was due to the addition of the amount of composition *K. alvarezii* seaweed also affect the colour of catfish ilabulo.

Ilabulo catfish formulations B and C were not significantly different due to the addition of *K. alvarezii* seaweed to cover the colour of yellow cornflour. Colors on ilabulocatfish were also also due to the addition of brown sago flour also affect the formation of color. In addition, the processing at the time of heating and baking also contribute to the formation of the colour of *Maillard* reaction. The *Maillard* reaction is an enzymatic browningthat occurs between the reducing agents and the amino acids that produce a brownish color on the foodstuff when subjected to heating.

Aspects of colour formation of catfish ilabulo at the time of roasting is very important because it can affect the reception of panelists, because if too long in baking cause ilabulo color becomes somewhat blackish other than that the use of white sago flour compared with sago flour is slightly reddish brown needs to be considered. According Winarno (2008), colour is the result of the eye senses that can be considered in the assessment of a product.

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Flavour

The result of the hedonic quality flavouranalysis is shown in Figure 5.

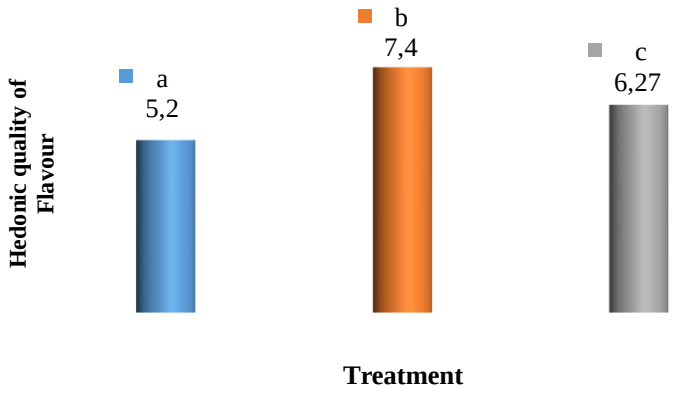


Figure 5. Results of hedonic quality flavourtest

The result of organoleptic test of hedonic quality of taste was obtained that the selected formulation was formulation B (10:15) with the highest value of 7.4 criteria like the hedonic quality of fish smell.

Based on *Kruskal-Wallis* test, the aroma of catfish ilabulo which fortified by *K. alvarezii*seaweed and catfish bone meal of the three formulations had significant effect (p> 0,05).

These results indicated that the fortification of *K. alvarezii* seaweed and Catfish bone meal formulation A (5:10) B (10:15) C (15:20) in ilabulo catfish is said to affect the peculiar aroma of catfish ilabulo. The aroma of the catfish ilabulo is also the formation of volatile compounds through the process of processing. It is known that the aroma is one important factor that helps determine the acceptance or the fondness of a food product.

Taste

The result of hedonic quality test of taste criteria of ilabulo catfish fortification *K. alvarezii* seaweed and catfish bone meal can be seen in Figure 6.

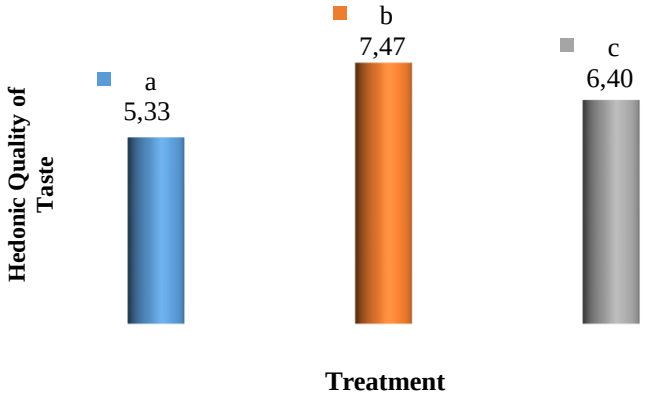


Figure 6. Results of the taste hedonic quality test

Based on Figure 6 showed that the hedonic quality of taste obtained the highest value in the formulation B (10:15) that was 7.47 with the criteria feels fish,

savory. The lowest value was on the formulation A (5:10) 6.40 with the criteria of less tasty fish less savory.

The results of *Kruskalwallis* analysis showed that the three formulations had significant effect. The results of *Duncan*'s advanced test analysis showed that the formulation of A (5:10) was different from the formulation B (10:15) and C (15:20), the different formulation B (10:15) Real with formulations A (5:10) and C (15:20) and formulation B (10:15) was different from formulation A (5:10) and C 15:20).

The three different formulations were significantly different due to differences in the composition of seaweed and bone meal of different catfish so that the panelists give the organoleptic value of hedonic quality in accordance with the addition of the composition according to the formulation. The more composition of *K. alvarezii* seaweed and bone meal added, the product will produce different flavors despite the addition of spices with the same formulation. In addition, due to the processing included in the case of fumigation that contributes to different flavors that cause the product ilabulo catfish have a distinctive flavor. This is as proposed by Lewless and Heymann in Ariyani (2012) that the taste of a food comes from the constituents themselves who have undergone the processing.

The flavor on ilabulo catfish fortification *K. alvarezii* seaweed and catfish bone meal is an important factor in the acceptance of a food. Although the parameters such as texture, appearance, color and aroma with a good judgment on a product but if the taste is not preferred or not accepted then the product will be rejected.

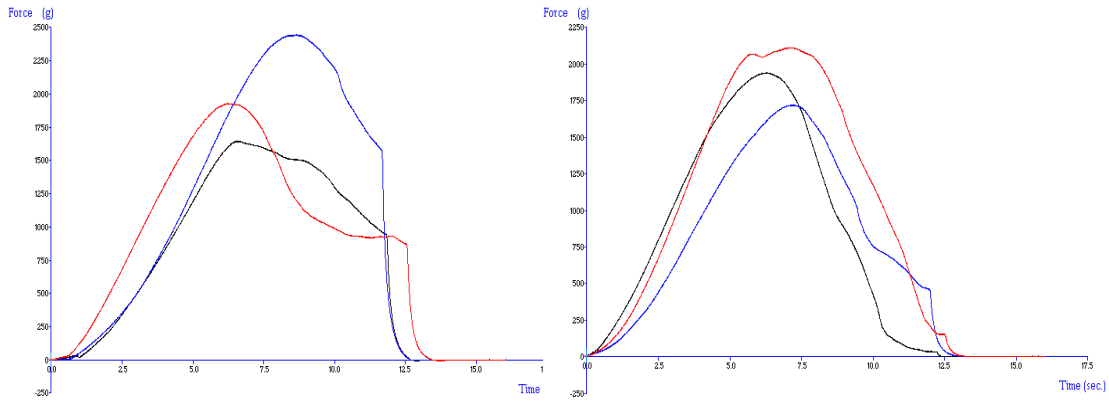
Strength Gel

Data from analysis of gel strength of ilabulo catfish fortified *K. alvarezii* seaweed and selected catfish bone form (C) (15:20) and without treatment (control) are shown in Table 3.

Table 3. Data analysis of gel strength of ilabulo catfish fortification *K. alvarezii* seaweed and catfish bone.

Repeat	Selected Formulation of Product (C) (Gram fource/gf)	ProductWithoutTreatment (Control) (Gram fource/gf)
1	1933.9	1943.7
2	2063.4	1721.5
3	2450.6	2115.8
Average	2149.3	1927

The results of gelilabulopatellarity analysis of catfish fortification of *K. alvarezii* seaweed and selected catfish bone (C) (15:20) and without treatment (control) can be seen in Figures 7a and 7b.



a) Selected formulation (C) (15:20) b) Without treatment (control)

Figure 7. Analysis of gel strength of the catfish ilabulo fortification of *K. alvarezii* seaweed and selected catfish bone formula (C) (15:20) (a) and without treatment (control) (b).

Conclusion

Based on the result of the research, it is concluded that ilabulo catfish *(Pangasius*sp.*)* selected formulation fortified seaweed *K. alvarezii* 15% and catfish bone flour 20% hedonic quality criteria appearance intact, tidy, flat surface, uneven thickness, chewy texture, compact, Solid, clear brown color, smell smell fish, taste fish feels, tasty. Based on the physical ilabulo catfish fortification of seaweed *Kappaphycusalvarezii* and catfish bone flour obtained gel strength is 2149.3/gf higher without fortification ie 1927/gf.

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Ecoedutourism as Marine Conservation Alternative: Case of Taka Bonerate National Park

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ABSTRACT

Taka Bonerate National Park is a coral reef site that has a high diversity of coral and fish species. Damage to coral reefs in Taka Bonerate has occurred since the past, even the activity of fish bombing and the use of fish poison still occur today. As a result, massive damage occurs in many coral reef locations. This encourages the need of conservation. Ecoedutourism is one of the concepts of tourism that encourages the conservation of natural tourist attractions and provides conservation education to tourists. The development of ecoedutourism concept of Taka Bonerate National Park is done through Analysis, Design, Development and Production, Implementation (ADDIE Method). Edutourism of Taka Bonerate focuses on Biodiversity of Marine Biota, Corals Ecosystem, and Conservation topics. The development product used in this edutourism are teacher manual (if this is for student tourist), edutourism worksheet, material booklet, guide's manual, and Taka Bonerate National Park governor manual. After going through the evaluation phase, the concept of ecoedutourism is very supportive of conservation efforts in Taka Bonerate National Park. Therefore it can be concluded that edutourism can be used as an alternative to marine conservation.

Keywords: Ecotourism, Edutourism, Taka Bonerate, Marine Conservation

Introduction

Damage to coral reef ecosystems began to occur in Taka Bonerate National Park. It is a warning for all of us to save the marine biological resources. The most common cause of such damage is the arrest especially the use of illegal fishing gear. This is also supported by the increasing demand for reef fish at high prices, resulting in higher levels of fish exploitation. In addition, irresponsible tourism is also one of the factors causing damage to coral reef ecosystem of Taka Bonerate National Park. Therefore, efforts are needed to overcome this problem, one of them is by sustainable marine management.

One way to make people aware of the importance of coral reef conservation and biota in it is by sustainable management of coral reefs, one of them is through ecoedutourism concept that involves local community. Ecoedutourism is a tour of the natural environment that is more emphasized on the learning experience. Ecoedutourism is a combination of the concept of ecotourism with edutourism. Ecoedutourism emphasizes more on the learning experience of tourists. This research and development aims to develop ecoedutourism Taka Bonerate National Park as one of conservation alternative.

Methods

This is a research and development (R & D) with ADDIE development model. ADDIE consist of five steps, these are Analysis, Design, Development and Production, Implementation, Evaluation. It was adapted from Dick and Carey model (Dick, Carey, Carey, 2005: 6-8). Analysis stages consist of learning objects

identification, student's need analysis, curriculum analysis, and instructional analysis. Design stage consist of develop learning objectives, framework (outline) of edutourism development product, and design evaluation tools. Development and productionstageconsist of developedinstrument to assess edutourism, develop learning strategy, materials selection, writing draft of edutourism development product, draft review, draft assess, and firstrevision. Implementation stage is trial for edutourism development product.Implementation subject are students from SMA Taka Bonerate who school location adjacent to Taka Bonerate National Park and previously they never visit to Taka Bonerate National Park. The last step is evaluation stage where summative evaluation conducted to determine the usefulness of the product and make recommendations on further product development.

Results and Discussion

Taka Bonerate National Park is a part of Taka BonerateSubdistrict, in Selayar Islands District, South Sulawesi Province. Taka Bonerate National Park is a natural conservation area that is geographically located in the Flores Sea at 120°55'-121°25' East Longitude and 6°20'-7°10' South Latitude. Taka Bonerate is a reef atoll covering an area of 220.000 Ha. This area has been identified as the largest atoll in Southeast Asia and the third largest in the world after Kwajilein atoll in Marshall Islands and the Suvadival atoll in Maldives (Kumalasari, I, *et al*., 2013: 2). The largest reef atoll area with a very high level of biodiversity and as a habitat for various rare and protected marine biota, then Taka Bonerate area was initially designated as a marine reserve in 1989, then designated as the Marine National Park in 1992, and designated as a National Park In 2001 with an area of 530,765 Ha (Rahmah, Nur*et al*, 2012: 2-3). Marine conditions and marine biodiversity make Taka Bonerate potential for marine tourism development.

Taka Bonerate National Park area has the potential of tourism in the form of natural and cultural potential, which is very prospective to be developed. Based on this potential and as a Nature Conservation Area, the concept of tourism currently being developed is eco-tourism or eco-friendly and sustainable tourism. Characteristics of the region in the form of small islands, marine waters with coastal ecosystems, coral reefs, sea grass, and marine biota, making the beauty and uniqueness of nature into a potential tourist attraction with a great comparative and competitive value.Nature tourism that can be done with various activities such as seeing the beauty of nature and exercise (sport). The beauty of nature that can be enjoyed in the form of sunrise and sunset, white sand around the beach, the diversity of marine life (coral reefs, fish and other rare biota), palm trees, and various other natural beauty. While sports activities can be very diverse, among others, swimming, snorkeling, scuba diving, canoeing/sailing, fishing, jogging/trekking and sunbathing (Allo, Layuk Noel, 2011: 2) . The potential of coral reefs that are large enough to make Taka Bonerate as a paradise for divers. Taka Bonerate has had the location of the point of diving which each point has its own advantages and uniqueness.

Culture is also one of the tourist attractions that can be shown in this tourist attraction. Taka Bonerate, which in the local language (Bugis language) means "reefs piled on the sand" or "sandstone mounds", consists of 21 islands where 7 islands are inhabited by residents of the Bajo, Bugis, Selayar, Buton and Flores tribes. Civilization of people who live in the small islands in Taka Boneratearea is also one of tourist attraction in Taka Bonerate National Park. The society dominated by the Bugis and Bajo tribes, each one of them has a cultural uniqueness and surrounded by maritime culture and Islamic nuances which are very thick and making cultural attractions to be a supporting factor for the development of tourism in Taka Bonerate National Park.

Damage to the coral reef ecosystems began to occur in Taka Bonerate National Park. In Taka Bone Rate area, the average damage rate is still with live coral cover about 40-60%. That data is a warning for all of us to save the marine biological resources. Some of the main contributing factors to coral reef damage include coral mining, explosive and cyanide (illegal fishing), fishing by unsustainable fishing gear, dredging around coral reefs, waste disposal, deforestation in upland areas, uncontrolledand poor of tourism management. The most common cause of such damage is catching especially use of illegal fishing gear. This is also supported by the increasing demand for reef fish at high prices, resulting in higher levels of fish exploitation. Various types of fishing gear that operates in reef areas such as bottom gill net, bubu, kulambi, spear, has had an effect on the exploitation pressure in the coral reefs. If this condition continues to be left for several years, it is expected that most coral reefs in the coastal areas of South Sulawesi Province will suffer serious damage and will have a decrease in the productivity of capture fisheries around the coral reefs. In addition, the impact of irresponsible tourism activities also contributes to the damage to coral reefs of Taka Bonerate National Park. Therefore, efforts are needed to overcome this, one of them is by sustainable marine management.

Tourism is one of the solutions of marine management. However, this tourism needs to be designed to support the concept of sustainable development. Not infrequently, tourism actually provides a negative effect for the natural environment. The construction of accommodation, visitor centers, infrastructure, and other services has a direct impact on the environment, from vegetation removal, animal disturbance elimination of habitats, impacts on drainage etc. In the Taka Bonerate National Park, ecosystem damage due to irresponsible tourism has also occurred, such as: 1) Wildlife habitats may be caused by tourism; hunting areas, breeding areas, etc.; 2) Increased demands for fresh water; 3) Disposal of sewage or litter; 4) Release of oil and fuel from ships and smaller craft; 5) Propeller-driven watercraft may affect certain aquatic plants and species.

In order to preserve the marine ecosystem, in this case the coral reef of Taka Bonerate National Park, there are several things that need to be done, among others: 1) improvement of surveillance and security of coral reef ecosystem from destructive activity. 2) prevention of the use of materials or fishing equipment that

may threaten the preservation of coral reef ecosystems. 3) the establishment of Marine Protected Areas in some small islands to prevent increasing coral reef damage and protecting some good ecosystems. Such activities have been undertaken by the consortium of MitraBahariSulsel in several places. 4) Increased understanding and public awareness of the importance of coral reef ecosystems should still be improved. The development and maintenance of coral reefs on small islands should focus on how to protect the area so that coral reef conditions are maintained.

Most of the people of Taka Bonerate have not understood the importance of conservation of marine biota. Observations on reduction of kima(*Tridagna* sp) population in Taka Bonerate National Park indicate that it is reduced due to Hunting, Habitat Damage, Potassium Use and Fish Bomb and Meets Consumer Needs. One way to make people aware of the importance of coral reef conservation and biota in it is by sustainable management of coral reefs, one of them is through tourism ecoedutourism concept that involves local community.

Ecoedutourism is a tour of the natural environment that is more emphasized on the learning experience. Ecoedutourism is a combination of the concept of ecotourism with edutourim. Ecoedutourism emphasizes more on learning experience of tourists. Edutourism is when someone travels to a unique location, for the purpose of formal or informal learning. Meanwhile, ecotourism is environmentally responsible travel and visits to undisturbed natural areas, in order to enjoy and appreciate nature (and any accompanying cultural features, both past and present), that promotes conservation, has low visitor impact, and provides for beneficially active socio -economic involvement of local population (Ceballos-Luscurain, 1996). The term ecotourism can be interpreted as a journey by a tourist to a remote area with the aim of enjoying and learning about nature, history and culture in an area, where the pattern of tourism helps the economy of local communities and supports nature conservation. Some key aspects of ecotourism are: 1) The number of visitors is limited or arranged to fit the carrying capacity; 2) environmental and socio-cultural societies (vs. mass tourism); 3) Eco-friendly tourism pattern (conservation value); 4) Patterns of cultural tourism and local customs (value of education and tourism); 5) Directly assist the economy of local communities (economic value); 6) The initial capital required for infrastructure is not large (value of community participation and economy).

Ecotourism can benefit national parks in three ways. First, direct benefit. Ecotourism is one of the most important ways in which money can be generated to manage and protect the world's natural habitats and species. Ecotourism can contribute directly to conservation through park admission fees and payments for guiding, accommodation and interpretation centres. Central to the definition of ecotourism is reinvestment by the industry in the maintenance of habitats and species.Second, indirect benefit. Ecotourism can enable local people to gain economically from the protected area with which they live. Protected areas cannot coexist in the long term with communities which are hostile to them. Local people

are important stakeholders with whom protected area managers must co-operate. More of the benefits of conservation need to be delivered to local people by enabling them to benefit from the protection of the park - their use of which is now regulated. If local people secure a sustainable income (a tangible economic benefit) from tourism to these protected areas, they will be less likely to exploit them in other less sustainable ways - obvious examples are overfishing, poaching or coral blasting. If local people gain from the sustainable use of, for example, a coral reef or wild animals through tourism, they will protect their asset and may invest further resources into it. Third, education benefit. Ecotourism can offer a means by which people's awareness of the importance of conservation and ecological literacy can be raised, whether those tourists are domestic or international. The clients on whom the ecotourism section of the tourism industry depends are potential voters, taxpayers and leaders who may help to build constituencies of support to lobby for conservation.

The development of ecotourism in Taka Bonerate National Park has not been accompanied by the development of edutourism. Stake holder has not developed the potential of object in location for conservation education through tourism (edutourism). The concept of tourism that is applied in the form of ecotourism, which is tourism that is not environmentally destructive and sustainable, but has not included many concepts of education. There are no support of facilities such as mapping the potential of tourist attraction for learner/student tourist or teaching materials that can be used by tourist. Other limitations is the quantity and quality of human resources in Taka Bonerate, in this case knowledge, skills, and understanding of tourism, causing the lack of quality of service to tourism activities (Alloe, Layuk Noel. 2011: 3). Therefore, this ecoedutourism development aid is needed for Taka Bonerate National Park.

The richness of biodiversity and the uniqueness of natural conditions makes the edutourism of marine biodiversity potential material developed in Taka Bonerate National Park. In this area there are three categories of coral reefs, namely barrier reef (reef barrier), fringing reef (reef), and atoll. And there are several locations of a very steep reef profile (drop off). There are 68 genera and 242 species of corals, 526 species of reef fish (155 genera), 112 species of macro algae (46 genera), 11 species of seagrass (7 genera), 70 species of terrestrial plants, 34 bird species (covering land birds, And beach birds), and some other marine and terrestrial biota such as turtles, dolphins, whales, etc. (Effendi, Danil Ahmad, 2011: 15). Moderate coral reef habitat 10,029 ha, dead coral 8,559 ha, and algae 19,748 ha, sand 20,381 ha, island 437 ha and sand dunes 76 ha.

Taka Bonerate National Park has many potential as learning resources, it can be developed ecoedutourism concept. Tourist, especially students tourist can study in Taka Bonerate National Park. Potential analysis conducted to find learning object and decide ecoedutourism activity in Taka Bonerate National Park. Then tourist activities arrange in packages.

Table 1. Edutourism Package in Taka Bonerate National Park

Ecoedutourism package "Marine Biota"		
Learning Post	Learning Aspects (Education)	Refreshing Aspects (Tourism)
Baby Shark Spot Corina Corner Seagrass Spot Kima Spot	Observediversity of marine biota Studydiversity of marine biota Study the importance of marine biota diversity Study many cases of marine biota conservation in Taka Bonerate National Park Study how to conserve the diversity of marine biota	Diving Snorkeling Photography below sea level Canoeing Boating Swimming with baby shark
Ecoedutourism package "Coral Reef"		
Learning Post	Learning Aspects (Education)	Refreshing Aspects (Tourism)
Ibel Orange Spot Softcoral Points Acropora Points Other Corals Spot	Observe the diversity of corals Study the components of coral reef ecosystem and their interactions Study the importance of coral reef ecosystem Study how to conserve coral reef ecosystem Practice Coral Transplantation	Diving Snorkeling Photography below sea level Boating

Learning objects that potential to be studied by students tourist in Taka Bonerate then developed into instructional organization that consist of teacher manual, edutourism worksheet, Booklet Material, *guide's* manual, and Taka Bonerate National Park governor manual.

1. Teacher Manual
   Teacher manual consist of three parts, Part I. Introduction of Edutourism Taka Bonerate National Park, Part II. Edutourism Activities with Scientific Approach, and Part III. Edutourism Learning Equipment consists of syllabus and lesson plan
2. Edutourism Worksheet
   Worksheet consists of four learning activities, 1st Learning Activity: Marine Biota Diversity, 2nd Learning Activity: Understand Coral Reef, 3rd Learning Activity: Coral Reef Ecosystem, 4th Learning Activity: Marine Biota Conservation. Before learning activities, students introduced work safety to have activities in the sea. After learning activities, students evaluated with assess instruments that included in edutourism worksheet.
3. Booklet Material
   Booklet material consists of three topics, namely: Diversity of Marine Biota, Coral Reef Ecosystem and Marine Biota Conservation. Each topic begins with an explanation of learning objectives and ends with "Do You Know?". In the end of the booklet therea are given conclusion and glossary
4. Guide's Manual
   Guide's manual consists of two parts. First part, guide are introduced about the potential of Taka Bonerate National Park for edutourism development. Second part, guide can study how to guide edutourism activity in Taka Bonerate National Park.

5. Taka Bonerate National Park Governor Manual
   Governor manual consist of two parts. First parts, governor of Taka Bonerate National Park are introduced about the potential of Taka Bonerate National Park for edutourism development. Second part, governor can study edutourism activity in Taka Bonerate National Park.

Edutourism products that have been developed were implemented on students of SMAN Taka Bonerate. Each student did activities based on worksheet and learns the material from booklet material. Edutourism activities conducted with scientific approach and cover three topics; there are Marine Biota Diversity, Coral Reef Ecosystems, and Marine Biota Conservation. Stages of edutourism with scientific approach are observing, questioning, associating, experimenting, and networking. From these activities, tourist, especially student tourist can be learn about how to conserve. It is one of effort to increase the awareness of society to conserve Taka Bonerate National Park.

Conclusion

Ecoedutourism is very supportive of conservation efforts in Taka Bonerate National Park. Therefore it can be concluded that edutourism can be used as an alternative to marine conservation.

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Extracts of Majapahit (*Crescentia cujete*) Fruit for Use Ineradicating *Vibrio Harveyi* Bacteria Caused Vibriosis in Vannamei Shrimps: An *Insilico* Method Approach

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ABSTRACT

Shrimps features fisheries revitalization program, as well as seaweed and tuna. Constraints to the cultivation of shrimpsare diseases caused by viruses and bacteria, such as white spot syndrome (WSSV) and vibrosis, leading to massive animal and economic losses during farming. Vibrosis is caused by *Vibrio* genus of bacteria including *Vibrio harveyi*, and antibiotics and chemicals areamongst the most widely-used agents for controlling these diseases. However, long-term uses of these agents can negatively impact the aquatic environment, pathogens become resistance, and consumers' health is compromised with antibiotic and chemical residues.Herbs have been used for thousands of years as anti-viral and anti-bacterial agents, and the fruit of Majapahit (*Crescentia cujete*) plant is a notable example.Majapahitfruitcontains bioactive compounds with analgesic, antiplasmodicand bacteriocidal properties, which can be established with *in vitro*, *in vivo* and *insilico* techniques. The *insilico* technique was used with a special software, and Majapahit fruit was extracted with methanol. The extracts were found to contain furfural, furancarboxaldehyde, 2-propenoic acid, and 3-phenyl/1-phenylpropane-1,2-dione with abilities to adversely interact with *V. harveyi*proteins Vibhar_05229 (KO7140), Vibhar_05086, Vibhar_06648, Vibra_06715, and Vibra_00828. These adverse interactions can control the activities of *V. Harveyi*, and Majapahit fruit extracts can be used to preserve shrimps as a green technology.

Keywords; Crescentia cujete,vibriosis, *Vibrio harveyi*, insilico

Introduction

Ministry of Maritime Affairs and Fisheries (MMAF) sets a target fishery production amounted to 22.54 million tons in 2014, of which 16.89 million tons came from aquaculture, in line with the increase in fish production program set by the government. The 10 leading commodity cultivation, one of which are shrimps. The commodity is projected to increase annual production by 13% to 16% black tiger shrimp and vannamei shrimp. Shrimp production in 2014 was expected to reach 699 tons of black tiger shrimp and 511 thousand tonnes of vannamei shrimp (KKP, 2010). This sector accounts for less than 10,000 metric tons in 1970 to more than 3,000,000 metric tons in 2011. Most of the production comes from the shrimp vannamei shrimp (*Litopenaeus vannamei*), which accounted for 67% of the total world shrimp production (Li, and Xiang, 2013).

A disease that often affects the shrimp farming are the disease caused by viruses and bacteria, such as the syndrome white patches (WSSV) and Vibrosis has made losses for the shrimp industry approximately one billion dollars per year since the 1990s in this world. Shrimp production in China has plummeted from 200,000 tons to 50,000 tons due to an outbreak of disease in the early 1990s (Li and Xiang, 2013). In addition to disease caused by bacteria can also cause death or seed shrimp larvae. As a result of infection with pathogenic microorganisms, many aquatic organisms are cultured suffered mass mortality, causing considerable economic losses high. Vibrosis disease caused by the bacterium *Vibrio* genus has long been a major problem for the industry, especially shrimp farming on shrimp larvae or seed.

Vibrosis has caused losses and destruction on a variety of shrimp farming. Vibrio bacteria attacks the larvae of shrimp, namely when the shrimp in a state of stress and weak, therefore it is often said that the bacteria vibrio including opportunistic pathogens.

Shrimp production improvement program to be sustainable, both ecologically and economically, then control the disease should be a priority. Extent of disease control efforts can be done for example by the use of antibiotics or chemicals, vaccines, probiotics, the use of SPF / SPR, and biosecurity. The use of antibiotics and the use of chemicals are a control method that has long illness and most widely applied in farming activities, but its use for the long term can have negative impacts. This impacts not only on the marine environment and pathogens into resistance, and even the health of consumers in the form of the antibiotic residues. Based on several studies that have been conducted, it was found that the administration of antibiotics in the ponds has resulted in the emergence of antibiotic-resistant pathogens (antibiotic-resistant pathogens). In addition, administration of antibiotics in the ponds require large amounts of expensive materials and can accumulate in fish / shrimp farming or the environment and endanger the health of consumers. According to Harikrishnan *et al*., (2011), the application of antibiotics and chemotherapy as prophylactic measures in intensive aquaculture system has been widely criticized for having a negative impact such as immunosuppression and residue accumulation in the tissues as well as lead to the occurrence of drug-resistant pathogens. Application of antibiotics or other chemicals to aquaculture ponds is quite expensive and undesirable because it causes mortality risk shrimp / fish and environmental pollution, and cause growth disorders. Repeated antibiotic use and in the long term, also encourage the spread of resistant pathogens.

Many herbs have been used for thousands of years as a home remedy and some of them have anti-viral and antibacterial. Natural plant product has been reported to have a variety of activities such as antistress, growth promoters, appetizer, tonic, immunostimulatory and antimicrobial (Citarasu*et el*., 2002). In addition, substances derived from natural sources / plants have interesting things such as non-toxic, biodegradable and biocompatible immunostimulant derived from herbs with different doses helps improve endurance, especially by improving survival by 74% (Thavasimuthu *et al*, 2006)One alternative is to use the plant majapahit (Crescentia cujete). to substitute antibiotics. This plant can be used as an anti-bacterial compounds that contain bioktif that can be used as an analgesic, antiplasmodik and has a bacteriocidal effect (Frotan, *et al*., 1983). The use of the fruit and leaves of Majapahit as anti-bacterial done research on the bacterium *Staphylococcus aureus, Enterococcus faecalis, Streptococcus pneumoniae, Streptococcuspyogenes, Escherichia coli, Candida albicans*, and *Ralstonia solanacearum, Vibrio alginoliticus*(Rojas *et al*. 2001; Dewi *et al*., 2014, Rinawati, 2011). For it must needs be done in an experiment on the effect of the bioactive compounds contained in extracts of plants, especially fruit majapahit as an antibacterial against *V. harveyi* bacteria which is one of the causes of disease in shrimp vibrosis, as well as how the mechanism patogenitasnya on vannamei shrimp

(*L. vannamei*).This research generally aims to determine the ability of bioactive materials majapahit fruit methanol extract (*Crescentia cujete*) as an antibacterial material in bacteria *V. harveyi*with in silico method.

Materials and Methods

Tool

This study uses equipment such as hardware and computer software hp brands with specification Intel Atom processor @ 2.3 GHz, 4MB RAM and software such as PubChem (http://pubchem.ncbi.nlm.nih.gov/), PassOnline (http ; // www.pharmaexpert.ru/passonline/), software STTITCH (http://sttitch.embl.de/cgi/show_input_page.pl) and software UNIPROT

Material

The materials used in this study are compounds GC-MS results from the methanol extract of the fruit majapahit (*Crescentia cujete*) in the form of compounds derived predictions of five highest peak point (Rahmaningsih, 2017) (Figure 1)

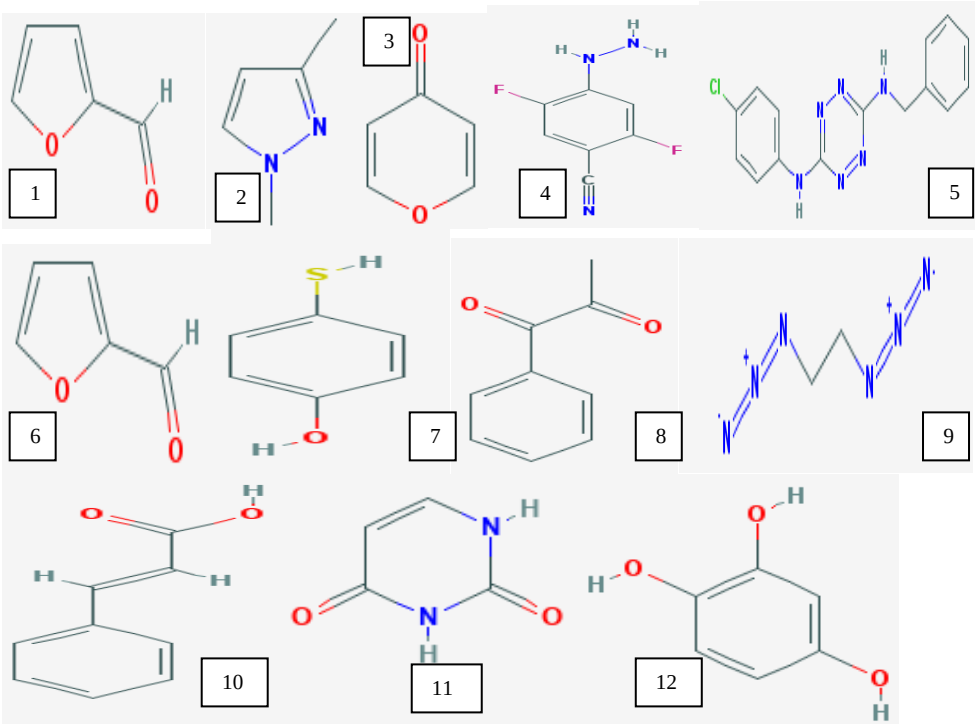

Figure 1. The compound GC-MS assay results majapahit fruit extract (1) compounds furfural (2) pyrazole 1,4dimethyl (3) 4H-Pyrans-4-one (4) 2.5 difluorophenyl hydrazine, (5), 2.4 , 5-tetrazine-3,6-diamine, (6) Furan carboxaldehyde, (7) 4-Mercaptophenol (8) 2-propenoic acid, (9) 1,3,5-Triazine-2,4,6-triamine (10) Trans-Cinnamic acid (11) 2.4 (1h, 3h) -pyrimidinedione (12) 1.2.3 Benzenetriol (PubChem, 2016).

Insilico Test

Studies In Silico Compound GC-MS assay results majapahit fruit extract conducted with several stages;

a. Characterization of compound

Characterization of compounds using PubChem software (http://pubchem.ncbi.nlm.nih.gov/)

b. Analysis of Biological Activity

Analysis of the biological activity of these compounds using PassOnline software (http; // www.pharmaexpert.ru/passonline/)

c. Prediction of Antibacterial Mechanism Against Vibrio sp.

Prediction antibacterial mechanism uses software STTITCH (http://sttitch.embl.de/cgi/show_input_page.pl) and software to determine the bacterial protein UNIPROT V. harveyi.

Results and Discussion

From the results of GC-MS analysis obtained 12 compound derived from the 5 highest peak point (Rahmaningsih, 2017) and then analyzed to determine the characteristics of each compound, using PubChem software (http: //PubChem.ncbi.nlm.nih .gov /) (Table 1)

Table 1. The characteristics of each compound GCMS test results

No	Compound name	Other name	Molecular weight	Molecular formula	PubChem CID	*Canonical smiles*
1	furfural	2-Furaldehyde; FURFURAL; Furan-2-carbaldehyde; 2-Furancarboxaldehyde; 98-01-1; Furaldehyde	96.085 g/mol	$C_5H_4O_2$	7362	C1=COC(=C1)C=O,
2	1,4dimethyl	1,3 Dimethylpyrazole; 1,3-Dimethyl-1H-pyrazole; 694-48-4; 2,5-Dimethylpyrazole; 1H-Pyrazole, 1,3-dimethyl-; Pyrazole, 1,3-dimethyl-	96.133 g/mol,	$C_5H_8N_2$		CC1=NN(C=C1)C,
3	4H-Pyran-4-one,	4H-PYRAN-4-ONE; 108-97-4; 4-Pyrone; Pyran-4-one; Gamma-Pyrone; 4-Pyranone	96.085 g/mol	$C_5H_4O_2$	7968.	C1=COC=CC1=O
4	2,5 difluorophenylhydrazine	2,5-difluoro-4-hydrazinylbenzonitrile; 129946-63-0; Benzonitrile,2,5-difluoro-4-hydrazinyl-; 2,5-difluoro-4-cyano-phenylhydrazine; ACMC-20a3qy	169.135 g/mol,	$C_7H_5F_2N_3$	10920925	C1=C(C(=CC(=C1F)NN)F)C#N
5	1,2,4,5-tetrazine-3,6-diamine	CHEMBL1210570; N6-benzyl-N3-(4-chlorophenyl)-1,2,4,5-tetrazine-3,6-diamine,	312.761 g/mol	$C_{15}H_{13}ClN_6$		C1=CC=C(C=C1)CNC2=NN=C(N=N2)NC3=CC=C (C=C3)Cl
6	Furancarboxaldehyde,	2-Furaldehyde; FURFURAL; Furan-2-carbaldehyde; 2-Furancarboxaldehyde; 98-01-1; Furaldehyde	96.085 g/mol	$C_5H_4O_2$	7362	C1=COC(=C1)C=O
7	4-mercaptophenol	4-Hydroxythiophenol; 4-Mercaptophenol; 637-89-8; 4-Hydroxybenzenethiol; P-Hydroxythiophenol; P-Mercaptophenol,	126.173 g/mol	C_6H_6OS	240147	C1=CC(=CC=C1O)S,
8	2-propenoic acid, 3-phenyl,	1-PHENYL-1,2-PROPANEDIONE; 1-Phenylpropane-1,2-dione; 579-07-7; Acetylbenzoyl; Acetyl benzoyl; Benzoylacetyl	148.161 g/mol	$C_9H_80_2$	11363,	CC(=O)C(=O)C1=CC=CC=C1

Table 1. The characteristics of each compound GCMS test results (continued)

No	Compound name	Other name	Molecular weight	Molecular formula	PubChem CID	*Canonical smiles*
10	Trans-Cinnamic acid	CINNAMIC ACID; TRANS-CINNAMIC ACID; 140-10-3; (E)-Cinnamic acid; 3-Phenylacrylic acid; Trans-3-Phenylacrylic acid	148.161 g/mol,	$C_9H_8O_2$	61176,	C1=CC=C(C=C1)C=CC(=O)O
11	2,4(1h,3h)-pyrimidinedione	Uracil; 66-22-8; 2,4-Dihydroxypyrimidine; 2,4(1H,3H)-Pyrimidinedione; 2,4-Pyrimidinediol; 2,4-Dioxopyrimidine	148.161 g/mol	$C_4H_4N_2O_2$	1174,	C1=CNC(=O)NC1=O.
12	3 Benzenetriol	1,2,4-BENZENETRIOL; 1,2,4-Trihydroxybenzene; Benzene-1,2,4-triol; Hydroxyhydroquinone; 533-73-3; Hydroxyquinol	112.088 g/mol	$C_6H_6O_3$	10787,	C1=CC(=C(C=C1O)O)O.

Having in mind the possibility of the characteristics of each compound, and then do a screening to find compounds that have antibacterial activity. Screening does with the strategy: 1) By bioactivity (antimicrobial) and 2) Based on potential targets.The results of the screening of the 12 active compound are known to exist 5 predictions active compound has antibacterial activity . The prediction activities increasingly accurately if the value of Pa> 0.3 is a lower limit to state that the compound has a specific activity computationally (Figure 2)

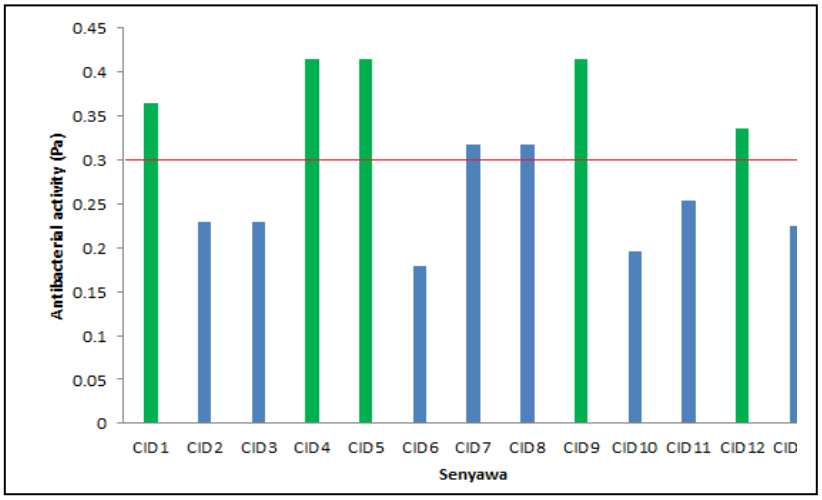

Figure 2. The results of anti-bacterial activity prediction

There are 5 prediction(Figure 2) active compound has antibacterial activity as follows: CID 1, CID4, 5 CID, CID CID 9 and CID 12. The five active compounds is: 1) 4H-Pyrans-4-one, 2) Furancarboxldehyde , 3) Furfural, 4) 2-propenoic acid, 3-phenyl.

Analysis of Biological Activity

Analysis of the biological activity of these compounds using PassOnline software (http; // www.pharmaexpert.ru/passonline/) The results of this analysis in the form of a prediction based on the value Pa (Probability Activity) and the value of Pi (Probability inactivity). Results of analysis only one compounds primarily as an antimicrobial (Table 2)

Table 2. Biological Activity as Antimicrobial of Compounds furfural

No	Pa	Pi	Aktivitas Biologi
1	0,519	0,028	Antifungal
2	0,484	0,012	Antiprotozoal (Amoeba)
3	0,476	0,015	Antituberculosic
4	0,450	0,028	Antimycobacterial
5	0,462	0,069	Antiviral (Picornavirus)
6	0,415	0,027	Antibacterial
7	0,371	0,037	Antiparasitic
8	0,350	0,054	Antiviral (Adenovirus)
9	0,269	0,079	Antiviral (Poxvirus)
10	0,282	0,104	Antiviral (Herpes)
11	0,196	0,023	Antiprotozoal (Babesia)
12	0,261	0,096	Antiprotozoal (Coccidial)
13	0,245	0,084	Antiviral (CMV)
14	0,185	0,071	Antirickettsial
15	0,252	0,146	Antiprotozoal (Trypanosoma)
16	0,125	0,062	Antibiotic

Information
Pa : (Probability Activity)
Pi : (Probability inactivity)

The result of biological activity accurately predicted if the value Pa (probability activity) is more than 0.3 (Pa> 0.3) means by computing the results are not much different from the results of laboratory tests (http; // inbioIindonesia.org). From the above table it is known that furfural compound has the highest prediction as an antimicrobial that is as antifungal with the highest value that is equal to 0519 Pa, antiprotozoal (.484), antibacterial / antituberculosis (0.476), and antiviral (0,462). Furfural compounds are based on the chemical formula with a molecular bond O-H which is characteristic of the compound phenols.

Antibacterial mechanism against bacteria Vibrio sp.

The results of this analysis using software antibacterial mechanism STTITCH (http://sttitch.embl.de/cgi/show_input_page.pl) and software to determine the bacterial protein UNIPROT *V. harveyi*. The result is two compounds that have antibacterial mechanism that furfural compounds and compound 2-propenoic acid, 3-phenyl.They based on criteria including phenols owned by the main characteristic is the presence of O-H bonds owned. Antibacterial mechanism against bacteria *V. harveyi* are as follows (Figure 3)

That compounds furfural (a) when simulated with *V. harveyi* bacteria will bind to and damage proteins hmp (nitrous oxide dioxygenase), protein Vibhar_05229 (KO7140) and Vibhar_06648 protein (ferredoxin-NADP reductase) (indicated by blue color bond means binding / binding) While the protein Vibhar_05086 no effect (indicated by the gray arrows). According Susanti (2008) phenols compounds will damage the protein found in bacteria through hydrogen bonds owned phenol compound so that the structure of proteins would be broken. Meanwhile, according to Singh and Bharate (2005)the mechanism of action of phenols compounds in inhibiting pathogenic bacteria by means of inactivation and

binding proteins (enzymes) in the cell membrane of bacteria. Further explained that protein hmp (nitrous oxide dioxigenase) NO plays a role in the detoxification process of aerobic bacterial cells called oxide dioxygenase (NOD) is a reaction that utilizes nitric oxygen O2 and NADP to convert No to nitrates and protect the bacteria from the toxic nitrogen compounds.

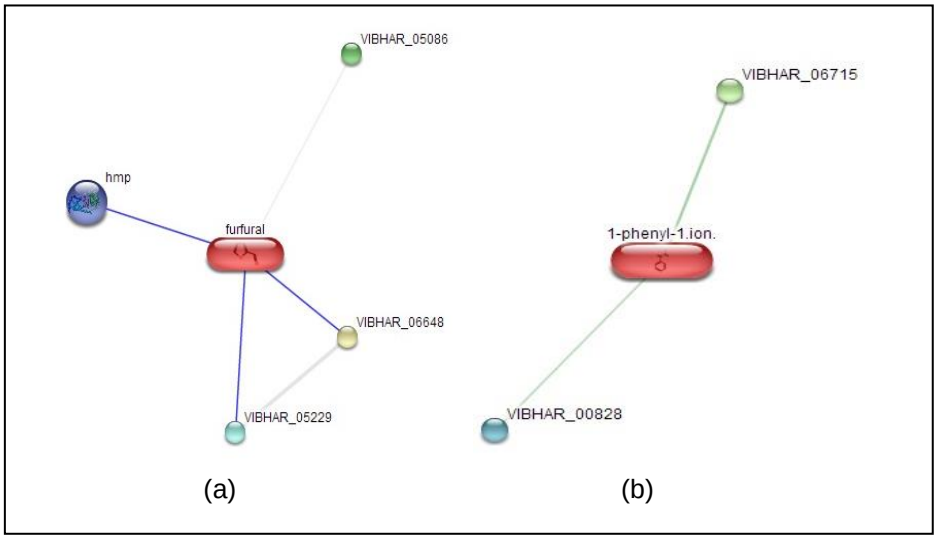

Figure 3. Mechanism of Antibacterial (a) Compounds Furfural and (b) compound 2-propenoic acid, 3- phenyl against bacteria *V. Harveyi*

Vibhar_06648 protein has the function as a molecular and activity of ferredoxin-NADP reductase, an enzyme which catalyzes a chemical reaction. These enzymes including oxidoreductases groups, which are proteins that use iron-sulfur as an electron donor and NAD + or NADP + as an electron acceptor. This protein also plays a role in the reaction in reverse to generate reduced ferredoxin, which can then be used in a variety of biosynthetic pathway. Some bacteria and algae using molecular flavodoxin not ferredoxin as a single electron carrier molecules are reduced or oxidized Carrillo, and Ceccarelli, (2003). While protein Vibhar_05229 according to Genbank is hypothetical proteins with code KO K07140 and including uncharacterized proteinite, the bacterium Vibrio harveyi ATCC BAA-1116. Molecular functions as a binder group 2 iron, 2 sulfur plays an important role in the transfer of electrons, electron carrier activity, as molybdenum ions, play a role in oxidoreductase activity and pyridoxal phosphate binding.Furthermore, the compound 2-propenoic acid, 3-phenyl (b) when simulated with V. harveyi bacteria binds to a protein from the bacterium V. harveyi is Vibra_06715 and Vibra_00828. The bond green means that the compound 2 -propenoic acid, 3-phenyl / 1-phenylpropane-1,2-dione works by activating a protein Vibra_06715 and Vibra_00828 existing protein in bacteria V. harveyi. Based on the characteristics possessed by the compound 1-phenylpropane-1,2-dione, which has the O-O bond which is a constituent carboxylic group of phenols.

Vibra_06715 Protein is a protein with a gene coding symbol VIBHAR_RS25870, hydroxyglutarate oxidase is a protein found in bacteria Vibrio campbellii ATCC BAA-1116 (strain: ATCC BAA-1116; BB120) and connected with Bacteria; Proteobacteria; Gammaproteobacteria; Vibrionales; Vibrionaceae;

Vibrio (NCBI, 2017). The role of this protein is a catalyst formation of 2-ketoglutarate of 2-hydroxyglutarate. While protein Vibra_00828 found among others in campbellii Vibrio (strain ATCC BAA-1116 / BB120), with the function of molecular binding to DNA, play a role in activity transcription factors and bind to specific DNA sequences. So biologically Vibra_00828 protein plays a role in the process of transcription and transcriptional regulation.

Conclusion

Based on the results and the previous discussion it can be concluded that the results of insilico test are known as a potential antibacterial compounds are compounds of furfural and the compound 2-propenoic acid, 3-phenyl which is known to affect some protein in bacteria *Vibrio harveyi*

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Fingerprints of the Anthropocene: the 2016 Coral Bleaching Event in an Equatorial Archipelago

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ABSTRACT

Coral reef ecosystems worldwide are experiencing increasingly frequent episodes of temperature-related "coral bleaching". The Banggai Archipelago in Central Sulawesi, Indonesia, has extensive coral reefs and is home to the endemic Banggai cardinalfish, *Pterapogon kauderni*, a species listed as Endangered in the IUCN red List. A rapid survey was undertaken at seven sites (1.2°S-2°S) in this archipelago, in response to the national call for action during the 2016 global bleaching event. The CoralWatch method (6 point colour scale: CW1-CW6) was used; colony life-form (Global Coral Reef Monitoring Network categories) and genus (Indo-Pacific Coral-finder) were recorded. Partial and full bleaching were observed at all sites; of 1166 colonies, 64.7% were fully bleached (CW1) or very pale (CW2); with 13.5% in CW4-CW6. Water temperatures were 1-3°C above recorded maxima from 2004-2012. Branching and encrusting life-forms had the highest full/severe bleaching rates. Common genera with above average bleaching rates included *Stylophora, Seriatopora, Pocillopora, Isopora, Merulina, Galaxea*, some forms of *Acropora* and *Porites*. Algal overgrowth was observed on both live (fully/partially) bleached and dead colonies. Densities of *Diadema* sp. urchins, a key simbiont of the Banggai cardinalfish, until recently the most abundant coral reef herbivore, were extremely low (orders of magnitude less than 2004 densities), with few adult individuals present at 5/7 sites. The Caribbean experience underlines the urgency of addressing the unregulated *Diadema* fishery which has developed in the Banggai Archipelago since around 2007. Rehabilitating populations of this key invertebrate herbivore would contribute to biodiversity conservation and reef resilience/recovery in this equatorial archipelago.

Keywords: Banggai Archipelago, Invertebrate herbivory, *Diadema* sp., *Pterapogon kauderni*, Coral resilience

Introduction

Our home planet, "a pale blue dot [...], a lonely speck in the great enveloping cosmic dark, ..."the only world known so far to harbor life" (Sagan, 1997) has gone through many eras since life first evolved around 3.7 billion years ago. Although some scientists still regard our present epoch as the Holocene, which began around 11,500 years ago at the end of the last ice age, there is a growing consensus that we are now in a new geological epoch, the "Anthropocene" (Zalasiewicz et al., 2011; Barnosky, 2014). Coined by Nobel Laureate Crutzen in 2000 (Crutzen & Stoenmer, 2000; Crutzen, 2002), Anthropocene comes from two ancient Greek words; *Anthropos*, humans, and *kainos*, "new". Thus we have entered the "new epoch of humans" or the "Age of Humanity", an age where "humans are becoming the dominant force of change on earth" (Schwägerl, 2014).

There is ongoing debate regarding the start date of the Anthropocene, with cogent arguments for the beginnings of widespread agriculture (Ruddiman, 2003), the dawn of the industrial age, and in particular the invention of the steam engine (Crutzen and Stoermer, 2000; Crutzen, 2006; Steffen et al., 2011), or the mid-20th

Century (Steffen et al, 2015). However a growing body of scientific evidence demonstrates beyond all reasonable doubt that in this 21st Century humanity is radically altering the biosphere on which we all depend (Ellis, 2011; IPCC, 2014). Furthermore, we as a species are responsible for the 6th major extinction event (Pimm et al., 1995; Jackson, 2008; Dirzo et al., 2014).

One hallmark of the Anthropocene is an unprecedented rate of global climate change (GCC). One of the main drivers of GCC is the increase in emissions of carbon dioxide, (CO_2) and other greenhouse gases (GHG) with long residence times in the atmosphere (IPCC, 2014). Ocean temperature and chemistry are changing, as much of the additional CO2 and heat energy have been absorbed by the oceans; observed phenomena include higher average seawater temperatures, lower seawater pH, and increasing instability in climate regimes leading to increased frequency and severity of extreme weather events (Hoegh-Guldberg et al., 2007; Jackson, 2008).

One particularly visible "footprint" of the Anthropocene is the increased prevalence of mass bleaching in scleractinian corals and related organisms (Hoegh-Guldberg et al., 2007; Bowen, 2015). At the global level, the fate of coral reefs in forthcoming decades and centuries is arguably dependent on a massive global shift in policies and actions (Hoegh-Guldberg, 2007; Gattuso et al., 2015), it is a well-established fact that local policies and activities can have a major influence on the severity of impacts, through affecting both the resistance and resilience/recovery potential of corals and coral reef ecosystems to GCC in general and temperature-related bleaching in particular (Westmacott et al., 2000; Grimsditch & Salm, 2006; Jackson, 2008; Hoegh-Guldberg et al., 2009; Aswani et al., 2015).

In this context it is vital to have data on coral reef ecosystem responses to the conditions which cause mass coral bleaching events at a variety of scales. The Indonesian Province of Central Sulawesi occupies a strategic position, with coasts and small islands in four seas: Sulu-Sulawesi Sea, Makassar Straits, Tomini Bay and Gulf of Tolo, including three major small island groups: the Togean, Menui and Banggai Archipelagos. The Banggai Archipelago is perhaps best known as the home of the Banggai cardinalfish, *Pterapogon kauderni* (Koumans, 1933), a small marine fish with no pelagic phase which is endemic to shallow (< 6m) sheltered waters in this Archipelago and a few nearby islands (Vagelli, 2011). Traded as an ornamental fish (Lunn & Moreau, 2004; Moore et al., 2011&2012; Vagelli, 2011; Ndobe et al., 2013a&b), the Banggai cardinalfish is listed as Endangered in the IUCN Red List (Allen & Donaldson, 2007) and has been proposed twice for CITES Appendix II listing[1]. Coral diversity is high (Allen & McKenna, 2001) and the Banggai Archipelago is at or very close to the centroid of coral distribution for all

[1] Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES): CoP14 Proposal 19. Inclusion of the Banggai cardinalfish (*Pterapogon kauderni*, Koumans 1933) in Appendix II of CITES. Retrieved from https://cites.org/sites/default/files/eng/cop/14/prop/E14-P1; CoP17 Proposal 46. Inclusion of *Pterapogon kauderni* in Appendix II, in accordance with Article II, paragraph 2(a) of the Convention and satisfying Criteria A and B in Annex 2a of Resolution Conf. 9.24 (Rev. CoP16), https://cites.org/sites/default/files/eng/cop/17/prop/060216/E-CoP17-Prop-46.pdf

Indo-Pacific corals combined, and of the Genus *Acropora* in particular (Veron et al., 2015); thus this island group can truly be considered to be at the heart of the coral triangle.

Initial signs of bleaching in Central Sulawesi were noted in all four areas during a survey on priority conservation species in mid-2015. As the magnitude of the 4th global scale mass bleaching became apparent, the Indonesian Ministry of Marine Affairs and Fisheries (MMAF) issued a call to stakeholders (Letter 860/PRL.0/IV/2016) outlining a national survey program and requesting assistance in collecting additional data on the extent and severity of coral bleaching across the archipelagic nation. In Central Sulawesi, the core central government program was limited to one site, the Togean Islands in Tomini Bay. The Central Sulawesi Sea Partnership responded to this call for action and gap in coverage by planning and implementing a rapid survey of several key sites, in particular the Banggai Archipelago in the Gulf of Tolo.

Materials and Methods

Coral bleaching data were collected during 12-20 May 2016 These comprised from 7 sites in the Banggai Archipelago (Banggai Laut and Banggai Kepulauan Districts), Central Sulawesi Province, Indonesia (Fig. 1). A GPS unit was not available, but for most sites approximate coordinates were known from previous research by the observer in this area; for the remaining sites approximate coordinates were determined using Google Earth. The latitudinal range was from approximately 1.2° South in Bakalan Island (Banggai Kepulauan District), close to the northern extremity of the Archipelago, to approximately 2° South at the southernmost tip of Bokan Island (Banggai Laut District), close to the southern limit of the Archipelago, and thus entirely within the Equatorial zone.

At the southernmost site (Mbuang-Mbuang) the survey was completed using SCUBA diving equipment, while at the other 6 sites snorkelling equipment was used. Each survey lasted about one and a half hours (90 minutes). Visual records were made using a Hero 4 digital underwater camera. At the SCUBA diving site, the observer descended to around15m, then swam along the reef and back twice, at depths of 11-15m and 7-10m, then 3-6m and 1-3m. At the snorkelling sites, the observer swam out along or close to the reef crest (depending on depth) and back over the reef flat, thus avoiding any risk of counting the same colony more than once. Number of colonies recorded varied depending on coral condition/density and ease of identification (affected by depth as well as taxon).

Coral bleaching data were collected using the CoralWatch method (CoralWatch, 2011), modified to include collection of data on coral colony life-form using the Global Coral Reef Monitoring Network (GCRMN) categories (English et al., 1997). Coral colonies observed (N = 1366) were identified to Genus level using the Indo-Pacific Coralfinder (Kelley, 2011), to which a thermometer (1°C intervals) was affixed. The genus, life-form and CoralWatch code(s) of each coral colony were recorded on the Coralfinder slate using a 2B pencil. Sea water

temperature was recorded (at 1-2m depth) at the beginning of each survey when snorkelling, then each 30 minutes or whenever there was an observed change in temperature thereafter, and monitored at each depth range when SCUBA diving.

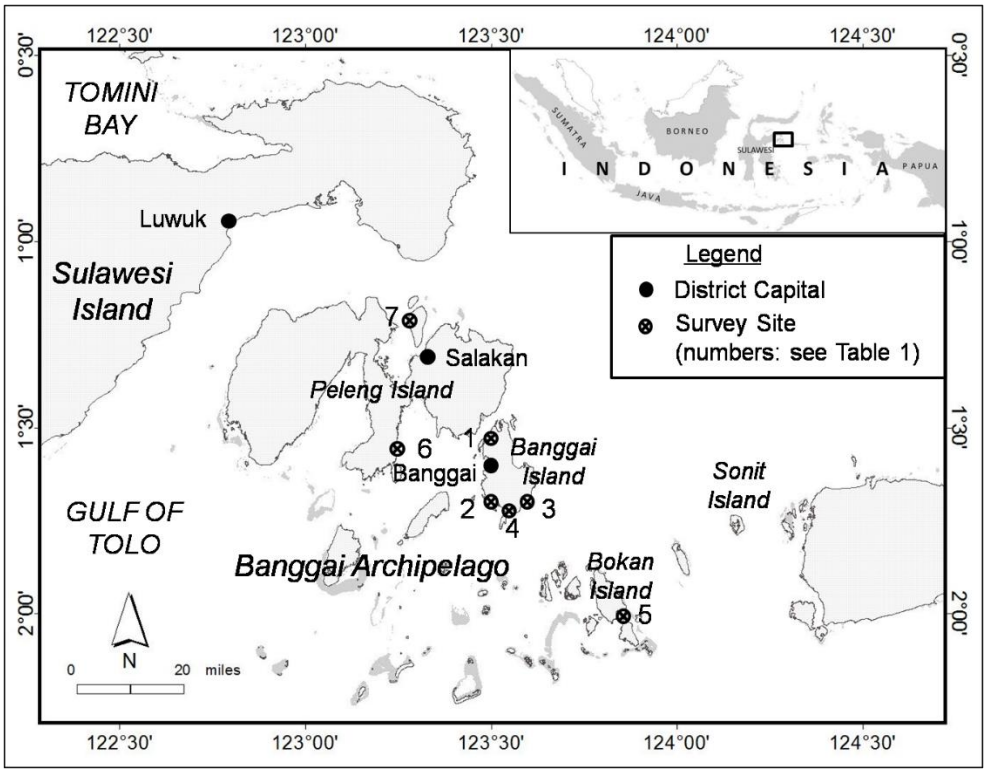


Figure 1. Map of Central Sulawesi Province showing survey sites. Approximate coordinates: Bone Baru: S1º32', E123º29'; Tolokibit: S1º43', E123º31'; Pompon: S1º44', E123º33'; Kapela: S1º42' , E123º34'; Mbuang-Mbuang: S2º05', E123º52'; Bakalan: S1° 12', E123° 16'; Liang: S1º 33', E123º 14'.

Additional data collected varied at each site, but included weather parameters (Beaufort scale and Octa, English et al., 1997), time of day, a visual record of the surrounding environment and notes on coral reef condition. Wherever present, data were collected on the endemic Banggai cardinalfish abundance and size classes present, based on standard length (SL): recruit, ≤18mm SL; juvenile, 18<SL≤ 30mm SL; sub-adult, 30<SL≤42mm SL; adult, > 42 mm SL), based on Ndobe (2013). Sea urchins of the Genus Diadema (D. setosum and/or D. savigny, hereafter referred to as Diadema sp. or Diadema urchins) are an important symbiont of the Banggai cardinalfish (Vagelli, 2004; Ndobe et al., 2008&2013a&b; Moore et al., 2011 & 2012). Data were collected on the abundance and size of Diadema urchins. Further supporting data and information were collected through the key informant interview (KII) participatory rural appraisal (PRA) method (DFID-SEA, 2002). Respondents included stakeholders at village and district level: fishermen and other village community members, local leaders and government officers.

The CoralWatch data were tabulated and analysed descriptively by site, life-forms and genera as well as in comparison with data from other studies. Environmental data and data on the Banggai cardinalfish and Diadema sp. populations were tabulated and compared with observations made (published and unpublished) over the period 2004-2014 at the same or nearby sites. Finally, all data

were considered in the context of small island resilience and the conservation outlook for the endangered Banggai cardinalfish.

Results

Environmental conditions

Data on environmental parameters and conditions as well as Banggai cardinalfish and *Diadema* sp. populations are summarized in Table 1. Weather parameters were in the range of Beaufort 1-2 and cloud cover of 1-3 Octa, except at Pompon where the weather was Beaufort 2-3 with 5-6 Octa of cloud cover, and Tolokibit where cloud cover reached 7-8 octa, but in flat calm conditions. The survey at Bone Baru was undertaken in clear sunny weather but shortly after heavy, cold rain. It is likely that this influenced (reduced) the temperature on the extensive shallow reef flat in and around the village community MPA (marine protected area) where the survey took place, an area where the authors have carried survey and other research activities almost every year since 2004. Warmer currents above ambient temperature recorded could be felt, and it is considered likely that in the absence of rain the temperature would have reached a maximum of 33°C, similar to the three other relatively sheltered sites around Banggai Island. Sediment deposits on corals were minimal except close inshore at Tolokibit. Pollution other than domestic waste (garbage) was not observed, though sewage could be inferred from sanitary arrangements. Some pollution from motorised boats using the harbours was observed in Bakalan and Liang.

Subjectively, the warmer than usual temperatures were very noticeable. Whenever temperatures reached 33-34°C for more than a few minutes the observer was uncomfortably warm and experienced in-water sweating, a sensation only experienced prior to this survey during the 2010 global bleaching event in Tomini Bay, at a site where over 90% of corals were fully bleached or very pale and fluorescent. Invisible "stingers" (most likely propagules of Cnidaria such as hydroids or jellyfish) were also more abundant than usual, except at the more exposed Pompon and Mbuang-Mbuang survey sites, necessitating the use of protective clothing, including a full-body suit, hood and gloves, despite the warmth of the water. The increase in "*gatal-gatal*" (itchy skin after fishing or other waterborne activities) was also mentioned by KII respondents.

Coral bleaching

CoralWatch data are summarised in Fig.2, providing a snapshot of the extent and severity of bleaching across all taxa by site and for the survey area as a whole, while Fig. 3 contains examples of bleached coral colonies demonstrating some widespread trends. Table 2 contains a summary of CoralWatch data aggregated by life-form (all 7 sites). A summary of CoralWatch data aggregated by coral genus is given in Table 3; the coral genera recorded are also ranked according to the percentage of colonies in CW1 and CW2, as an indication of observed coral vulnerability. The number of colonies observed for each genus and the number of

sites at which the genus occurred are also shown, providing an indication of relative abundance within and across sites.

The majority of colonies observed were partially bleached but otherwise "normal" coloured, however some colonies exhibited abnormal "fluorescent" colouration. Unfortunately the fluorescent colours were not clearly visible in the visual record and thus not shown in Fig. 3. This phenomenon occurred predominantly in normally blue or bluish corals (fluorescing pale blue) as well as some reddish corals (fluorescing pink) and brownish corals (fluorescing yellow or yellowish-green), both representing several genera.

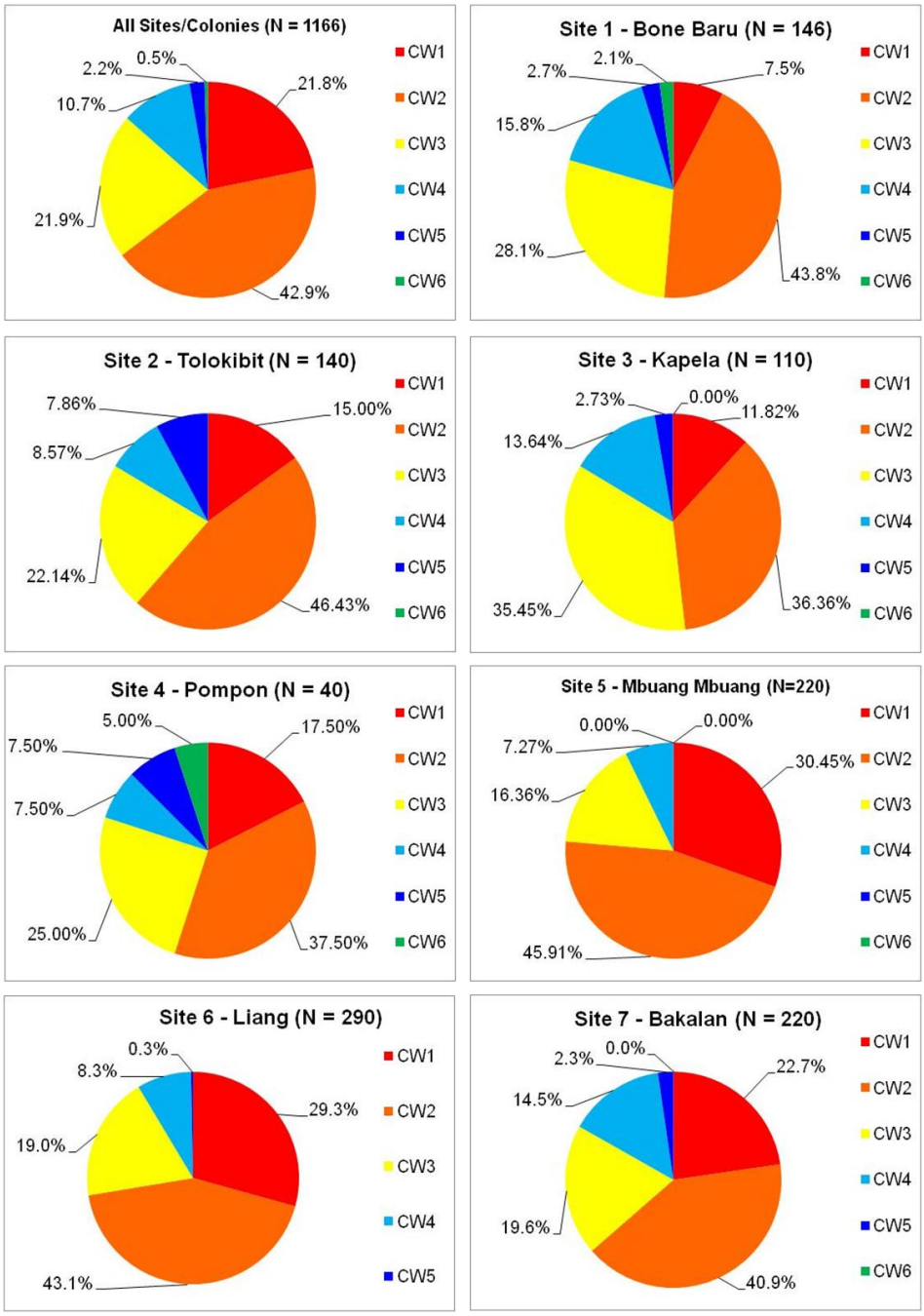
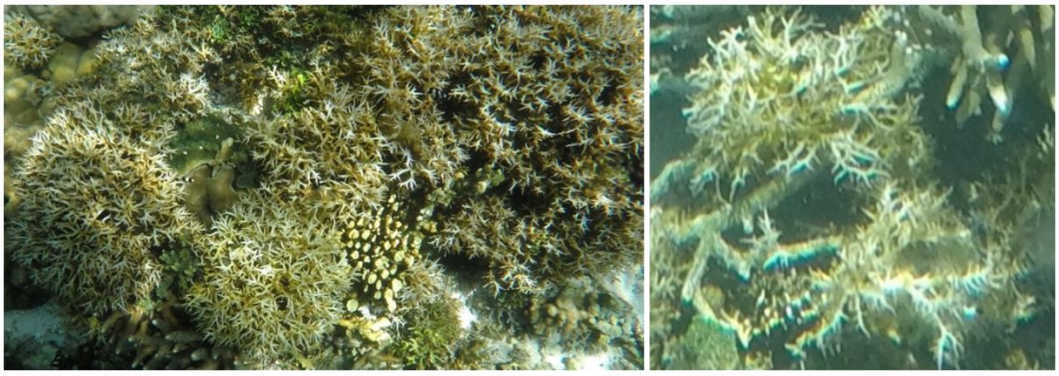


Figure 2. Summary of CoralWatch data by site and for all sites/coral colonies combined

Table 1. Summary of Environmental Data

Site		Seawater	Horizontal	Condition and changes since 2004*		
No.	Name	temperature (°C)	visibility (m)	Environmental conditions	Banggai cardinalfish population	*Diadema* sp. population
1	Bone Baru	31-32	> 15	Average 32°C. Algal overgrowth increased Recent mechanical damage to corals in/near village MPA	Reduced from several thousand readily visible, all age/sizes, often in groups of hundreds, to a few dozen found after extensive search, mostly adults in small groups of 1-10 associated with the few remaining *Diadema* urchins and sea anemones	Reduced from many thousands, largely adult to a few hundred mostly small/probably immature
2	Tolokibit	33	3-15	Increase in coral cover Turbidity limited to intertidal area and reef flat close to shore, otherwise clear waters Algal overgrowth increased		Reduced from many thousands, largely adult to a few small groups mostly small/probably immature
3	Kapela	31-33	7-10	Tidal temperature variation Increase in coral cover	Increased population since 2011	Similar in abundance and size to 2011
4	Pompon	31-32	> 10	Exposed site (waves/currents)	New sites, though both close to previous survey sites; none observed (suspect too exposed)	Once very abundant at nearby sites. Very few, mostly small and probably immature
5	Mbuang-Mbuang	33 31-32	> 15	Depth: 1-7 m (thermocline) Depth: 8-15m (mostly 32°C)		
6	Liang	32-33	> 15	Average 32°C, with hot currents at 33°C Algal overgrowth increased.	Reduced from many thousands in 2004 to a few dozen in remaining *Diadema* urchins and sea anemones	Reduced from millions in 2004 to a few hundred, vast majority juvenile (immature)
7	Bakalan	32-34	2-10	Average 33°C, with hot currents at 34°C, similar to temperature measured in Luwuk to the North (0.97°S) on the Sulawesi mainland	Suspect this is an introduced population Site with second highest abundance (after Kapela) in this survey	Reduced in abundance compared to 2013 with higher proportion of juveniles, but still several thousand

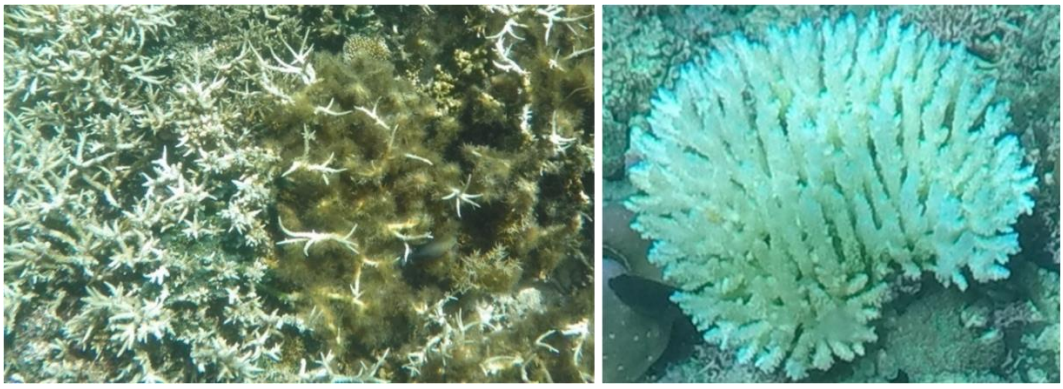
A. *Stylophora*. At some sites 100% of colonies were bleached and at all sites > 50% were in CW1 - fully bleached, often with polyps visibly feeding in daytime (left); some (live) CW1 colonies were being covered by filamentous algae (centre; example of very pale CW2 colony (right)



B. *Seriatopora*. This genus generally has relatively fine sharply pointed branches. The majority of colonies at all sites were fully bleached (CW1), very pale (CW2), or mixed (left). Where polyps have died, this genus seems especially vulnerable to rapid algal overgrowth, sometimes spreading over live tissue (right), and there was often some skeletal pigmentation in CW1 colony skeletons, so that even fully bleached colonies were rarely pure white.

C. *Porites* – branching Life-form (CB). A substantial number of colonies were fully bleached (CW1), with many more pale or very pale (CW3 - CW2). At the Bakalan site, close to 100% of one branching Porites type were in CW; some polyps were actively daytime feeding, while others were being overgrown by algae (left). Nearby colonies of different colours (presumably different species and/or strains of symbiotic zooxanthellae, Symbiodinium sp.) sometimes exhibited very different conditions (right). Anemones hosting clownfishes (Amphiprion sp.) and Banggai cardinalfish (Pterapogon kauderni) were also partially bleached (left), though rarely fully bleached

D. *Porites* – massive and semi-massive life-forms (CM and CS). At most sites few massive corals were fully bleached (CW1, above), though many, often the vast majority, were unusually pale (CW2 or CW3), and some (mainly colonies with a bluish colouration) exhibited abnormal fluorescent colouring. At the Luwuk site, 100% of large-polyped Porites shown above were bleached, and most were actively daytime feeding



E. *Acropora*. Proportionately more branching colonies (ACB) were fully bleached (CW1, left) compared to tabulate (ACT, right) or digitate (ACD) colonies. The majority were unusually pale (CW2 or CW3), while a substantial number of partially or totally recently dead colonies were observed. Some colonies in CW1 to CW3 were being overgrown with algae, especially branching life-forms (left, right hand side of frame).

Figure 3. Some examples of bleached coral colonies by Genus.

This phenomenon was also observed during coral bleaching in Tomini Bay in 2010, 2015 and 2016, and in Palu Bay in 2016 (Moore, unpublished data). The blue fluorescent colonies were predominantly massive corals in the Genus *Porites*, with the highest frequency at Bakalan, also the site with the highest seawater temperature. Pink and yellowish fluorescence occurred in isolated colonies of several genera spread across sites; these were highly visible even at the limits of visibility.

Table 2. CoralWatch data aggregated by Life-Form

Life-form		Percentage of Colonies by CoralWatch Colour Code						No of colonies
Code	Description	CW1	CW2	CW3	CW4	CW5	CW6	
		Genus Acropora						
ACB	Branching	28.3%	43.5%	15.2%	9.4%	2.2%	1.4%	138
ACD	Digitate	6.7%	33.3%	33.3%	26.7%	0.00%	0.00%	15
ACT	Tabulate	23.9%	39.1%	19.6%	8.7%	8.7%	0.00%	46
		Other coral genera (non-Acropora)						
CB	Branching	37.1%	35.1%	17.2%	8.6%	1.7%	0.3%	302
CS	Semi-massive	8.9%	56.6%	19.4%	13.3%	1.8%	0.00%	113
CM	Massive	11.8%	49.3%	27.4%	10.2%	1.3%	0.00%	373
CF	Foliose	17.0%	39.3%	23.2%	12.5%	8.0%	0.00%	112
CE	Encrusting	48.3%	20.7%	17.2%	13.8%	0.00%	0.00%	29
CMR	Mushroom	10.6%	34.2%	34.2%	18.4%	2.6%	0.00%	38
Total	All colonies	21.8%	42.9%	21.9%	10.7%	2.2%	0.5%	1166

Level of observed impact on coral colonies	Severe	Mild	No impact
	64.7%	32.6%	2.7%

Increased risk of mortality from 2016 bleaching event	Yes	No
	86.5%	13.5%

Table 3. Coral watch codes by genus, ranked by observed coral vulnerability

Rank	Coral	CoralWatch colour intensity (bleaching) code							No. of
(CW1+2)	Genus	CW1	CW2	CW3	CW4	CW5	CW6	sites	colonies
1	Paraclavarina	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	1	4
2	Stylophora	54.8%	32.1%	10.7%	2.4%	0.0%	0.0%	6	84
3	Merulina	42.9%	42.9%	14.3%	0.0%	0.0%	0.0%	2	14
4	Pectinia	23.1%	61.5%	15.4%	0.0%	0.0%	0.0%	3	13
5	Gardineroseris	16.7%	66.7%	16.7%	0.0%	0.0%	0.0%	2	6
6	Euphyllia	11.1%	66.7%	22.2%	0.0%	0.0%	0.0%	2	9
7	Cyphastrea	14.3%	57.1%	28.6%	0.0%	0.0%	0.0%	4	14
8	Seriatopora	34.2%	37.0%	21.9%	6.8%	0.0%	0.0%	7	73
9	Astreopora	11.8%	58.8%	29.4%	0.0%	0.0%	0.0%	4	17
10	Galaxea	29.6%	40.7%	20.4%	9.3%	0.0%	0.0%	5	54
11	Symphyllia	2.8%	66.7%	22.2%	8.3%	0.0%	0.0%	5	36
12	Goniastrea	15.4%	53.8%	15.4%	11.5%	3.8%	0.0%	4	26
13	Favites	13.5%	54.1%	27.0%	2.7%	0.0%	2.7%	6	37
14	Acropora	25.6%	41.7%	17.6%	10.6%	3.5%	1.0%	7	199
15	Pocillopora	31.0%	35.7%	26.2%	7.1%	0.0%	0.0%	4	42
16	Echinopora	33.3%	33.3%	33.3%	0.0%	0.0%	0.0%	1	6
17	Porites	25.0%	40.8%	16.3%	13.6%	3.3%	1.1%	7	184
18	Isopora	10.0%	55.0%	17.5%	15.0%	2.5%	0.0%	5	40
19	Favia	0.0%	61.3%	38.7%	0.0%	0.0%	0.0%	4	31
20	Platygyra	20.0%	40.0%	40.0%	0.0%	0.0%	0.0%	1	5
21	Mycedium	20.0%	40.0%	40.0%	0.0%	0.0%	0.0%	2	5
22	Pavona	13.3%	46.7%	40.0%	0.0%	0.0%	0.0%	3	15
23	Montastrea	6.7%	53.3%	20.0%	20.0%	0.0%	0.0%	4	15
24	Hydnophora	10.0%	50.0%	20.0%	10.0%	10.0%	0.0%	3	10

Table 3. Coral watch codes by genus, ranked by observed coral vulnerability (Continued)

Rank	Coral	CoralWatch colour intensity (bleaching) code							No. of
(CW1+2)	Genus	CW1	CW2	CW3	CW4	CW5	CW6	sites	colonies
25	Diploastrea	6.7%	53.3%	20.0%	20.0%	0.0%	0.0%	3	15
26	Pachyseris	0.0%	54.5%	9.1%	9.1%	27.3%	0.0%	3	11
27	Turbinaria	22.9%	28.6%	28.6%	11.4%	8.6%	0.0%	4	35
28	Psammocora	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	1	4
29	Polyphyllia	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	1	2
30	Lobophyllia	0.0%	50.0%	30.0%	20.0%	0.0%	0.0%	2	10
31	Fungia	18.2%	31.8%	31.8%	18.2%	0.0%	0.0%	1	22
32	Caulastrea	0.0%	50.0%	37.5%	12.5%	0.0%	0.0%	2	8
33	Goniopora	0.0%	44.0%	28.0%	24.0%	4.0%	0.0%	4	25
34	Heliofungia	0.0%	40.0%	40.0%	20.0%	0.0%	0.0%	1	5
35	Montipora	9.2%	26.3%	31.6%	28.9%	3.9%	0.0%	6	76
36	Herpolitha	0.0%	33.3%	33.3%	22.2%	11.1%	0.0%	2	9
37	Oulophyllia	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	1	1
38	Leptastrea	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	1	2
39	Coscinaraea	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	1	2

Fishery-related threats to coral reef ecosystems

Many invertebrate taxa were noticeably less abundant than when observed by Ndobe et al. (2005) in 2004, including edible sea urchins (genus *Tripneustes* and *Diadema*) and sea cucumbers; sea anemones (all large species used by clownfishes of genus *Amphiprion* and *Premnas* and by the Banggai cardinalfish); and molluscs (bivalves and gastropods). Information obtained from KII respondents in the Banggai Archipelago confirmed a continued rising trend in the unregulated and unreported invertebrate fisheries first observed in 2008 (Ndobe et al., 2008). All benthic animals with any economic or subsistence value were being collected, both as targets and opportunistically, including several protected species (all clam species in the Family Tridacnidae, the helmet shell *Cassus cornuta*, and the now extremely rare *Charonia tritonis*).

Diadema urchins were increasingly sought after for three main purposes: as a source of protein for coastal community members, many of whom are finding it increasingly difficult to catch fish nearby; as an aphrodisiac; and as feed for the grow-out of carnivorous reef fish. Despite growing awareness of their decline in abundance, these urchins would be collected as soon as they were considered likely to be sufficiently large to have mature gonads, as it is the gonads which are consumed. Seaweed farming, generally considered environmentally benign, was implicated in this process. *Diadema* sp., and indeed all edible shallow water fish and invertebrates, were increasingly targeted by seaweed farmers who no longer have the time or energy to go fishing further away from their farms, mostly over shallow seagrass, reef flat or coral reef habitat.

Degradation of the coral reef ecosystem within the Bone Baru community-based marine protected area (MPA) was especially noticeable. In addition to the

widespread decline in Banggai cardinalfish and *Diadema* sp. populations, a significant decrease in live coral cover and increase in rubble and dead coral were observed in the Bone Baru community-based marine protected area (MPA), where few fish were visible and very few non sessile invertebrates were visible. This MPA was informally established in 2006, and despite not having any official status, by 2014 the once degraded reef within the MPA was vibrant and colourful; most available hard substrate was covered with corals of all life-forms and at least 44 genera (Ndobe & Moore, 2015), providing habitat for relatively abundant and diverse populations of reef-associated fishes and invertebrates. Physical damage observed in the MPA was consonant with the use of blunt objects and brute force to break apart the corals, a practice common in the highly destructive abalone fishery. According to KII respondents, crowbars were still the main gear used to overturn coral colonies and collect the high-value abalone (*Haliotis asinina*, locally called *mata tujuh*) hidden below, just as they were in 2004 (Ndobe, 2005). However the fishing grounds had shifted in what appears to be a serial depletion process such as those described by Berkes et al. (2015), albeit at a much smaller scale.

The village conservation group, Kelompok Kalli, and indeed all villagers, felt powerless to prevent incursions by outsiders collecting fish and/or invertebrates, as the MPA does not have legal status. It was also reported that the raiders generally came at night, when the villagers are generally sleeping, and giving chase would be very difficult if not impossible. There were indications that some villagers participated in the extractive activities, on the grounds that if their MPA was going to be trashed anyway they might as well get a share of the (short-term) benefits.

Respondents from the various government agencies involved in fisheries and marine resource management revealed that they felt equally powerless. They were unanimously of the opinion that the otherwise legal collection of non-protected/unregulated species would become illegal if it caused damage to the coral reefs, and that action should be taken with respect to destructive fishing, even when not involving explosives or poisons. However each was also of the opinion that another service should be the one approached and responsible for responding, if by any chance any member of the public should wish to report an infraction in progress. It was pointed out that the number of enforcement personnel was very low and that they were already overloaded with other tasks. In particular the current emphasis from the Ministry for Marine Affairs and Fisheries (MMAF) on proper administrative procedures for fishing vessels, e.g. sailing and fishing permits, was placing a great strain on human resources; in addition, there was an acute lack of logistical support for any "field" work, even as close as Bone Baru, just a few kilometres up the coast from Banggai Town, the district administrative centre. None of the officers (or any other respondents) had any knowledge of there being any kind of helpline or reporting mechanism other than coming directly to the offices of a relevant agency – by which time, as pointed out by many respondents, the offenders would be long gone. Should they catch

an offender, even red-handed, they were very pessimistic about the chances of making a successful case and obtaining a conviction.

Discussion

Seawater temperature and bleaching patterns

Based on the data in Table 1, observed seawater temperatures can be considered unusually high for this area. Ndobe et al (2013a) compiled data on sea temperature in the shallow coastal waters of the Banggai Archipelago (0.5-6m depth) in order to estimate the parameter M (natural mortality) of the Banggai cardinalfish. They concluded that sea temperatures ranged from 26-31°C with an average of around 28°C, though there were indications that in some years or at some sites it might be closer to 29°C. Thus, the average (32-33°C) seawater temperatures during this survey were about 4°C above the estimated average for the area. Furthermore, the maximum observed temperatures (32-34°C) were 1-3°C higher than the highest values previously recorded for the same or nearby sites in the Banggai Archipelago (Ndobe et al., 2005, 2008, 2013a; Ndobe, 2013; unpublished data[2]).

It is a well established fact that Seawater temperature elevation above "normal" regional or seasonal ranges by 1-2°C over several weeks or by 3-4°C over a few days substantially increases the likelihood of bleaching in scleractinian corals (Jokiel and Coles, 1990; Goreau & Hayes, 1994; Loya et al., 2001; Coles & Brown, 2003; Pendleton et al., 2016). The synergistic combination of time and temperature is reflected in the NOAA global coral reef watch methodology (NOAA, 2011), where bleaching risk is measured in degree heating weeks (DHW), The spatial resolution of the NOAA data products are too coarse to provide more than a very general indication for the areas surveyed; however the NOAA reef watch predictions in the national call for action showed bleaching alerts (level 1 and Level 2) for the general area of the Banggai Archipelago in May and June 2016.

With actual seawater temperatures in the range measured during this survey, widespread bleaching would not be unexpected. Comparing the temperature data (Table 1) and bleaching prevalence (Fig. 2), it can be seen that empirically the percentage of coral colonies sampled which were fully bleached (CW1) correlated with sites with higher maximum seawater temperatures. Although the number of samples and the survey method do not support the use of inferential statistics, these observations indicate a positive correlation between seawater temperature and bleaching impact.

[2] Data collected by a team from the STPL-Palu lead by the authors when carrying out Ecosystems Approach to Fisheries Management (EAFM) evaluation activities in 2013 and 2014 under a contract with the Worldwide Fund for Nature Indonesia (WWF-Indonesia)

Bleaching and coral diversity

The data on coral bleaching severity and prevalence in Tables 2 and 3 and Figure 3 show that the vast majority of corals in both study areas were negatively impacted by the 2016 global bleaching phenomenon. As in other regions/previous bleaching events (e.g. Baird and Marshall, 2002), bleaching was not uniform within or among taxa. There were a few notable differences in susceptibility in this study compared to other published studies, for example Marshall and Baird (2000) found the Genus *Galaxea* particularly resistant to bleaching; however in this study not only were over 90% of colonies recorded fully or partially bleached, but an unusually high (compared to other genera) number of recently dead colonies were observed; it is highly likely that most (possibly all) were bleaching casualties. This indicates that responses may vary between sites, regions or possibly species within genera, and points to a need for more fine-scale bleaching data with the highest possible taxonomic resolution (minimal to Genus level).

Foden et al. (2013) conducted an in-depth review of the vulnerability of coral species to climate change. All species were considered to have high sensitivity, but overall vulnerability was modified by adaptability and exposure. While temperature-related bleaching was not the only factor considered, it is interesting to compare their evaluations with the results of this survey. The temperature data show that all species were exposed, however Table 4 shows the percentage of species in high and low un-adaptability categories for each of the genera recorded in this survey, alongside the rank based on percentage of colonies in CW1 and CW2 categories. It is clear that severity of observed bleaching in this study and predicted ability (or lack of ability) to adapt based on Foden (2013) do not correlate well. Genera with relatively low observed bleaching and low un-adaptability (e.g. *Caulastrea, Pachyseris*, *Turbinaria*) could be expected to fare better than those with high bleaching and high un-adaptability (e.g. *Astreopora, Cyphastrea, Favia, Favites, Gardinoseris, Goniastrea, Porites, Stylophora, Symphyllia)*. The second group is not only more diverse but contains genera which are more abundant in the Banggai Archipelago.

Comparing the relative severity of bleaching with the "winners and losers" identified by Loya et al (2001) after the 1998 mass coral bleaching event at Okinawa in Japan reveals several similarities with this study. In particular, bleaching was more prevalent and severe in branching *Porites* than in massive forms of this genus, although large-polyped massive species were also severely affected in the Banggai Archipelago (as well as in nearby Luwuk on the Sulawesi mainland coast, see Fig. 3). Other short-term "losers" reported by Loya et al. (2001) which were also severely affected in this study include *Seriatopora, Stylophora, Pocillopora* and some species of *Acropora*. A review of the recovery process in Okinawa a decade later by van Woesik et al (2010), substantially the same team as Loya et al. (2001), showed that coral cover and diversity had rebounded; however a marked shift in coral community composition had taken place. The once common Pocilloporids had all but disappeared, indeed *Stylophora* and *Seriatopora* seem to have been extirpated (along with most branching and one

encrusting *Porites*), and *Pocillopora* recovery was minimal. This precedent bodes ill for the *Stylophora* and *Seriatopora* populations in the Banggai Archipelago, especially *Stylophora*, the common coral genus most severely affected by the 2016 bleaching event. In contrast, Loya et al (2010) report that all but one species of *Acropora* had recovered by 2010, and longer-term "winners" included some other branching species such as branching forms of *Montipora*.

Although relatively few corals in the reefs of the Banggai Archipelago were totally bleached (around 5-20%), and signs of recent mortality likely to be due to bleaching were limited, it is highly likely that coral mortality during and after the 2016 bleaching event was and will be significantly above background levels . The long terms effects are as yet unknown, but it is likely that coral growth and reproduction will be affected, not only during but for some months after the event (Baird and Marshall, 2002). Furthermore, under the conditions predicted by global climate change scenarios, widespread bleaching events are likely to occur with increasing frequency worldwide (Hoegh-Guldberg et al., 2007; IPCC, 2014), and in the Coral Triangle in particular (Hoegh-Guldberg et al., 2009; Burke et al., 2012). Although there is no record of widespread bleaching in the Banggai Archipelago prior to 2015/2016, it is almost certain that the reefs around these islands will repeatedly experience bleaching again in the coming decades. The severity of bleaching in certain genera, particularly *Stylophora*, indicates the possibility of local extinctions (extirpation) of some species, thus reducing biodiversity and changing the community composition of corals and associated species. As noted by Chapin III et al. (2000), such changes in themselves could have negative consequences for coral reef productivity and resilience.

Diadema decline – causes and possible consequences

Environmental changes noted at several sites surveyed previously (Table 1) included a marked increase in algal overgrowth of dead (and sometimes even live) corals, and a sharp (drastic) decline (estimated 90-99%) in once abundant herbivorous *Diadema* sp. sea urchin populations in the Banggai Archipelago. Herbivory is considered to be a key factor in coral reef resilience, in particular coral recruitment and the coral-algal balance (Obura and Grimsditch, 2009; Jompa and McCook, 2002; Hughes et al., 2007); in this context, *Diadema* urchins in particular can play key role (Carpenter and Edmunds, 2006; Mumby et al., 2006 & 2007).

Very few other herbivores were observed during this or previous surveys in the Banggai Archipelago. High *Diadema* urchin abundances coupled with extremely low algal growth and high coral recruitment on dead coral as recently as 2004 (Ndobe et al., 2005) indicate that Diadematid urchins are likely to be a keystone species in this Archipelago, as they were in the Caribbean. Comparing temperature and *Diadema* urchin population data (Table 1) with bleaching prevalence (Fig. 2) it can be seen that, at equal maximum temperatures, the sites with the lowest proportion of bleached colonies were those with higher (less depleted) *Diadema* sp. populations. The number of samples and the survey

method do not support the use of inferential statistics; nonetheless, these observations indicate a negative correlation between herbivore populations (in this case *Diadema sp.*) and bleaching impacts, indicating the possibility of a mitigating effect from urchin herbivory at equal maximum temperatures, the sites with the lowest proportion of bleaching were those with higher (less depleted) *Diadema* sp. populations.

In the Caribbean, a decline of over 90% in *Diadema antillarum* abundance is widely viewed as a major causal factor in the widespread phase shift from coral to algal dominated coastal ecosystems across the region (Hughes et al., 1987; Mumby et al., 2006). Viewed from a restoration and climate change mitigation perspective, Aronson and Precht (2006) considered conserving and enhancing populations of *Diadema antillarum* as a key component of "the most direct route to coral recovery", and considered these urchins to be "more effective than fish at reducing macroalgae and enhancing coral recruitment". However the slow and uneven recovery to date (Rogers and Lorenzen, 2016) indicates that once depleted beyond a certain point, *Diadema* populations may not easily return to their former abundance and distribution.

Unlike the Caribbean case, *Diadema* sp. decline in the Banggai Archipelago is not due to disease, but to an unreported and unregulated fishery. Gleaning and the collection of shallow-water benthic organisms has been an integral part of local livelihoods and food security in the Banggai Archipelago since time immemorial, and all invertebrates of value for sale or as food were already exploited to some extent in 2004 (Ndobe et al., 2005). As reported by Ndobe et al. (2008, 2013b) and Moore et al. (2011, 2012) and confirmed by data collected during this survey, *Diadema* exploitation has been increasing since around 2007, mainly for human consumption but also as feed for the grow-out of carnivorous fish. The reasons are complex and the sea urchin fishery is not actually illegal; however it is part of the pervasive unregulated and unreported exploitation of shallow-water invertebrates causing extensive defaunation of small island coral reef and seagrass ecosystems, and the decline in this key symbiont due to overharvesting can be considered a major threat to endemic populations of the endangered Banggai cardinalfish, *Pterapogon kauderni* (Moore et al., 2011 & 2012; Ndobe et al., 2013a&b; this study).

conclusion

Equatorial coral reefs in the Banggai Archipelago, Central Sulawesi were significantly impacted by the 2016 global bleaching event. Despite signs of potential resilience at certain sites and in certain species, it is clear that these reefs are at risk from GCC in the Anthropocene. The 12th International Coral Reef Symposium (ICRS) Consensus Statement concluded with the words: "*A concerted effort to preserve reefs for the future demands action at global levels, but also will benefit hugely from continued local protection*"[3]. The observations made during

[3] http://www.icrs2012.com/Consensus_Statement.htm

this study reinforce the view that outcomes will depend not only on the success of world-wide GCC mitigation measures, but also on local actions. The level of observed coral mortality due to mechanical damage as well as likely subsequent mortality from the effects of full or partial bleaching in the Banggai Archipelago, underscore the vital importance of promoting resilience and enabling recovery. This means addressing not only the well-recognised direct human impacts on corals and water quality, but also maintaining ecological processes such as herbivory.

While further research and ongoing monitoring are vitally important, existing data and knowledge are sufficient to implement concrete and urgent actions to minimise coral mortality (maximise resistance) and maximise recovery potential (resilience). In particular, the oft-repeated but still elusive effective implementation of existing legislation and regulations is essential to prevent stressors such as coral mining, destructive fishing, pollution, sedimentation from upland degradation, and all the other "normative" threats addressed in publications such as Westmacott et al. (2000) and Hoegh-Guldberg et al. (2009).

Equally important and often overlooked are local measures to maintain ecological balance, in particular the guild of herbivores, both fish and invertebrates. In the Banggai Archipelago, and possibly other areas where *Diadema* sp. urchins are experiencing sharp declines, the Caribbean example should be a warning. There is an urgent need to regulate this unreported and unregulated fishery, not only to save the charismatic Banggai cardinalfish, but also to maintain the ecosystem services of a keystone herbivore whose silent demise is likely to substantially reduce the resilience of small island socio-ecological systems. Thus, effective measures to conserve an iconic endangered endemic fish could also promote coral reef resilience and human welfare in the Anthropocene.

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Rare Earth Element Potential in Sulawesi: A New Source for Clean Energy Technology

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ABSTRACT

The global concern on climate change demands the constant supply of rare earth element (REE). These elements play an important role in providing high-technology application such as permanent magnets and rechargeable batteries, petroleum refining, high-efficiency lighting. REEs also serve as new important source for clean energy technologies such as wind turbine and hybrid electric vehicles which in turn are important for energy conservation, developing a low- -carbon economy, and eventually reducing carbon emissions. However, due to its rarity, the global REE demand grows rapidly during the decades which require a steady supply chain in the long term. This condition has led to the growing concern that the world may soon face a shortage of REEs resources. Therefore, other sources of rare earth elements are expected to be developed. Sulawesi Island consists of various lithologies which are originated from many tectonic setting. Using petrological and geochemical method, REE potential in Sulawesi were found in some deposits, including highly weathered granitic rocks and limonite layer of lateritic nickel deposit. This study shows that REEs potential in Sulawesi is abundant and very promising to be developed.

Keywords: REE, potential, Sulawesi, Clean Energy

Introduction

The rare earths are a moderately abundant group of 17 metallic elements that includes the 15 lanthanides, yttrium, and scandium. The elements range in crustal abundance from cerium, the 25th most abundant element of the 78 common elements in the Earth's crust at 60 parts per million (ppm), to thulium and lutetium, the least abundant rare-earth elements at about 0.5 ppm. In rock-forming minerals, REE typically occur in compounds as trivalent cations in carbonates, oxides, phosphates, and silicates. Based largely on ionic radius, the REE are classified into two groups; the light-group rare-earth elements from lanthanum to europium, abbreviated LREE, and the heavy-group rare-earth elements from gadolinium to lutetium, including yttrium, abbreviated HREE. REE minerals and deposits generally are classified as either a LREE or HREE type although minerals of both types may occur in a single deposit. Minerals and deposits with LREE are more abundant than those with HREE.

Rare earth metals, including rare earth elements (REE) and scandium (Sc), have become a critical issue due to their dramatic increase in industrial use especially in green energy technology. REE is an important element in the use of permanent magnets, wind turbine and rechargeable batteries whereas scandium is an important metal for electrolyte of solid oxide fuel cells. Demand of these materials is likely to increase in the near future.

REE is heavily dependent on some weathered crust deposits in China (ex. Bayan Obo Deposit and highly weathered granitic rock from Southern China) (Tabel 1 and Fig. 1). These conditions have led to the growing concern that the world may soon face a shortage of scandium and rare earth elements resources.

One of the most promising sources of REE is granitic rocks as reported by previous studies (Murakami & Ishihara, 2008). This rock is widely distributed in Sulawesi Island, covering almost 20% of the island (Maulana, 2013). However, report on the occurrence of rare earth elements from this rock is still lacking despite its important economic value.

Scandium is usually found only in two different kinds of ores. Thortveitite is the primary source of scandium with uranium mill tailings by-products also being an important source. World productions amount to only 50 kg per year. There is no estimate of how much is potentially available. As Sc is a compatible element, mafic rocks generally have higher Sc contents. Scandium is incorporated into pyroxene (or amphibole) but is rarely contained in olivine. Thus, pyroxenite has higher Sc contents than peridotite. In the process of chemical weathering, Sc is immobile and other mobile elements are leached away. As a result, laterite becomes enriched in Sc. Whole-rock compositions indicate that Sc is likely to substitute Fe3+, Al3+, Ti3+ and other sites in laterites. The Peridotite as a host of Sc-bearing mineral is largely distributed in Sulawesi. However, study in the Sc occurrence in Sulawesi has never been conducted. Since REE and scandium play an important role in high advanced technology, especially in clean energy technology, (energy reduction, energy production and energy efficiency), sources of these elements are expected to be developed in order to balance supply and demand of them. In this study, we report an overview of potential distribution of REE and scandium in Indonesia, particularly in Sulawesi as a new source for energy technology.

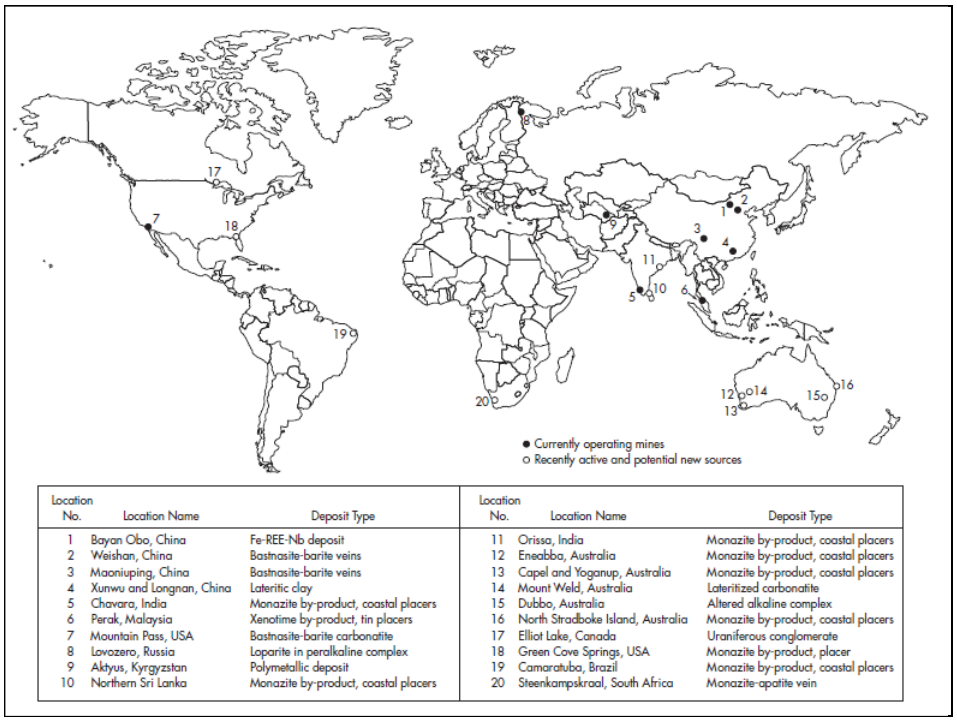
Table 1 Estimated annual world miner production of REEs, by country

	1983	1985	1987	1989	1991	1993	1995	1997	1999	2001	2003*
Country	**Metric Tons of REO Equivalent**										
Australia	8,328	10,304	7,047	7,150	3,850	1,650	110	0	0	0	0
Brazil	2,891	2,174	2,383	1,377	719	270	103	0	0	0	0
China	na†	8,500	15,100	25,220	16,150	22,100	48,000	53,000	70,000	80,600	90,000
India	2,200	2,200	2,200	2,365	2,200	2,500	2,750	2,750	2,700	2,700	2,700
Kyrgyzstan	na	na	na	696	721	0	na	na	6,115	3,800	na
Malaysia	601	3,869	1,618	1,700	1,093	224	452	422	631	281	450
Mozambique	2	2	0	0	0	0	0	0	0	0	0
South Africa	0	0	660	660	237	237	0	0	0	0	0
Sri Lanka	165	110	110	110	110	110	110	110	120	0	0
Thailand	164	459	270	368	229	127	0	7	0	0	0
Russia	na	na	na	7,626	6,138	4,468	2,000	2,000	2,000	2,000	2,000
United States	17,083	13,428	11,100	20,787	16,465	17,754	22,200	10,000	5,000	5,000	0
Zaire	6	0	53	96	66	11	5	0	0	0	0
Total	31,439	41,047	40,541	68,155	47,978	49,449	75,730	68,288	86,566	94,381	95,150

Courtesy of USGS.

* Estimated. Some data have been added or modified using unpublished data from USGS files.

† na = not available.



Location No.	Location Name	Deposit Type
1	Bayan Obo, China	Fe-REE-Nb deposit
2	Weishan, China	Bastnasite-barite veins
3	Maoniuping, China	Bastnasite-barite veins
4	Xunwu and Longnan, China	Lateritic clay
5	Chavara, India	Monazite by-product, coastal placers
6	Perak, Malaysia	Xenotime by-product, tin placers
7	Mountain Pass, USA	Bastnasite-barite carbonatite
8	Lovozero, Russia	Loparite in peralkaline complex
9	Aktyus, Kyrgyzstan	Polymetallic deposit
10	Northern Sri Lanka	Monazite by-product, coastal placers
11	Orissa, India	Monazite by-product, coastal placers
12	Eneabba, Australia	Monazite by-product, coastal placers
13	Capel and Yoganup, Australia	Monazite by-product, coastal placers
14	Mount Weld, Australia	Lateritized carbonatite
15	Dubbo, Australia	Altered alkaline complex
16	North Stradboke Island, Australia	Monazite by-product, coastal placers
17	Elliot Lake, Canada	Uraniferous conglomerate
18	Green Cove Springs, USA	Monazite by-product, placer
19	Camaratuba, Brazil	Monazite by-product, coastal placers
20	Steenkampskraal, South Africa	Monazite-apatite vein

Figure 1 Location of the world`s rare earth mines

REE in lateritic deposit

REE deposit from lateritic deposit is well known as ionic type deposit or ion adsorption type deposit. Following are the typical characteristic of ionic type deposit from well-known REE deposit in southern China, particularly Jiangxi Province (Zhang et al, 1996).

a. Geologic Setting of ionic type REE Deposit.

The deposits occur in the weathering crust of granites which supply the REE source for mineralization. The moisture and rainy climate in near subtropic zone provide a suitable condition for REE to be transferred and concentrated in the weathering crust of granites which are rich in REE

b. Mineralizing characteristic of ionic type REE deposits.

The so-called ionic type deposits are the weathering crust of granitoid. After weathering and decomposition of granitoids, REE are released from them and hosted in the weathering crust as ionic form. From the top to bottom the weathering crust can be divided into: (a) humus layer which are several centimeter thick; (b) eluvium and slide rock which are 1 – 2 meter thick; (c) completely weathered layer whose thickness is usually about 5 – 10 meters and the thickest is about 20 meters; (d) semi-weathered layer which is 3 – 5 m thick; (e) bedrock granitoids.

c. Mineral compositions of ionic type REE deposits

1. Supporter minerals for REE ions in the weathering crust of granitoids.
2. At present, studies show that all supporter minerals for REE ions are clay minerals, most of which are kaolinite and halloysite. Both of them are polymorph of $Al_2SiO_5(OH_4)$. Two kind of halloysite exist; with and without water in the structural layer. The other clay mineral in the weathered crust

of granitoids are montmorillonite, gibbsite, hydrobiotite which is mixture of biotite and vermiculite.

3. Primary RE minerals
4. The primary RE minerals are hosted in granitoids. Under weathering conditions, some of them are resistant to weathering, some semi-weathered and some completely weathered and disappear.

Scandium

In nature, scandium is found in the following: aluminum phosphate minerals; amphibole-hornblende; basalt; beryl; biotite; cassiterite; columbite; gabbro; garnet; muscovite; pyroxene; rare earth minerals, and wolframite. In addition, scandium is to be found in such rare minerals as bazzite; euxenite; gadolinite; ixiolite; kolbeckite; magbasite; perrierite, and thortveitite. However, rather than being extracted from these "raw" minerals, "primary" scandium has most commonly been produced either from mine tailings and residues containing the element, or as a byproduct from the processing of a variety of different ores.

Tailings and residues have included those from fluorite, moly, tantalum, titanium, tungsten and uranium mining operations. In China, in particular, scandium has also been, and is, produced as a by-product of the extraction of rare earth metals. Scandium is also to be found, in minute quantities, in the following ores: aluminum, cobalt, iron, nickel, phosphate, tin, zinc and zirconium, as well as in certain low-grade coals.

Scandium is used as additives to alloys and electrolytes of a certain fuel cell. A very small amount of Sc has been produced from a variety of ore deposits in the world as a by-product, and few previous studies discussed the economic Sc mineralization except for pegmatite. In recent years, Sc is expected to be produced from lateritic Ni deposits in some countries. Ultramafic rocks form nickel laterites by weathering in the high-latitude region (e.g., Indonesia), because numerous previous study data indicated that Ni^{2+} is generally incorporated into mafic minerals in magma and that they are easily altered by soil or ground water. The previous studies indicate that Sc^{3+} is also contained in mafic minerals such as pyroxene, amphibole and magnetite, but significantly less Sc is contained in olivine.

Uses of REE and Sc in green energy

REE have been used in many industries as seen in Table 2. Environmental applications of REE have increased markedly over the past three decades. This trend will undoubtedly continue, given growing concerns about global warming and energy efficiency. Several REE are essential constituents of both petroleum fluid cracking catalysts and automotive pollution-control catalytic converters. Use of REE magnets reduces the weight of automobiles. Widespread adoption of new energy-efficient fluorescent lamps (using Y, La, Ce, Eu, Gd, and Tb) for institutional lighting could potentially achieve reductions in U.S. carbon dioxide emissions equivalent to removing one-third of the automobiles currently on the road. Large-scale application of magnetic-

refrigeration technology (described below) also could significantly reduce energy consumption and CO_2 emissions. Some of REE are also used in energy-related technology especially green technology as explained below.

Catalysis

Cerium oxide is used to enhance performance of automotive emission catalyst, for converting carbon monoxide, unburnt hydrocarbons and nitrogen oxide to carbon dioxide, water and nitrogen. It is said to stabilize the alumina support, enhance cartalytic reactions and promote the NOx reduction activity of rhodium. It also improves the cold start performance of catalysts. Rare earths are also used to help catalyze various hydrocarbons reactions in the petroleum and plastic industries.

Phosphors

The most readily visible rare earth market is in luminisicent or phosphor material. The electronic structures of rare earth atoms makes them particularly efficient at converting high-energy-exitation-gamma rays, X-ray, cathode ray (electron) and UV, for example - into visible light of fairly narrow wavebands. The new generations of compact"triband" fluorescent lamp, which are replacing less-efficient incandescent lamps, use three phosphors to convert UV into red, green and blue emissions, resulting in overall white light.

Magnet

Today, permanent magnets dominate rare earth technology because of their ability to provide greater magnet power in vastly smaller sizes. Permanent magnets are magnets that, unlike electrical magnets, produce their own magnetic fields. Permanent magnets are what provide the ability to make computers smaller, for example. Magnetic technology rates as the most important use of rare earth elements due to its many uses in energy. The two primary rare earth magnets are the samarium cobalt (SmCo) magnet and the neodymium-iron-boron (NdFeB) magnet. The SmCo magnet is able to retain its magnetic strength at elevated temperatures. Because of its thermo-stability, this type of magnet is ideal for special military technologies. The ability of neo magnets to generate a strong field from a small volume has made them an integral part of ongoing electronics miniaturization. Sm-Co magnet has 8-10 times greater magnetic power compared to traditional ferrite and this had lead to new innovation of miniature and portable electronic equipments such as the walkman CD and stereo, mobile phone and notebook computer. Another important milestone in the rare earth magnet is the development of Nd-Fe-B magnet with better magnetic power and cheaper cost than the Sm-Co magnet. It could be used in motors of automobiles, magnetic bearings and ignition, analytical and medical equipment, toys, etc.

The next high-technology application of the REE to achieve maturity may be magnetic refrigeration. The six REE ions Gd3+ through Tm3+ have unusually large magnetic moments, owing to their several unpaired electrons. A newly developed alloy, Gd5(Si2Ge2), with a "giant magnetocaloric effect" near room

temperature reportedly will allow magnetic refrigeration to become competitive with conventional gas-compression refrigeration. This new technology could be employed in refrigerators, freezers, and residential, commercial, and automotive air conditioners. Magnetic refrigeration is considerably more efficient than gas-compression refrigeration and does not require refrigerants that are flammable or toxic, deplete the Earth's ozone layer, or contribute to global warming.

Turbine and Solid Oxide Fuel Cell

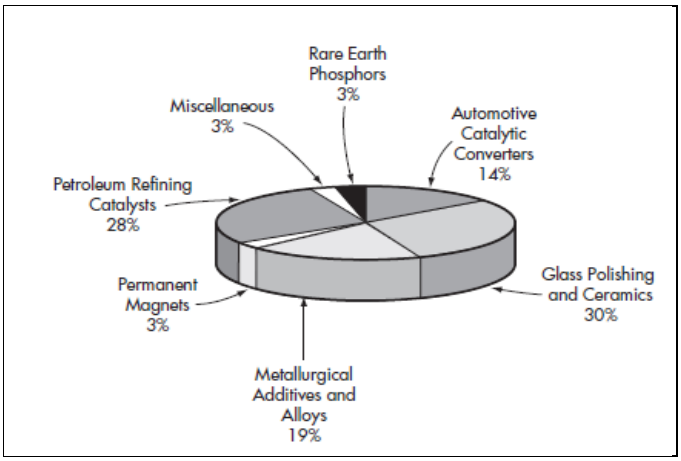
A massive wind turbine—capable of turning the breeze into two million watts of power—has 40-meter-long blades made from fiberglass, towers 90 meters above the ground, weighs hundreds of metric tons, and fundamentally relies on roughly 300 kilograms of a soft, silvery metal known as neodymium. Solid oxide fuel cells utilise lanthanum manganite doped with rare earths for the cathode, and yttria-stabilised zirconia as the electrolyte. Potential applications include yttria-stabilised zirconia as an electrolyte film for fuel cells, and battery electrodes composed of nano-sized crystalline materials. Recent new application of Sc is electrolyte of solid oxide fuel cell (SOFC), as Sc-stabilized zirconia (ZrO_2) which is more efficient.

Battery

Rechargeable lanthanum-nickel-hydrate battery, usually know as nickel-metal-hydrate, are gradually replacing nickel-cadmium because of their superior performance and environmental advantage.

Table 2. REE uses and application in industry (upper) and REE market by weights (down)

Application	Product(s)	Rare-earth element(s)
Glass polishing	Lenses, display screens (CRT, LCD, PDP)	Cerium
Glass additives	Optical lenses, display screens	Cerium, lanthanum, neodymium
Lighter flints		Mischmetal alloy
Catalysts, fluid cracking	Petroleum refining	Mixed rare earth products
Catalysts, auto	Automobiles	Cerium, lanthanum, neodymium
High intensity magnets	Electronic and electric motors, audio equipment	Neodymium, samarium, dysprosium, praseodymium, terbium
Batteries and hydrogen storage systems	Electronics, tools, hybrid cars	Mischmetal, lanthanum alloys
Phosphors, display	Computer, TV and other display screens	Yttrium, europium, terbium
Phosphors, lamp	Fluorescent and halogen lamps	Yttrium, lanthanum, cerium, europium, gadolinium, terbium
Phosphors, X-ray	X-ray film	Lanthanum
Fibre optics/lasers	Rare earth dopants	Lanthanum, erbium, ytterbium
Advanced ceramics	Nitrides, Y-stabilised	Yttrium
	ceramics etc	
Capacitors	Multilayer ceramic	Lanthanum, neodymium, cerium
Fuel additives	Gasoline, diesel fuels	Cerium
Fuel cells	Solid oxide fuel cells	Lanthanum, yttrium
Pigments	Replacement for cadmium in red pigments	Lanthanum, cerium
Magnetic refrigeration	Magnet alloy	Gadolinium
Steel and foundry	Desulphurisation	Mischmetal
Alloys	Magnesium, aluminium and hydrogen storage alloys	Cerium, neodymium, lanthanum, yttrium



Distribution and possible occurrence of REE and Sc in Sulawesi

Rare earth elements

The granitic rocks are widely distributed in Sulawesi Island in the central part of Indonesian Archipelago (Sukamto, 1979; Maulana, 2013). They occupy the western part to the northern part of the island, encompassing for more than 400 km (Fig. 2). The island is situated in the equatorial line and hence is located in tropical climate, causing the surface of the rocks is susceptible to weathering and alteration process. It has been reported that REE are mobile and tend to be enriched during weathering of granitic rocks in some sub tropic areas (Bao and Zhao, 2008). In addition, enrichments of REE in weathered granitic crusts from tropic areas were also reported (Sanematsu et al. 2009; Sanematsu et al. 2011). Fig. 4 show the REE content in weathered crust from granitic rocks in Sulawesi, particularly Mamasa and Palu area.

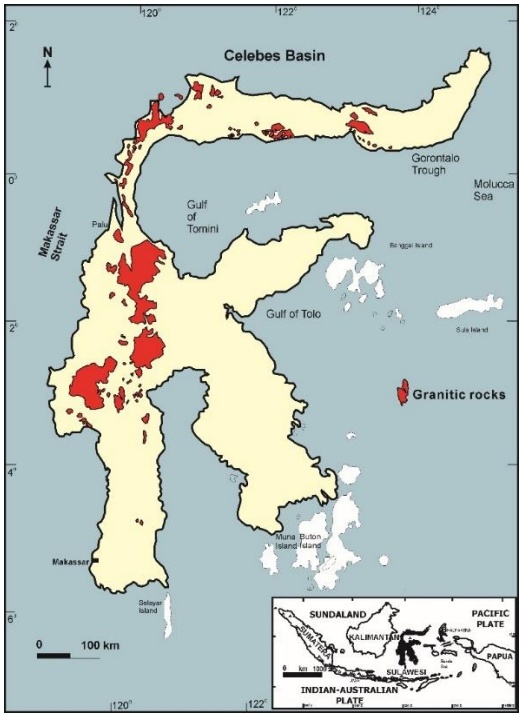


Fig. 3 Distribution of granitic rocks in Sulawesi

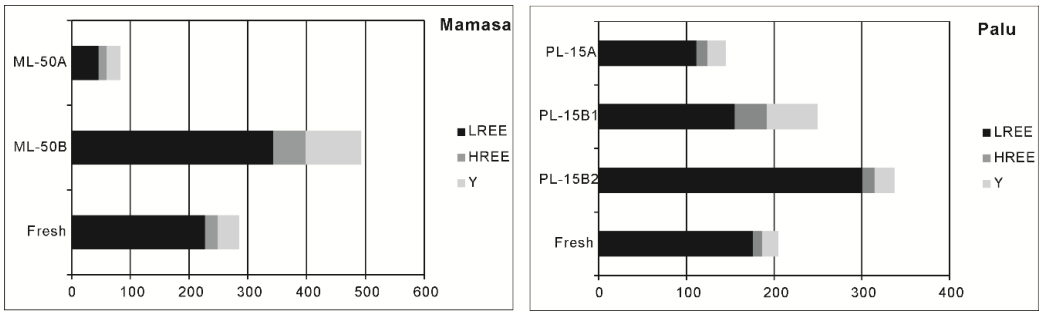


Fig. 4 Total LREE, HREE and Y of weathered crusts at Mamasa and Palu.

1. Scandium

Distribution of lateritic ultramafic as source of scandium in Sulawesi is depicted in Fig. 5. One of the promising areas in which scandium can be extracted from Ni-lateritic nickel deposit is Soroako. Most of ultramafic sequences in Soroako area have been weathered intensively and produced a lateritic profile. The profile consists of mainly bedrock, saprolite, limonite and top soil layer showing various ranges of thickness. Results of chemical analyses for weathering profile of ultramafic rocks from Petea and West Block are described in Fig.6.a and b. Bedrocks in these two areas are classified as harzburgite in composition. The bedrock in Petea profile contains of 40.8 wt% SiO_2, 34.8 wt% of MgO, 8.7 wt% Fe_2O_3, 0.2 wt% Ni, 9.8 ppm Sc. In relation to this, the weathering profile show decreasing content of SiO_2 and MgO, and increasing trend of Fe_2O_3 and Sc from bedrock to limonite layer. SiO_2/MgO ratio shows a slightly increasing trend from bedrock to soft saprolite but significantly enriched in yellow limonite layer.

Overall, West Block weathering profiles showing a somewhat similar pattern to Petea profile. SiO_2 and MgO are significantly decreased whereas Fe_2O_3, Sc and SiO_2/MgO ratio are enriched toward the upper part of the weathering profile. This variation suggests the enrichment of Sc was concentrated in the limonite horizon (yellow limonite) as shown by profile pattern.

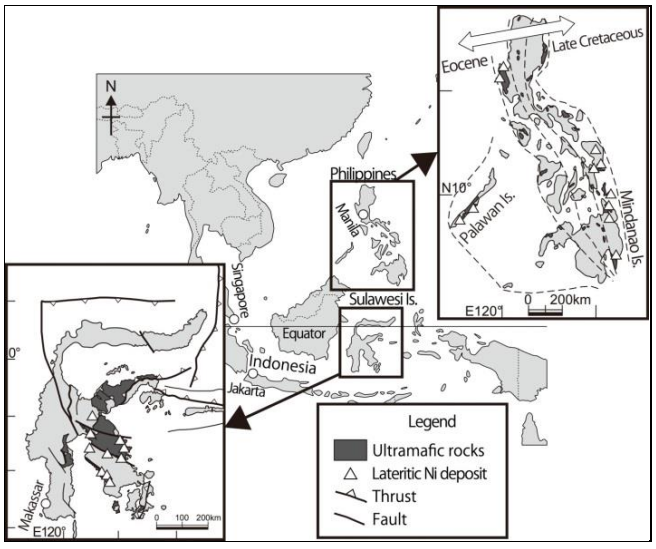


Fig. 5. Ultramafic rocks and lateritic Ni deposit distribution in Sulawesi Island. Inset figure show ultramafic and lateritic Ni deposit distribution in Philippines which have been exploited for Sc.

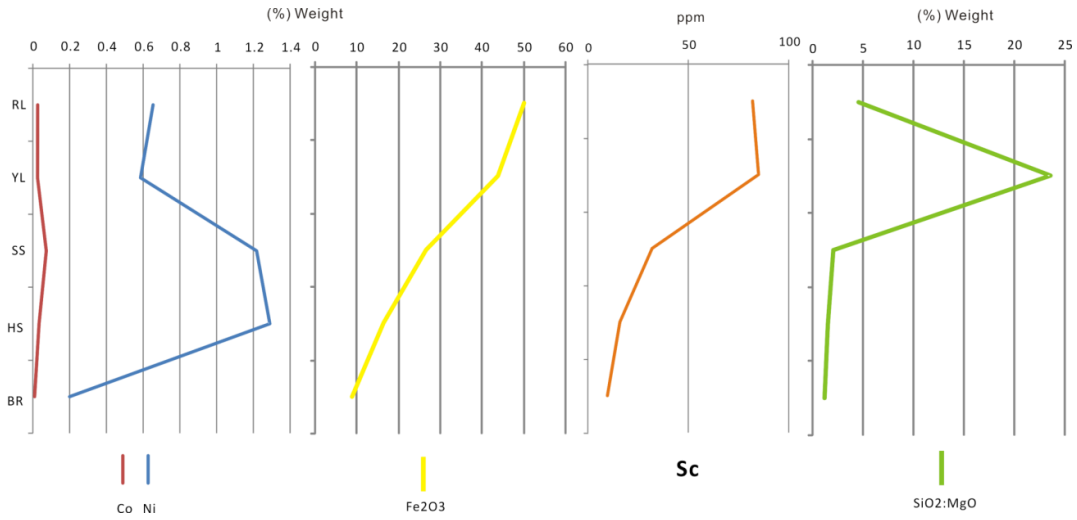


Fig. 6.a. Diagram showing vertical distribution of some elements in Petea A

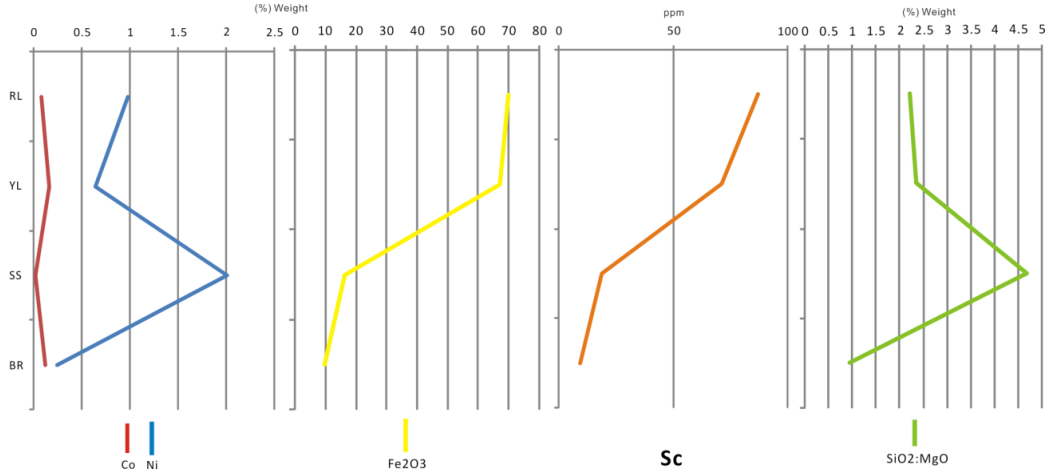


Fig. 6.b. Diagram showing vertical distribution of some elements in West Block

Conclusion

1. REE resources in Sulawesi can be extracted from ion-adsorption type deposit from heavily weathered I-type granitic rocks in Sulawesi. REE-sourced minerals are predominantly allanite, titanite and REE flourocarbonate. Depletion of Ce (negative Ce-anomaly) in weathered granite is a good indicator of ion-adsorption ores. Sc-bearing laterite Ni deposit in Sulawesi could be a dominant source of Sc resources in near future. Sc is likely to substitute Fe3+ site of mafic minerals (pyroxene, amphibole, etc) but further studied are required. Metallurgical process has an important role to extract Sc economically from Ni laterite.

2. Rare Earths play a key role in advanced green environmental products from energy efficient compact fluorescent light bulbs to hybrid cars, automotive catalytic converters and wind turbine generators. They are also essential in the development and manufacturing of many modern technological products from hard disc drives to flat panel displays, electronic and medical applications.

3. Some places in Sulawesi can be a promising source of REE and scandium in the future. However, further detail study on the occurrence of rare earth element and scandium are needed in order to maximize the potential of these materials for better development, especially in green energy technology

Acknowledgments

This paper is a summary of some thematic research on REE and Sc occurrence in Sulawesi conducted by the authors and some collaborators. We would like to express our sincere gratitude to Kenzo Sanematsu (AIST Japan), JICA C-BEST Program and member of Field Geology Laboratory in Geology Department, Hasanuddin University for the constant support. PT Vale Indonesia is greatly acknowledged for their facility and permit.

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The Application of The Different Prebiotic Level Added To The Diet on The Activity of *Lactobacillus* Bacteria In The Digestive Track of White Shrimp, *Litopenaeus Vannamei*

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ABSTRACT

This study aims to analysis of performance of the *Lactobacillus* sp, in the digestive track of the white shrimp after being given various prebiotic in the feed. Test animals use in this study was white shrimp juvenile, *Litopenaeus vannamae* measured the weight of 1.84 ± 0.23 g/individu with a stocking density of 10 shrimp/container, cultured for 30 days in a tank measuring of 50 x 45 x 45 cm^3 of 12 units use the recirculation systems and filled 50 L seawater with salinity of 15 ppt. The treatments were four types of feed that is formulated with various of prebiotics ie A: (without prebiotic), B:(lotus seeds), C: (sweet potatoes) and D (copra). These four types of treatments have been added *Lactobacillus* sp. with a population density of 1.5 x 10^9 CFU/ml. The result showed that the effect feeding with various prebiotic on the performance of *Lactobacillus* bacteria population (1,4 x 10^4 – 1,2 x 10^5 CFU/ml)were not significantly difference, but it was significantly difference to the enzyme α-amylase activity, (0,2558 IU/mL/minute), digestibility of carbohydrates (91,89%) The best resulted is feed added with probiotic copra.

Keywords: Feed, prebiotic, white shrimp, *Lactobacillus* sp

Introduction

White shrimp. *Litopeneus vannamei* is one of the most important commodity export of Indonesia which can inrerase the devisa .According to FAO (2013) Indonesia is occupaid the second rank of world producton above Thailand

Currently, the culture of the white shrimp is very increase both intensive and extensive culture due to the demand of this species from national and international markets are increased. The price of white shrimp in national market is Rp 58 000 per kg for size 100 while for size 50 the price is Rp. 85 000 per kg and for size 40 is Rp 102 000 per kilogramne. (Panca 2016) . In internatonal market the price of prozen white shrimp is US $5000-8000 / Metric Ton., (92 Metric Tons Minimum Order) (*www.verifyindonesia.com/* cited at hr 23..24, June 17,2015).

Some efforts have been conducted to increase the digestibility of food in the intestine. For example the used of probiotic that is the *Lactobacillus* which is included in lactic acid bacteria. This bacteria often found in food fermented, such as fish food processed, meat, milk, and fruits (Napitupulu *et al*., 1977). Probiotic bacteria needs the nutrition for the growth of the population. Probiotic using the prebiotic that is the food materials that have the polysaccharide content.. Nopitawi (2010) have been conducted the study on the prebiotic added to the shrimp food and using the probiotic. According to Puspita *et al*., (2012) and Basir (2013) the application of prebiotic and probiotic in the food will increase the growth and production of the fish culture.

Base on the these informations the research on the application of some kinds of prebiotic and using the probiotic *Lactobacillus* sp on the shrimp food is needed so that the useful of some prebiotics for support the performance of probiotic *Lactobacillus* sp in the digestive track of the white shrimp.

The objective of the research is to analysis of of the *Lactobacillus* sp, in the digestive track of the white shrimp after being given various prebiotic in the feed.

Materials and Methods

The research was conducted at Mini Hatchery Faculty of Marine Science and Fisheries Hasanuddin University. The Research Institute for Development of Brackish water Culture Maros and Laboratory of Testing and Development of the Fishery Production Quality.from February to April 2016.

The research device is aquaria measured of 50x45x45 cm3 for culture the white shrimp , Litopenaeus vannamei juvenile of 10 fish/aquaria. The water sirculation system was used to culture the shrimp

Research procedure

The shrimp were acclimated in a tank for one week before used in the experimental tanks. . During this period. the shrimp fed by commercial food (fellets), 10 % of body weight 4 times a day. After that then the shrimp not fed for 24 hours in order to eliminate the food in the intestine.

Shrimp measured of the weight and length using the analytical balance and the ruler respectively before introduced into the culture tanks. The culture period is one month and during this period the shrimp fed by same food and methos as in the acclimatization tanks.

The water exchange was done of 10-20 % daily. The water quality parameters were measured included pH,salinity,disolved oxygen and amonia measured using the spectrophotometer at the initial, middle and the last experiment in the laboratory.

Experimental Design

The completely randomized design with four treatments and 3 replicates was used in this research. Treatments in this research were A. food without prebiotic plus *Lactobacillus* sp. B. Food with lotus seeds plus *Lactobacillus* sp., C. food with sweet potatoes plus *Lactobacill*us sp. and D. Food with copra plus *Lactobacill*us sp

Parameters Test

Parameter test in this research were :1. bacteria population counted with petri dish method. Sample was taken from the digestive track of shrimp extract then each 1 gram of extracted, diluted with 9 ml physiology solution. The result of this solution used to culture the lactic acid bacteria in MRS media. 2. Food efficiency analysis using the prescription of Takeuchi (1988). 3. Observation on

Digestibility Enzyme include protease enzyme activity, α-amylase Enzyme Activity 4. Specific Growth Rate (SGR) counted following the prescription of Harjamulia *et al* (1986).

Data of bacteria population, food efficiency, SGR and enzyme activity were analyzed using the One way ANOVA, While the water quality parameter was analyzed with descriptive.

Results

A. The average of bacteria population taken from the digestive track of white shrimp fed by diet added different prebiotics are shown in Table 1

Table 1. The average of bacteria population taken from the digestive track of white shrimp fed by diet added different prebiotics (CFU)

Treatments	Average of bacteria population
Control	$1.4x10^4$
Lotus seeds	$3.4x10^4$
Sweet potatos	1.2×10^4
Copra	8.6×10^4

B. The average of food efficiency of shrimp fed by diet added different prebiotics are shown in Table 2

Table 2. Average of food efficiency of shrimp fed by diet added different prebiotics

Treatnments	Food efficiency (% ± SD)
Control	3.2233 ± 0,1955
Lotus seeds	3.2167 ± 0.1347
Sweet potatos	3.1467 ± 0.8313
Copra	3.4067±0.2656

C. The average of the protease enzyme activity of shrimp fed by diet added different prebiotics are shown in Table 3.

Table 3. The average of the protease enzyme activity of shrimp fed by diet added different prebiotics

Treatnments	protease enzyme activity (IU/mL/minute ± SD)
Control	0,1534 ± 0.0087
Lotus seeds	0,1567 ±0.0056
Sweet potatos	0,1706 ± 0.0463
Copra	0,1488 ± 0.0067

D. The average of the α-amylase enzyme activity of shrimp fed by diet added different prebiotic are shown in Table 4

Tablel 4. The average of the α-amylase enzyme activity of shrimp fed by diet added different prebiotics

Treatnments	α-amylase enzyme activity (IU/mL/minute)
Control	$0,2200 \pm 0.0522^a$
Lotus seeds	$0,0603 \pm 0.0433^b$
Sweet potatos	$0,2240 \pm 0.0744^a$
Copra	$0,2558 \pm 0.0333^a$

Note: Subscript character different indicated the significant difference (P<0.0-5)

E. Specific Growth Rate :SGR (%) of shrimp fed by diet added different prebiotics are shown in Figure 1.

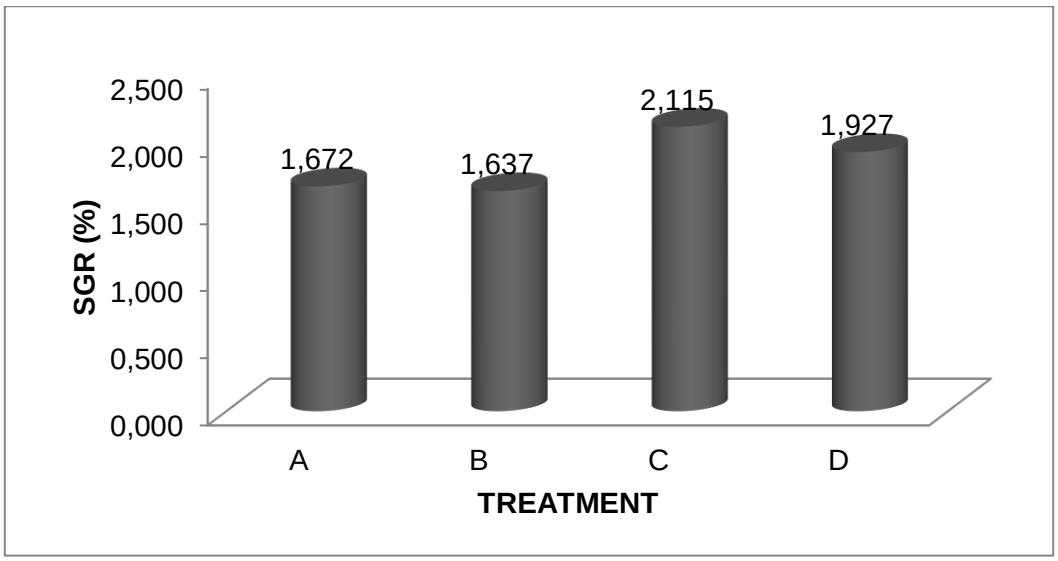

Figure 1. Specific Growth Rate (%) of shrimp fed by diet added different prebiotics

Water quality parameters recorded during the research period are shown in Table 5.

Table 5. Water quality parameter recorded during the research period

No	Parameters	Rank
1	Temperature (°C)	27-29
2	pH	7,5-8
3	Salinity (ppt)	15-19
4	DO (ppm)	6,27-6,80
5	Amonia (ppm)	0,002-0,019

Discussions

There was no significantly difference (P>0.05) between treatments on the bacteria population of the shrimp fed with the diet added by the different probiotic plus *Lactobacillus* sp due to three source of the prebiotic used in the present research have high carbohydrate especially oligosaccharide so that the usage of bacteria for its development is relatively the same. The decreasing of development of bacteria population of each source of prebiotic will effect on the acrivity of digestibility enzyme for utility the nutrient such as protein, fatty and carbohydrate. Verschuera *et al*., (2000) explained that the inhibitory of probiotic bacteria to the pathogen bacteria due to its ability to produce the anti bacteria such as bacteriosin, lysozyme, siderophore, hydrogen peroxide and organic lipid.

The effect of the treatment of the various prebiotic added to the diet on the food efficiency was no significant difference (P>0.05). That is indicated that food added with various prebiotics plus *Lactobacillus* sp will utilized by the white shrimp for its growth. The usage of various row materials together in food

formulation will complement for nutrient needed to the optimal growth of the white shrimp.

The effect of the treatment of the various prebiotics added to the diet on the enzyme protease activity was no significant difference (P>,0.05). It is assumed that the protein content in each treatment is nearly the same so that the require substrate for protease enzyme is also nearly the same. According to Nopitawati (2010) the commercial food added by probiotic produces protease enzyme result the highest growth.. Protease or endopeptidase is a group digestive enzyme of shrimp which responsible for more than 60 % of total protein for digestibility of shrimp

The effect of the treatment of the various prebiotics added to the diet on the α-amylase enzyme activity was significant difference (P<0.05). Treatment of the copra shows the highest result (0.2558± 0.0333 IU/mL/minute), while the lotus seed shows the lowest result (0.0603±0.0433 mL/minute) This is due to the high content carbohydrate in the prebiotic copra. The copra contents about 43-45 % polysaccharide of total carbohydrate which can utility for the source of carbon for growth media .

The effect of the treatment of the various prebiotics added to the diet on the Specific Growth Rate of white shrimp was no significant difference (P>0.05) This is due to the prebiotic have the nutrient content and the chemical structure relatively the same, so that the utility by *Lactobacillus* sp bacteria relatively easy in the digestive tract of shrimp. It is in accordance to Suryadjaja (2010) that usage of prebiotic can accelerate the growth and increase the viability of the non pathogen bacteria such as *Lactobacillus* sp that have function in the metabolism process, so that nutrient easy to absorbed by cell for the development.

Parameter of all water quality during the study period were in the limit rank of the survival and growth of the white shrimp and it support the study conducted.

Conclution

1. Prebiotics copra and sweet potatos have a big supporting to the α-amylase enzyme activity and digestibility of carbohydrate in white shrimp.
2. Prebiotic sweet potatos has a big constribution to the specific growth rate of the white shrimp.

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The authors thanks to the Director of the School of Post Graduate, Hasanuddin University and the Dean of Faculty of Marine Science and Fisheries of the same university for their support to finishing the study. Authors also thanks to Kamaruddin, S.Pi.M.Si., Aisyah A .Md.Pi., Buana Basir, S.Pi. M.Si Naharia Idris, Sp., Andi Masriah, S.Pi, M.Si, Yudi and Yusa and the technician of the Mini Hatchery of the Hasanuddin University (Mr Yulius and Mail) for their assisting in the experimental study.

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On Board Survey of The Small Pelagic Purse Seine Fishing

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ABSTRACT

The displayed real data in this study can be used to support fisheries management in Indonesia. The information and data related to the fishing ground, the composition of catches, the depth of the waters and the best time to fishing are also very useful for the fishermen and industry. This study was conducted over three months, starting from January to March 2016 in a fishing boat of Juwana – Pati, Central Java (KM Aungerah Bahari). The fishing grounds are in WPP RI-712 area, to be precise in waters around Kangean, Kalimantan. Total number of fishing were 48 times. The results showed that the most dominant catch caught was Lemuru *(Sardinella lemuru)*, as many as 49,990 kg or 41% of the total catches, followed by Tongkol *(Auxis thazard)* 16%, Layang *(Decapterus ruselli)* 15%, Selar bentong *(Selar crumenophthalmus)* 13%, Kembung *(Rastreliliger brachysoma)* 3.6%, and the other fishes 11%. If seeing at the data purse seine fishing operations base on the depth of the water, the fishermen operated the gear at the depth of 60-69 m were the most, where the average catch per setting reached 2,784 kg. And based on the fishing time, the average catches at 19:00 – 24:00 pm (WITA Time) was the highest. It was 2,768 kg/setting, higher than at 00:00 – 05:00 am was 2,451 kg/setting.

Keywords: small pelagic, WPP RI-712, purse seine,

Introduction

In Java, the dominant catches are small pelagic fish. The small pelagic fish are often caught using purse seine. Kembung *(Rastreliliger brachysoma)*, Selar bentong *(Selar crumenophthalmus)*, Lemuru *(Sardinella lemuru)*, are several kinds of fish that dominant caught and accounted for half of the total catch. This research is expected to provide upated information and data needed annualy for the fisheries management of Indonesia, in particulat the small pelagis fishery.

Research Method

This study was conducted on the boat KM Anugerah Bahari, one of the boats owned by PT Putra Leo Group in Juwana Pati – Central Java. This boat is a purse seiner wood with a groos weight of 90 GT, equipped with main engines powered 300 PK. Mesh size used was 25.4 mm in the part other than the bunt, while in the net bunt is 19.5 mm. KM Anugerah Bahari has two kinds of lights, which is kind of a strength of 400 watt mercury lamp /pieces with the number of 28 pieces, and the types of floodlight Light Emitting Diode (LED) powered 750 watt per pair with the number of 15 pairs (30 pieces). The fishing ground of KM Anugerah Bahari was in WPP RI-712 area, in the vicinity of Kangean waters, Kalimantan. These waters is one of the areas that have the potential fishery is quite high, especially small pelagic fish.

Results and Discussion

The catching operations carried out as many as 48 times. In January the weight of the cacth obtained as much as 40,340 kg by the number of setting 13 times, in February the weight of catch obtained as much as 61,820 kg by the number of setting 21 times, while in March the catch earned as much as 18,360

kg by the number setting 14 times. The total fish catch is 120,520 kg. The catch result is the most dominant caught is Lemuru *(Sardinella lemuru)*, as many as 49,990 kg or 41% of total catch, followed by Tongkol *(Auxis thazard)* 16%, Layang *(Decapterus ruselli)* 15%, Selar bentong *(Selar crumenophthalmus)* 13%, Kembung *(Rastreliliger brachysoma)* 3,6%, and the other fishes 11%. Based on the data, the average weight of catches taken by each setting is Lemuru *(Sardinella lemuru)*, 1,041 kg/setting, Tongkol *(Auxis thazard)* 400 kg/setting, Layang *(Decapterus ruselli)* 376 kg/setting, Kembung *(Rastreliliger brachysoma)* 90 kg/stting, and other types of fish as much as 287 kg/setting. If seeing at the data purse seine fishing operations based on the depth of the water, the fishermen operated the gear at the depth of 60-69 m were the most, where the average catch per setting reached 2,784 kg. The interesting in this study was the highest catches according to the depth of water, it was 40-49 m (4,473 kg per setting). In this study also show the best time to fishing, the highest catch was at 19:00-24:00 pm (2,768 kg/setting), higher than the operating fishing gear at 00:00-05:00 am (2,451 kg/setting).

Conclusion

The displayed real data can be one source of studies that support for the fisheries management in Indonesia. The information and data related to the fishing ground, the composition of catches, the depth of the waters and the best time to fishing are also very useful for the fishermen and industry. This study was conducted over three months, starting from January to March 2016 in a fishing boat of Juwana – Pati, Central Java (KM Aungerah Bahari). The fishing grounds are in WPP RI-712 area, to be precise in waters around Kangean, Kalimantan. The results showed that the most dominant catch caught was Lemuru *(Sardinella lemuru)*, as many as 49,990 kg or 41% of the total catches, followed by Tongkol *(Auxis thazard)* 16%, Layang *(Decapterus ruselli)* 15%, Selar bentong *(Selar crumenophthalmus)* 13%, Kembung *(Rastreliliger brachysoma)* 3.6%, and the other fishes 11%. If seeing at the data purse seine fishing operations base on the depth of the water, the fishermen operated the gear at the depth of 60-69 m were the most, where the average catch per setting reached 2,784 kg. If seeing at the data from fishing operations based on the operating time of fishing gear, then average catches at 19:00 – 24:00 pm was the highest. It was 2,768 kg/setting, higher than the operation of fishing gear on the 00:00 – 05:00 am was 2,451 kg/setting.

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Status of Coral Reef Ecosystem and Indication of Coral Bleaching Event in Morotai Islands Water, North Moluccas

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ABSTRACT

The coral reef ecosystem is one of the most diverse ecosystems in the biosphere. Coral reefs also represent one of the threatened marine systems. Severity and frequency of coral bleaching events increased in recent years affecting the recovery and resilience of corals. This study outlines evidence from the Morotai Islands water in support of recent hypotheses on coral bleaching and reef vulnerability to thermal stress. Data obtained based on a survey conducted by Shark Diving Indonesia at five locations: Blacktip point, Eagleray Point, Aru Point, Lighthouse Point and Daloha Point. One of the methods that utilized in this research is quick survey using a method proposed by the Ministry of Maritime Affairs and Fisheries (MMAF). Line Intercept Transect (LIT) is applied to examine and record the coral conditions at the depth of 5 – 10 m in each survey location. The result showed early symptoms of coral bleaching (less than 25%) in Morotai's coral reef ecosystem. Hard corals such as *Acropora sp.* tabulate, branching and digitate were found sensitive and bleached. Whereas massive corals such as *Porites sp*. exhibited light symptoms of bleaching. Soft corals were found unresponsive to bleaching and remained healthy.

Keywords: coral reef, coral bleaching, Morotai.

Introduction

Report from *Reef at Risk* (2002) put Indonesia as one of the countries with the most threatened coral reef status. In the past 50 years, the total decline percentage in the coral reefs condition in Indonesia have increased from 10% up to 50%. Results of coral reefs condition in Indonesia between the year of 1993-2015 in 1259 research point at 93 different locations showed varieties of results: 5 % very good condition, 27,01 % good condition, 37,97 % average condition, and 30,02 % in a bad condition (CRITC COREMAP-CTI P2O LIPI, 2016).

One of the major cause of the coral reefs damage is bleaching caused by global warming. Bleaching coral is a disruption in symbiotic relations between the coral and photosynthetic algae (zooxanthellae) (Hoegh-Guldberg 1999; Wilkinson et al 1999 in Fine *et al*, 2002) as a result the color of coral faded or whitened (Brown 1997 in Downs et al. 2002). Bleaching coral are caused by various factors, including changing temperature, excessive irradiation from the sun, and bacterial infection (Stone *et al*. 1999 in downs *et al*. 2002), or environment pressure such as increase in salinity, sedimentation, brightness, solar radiation (Fitt *et al*. 2001) or the combinations of those factors.

During the bleaching event, corals lose 60-90% of their zooxanthellae and the remain zooxanthellae could lose 50-80% of their photosynthetic pigments (Glynn, 1996). In several types of coral reefs, bleaching can cause the growth and deposition of calcium to stopped and inhibition the process of sexual reproduction. Corals may survive if the pressure only lasts for a short-term period, but will die if it occurred for the longer term.

Temperature is an important factor affecting the stability of corals symbiosis in individual level and the ecosystem of coral reef (Glynn, 1991). The slight increase of temperature to some degree over the threshold can reduce growth rate or cause extensive mortality in coral species (Neudecker 1987, Jokiel & Coles 1990).

The ability of corals to adjust to changes in temperature can vary according to the species, the genus, the form of growth, and the location (Brown & Suharsono 1990; Siringoringo 2007).

Extensive and massive coral bleaching generally coincides with the occurrence of climatic anomalies such as El Niño in 1982-1983 and 1998, but there are also coral bleaching phenomena happened without the presence of the anomaly.

The purpose of this study is to find the coral reefs distribution and the extent of coral bleaching in Morotai Island. The results of the study will be given as recommendation to support in building better management for coral reef ecosystems in Morotai Island.

Method

This research was conducted in the Southern part of Morotai Island, North Moluccas. The survey research was held in January - March 2017. The method used in the survey to obtain the coral bleaching data was a quick survey method from the module "Coral Bleaching Monitoring Guide" published by the Ministry of Maritime Affairs and Fisheries (MMAF) in 2016. The method aims to provide a quick overview of coral bleaching condition on a survey location.

The method of a quick survey coral bleaching was supported by Line Intercept Transect (LIT) method to determine the condition of coral reef in Southern Morotai Island. LIT method is used to determine the percentage of each category of the benthic communities. Information obtained using this method is the percentage of coral coverage such as hard coral, soft coral, algae, rock, dead coral, and sponges. Detailed information can be obtained from the life form. Information up to the level of family, genus, and species depends on the purpose and the expertise of observers. The growth data will help in describing the coral reefs topography.

LIT methods need at least two divers that used SCUBA equipment. Other equipment needed to conduct the survey is measurement roll-tape. First step in LIT method is spreading the roll-tape up to 50m in the reef area or research point, and began collecting data from point 0 - 20m. Point 20-25m is a buffer zone, where researchers stop taking data to reduce the human error impact while obtaining the data. The survey continued from point 25-45m, and another buffer zone occurred in point 45-50m. Each of the buffer zone distance is 5m and the overall distance is 20m.

Figure 1. Map of observation station

1. The percentage of cover life form countable with formula (English, 1997):

$$C = \frac{\alpha}{A} \times 100\%$$

where: C = percentage cover life form i; α = length of transect life form i; A = amount a length of transect

2. Relative Abundance:

$$\frac{amount\ life\ form\ i}{total\ amount\ life\ form} \times 100$$

3. Mortality Index:

$$\frac{percentage\ cover\ (dead\ coral\ +\ rubble)}{percentage\ cover\ (dead\ coral + rubble +\ coral\ life)}$$

Results and Discussion

Coral Cover on Morotai Island

There is various condition of coral reef cover in southern Morotai, some factor is anthropogenic for example, destructive fishing using explosive that causing some of the areas that expected to be the main fishing ground are dominated with rubbles or new-growing colonies. Data collection was conducted in five different stations with a range of depth between 5 – 10 meters. The following table shows the percentage of coral cover and coral mortality index in every station:

Table 1. Percentage of substrate cover

Research Station	Life Coral Cover (%)	Mortality Index	Algae Cover (%)	Other Fauna (%)	Abiotic Cover (%)
Blacktip Point	51.94	0.26	3.88	3.88	31.78
Eagleray Point	72.12	0.15	6.96	6.74	9.21
Aru point	53.37	0.20	3.68	9.20	28.22
Light House Point	48.18	0.21	11.82	7.27	30.91
Daloha Point	74.19	0.14	5.38	5.38	8.60

Coral reef condition can be determine from percentage of hard coral coverage (Gomez & Yap, 1988) :

Very Good : 75 – 100%
Good : 50 – 74,9%
Medium : 25 – 49,9%
Bad : 0 – 24,9%

According to Table 1, the highest percentage of coral-reef coverage is recorded in Daloha point with 74.19% and classified in good condition. Daloha point is located in Southeast Dodola island that has slope contour. This part of the island is not disturbed by destructive fishing activity.

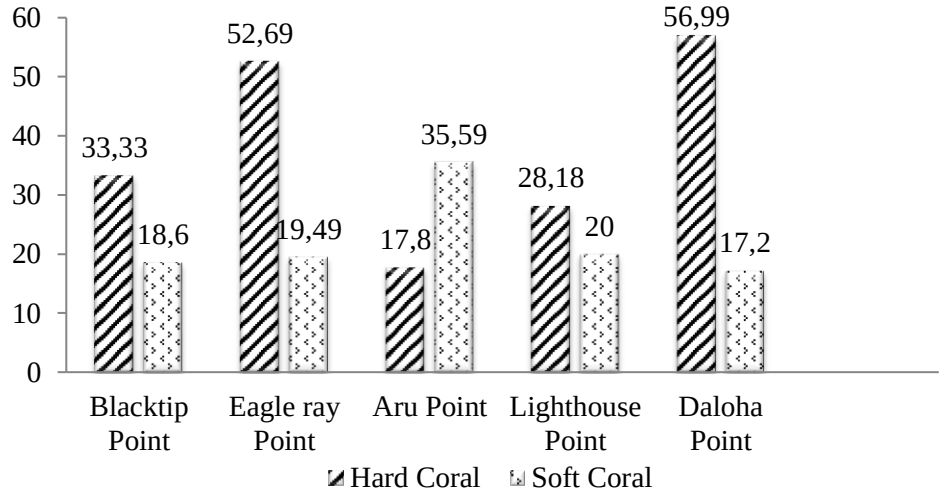

Figure 2. Comparison soft coral and hard coral in each station

The lowest percentage value of coral life cover is in Lighthouses point with 48.18% coverage and classified in medium category. Type of contour in Lighthouses point is slope with white sands and rubbles.

Figure 2. showing the comparison between hard coral and soft coral in every station. The highest percentage of soft coral coverage is found on Aru point with a range of depth between 8 - 10 m. The lowest percentage of soft coral coverage is found in Daloha point with 17.2%. This low coverage of soft coral could be related to the slow current flow in Daloha point. Soft coral needs current for giving them fresh water, more oxygen, protect them from sediment that will cover the colony, carrying nutrients and food (Nybakken, 1988; Bikerland, 1997 at Sugiyanto, 2004).

Besides the current, distance from the mainland also influencing soft coral growing. More soft coral will be found as the distance decrease from the mainland because of soft coral expected to receive more organic materials near the mainland (Soedharma et al., 2015). In this case, Aru point is the one and only station that located in the mainland (morotai Island).

Environmental parameters affect the density of soft coral too (Fabricius et al., 2001). In general, soft coral has a higher tolerance to environmental changes than hard coral, for example for increasing temperature. In many cases, we can see the first symptoms in coral bleaching on hard corals (less than 25%) while the range of maximum and minimum temperature limits of soft coral is is relatively higher between 16 – 36^{o}C (Kinsman, 1964 at Supriharyono, 2007).

Coral Bleaching Phenomenon in Morotai Island

The occurrence of bleaching in morotai waters still showing an early symptom where the percentage is less than 25%. Each station shows the same result that the number of bleaching percentage on hard corals is less than 25%. Type of hard coral that experience bleaching from species Acropora tabulate, branching and digitate and type of hard coral with minimum bleaching frequency is coral Foliose and coral Massive. During observation, no bleaching was found on soft coral and coral encrusted (Figure 3) in this study, water temperature was recorded at 29-30^{o} C.

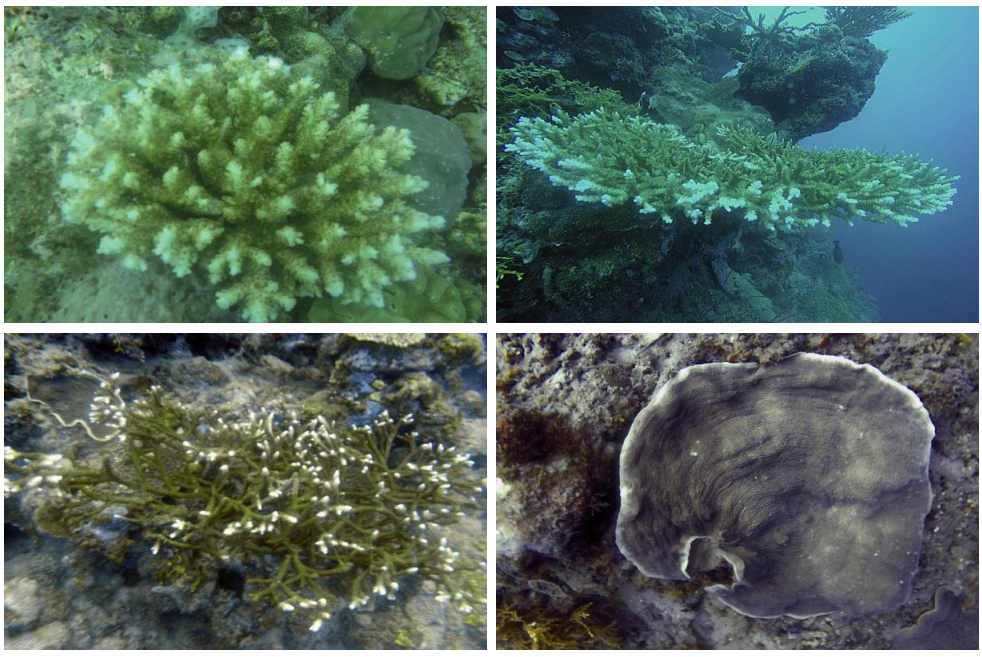

Figure 3. Coral Bleaching in Morotai

Drupella was found as a cause for a colony of coral branching has bleaching on Eagle ray point, but not found in other station. In this study, we found White Band Disease (WBD) in a colony on Lighthouse point.

The main factor that causing coral bleaching is the increasing water temperature that can not be tolerated by the coral reefs, and causing the coral reef's

polyp release the zooxanthellae, and further, lose the symbiotic algae that giving color to coral. The optimum temperature for coral growth is 23 – 30ºC (Nybakken, 1992). Based on these statements, water temperatures in Morotai Island are considered to be the optimum temperature for coral reef growth. However, each type of coral reef can have different temperature tolerances between one species to another or the same one with a different location. But on average, coral reef organisms live at temperatures close to their tolerance limits (Johannes, 1975).

Hard corals in Morotai waters are dominated by Acropora and Porites. Not all types of hard corals have the same sensitivity in receiving pressure due to temperature changes. Coral massive is more resistant to change pressure temperature and tend to recover faster (Rani, 2001). Inversely with Acropora, where coral was more sensitive to the increase of temperature waters where bleaching can occur up to 95 % of the total colonies and die in 3-6 the next month (Gleason & Wellington, 1993).

Acropora is more common to be bleach compared to any other coral species especially porites. Generally, the type of Acropora that experienced bleaching is branching, tabulate and digitate. In fact, we almost can not found the type of Porites that experienced bleaching. Some of the Porites colonies found in poor condition are usually not due to bleaching instead the part of the colony is damaged to death and overgrown with algae.

Based on research conducted by Warner (1996) states that the zooxanthellae that live behind the coral (radial corallite) is more resistant to temperature changes when compared with *Montastrea annularis* and *Agaracia lamarkii*. Zooxanthellae in *M. Annularis* are more vulnerable to changes in temperature and could explanation why Acropora have high sensitivity to temperature changes.

Hard coral and benthic algae compete to survive. Benthic algae generally covered the surface of hard coral, it prevents polyp to forage by blocking the way out from the frame. Studies in Costa Rica, Panama, the Galapagos Islands and Indonesia showed that benthic algae can quickly cover coral-reef that damaged by the rising temperature caused by El Nino (Glynn, 1993).

El Nino is an event of warming sea surface water temperature on the west coast of South America (east pacific) that emerges around December. El Nino phenomenon in Indonesia has occurred for four times since 1983, 1998, 2010 and 2015. This phenomenon causes rising waters temperature in Indonesia, but not significantly affecting all regions, for example, Morotai island where the effect is insignificant. This is because El Nino coming through the pacific ocean and passing Indonesia Through Flow (ITF) toward the Java Sea. Also the air brought in by Halmahera sea into Morotai turned back out by the Halmahera Eddy.

As an assumption, if El Nino affecting Morotai waters there was found more coral bleaching since 2000 because El Nino that occurred in 1998 was rated as strongest El Nino and caused massive coral bleaching event in Indonesia. The

increasing water temperature occurring in the Morotai waters assumed as an effect of global warming.

Therefore, the coral bleaching that occurred on Morotai island is still in an early symptom.according to the results in five different stations that still less than 25% of each colony. At this stage, the bleaching event did not have a significant effect on the ecosystem, there is still found a high abundance of reef fish in different species on the reef ecosystem. The anthropogenic activity still considered as one of the most significant causes for declining quality of marine ecosystems (Fachry, 2015)

Conclusion

The result from the observation in five different stations shows that Daloha point and Eagle ray point has good percentage coral cover with more than 70%. Lighthouse point classified into bad category, because the percentage value is below 50%. Some of the coral reef ecosystem in southern Morotai waters has damaged by destructive fishing using explosive, leaving rubble piles that spread under the slope in some areas. Coral bleaching events that occurred in Morotai waters still showing early symptoms and the number of bleaching occurrence is less than 25%. Coral bleaching is dominated by coral Acropora (branching, tabulate and digitate) that have low tolerance to the temperature changes. Other than temperature change, we discovered that Drupella and White Band Disease also causes bleaching of coral colonies. In this study, we conclude that the bleaching events is hardly caused by El Nino Phenomenon.

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Role of Cooperation to Increasing Economic in Coastal Communities

(Case Study: Juku Lele Cooperative, Barombong District of Gowa)

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ABSTRACT

The welfare of the members is the hope of every cooperative, but not all cooperative is able to realize these hopes. This study aims to look at the role of Juku Lele cooperative in improving the economy of coastal communities in the District Barombong, Gowa. Respondents who have interviewed directly, the data obtained were analyzed further using systems analysis and market analysis using the application Structure Conduct Performance (SCP). The results of this study indicate that the cooperative has been able to supply the catfish seed, helping members and surrounding communities accommodate the catfish farming and marketing of catfish farming. Respondents who sell to catfish farming cooperative has reached 100%. It indicates the role of cooperatives has been expected, where the sale price given the cooperative in accordance with the market price. The role of cooperatives as a channel catfish are very active (100%) where the respondent proceeds distributed to all customers even Juku Lele cooperative able to meet the market demand. Welfare members are improved with no more members of the cooperative who borrow capital in the Cooperative Juku Lele

Keywords: Role of Cooperatives, catfish farming, coastal communities, Welfare

Introduction

Cooperative is one of the instigators of the reliable economy as directly related to the goods and services produced by the needs of coastal communities. This is consistent with the purpose of the cooperative to prosper together. Cooperative becomes an alternative coastal communities in meeting their daily needs.

Micro-businesses are the economic part directly in contact with the lower middle income people as portrayed by members of the Juku Lele Cooperative where micro enterprises they work in the form of seeding, distribution and marketing of catfish farming. The importance of micro enterprises, played by Juku Lele cooperatives. This catfish is becoming serious concern, because this business can provide jobs to reduce unemployment and improve the well-being of coastal communities. Given the importance of the role of cooperatives and the lack of research on the role of cooperatives towards the coastal msyarakat life that need to be assessed whether the Cooperative Juku Lele role in improving the welfare of members and coastal communities.

Research Methods

This study was conducted in March-May 2016 is located in Juku Lele Cooperative the District Barombong, Gowa. The method used by descriptive method where the study was to identify the conditions that obtained in the field, case studies on Juku Lele Cooperative performed in accordance frame Lele research purposes so as not to bias the data retrieval. Primary and secondary data obtained by direct interview and filling the questionnaire by respondents.

Respondents were selected intentionally (purposive sampling) that the board of Cooperatives and Cooperative members Juku catfish totaling 25 people as well as the surrounding community Cooperative Juku catfish where they know the whereabouts of the Juku Lele Cooperative 25 people. The technique of taking a lot more data on field observations, interviews, documentation and triangulation or combined (Sugiyono, 2011).

The data obtained were further analyzed using the analysis of questionnaires. Result System be input for the Catfish Juku Cooperative for the development of further cooperation, in particular to improve the economy and members of coastal communities. The market analysis is used to determine the role of cooperatives by using the application Structure Conduct Performance (SCP).

Results and Discussion

The results of the questionnaire by member cooperatives Jukulele on the implementation of cooperative systems Juku Lele shown in Table 1.

Table 1. Results of Systems Implementation Questionnaire at Juku Lele Cooperative

No.	Question	Number of people	Percentage (%)
A	BUSINESS ACTIVITIES		
1.	Type Cultivation:		
	Catfish	20	80
	Catfish and other Catfish (Patin)	2	8
	Catfish and Parrot fish	2	8
	Catfish, other Catfish (Patin) and Parrot fish	1	4
2.	Cultivation place:		
	Pool	3	12
	Pool tarp	3	12
	Floating cages	19	76
3.	The average amount of spending		
	≤ 500.000	16	64
	501.000 – 1 Million	6	24
	1 Million – 2 Million	3	12
	> 2 Million	0	0
4.	Average amount of revenue		
	≤ 1 Million	0	0
	1 Million – 5 Million	4	16
	5 Million – 10 Million	20	80
	> 10 Million	1	4
5.	Why feel the need to become a member of the Cooperative?		
	The influence of fellow farmers	10	40
	Advice from a field officer	0	0
	Need capital for cultivation activities	15	60
6.	Loan cooperatives are used for :		
	Cultivation	20	80
	Capital sales business	4	16
	Other needs	1	4

Table 1. Results of Systems Implementation Questionnaire at Juku Lele Cooperative (continued)

No.	Question	Number of people	Percentage (%)
B.	THE ROLE OF COOPERATION		
1.	How to apply capital strengthening to		
	Cooperative	2	8
	Arrange for yourself	15	60
	Grouped with board	8	32
	Cooperative management makes		
2.	Grace period of submission is thawed :		
	< 1 month after submission	22	88
	1 month after submission	3	12
	2 month after submission	0	0
	3 month after submission	0	0
	> 3 month after submission	0	0
3.	Form of given capital		
	Cash	0	0
	Catfish seeds (CS)	22	88
	Pool tarp (PT)	1	4
	floating cages (FC)	2	8
	Cash and CS/PT/FC	0	0
4.	The amount of capital strengthening received		
	Subject to submission	22	88
	Less than submission	3	12
	More than submission	0	0
	Submission is rejected	0	0
C.	PRODUCTION AND SALES		
1.	How harvests are obtained		
	Did not achieve the expected result	2	8
	Achieve the expected result	20	80
	Exceeds expected result	3	12
2.	The amount of crops earned per harvest :		
	≤ 20 kg	0	0
	21-30 kg	0	0
	31-40 kg	2	8
	41-50 kg	20	80
	>50 kg	3	12
3.	Type of fish that is always harvested		
	Catfish	23	92
	Other catfish (Patin)	1	4
	Parrot fish	1	4
4.	Yields sold to:		
	cooperative	25	100
	Market	0	0
	Consumption it self	0	0
5.	Sale of harvested crops :		
	Below the selling price	0	0
	According to the selling price	25	100
	Above the selling price	0	0
D.	REFUND OF CAPITAL		
1.	Business payback plan		
	Paying off every harvest	0	0
	Paying off every month	0	0
	Get paid for each harvest	25	100
	Do not know	0	0

***Market** Analysis*

The performance of Jele Lele Cooperative includes business activities, production and sales that support each other so that Juku Lele Cooperative

developed more advanced. Application of SCP in cooperatives makes the performance more effective and efficient because the cooperative is able to produce seeds for the purposes of members. Productivity achieved has met the market demand in quality but the fulfillment of quantity can not be met because the members of the cooperatives are still lacking and production facilities are still minimal.

Table 2. Results of System Analysis based on SWOT

INTERNAL	**EXTERNAL**
STRENGTH	OPPORTUNITIES
The harvest is as expected and can produce catfish seeds	Unmet market demand (for Makassar alone takes 500kg / day)
The selling price of the harvest is in accordance with the market price	Increased interest in consumption catfish
Abundant catfish feed from chicken seller waste so as to facilitate the maintenance (cultivation).	The development of cultivation facility of catfish and its handling
WEAKNESS	THREAT
The quality of human resources is still minimal (enlargement of catfish still rely on nature)	The success of the harvest still relies on nature so that crop failure by disease lurks at all times
Although the harvest is as expected but the amount is not sufficient to meet market demand	The availability of human resources in handling cooperative sustainability is still minimal
Insufficient Facilities and Infrastructure	The presence of competitors from other regions (Surabaya) as a catfish distributor to the region

System Analysis and Market Analysis

A review of system analysis and market analysis that has been done shows Juku Lele Cooperative in the future able to grow in terms of helping its members. This can be seen from table 2, market demand that can not be fulfilled in quantity, while the selling price of harvest is in accordance with market price. This makes members of Juku Lele Cooperative does not sell their crops directly but sells to cooperatives. Seeds obtained by members can be obtained at the Cooperative so that members of the Cooperative can cultivate according to the production capacity owned. Cooperative members' dependence on capital is also overcome by Juku Lele Cooperative because of the profit sharing system that lends the seeds and sells back the harvest to Juku Lele Cooperative. This makes the members of the cooperative become more prosperous because it is free from usury and debt every time the harvest.

Juku Lele cooperative is very responsive to internal and external environment conditions. Internally the members of the Cooperative are not only assisted in the procurement of seeds but also in the procurement of facilities and infrastructure for catfish farming (Table 1). Although the condition of facilities and infrastructure is not sufficient but already can help members of cooperatives in running their business. The external conditions Juku Lele Cooperative has

provided the development of cultivation facilities and handling that is adjusted to the condition of each member.

Conclusion

Juku Lele Cooperative is very instrumental in the welfare of its members. Based on the results of the quisioner, respondents who sell the cultivation of catfish to the cooperative has reached 100%. This indicates the role of cooperatives is as expected, where the selling price provided cooperatives in accordance with market prices. The role of cooperatives as a catfish distributor is very active (100%) where the results of the sales of respondents distributed to all customers even Juku Lele cooperative overwhelmed to meet market demand. Increased member welfare is characterized by no more cooperative members borrowing business capital in Juku Lele Cooperative.

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Temporal Distribution of Mesozooplankton in Bidong Archipelago, Peninsular Malaysia

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ABSTRACT

Planktons are well known for their abundance in the water column but their dynamic population has been less studied especially on the temporal distribution pattern. Bidong Archipelago with the existence of coral reef ecosystems was chosen as the study area to investigate the temporal distribution of mesozooplankton during the season of pre-southwest, southwest, post-southwest, pre-northeast, northeast and post-northeast monsoon. 200-micron mesh size plankton net was used in this study. Nine phylum of mesozooplankton was identified in this study; where Arthropoda and its predominant class Crustacea was the most abundant organisms in the water sampled at all stations and seasons. Copepoda was the dominant order in phylum Arthropoda and its distribution pattern was closely similar to mesozooplankton distribution pattern. The highest density of mesozooplankton was found during post-southwest monsoon. However, larvae from phylum Echinodermata dominated Station 2 during post-southwest monsoon and Station 2 also showed relative low mean density of mesozooplankton over all sampling seasons together with Station 7 and Station 8. Findings from this study could contribute to the establishment of baseline for ecological dynamic of mesozooplankton in relation to coral reefs ecosystem resilience in Bidong Archipelago.

Keywords: mesozooplankton, zooplankton, monsoon, temporal, Bidong

Introduction

Plankton is important subject in connecting the ecosystem functions. Studying their distribution pattern will contribute further knowledge in determining the ecosystem conditions. Plankton abundance and community structure fluctuations were determined by the interactive effects of freshwater inflow, tidal and coastal currents or pretty much referring to monsoon seasons. Food abundance, light level penetration, temperature and a mixed water layer depth also important in determining the zooplankton distribution (Rezai et al. 2011).

Planktonic larvae are an important group structuring zooplankton community comprising of cirripedian larvae, brachyuran larvae, macruran larvae, molluscan larvae, echinoderm larvae, fish larvae and polychaeta larvae (Li et al. 2000). Some of these planktonic larvae contribute to zooplankton densities seasonally for example, molluscan larvae are abundance during post-monsoon of northeast season due to their spawning season (Khyril_Syahrizan, 2012; Al-Barwani et al. 2007). According to size by Day et al. (1989), mesoplankton size range between 200 µm to 2 mm contains primarily crustacean copepods, diverse invertebrate larvae and small gelatinous zooplankton (Moriarty and O'Brien 2013) compared to microplankton (20-200 µm) and megaplankton (> 20 mm).

Zooplankton communities give a big impact on marine survey of both biodiversity and ecosystem functions. Malaysia is a trophic country where the smaller mesh size of net is mainly used (Khyril_Syahrizan, 2012; Nakajima et al. 2014; 2008; Rezai et al. 2011; 2009; 2004; Yoshida et al. 2012; Idris et al. 1995; 2000; Shamsudin et al. 1998; Zaleha et al. 2006; 2008) compared to temperate study as suggested by Harris et al. (2000). Buitenhuis et al. (2006) study stated that mesozooplankton have a significant feedback to primary production as they directly feed on phytoplankton, microzooplankton and other mesozooplankton. Thus, this study was executed since mesozooplankton has significant important role in pelagic food web.

Methods

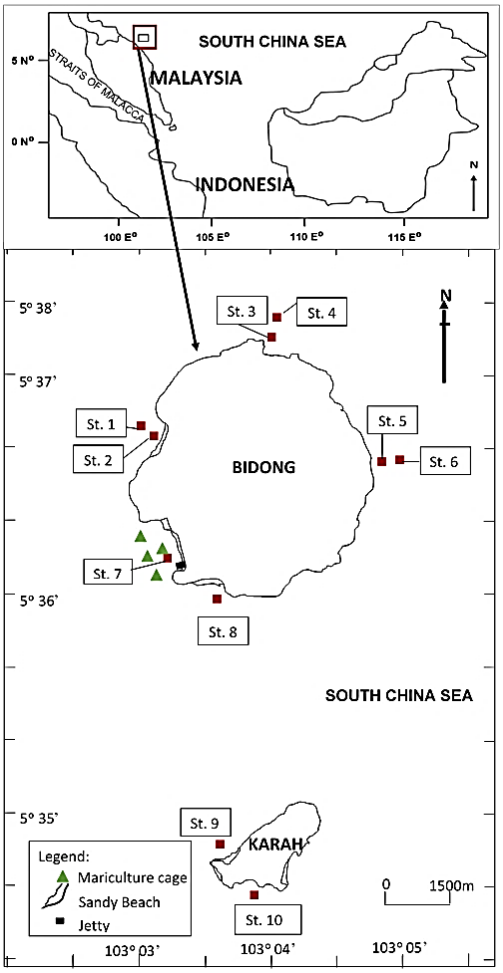

Fig. 1: Sampling stations in Bidong Archipelago, South China Sea.

Samples was taken around Bidong Archipelago, Terengganu (N 5.61543; E 103.05976) (Fig. 1). 10 fixed stations were chose based on the coral reefs area and coral reef related area. Diversity of the sampling area are influence by South China Sea tidal and currents. The sampling area has regulative experience of two main annual monsoon seasons, the southwest and northeast, and activities by human including snorkelling and diving. The area also located seabass and grouper mari-culture farm and extensive boating activity.The reef area is well known having a

diverse of organism but so far there is no temporal data on meso-size zooplankton (mesozooplankton).

Triplicate mesozooplankton samples were vertically hauled at each sampling station using 200 µm mesh size net with mouth was 30 cm in diameter. Samples were taken 1 meter from the sea bottom to the surface concerned to the coral reefs. Mechanical flowmeters of General Oceanics model 2030R was attached to the nets during the sampling (Harris et al. 2000). Samples were fixed with 3% of formaldehyde solution. 1/16 aliquots of sample were identified per the keys and references set by Arvin (1977) and Pechenik (2000). Samples were enumerated and counted with the aid of compound microscope. Mesozooplankton abundance was calculated to the total parts divided and presented in mean of total density (± SD) of each sampling station. Mesozooplankton density in individual per cubic meter (ind.m-3) were calculated as described by Allisson and Wisher (1986). Shannon-Weiner diversity index, Margalef's species richness and evenness test was run to describe the diversity pattern of mesozooplankton distribution in the sampling area of Bidong Archipelago, South China Sea.

Result and discussion

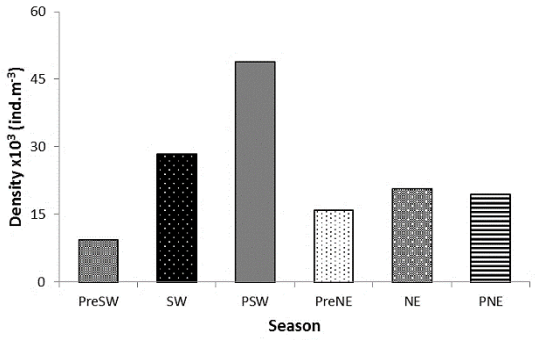

Fig. 2: Contribution of total mesozooplankton abundance between sampling seasons in Bidong Archipelago. Value in mean density; n=30. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

Mesozooplankton was found maximum during the season of post-southwest monsoon with 34% of total density (48,776.4 ind.m^{-3}) as portrays in figure 2. No study indicates that mesozooplankton abundance was found maximum during the post-southwest season besides Shamsudin et al., (1997) who found only the wide variety of zooplankton species in South China Sea occurred during the equivalent season of southwest monsoon. Studies by Khyril_Syahrizan, (2012) and Bibi-Shaheeda (2007) found zooplankton was highest during post monsoon season in South China Sea related area. Chandasekaran (2000) also found zooplankton was higher during post monsoon season and drier season (southwest monsoon) (Li et al. 2000) and signifies that zooplankton abundance has close association with monsoon but different local weather play a feature. Chew and Chong, (2011) found that rainfall pattern was the most influential factor controlling zooplankton and their community structure by changing the salinity level. Relatively dry weather during the sampling season may influence the mesozooplankton

abundance as mesozooplankton distribution strongly linked to higher salinity (Khyril_Syahrizan, 2012; Li et al. 2000; Zaleha et al. 2008; Bibi-Shaheeda, 2007).

Only Station 3, Station 5, Station 9 and Station 10 show significant high density of mesozooplankton during the post-southwest monsoon (Fig. 3) with highest Shannon-Weiner diversity index of 2.81, 2.60, 2.76 and 2.64 (nats) respectively (Fig. 5). These diverse mesozooplankton community from these stations may influenced from currents that derived nutrient from mangrove of the main land as supported by Nurul Rabitah and Fadzil (2015) where current flow are driven to north-eastward to Bidong Archipelago during southwest monsoon. Although there is no fringing mangrove alongside the Kuala Terengganu coastal, mangroves are available in Sungai Merang where the nearest boat transportation hub. Nutrients are believed was transferred to estuarine and adjacent coastal area by tides, and transferred farther by coastal currents. Nutrient perturbation is typically important in phytoplankton growth (Badosa et al. 2007; Chua et al. 2000). Shamsudin et al. (1998) stated that high zooplankton density is significantly related to annual bloom of phytoplankton. However, only Station 5 showed less variation (J'= 0.41 nats) of mesozooplankton and high Margalef's species richness (R= 3.30 nats). Mesozooplankton also was found highest at the station with 14987.7 ± 4916.9 ind.m^{-3}. This outcome may due to slight fluctuation of water parameter where a significant higher temperature fluctuation is believed accumulate higher zooplankton density (Fernandes and Molinero, 2008; Khyril_Syahrizan, 2012). Other physico-parameters impacted by water temperature fluctuation also directly affect the zooplankton distributions (Yebra et al. 2006).

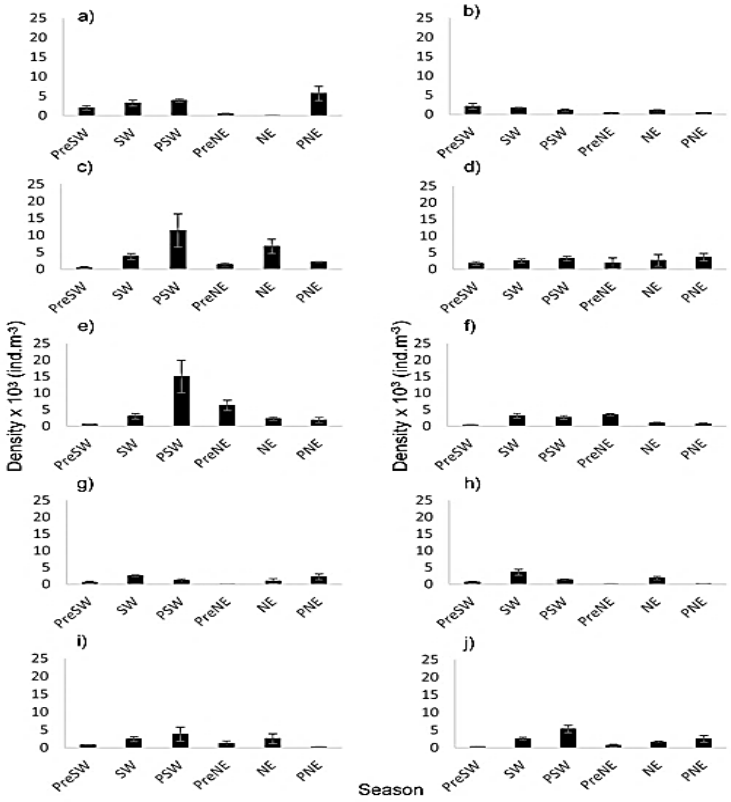

Fig. 3: Temporal distribution of mesozooplankton at (a) St. 1, (b) St. 2, (c) St. 3, (d) St. 4, (e) St. 5, (f) St. 6, (g) St. 7, (h) St. 8, (i) St. 9, and (j) St. 10. Value in mean density ± SD; n=3. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

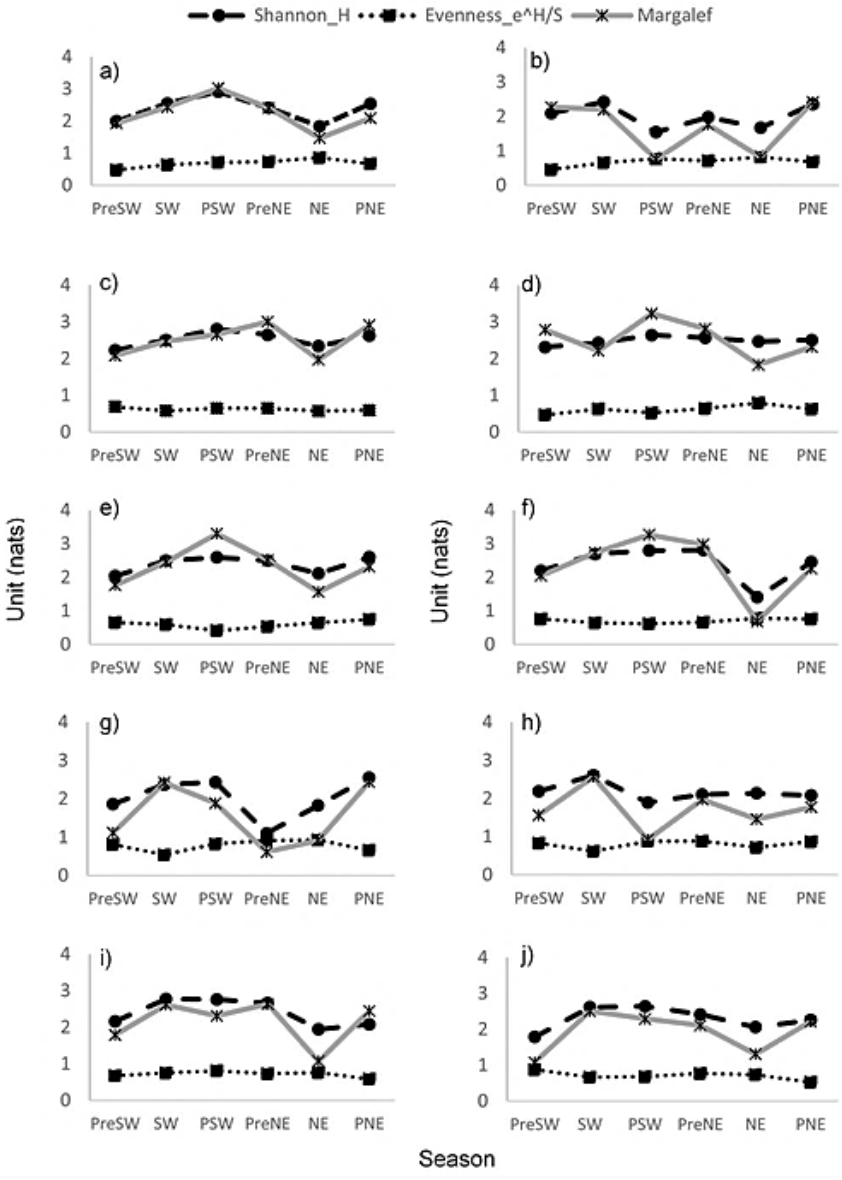

Fig. 4. Mesozooplankton diversity indices at (a) St. 1, (b) St. 2, (c) St. 3, (d) St. 4, (e) St. 5, (f) St. 6, (g) St. 7, (h) St. 8, (i) St. 9, and (j) St. 10. Nats is natural digits used for diversity index using $\ln_e$ in calculation; n=3). (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

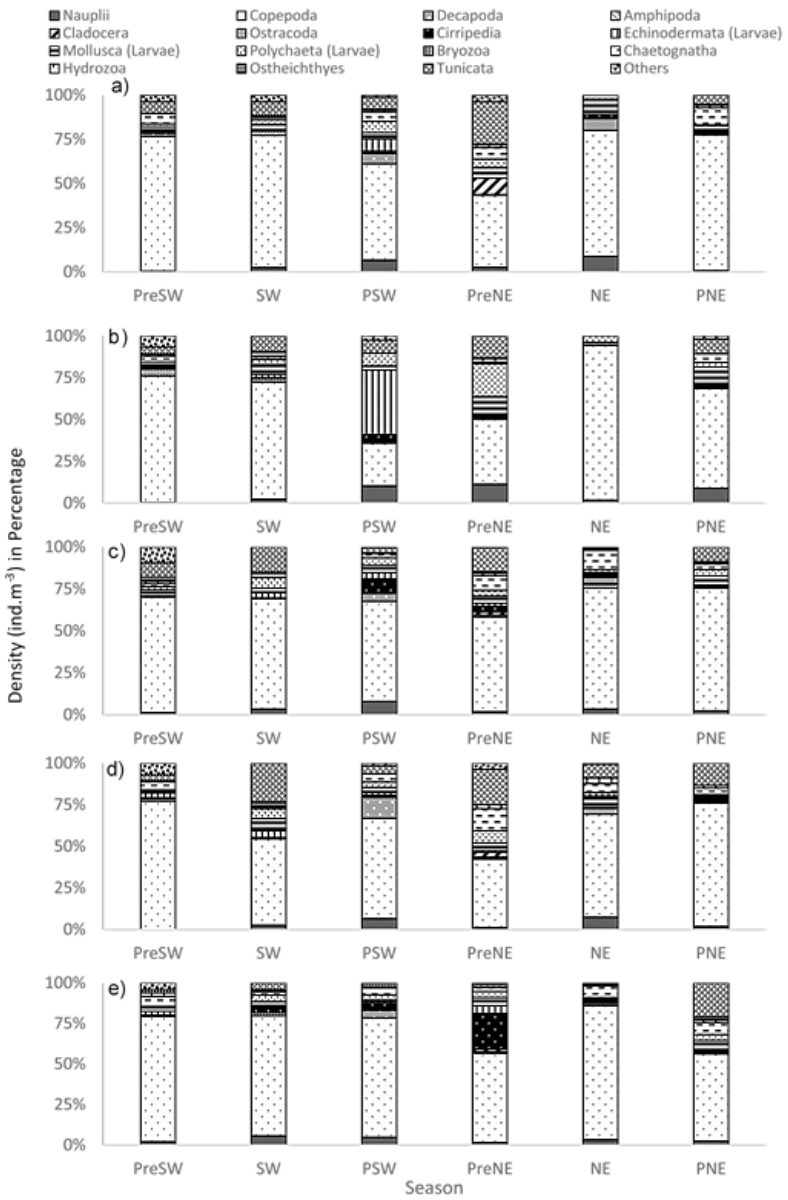

Fig. 5: Temporal distribution of mesozooplankton taxa at (a) St. 1, (b) St. 2, (c) St. 3, (d) St. 4, and (e) St. 5 in Bidong Archipelago. Value of density in percentage; n=3. Others indicate cumulative of unidentified taxa. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

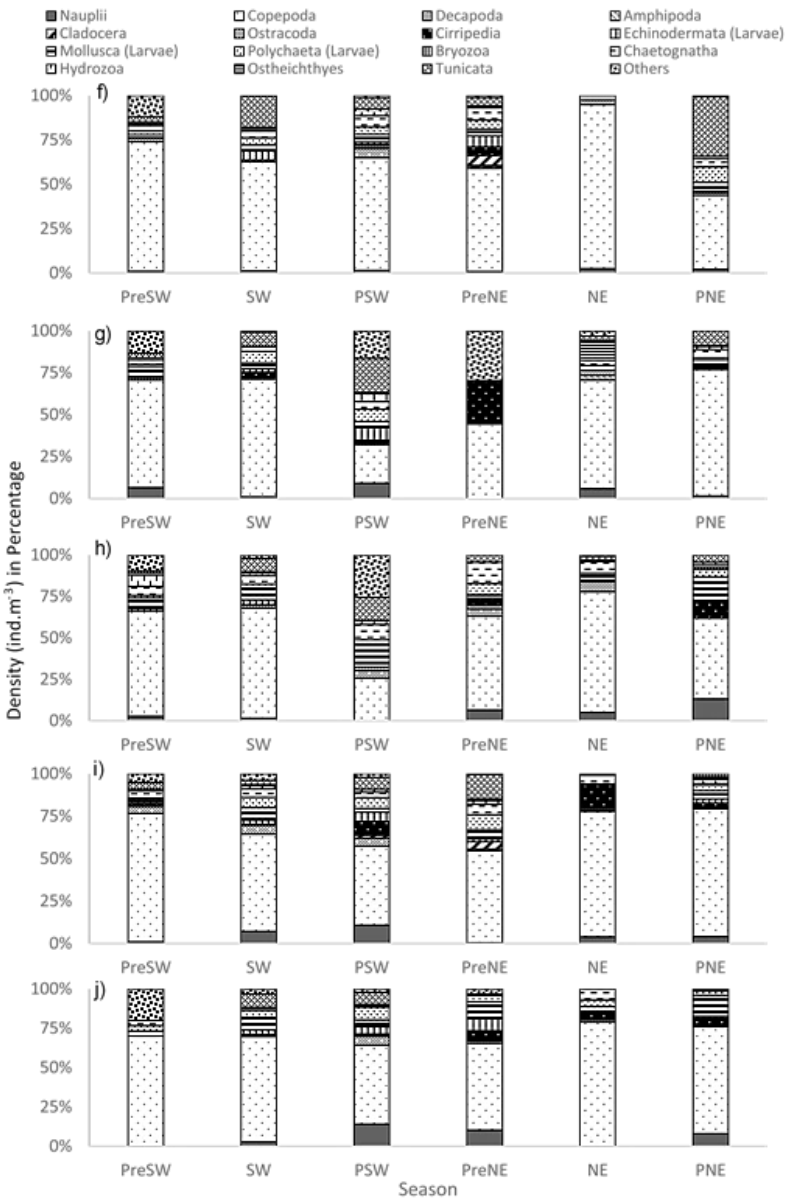

Fig. 6: Mesozooplankton diversity indices at (a) St. 1, (b) St. 2, (c) St. 3, (d) St. 4, (e) St. 5, (f) St. 6, (g) St. 7, (h) St. 8, (i) St. 9, and (j) St. 10. Value of density in percentage; n=3. Others indicate cumulative of unidentified taxa. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

16 taxa from nine phylums were identified in this study where Copepoda from phylum Arthropoda and its predominant class Crustacea was found dominant in the water column (Fig. 5; Fig. 6). Previous studies by Khyril_Syahrizan, (2012); Nakajima *e*t al. (2008); (2014); Zaleha et al. (2006); Jutamas, (1998); Shamsudin et al. (1998) that used various net mesh sizes in the sampling area that influenced by South China Sea current flow also found that copepod was the most dominant group in the water column. Study by Nakajima *et al.*, (2006) also stated that copepod was the dominant taxon in the reef area that show significant different of diel migration pattern between day and night. This is not deniable as Copepoda is widely known as 'water insect' with a mass density in the water column and only

appeared to an exception due to dominance of seasonal planktonic larvae (Khyril_Syahrizan, 2012).

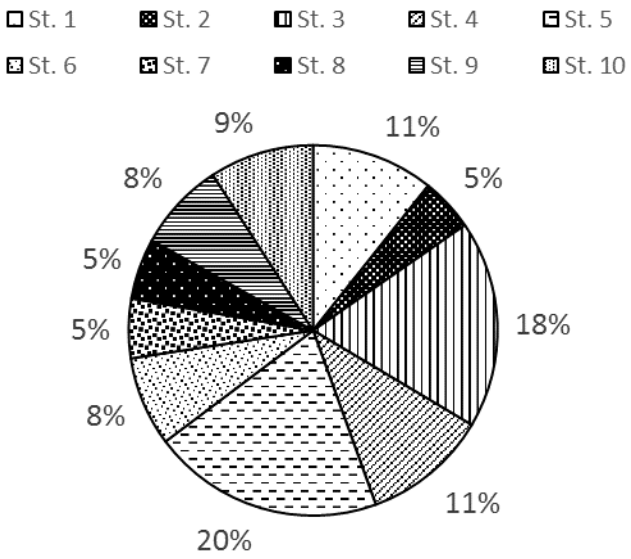

Fig. 7: Mesozooplankton distribution of sampling stations in Bidong Archipelago. Value in mean density percentage; n=18.

Larvae from phylum Echinodermata dominated Station 2 during post-southwest monsoon (Fig. 5b) and Station 2, Station 7 and Station 8 have relative low mean density of mesozooplankton throughout sampling seasons (Fig. 7). Both Station 2 and Station 8 showed significant low diversity index (1.55 and 1.90 nats respectively) and species richness (0.76 and 0.92 nats respectively) during post-southwest monsoon. Station 7 showed significant lowest diversity and species richness during pre-northeast monsoon (1.10 and 0.61 nats respectively). This distribution pattern may closely be related to predation which highly believed to greatly influence the species composition and zooplankton abundance in pelagic system (Chicharo and Chiharo, 2000; Jacobs, 1977). Planktivorous fish usually eat and removed larger size zooplankton from the community (Badosa et al. 2007). However, dominance by Echinodermata larvae was significantly related to the spawning season that occur from May to September/October (post-southwest) (Falkner and Byrne, 2003) as no evident that the larvae feed on other zooplankton. Studies by Strathmann, (1975; 1971) found the larvae of Echinodermata feed only on phytoplankton and other small suspended particles.

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Phytoplankton in Bidong Archipelago, Peninsular Malaysia

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ABSTRACT

Phytoplankton inhabits various areas of the oceans, estuaries and river at different times of the year. However, their distribution is not similar throughout the year and vary to different region in the world. Bidong Archipelago with the existence of coral reef ecosystems was chosen as the study area to investigate the spatial distribution of phytoplankton during series of pre-monsoon and post-monsoon to main monsoon seasons that surge Peninsular Malaysia, southwest and northeast monsoons. 20-micron mesh size plankton net was used in this study. Phytoplankton density was increasing to maximum during the post-southwest monsoon, onset of pre-southwest monsoon. Station 7 with maximum non-natural interference show relative similar phytoplankton abundance fluctuation through temporal seasons compared to other sampling stations. Bacillariophyta was dominant mostly at all sampling stations but dependent to the temporal season. Dinophyta and Cyanophyta shifted to dominate sampling station and seasons especially during pre-southwest, pre- and post of northeast monsoon seasons. Findings from this study portray the status and fluctuation of primary producer in coral reef ecosystem and could contribute to the establishment of ecological dynamic study toward relation to coral reefs ecosystem function in Bidong Archipelago.

Keywords: phytoplankton, Bacillariophyta, Monsoon, primary producer, Bidong

Introduction

There are thousands of microalgae species floating in the water column all over the world. Some of them maybe regional also some have seasonal peak characteristic. Their distribution pattern is also different through pelagic ecosystem, temperate waters and coastal environment including mangrove and coral reefs areas. Microalgae come in form of diatoms and dinoflagellates and diatom was found as the most phytoplankton in the water column (Boonyapiwat, 1997; Shamsudin, 1998). Bacillariophyta, Chlorophyta, Dinophyta as well Cyanophyta is the phytoplankton that present in the water column and their existence can determine the quality and quantity of the primary producer (Ganjian et al. 2010).

Bidong Archipelago, Malaysia, is located in southern of South China Sea and surrounded with sandy beaches and fringing reefs. Malaysia also located in the Indo-west Pacific region comprise large scale of marine life diversity in the world (Othman and Lotfi, 1995). East coast of Peninsular especially Terengganu has clusters of island with fringing off-shore reefs, with submerged reefs can be found in certain areas. The fringing reefs are the simplest form of reefs and known typically common in tropical area (Castro and Huber, 2013). Reef Check Malaysia, (2015) has highlight status of good condition to the coral coverage in Pulau Bidong with 54.58 % of total coverage of live coral over dead coral, rocks and algae. The reef areas were mainly constructed with branching type coral, Acropora with coverage up to 20 to 30 meter off shore. The reef area in Bidong

Archipelago is well known having a diverse of organism but so far there is no temporal data on phytoplankton distributions. On the west side of the sampling location, there are bays with a lot of activities including snorkelling, diving also seabass and grouper mari-culture farm.

Diatom (Bacilallariophyta) was found as the dominant group of phytoplankton in coastal waters (Boonyapiwat, 1997; Shamsudin, 1998; Salleh and Ruslan, 2010; Muhammad Adlan et al. 2012; Mohammad-Noor et al. 2012; 2013). Besides diatom, blue-green algae (Cyanophyta), green algae (Chlorophyta) and dinoflagellates (Dinophyta) are commonly found structuring phytoplankton community. Primary producers have a significant role in the ecosystems. It is very important to note that phytoplankton and chlorophyll-containing organisms are main producer and the primer food supply for food chain in the sea (Jamshidi and Abu Bakar 2011; Boonyapiwat, 1997). However, high abundance of phytoplankton does not necessarily show significant high concentration of chlorophyll-a. The study on primary producer can be considered scarce especially in coral reefs ecosystem (Mazlan et al. 2005). Thus, investigating their abundance and health in the ecosystem help understanding the effects and integrity of other trophic levels to the better way.

Methods

Samples from 10 fixed stations was taken around Bidong Archipelago, Terengganu (N 5.61543; E 103.05976) which is surrounded with the coral reefs area (Fig. 1). The stations are based on the coral reefs area and coral reef related area. Tri-replicates phytoplankton samples was collected using vertical plankton haul technique from bottom to the surface (Wu et al. 2014) using 20 µm mesh size shallow net with 20 cm x 20 cm square mouth opening. This technique was chosen due to standardising method in capturing only phytoplankton possible consequent to investigating trophic transfer between plankton. The plankton net was strictly hauled gently from the stationary vessel. Samples were taken 1 meter from the sea bottom to the surface concerned to the coral reefs. Mechanical flowmeters of General Oceanics model 2030R was attached to the nets during the sampling (Harris et al. 2000). Samples were fixed with 3% of formaldehyde solution. Phytoplankton samples are concentrated and undergo the Lackey's Drop Method (APHA, 1985). Samples of phytoplankton is presented in mean of total cells (± SD) of each sampling station. Shannon-Weiner diversity index, Margalef's species richness and evenness test was run to describe the diversity pattern of phytoplankton distribution.

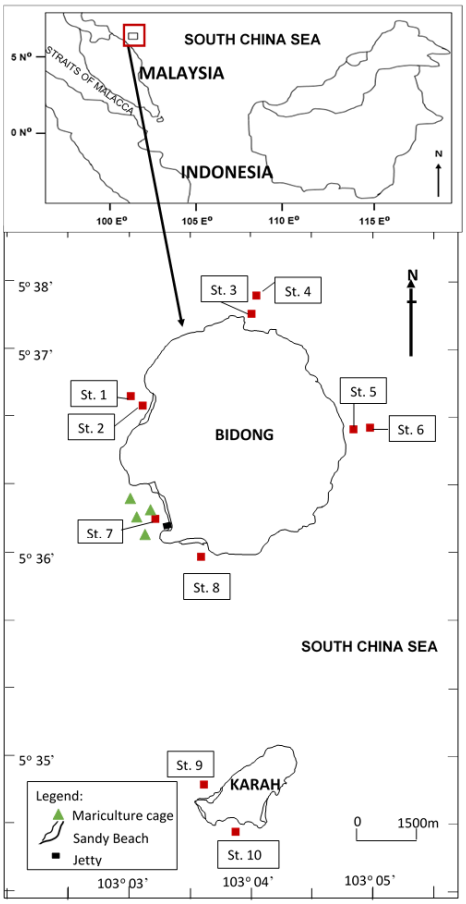

Fig. 1: Sampling stations in Bidong Archipelago, South China Sea.

Result and Discussion

Observation under microscope showed that collection was predominantly by phytoplankton. Onset of phytoplankton bloom was from the pre-monsoon, increasing to maximum during post-southwest monsoon season with 48 % (1423446.3 cells.m^{-3}) of total phytoplankton density (Fig. 2). Compare to study by Booyapiwat, (1997), she found that phytoplankton distribution was higher during pre-monsoon (Sept.- Oct.) than post monsoon (April- May) season. However, the data shown in the study specifically to east coast of Malaysian waters showed that phytoplankton was found highest during post monsoon season. Phytoplankton abundance may vary depend on the different area. Study by Mohammad-Noor et al. (2013) found phytoplankton was at peak during northeast monsoon (December) in coastal area of Kuantan, Pahang. Sidik et al. (2008) found phytoplankton was highest during southwest monsoon (July- Sept.) and literally

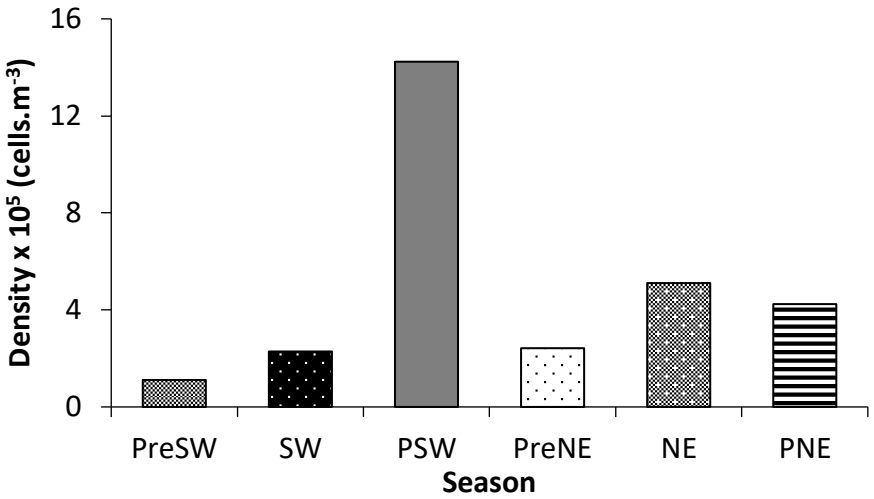

Fig. 2: Contribution of total phytoplankton abundance between sampling seasons in Bidong Archipelago. Value in mean of total density of all stations; n= 30. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

high abundance during inter-monsoon (Oct.) compared to the abundance during northeast monsoon (Nov.- Jan.) in their study in cage culture area of Sepanggar Bay, Sabah, which was relatively has similar phytoplankton fluctuation to this study. Occurrence of highest abundance of phytoplankton during post-southwest monsoon may because the coastal current flow that driven nutrient from the main land. Nurul Rabitah and Fadzil, (2015) stated that current flow is directed to north-eastward direction to Bidong Archipelago during southwest monsoon. Nutrient from mangrove area of Sungai Merang were believed transported to estuarine and adjacent area by tides and was driven farther by coastal currents. Thus, nutrient loaded and uptake by phytoplankton increase their density during the next season, post-southwest monsoon.

Station 2 during post-monsoon season showed the highest density of phytoplankton compared to other station (Fig. 4). Station 3 also showed relatively high density of phytoplankton during the season. Although sampling stations received current flow from the same direction, condition of the station itself also play role. Compared to station 3, station 2 has 'Acropora' branching coral reef which is more effective in trapping nutrients (Wild et al. 2004). Moreover, station 2 is in bay-shaped area. Station 6 showed lowest phytoplankton density may due to its location which is considered as station of coral reef's supported area as it is far outside from the coral reefs, and may because of Pulau Bidong act as barrier to the coastal current and weakened the nutrient transport to reach the station. However, besides nutrient perturbation that shaping the phytoplankton abundance (Badosa et al. 2007), pressure of predator is also believed to control density of phytoplankton of the sampling area.

Zooplankton is a factor that control the density, species compositions and size distribution of phytoplankton communities (Lynch and Shapiro, 1981; Deason and Smayda, 1982; Yebra et al. 2006). This is due to although station 2 showed highest

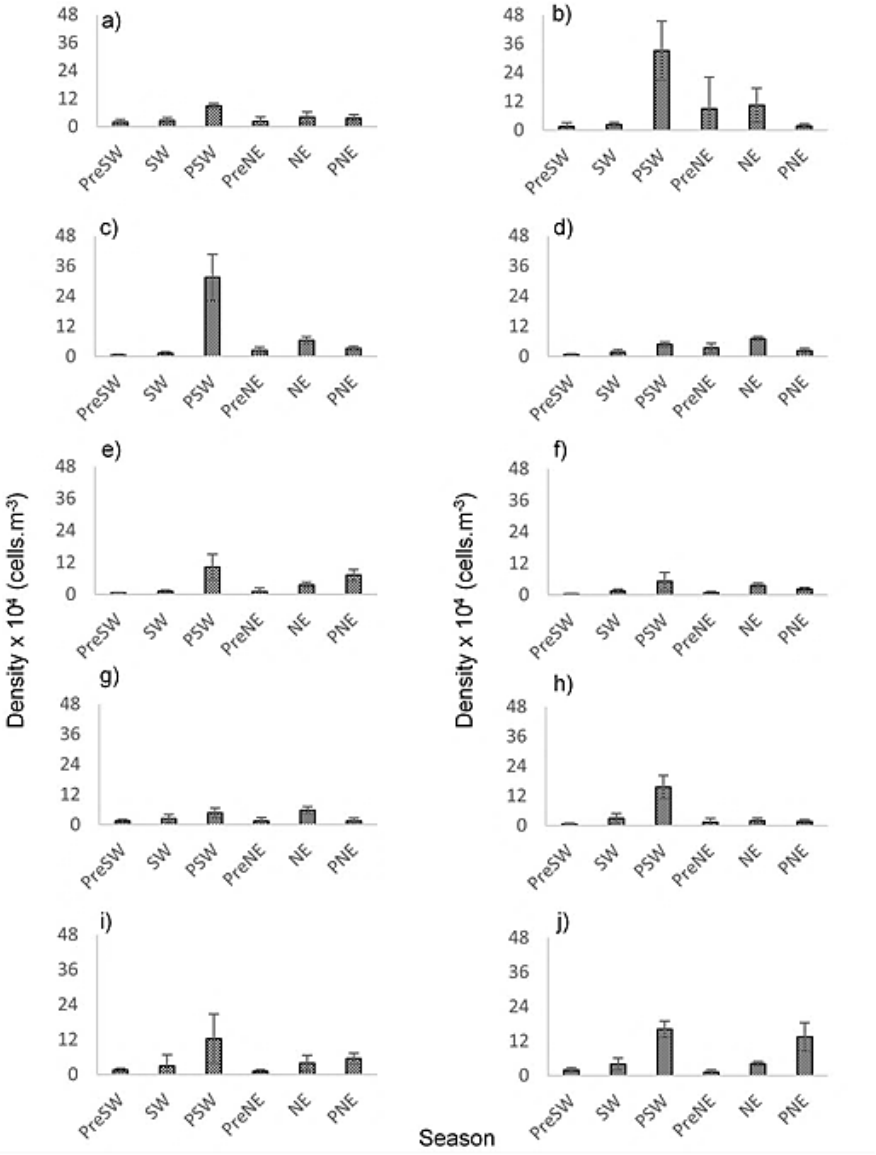

Figure 4: Temporal distribution of phytoplankton at (a) St. 1, (b) St. 2, (c) St. 3, (d) St. 4, (e) St. 5, (f) St. 6, (g) St. 7, (h) St. 8, (i) St. 9, and (j) St. 10. Value in mean density ± SD; n=3. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

density of phytoplankton during post-southwest monsoon, the diversity index and richness of species were not the highest (Fig. 5). Highest diversity and richness during the post-southwest monsoon was at station 1 (H'= 2.65; R'= 2.54), the station located next to station 2 (Fig. 1). Therefore, relative high predator pressure to phytoplankton may shape the diversity and the abundance to selective feeding, while present of low

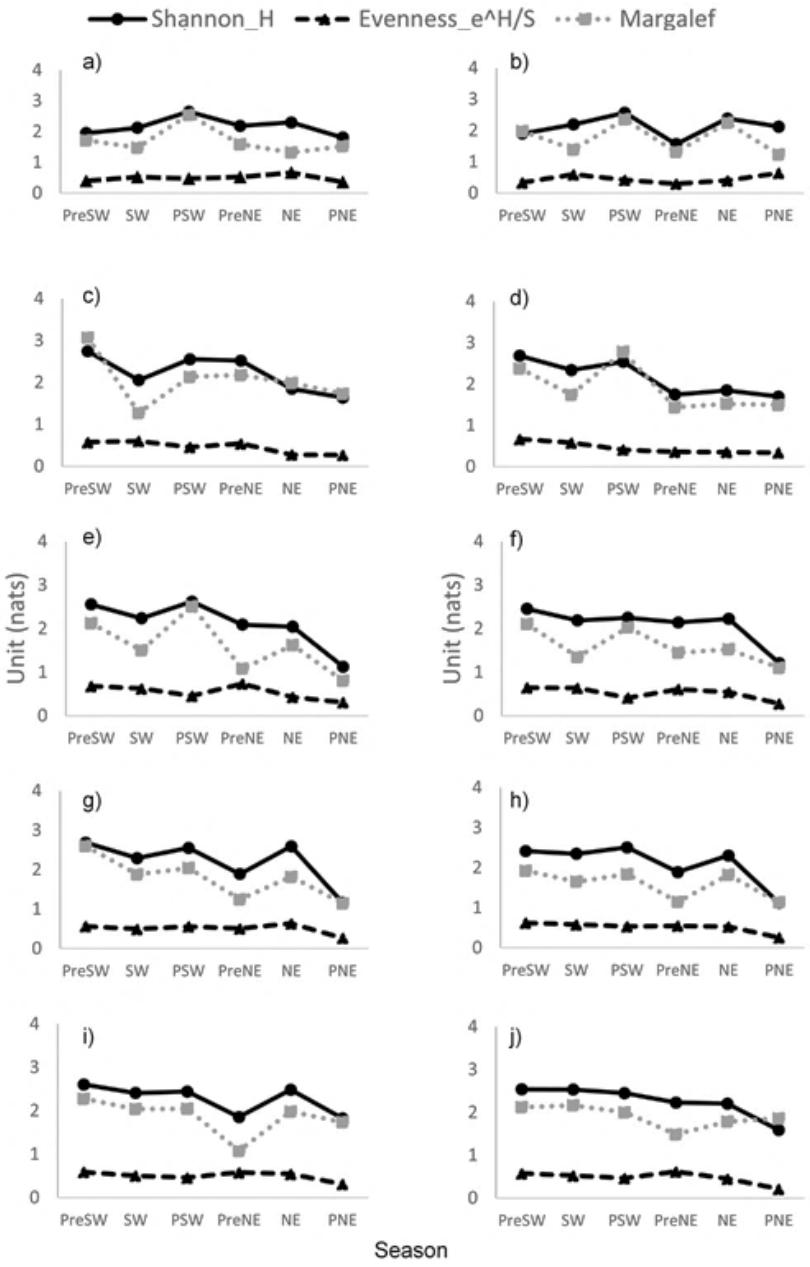

Fig. 5: Phytoplankton diversity indices at (a) St. 1, (b) St. 2, (c) St. 3, (d) St. 4, (e) St. 5, (f) St. 6, (g) St. 7, (h) St. 8, (i) St. 9, and (j) St. 10. Nats is natural digits used for diversity index using $\ln_e$ in calculation; n=3. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

predator let rare type or slow-growing nutrient specialist phytoplankton to bloom ((Vallina et al. 2014).One un-identified taxa and 77 genera of phytoplankton belonged to 9 class and 5 main phylum were identified in this study. Phylum Bacillariophyta (diatom) and its predominant class Coscinodiscophyceae was found dominate the

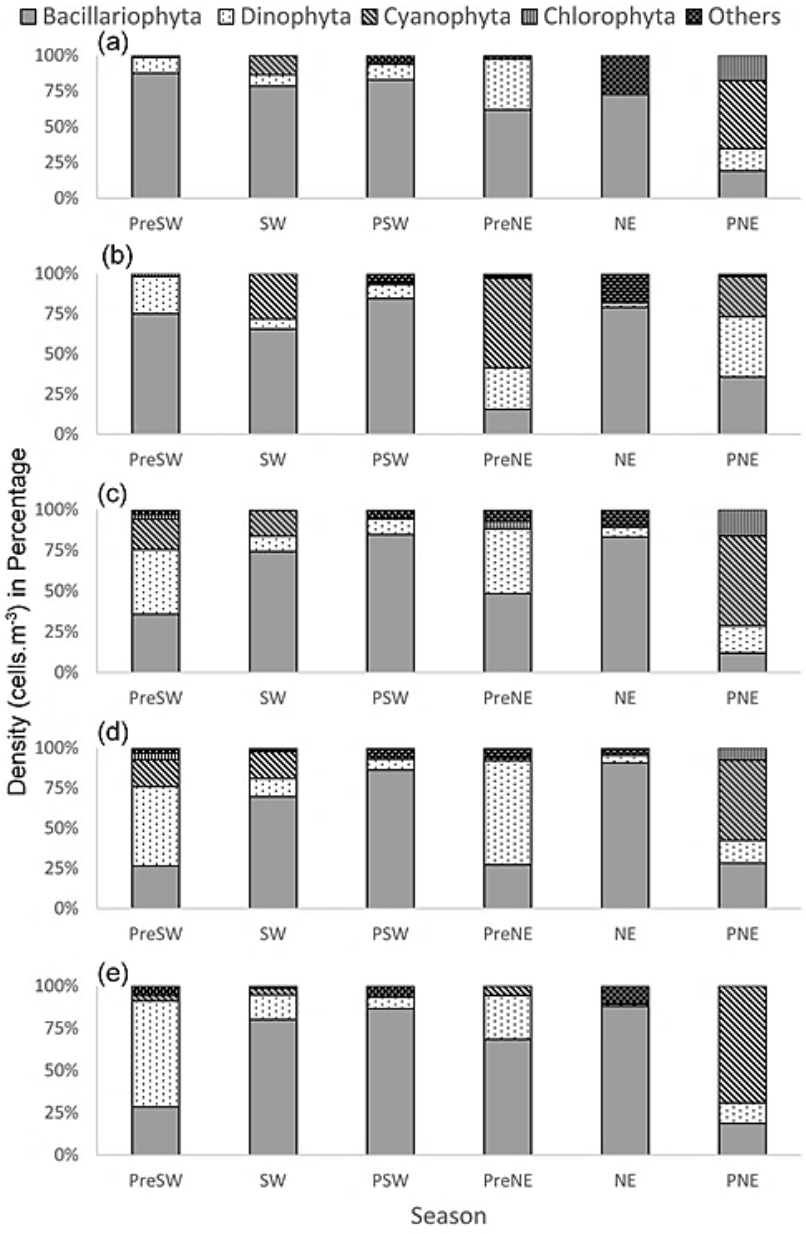

Figure 6: Percentage abundance of main phytoplankton phylum at (a) St. 1, (b) St. 2, (c) St. 3, (d) St. 4, and (e) St. 5. Value of density in percentage; n=3. Others indicate cumulative of unidentified taxa and low total density phylum. (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

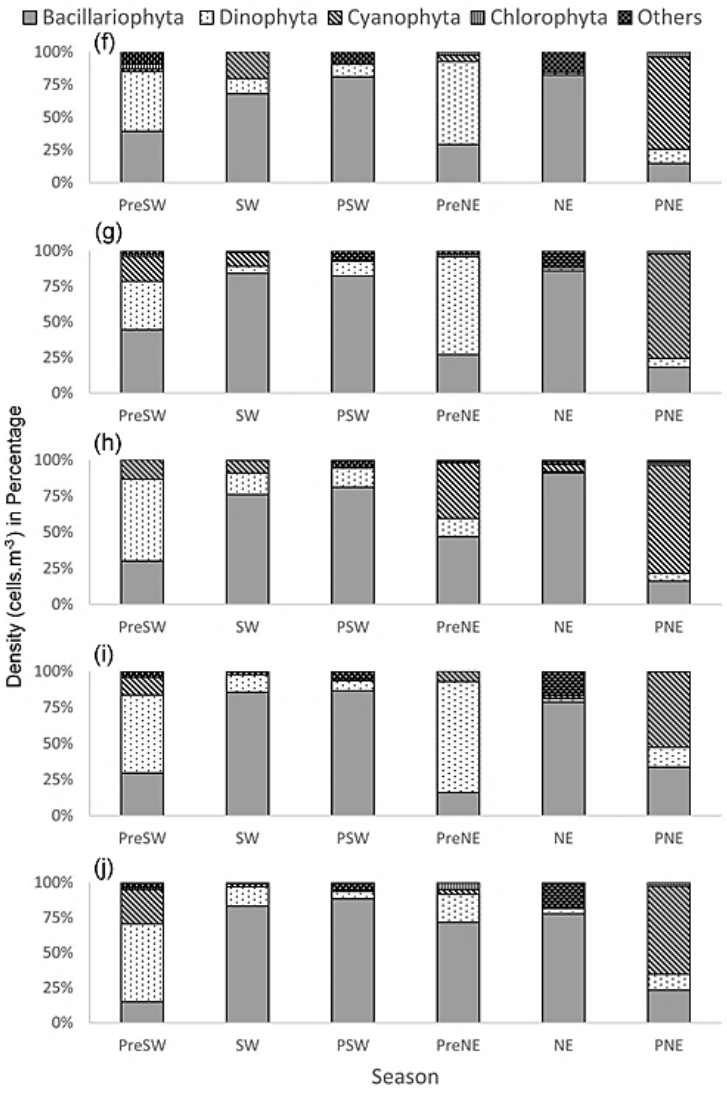

Figure 7: Percentage abundance of main phytoplankton phylum at (f) St. 6, (g) St. 7, (h) St. 8, (i) St. 9, and (j) St. 10. Value of density in percentage; n=3. Others indicate cumulative of unidentified taxa and low total density phylum (Abbreviation: PreSW= Pre-southwest; SW= Southwest; PSW= Post-southwest; PreNE= Pre-northeast; NE= Northeast; PNE= Post-northeast).

phytoplankton community. Studies by Boonyapiwat, (1997); Shamsudin, (1998); Salleh and Ruslan, (2010); Muhammad_Adlan et al. (2012); Mohammad-Nor et al. (2012; 2013) also found Bacilallariophyta as the dominant group of phytoplankton in coastal waters. In addition, study on the different area of South China Sea, the western Philippines also found Bacillariophyta to dominate the water column (Bajarias 2000). Besides Bacillariophyta, Dinophyta was found exclusively dominate both pre-monsoons season while plankton abundance during post-northeast monsoon was exclusively dominate by Cyanophyta at all sampling stations (Fig. 6 & 7). The dominant pattern of phytoplankton is significantly different from other studies as resulted to this study was done significantly related to coral reef ecosystem.

Diatom is recognized as heat tolerance plankton (Patrick, 1971) and can be found during dry season, pre-southwest, southwest and post-southwest monsoon. Moreover, the samplings were done on sunny day. Shifting to Gonyaulacales (dinoflagellate) during pre-northeast may because the increasing of water mixing that brings up nutrients or related to heat-tolerance plankton behavioural changes to rapid environmental changes (Krishnakumar et al. 1991) as the sampling was done during falling rain and the initial period of inter-change season. However, although dinoflagellates were major a contributor to harmful algal bloom (HAB) (Lim et al. 2012; Usop et al. 2008), respective low total density of phytoplankton during the season (Fig. 4) cannot considered it as bloom. Tricodesmium sp. (blue-green algae) was exclusively dominant during post-northeast monsoon may be was driven from off-shore (Boonyapiwat, 1997) to coastal area due to driven by northeast monsoon winds and current. Although comparison is significantly in different decade, sequences of influence is expected to happen due to the occurrence of annual cycles of monsoon trade winds and currents.

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Value Chain and Institutional Development Partnership of Commodity Seaweed (*Kappaphycus* alvarezii) in The Village Kolorai Morotai Island

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ABSTRACT

Commodity that can compete for the challenges of the trade is a commodity that has *added* a great value.Marine fisheries Morotai has a very high potential in areas with water quality that is quiet and extent of coastal and marine areas, which allows for an increase in the development of marine aquaculture, one of the commodities is Seaweed *(Kappaphycu salvarezii),*but in its development still has many obstacles. The study was using a combination of qualitative and quantitative approach that emphasizes an explorative descriptive analysis. Data collected through interview with the respondents and process of observation. There are a few of those interviewed include the fishermen, gatherers, village governments and local governments are being sampled in this study. The analytical method used is a SCAM *(A Commodity Systems Assessment Method*). The results showed that the characteristics of the value chain are Traditional Production Chain. The pattern of the value chain from producer to consumer consists of: (1) the manufacturer - collector – Ternate traders; (2) the manufacturer - collector - suppliers - Ternate traders; and (3) the manufacturer - supplier - Ternate traders. The added value given to farmers, namely: harvesting, drying, cleaning, packing. The added value given at the rate of collection, namely: transportation, drying, cleaning, re-packaging, weighing and storage. To see the potential of this commodity into a superior product that can compete in both domestic and international markets it is necessary to develop and promote the production and processed through a pattern of institutional development of the partnership.

Keywords: value chain, institutional development, seaweed, village kolorai

Introduction

Pulau Morotai in North Maluku is a border area which is a regional division with a view to the progress of development and improved welfare. Morotai Island which have been officially transformed into a definitive district since October 29, 2008 as a result of the expansion of North Halmahera District, a part of the outer islands of Indonesia cluster located at the tip of North Maluku and dealing with the Philippine Islands. Morotai Island is located between 20º-24º North latitude and 128'15º-128'48º east longitude. Morotai Island is bordered by the Pacific Ocean in the North Sea in the East Halmahera, Morotai Strait in the south and the Celebes Sea in the west. Morotai Island has an area of approximately 2,476 kilometers with a population of about 51 thousand inhabitants. This district consists of 5 sub-districts and 64 villages with the capital in Daruba, District of South Morotai (Directorate General of Rural Development, 2016).

Based on the Decree of the Regent No. 523.3 / 17 / PM / 2010, Morotai Island Regency is conveniently Minapolitan Minapolitan in Morotai Islands District is the district. South Morotai, district. South Morotai West as the core area (minapolis), as well as the district. North Morotai, district. Morotai Jaya district. East Morotai as a buffer zone*(hinterland).*Commodity that developed namely seaweed and grouper. The increase in the production of seaweeds and grouper every year from 2011-2014 was 33.76% and 38.89%, (PNPM Mandiri Fishery Products Processing, 2014). It is still extremely low by looking at Morotai marine

fisheries potential is very high with their calm waters quality condition and extent of coastal and marine areas, which allows for an increase in the development of marine aquaculture, especially groupers, lobsters, seaweed and pearl.

Efforts to coastal resource use with a variety of leading commodities with high economic value, such as seaweed *Kappaphycus alvarezii*, it is very important to note, because this type of seaweed has long been the main livelihood of the coastal population in the District of Morotai Island.

Problems or strategic issues that arise in the development of superior commodities in the fisheries sector is infrastructure inadequate, the fishing harbor ocean has not been optimally, electricity for manufacturing is not sufficient, condition of the road up in production areas are inadequate and airports yet to export direct, need to increase knowledge and skills of human resources for the cultivation and processing of fishery products.

Materials and Methods

Data collected by taking the primary data and data secondary. The primary data is done by observation into the field with target stakeholders who includes community leaders, government officials, business and industry groups, and seaweed farmers. Secondary data were obtained from various instansi such as the Department of Marine and Fisheries Development Planning Agency Regions, the Central Bureau of Statistics of Morotai Island, and Agency /Institutions / other related entities. The study was conducted in August 2016, in the village of Kolorai, District of SouthMorotai,Morotai Island Regency.

Results and Discussion

Potential of Seaweed

Factors such fisiska oceanography, chemistry, and dynamics of sea water greatly affects the growth and spread of seaweed, as well as the type of substrate. Seaweed is often found in shallow water areas (intertidal and sublitorral) with the condition of the sand, a little mud, or a mixture of both. According to Wong and Cheung (2000), seaweed generally contains complete nutrients, enzymes and vitamins. The percentage of material where these materials varies, depending on the type of seaweed. The content of amino acids, vitamins, and minerals in seaweed reach 10-20 times more than the land plants. Increased knowledge about the use of seaweed to make kelp as a commodity whose utilization is increasingly broad and diverse. According to Chen and Duan (2000), seaweed widely used as food for humans, as pharmaceuticals (anticoagulant, antibiotics, antimehmetes, antihypertensive agents, cholesterol reducers, dilatory agents and insecticides). Seaweed is also widely used as feed material in marine organisms, as a fertilizer and soil conditioner, as excellent transport packaging for lobster and clam life (especially of the type *Ascophyllum* and *Focus),*as a stabilizer solution, as well as other uses. The development of derivative products today are also many processed

into paper, paints, cosmetics, laboratory supplies, toothpaste, ice cream, etc. (Indriani & Suminarsih, 1999)

Seaweed has many important roles for humans. Ilalqisny and Widyartini (2000) reported that since the year 2700 BC, seaweed has been used as human food. France, Normandy, and England in the 17th century began to pioneer the use of seaweed for the manufacture of glass (Soegiarto *et*al.,1978). However, the economic use of seaweed started in 1670 in China and Japan, namely as pharmaceuticals, food additives, cosmetics, animal feed and organic fertilizer. In 2005 it was reported that the consumption of seaweed for the people of China, Japan, and Korea reached 2 billion US $. Each day about 168 species of algae have been commercialized, in Japan, China, Taiwan, and Korea, among others porphyra (nori), laminaria (kombu), Undaria (wakame). Porphyra seaweed or nori is the most popular in Japan (Steinman, 2006). One example of kelp in Indonesia is *Sargassum* sp, in various parts of the world, *Sargassum* sp is a type of seaweed in tropical waters known as alginofit (producer of alginate). Philippines, India and Vietnam are among the countries that began to take advantage of this type of seaweed. According Atmadja et al., (1996) in early 1980 demand growth of seaweed in the world increases with an increase in the use of seaweed for a variety of purposes, among others in the fields of industry, food, textile, paper, paints, cosmetics, and pharmaceuticals (drugs). In Indonesia, the use of seaweed for the industry begins to industrial agar-agar*(Gelidium* and *Gracilaria)*and then to the craft industry*(Eucheuma)*as well as for industrial alginate(Sargassum)

During 2010 to 2014, several villages in the district of South Morotai and Morotai West there is seaweed farming activities, but in the following year the fishermen not to undertake farming activities due to technical problems cultivation are rudimentary, it is difficult to get seaweed seedlings in accordance with the water conditions, ice-ice disease and commodity prices plummeted from Rp 12,000 / kg to Rp 5,000 / kg in the level of fishing, it makes seaweed farming activities do not continue anymore and it is unfortunate if it is not followed up by the local government.

Marketing Competitiveness and Globalization

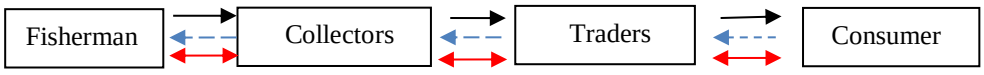
Competitiveness is the ability of companies, industries, regions, countries, or regions to generate revenue factors and factors of relatively high employment and sustainable to face international competition. The competitiveness of a commodity can be measured by using the approach of comparative and competitive advantages. The law of comparative advantage states that even if a country does not discount an absolute advantage and produce two types of commodities when compared to other countries, but a mutually beneficial trade could still take place, as long as the ratio of prices between countries are still different when compared with no trade (Lindert and Kindleberger, 1993). Ricardo's theory assumes only one factor of production that is important to determine the value of a commodity that is labor. Ricardo's theory of comparative advantage, then refined by theory, the opportunity costs

(Theoryopportunitycost).The argument essentially is that the relative prices of different commodities is determined by the difference in cost. Costs here show alternative crop production should be sacrificed to produce the commodity in question.

Value Chain Analyisis,is a tool to understand the value chain to form a product. The value chain is derived from activities that are carried out, ranging from raw materials till the hands of consumers, as well as after-sales service. Furthermore, Porter (1985) in Agus Widarsono explained, Analysis of the value chain is an analytical tool strategic used to gain a better understanding of the competitive advantage, to identify where the value of customers can be increased or decreased costs, and to better understand the company's relationships with suppliers / suppliers, customers, and other companies in the industry. Value Chain identify and connect various strategic activities of the company (Hansen, Mowen, 2000). Personality Value Chain depending on the nature of different industries and for manufacturing companies, service companies and organizations are not profit-oriented.

According to Ruth Campbell (2008), covering the entire value chain of activities and services required to bring a product or service from conception to sale in the market place. Value chains include input suppliers, producers, processors and buyers. They are supported by a range of technical, business, and finance. While Ben Otto (2008) states that the value chain is a system of interrelated steps necessary to transform raw materials into finished products to the final consumer, where each step adds value to the product. It's much like a supply chain, but more focused on how the value added is not how raw materials from one place to another.

From the results of data collection and interviews with some respondents associated with the development of the cultivation in the District of Morotai, then the process flow analysis (marketing channels) to further discuss the relationship between sub-processes that influence the development of seaweed cultivation in Pulau Morotai as follows:



Description:
Product Flow:
Flow Information:
Financial Flows:

Flow product, product flow is the flow of goods from the upstream*(upstream)*to downstream*(downstream).*From the analysis and interview some respondents fishermen or farmers, sell their crop to the collectors in their area respectively, that they did considering the distance they are quite far from the center of trade in the District of Morotai or areas where the sale of fishery products to them, throughout the first phase of the process flow of the product, the product is still a raw material which has not improved processing with touch technology.

Products produced post-harvest is still a dried material for seaweed, while the other fishery products should be marketed before the decay in the cultivation or catches. This fact is due to the lack of processing technology, and the patterns of relationships and financing that affect the bargaining power between actors with investors after harvest. The investors have the power to suppress the perpetrators to immediately return the loan capital they have acquired and to avoid additional interest charges that may be imposed, on the other hand the actors burdened by the responsibility to meet the needs of families.

Information flow, information flow is the flow that occurs either from upstream to downstream and vice versa from downstream to upstream. The information flows associated with the condition results aquaculture products, demand, prices, information related to the quality of production. The flow of information to flow vertically or horizontally. Stream flows vertically meaning that there is coordination on a different chain, ie between farmers, traders, entrepreneurs, retailers and consumers. While the horizontal flow means that there is coordination on fellow members of the chain. Examples of horizontal coordination is coordination among traders related to the availability of farmed aquaculture product results in the level of farmers. and coordination among fellow entrepreneurs related results aquaculture products farmed amount owned to form horizontal coordination.

Financial flow, financial flow is the movement of money flowing from downstream to upstream. Financial flow flowing from consumers to the farmers or fishermen, the flow pattern in the chain shows that the financial flows from traders to farmers. System payments are made in cash and the transaction will occur if there is an agreement and conformity of products with the price offered by the farmers. Traders will directly buy the products of aquaculture where farmers who want to sell then do the transaction.

Based on the results of research in the field can be seen that there are three streams that flow products, financial flow and information flow in the supply chain results aquaculture products. The third stream flows in the chain such as farmers / fishermen, retailers, entrepreneurs, traders and consumers. Efforts to optimize the three streams that exist in the supply chain results aquaculture activities can be done with the system approach involving multiple parties, such as farmers, retailers, entrepreneurs, traders, consumers and government as policy maker. Supplies products of aquaculture activities in Pulau Morotai been insufficient because the fishermen or farmers only dependent on the capital given to each farmer group and the constraint in cultivation that water quality conditions of cultivation and the disease were found in the continuous production of which affects the outcome of aquaculture production. Parties involved in the supply of product yield farming activities are fishermen or farmers because if they do not do cultivation optimally, the available cultivated will not be fulfilled until the level of the consumer, for the fulfillment of the government's cooperation in this regard

is needed in terms of policy and the availability of technology and capital in doing cultivation.

Production andrevenue

final results expectedfor the farmers of the business is the production. Old seaweed maintenance done by respondents to be dried on average 52 days, and for a long seedlings pemeliharannya an average of 38 days. Seaweed drying time average of 4 night.With the average production of the tightrope lis was 38.18 kg. For details of production and income of respondents can be seen in Table 1.

Table 1. Financial Analysis of seaweed farming crops per season, in the village of Kolorai, District of South Morotai, 2016.

No	Description	Amount (USD)
	Acceptance:	
1	Production (85 x 38.18 kg / rope ris) x Rp. 16.226.500	5000
2	Income Tax (15%)	2,433,975
3	Receiptsafter income tax (1-2)	13,792,525
4	Total Cost (Variable Cost + Cost tetapl)	4608667
5	Advantages (3-4)	9,183,858
6	R / C ratio (1: 4)	3:52
7	Pay back period (total investment / profit)	1:16

Revenue obtained is smaller than the first-year admission to the activities of seaweed. This is because in addition to lower selling prices as well as pests and diseases ice- ice. However, the income respondents still profitable. The result of the calculation of the R / C ratio showed> 1 is 3.52 meaning that every korbanan Rp 1, - will produce revenues of 3.52 with *a pay back period* is also faster at 1.16 months to payback the initial investment does not take a long time. From the analysis it can be seen that seaweed farming activities has the potential to serve as a useful activity for the fishermen in the village Kolorai Morotai Island Regency.

The structure of value chain

activities required in the product through the different phases of production which involves a combination of physical transformation and the input of various producer services, delivery to final consumers, and final disposal after use is an illustration of the value chain (Kaplinsky, 2000). In the context of value chain management, value is usually defined in the perception of the customer*(downstream* next company) or consumers (end-buyers of finished goods). In the definition of value there are three things that went as follows: (1) The value of the customer associated with the use of a product or service; (2) The value perceived by the customer, is not determined by the seller, and (3) Customer value usually involves *a trade-off* between what customers want and what should be given in order to obtain and use a product or service.

In the value chain are members of the chain consisting of the main members and supporters, the main members in this case are: Fishermen, Traders Gatherer, Traders Pulau Morotai, Ternate Wholesalers and Suppliers. Fishermen as

producers in the value chain activities such as the purchase of seeds and inputs for cultivation, harvesting, transfer of land to a temporary storage, as well as sales. Traders Gatherer, Pulau Morotai traders, traders in Ternate, and Suppliers, acts as an intermediary*(middleman).*Activities undertaken are purchasing, temporary storage, maintenance, and removal. Especially for suppliers*(suppliers),*there are additional activities undertaken, namely washing, sorting, pengkelasan*(grading),*and displacement. Supplier guarantees that the seaweed will always be available. Supporting members in the value chain in this case is: Government, Employers, and Universities or institutions. The government acts as a provider of infrastructure such as roads and markets, as well as policy providers. Poor road infrastructure, will impede seaweed commodity distribution and the high loss incurred, which impact on the commodity prices at the consumer level. Policies that are expected from the government, among others: the ease in obtaining credit for businesses, local commodities of import protection, and guarantee the availability of inputs in cultivation kegiaatan. In addition, the government in collaboration with universities or institutions can provide guidance and assistance, ranging from cultivation, postharvest treatment, marketing, to processing seaweed into a new product.

The management structure of the value chain describes aspects of the action at every level of management within the chain members. Management applied at the level of the Fisherman, Traders Gatherer Pulau Morotai and Ternate is still modest. The owners directly run the entire business process value chain. Workers still labor used per unit of activity, with daily wages. At the supplier level, the management structure has been more complex. The owner was not directly involved in the processing of seaweed. Processing is done by the workers, who are paid monthly.

Selection partnership relations of partnership on the value chain aims to ensure the creation of a partnership that is mutually beneficial. The intensity of collaboration in a partnership are generally divided into four levels, namely *Transactional Collaboration, Cooperative Collaboration, Coordinated Collaboration,* and *Synchronized Collaboration* (Gibson *et*al,2008). Levels of *Transactional Collaboration* in villages Kolorai which happens only transactional relationship is the collaboration that took place in the value chain: Fishermen → traders, collectors → merchant wholesale market district of Morotai Island, as well as merchant wholesale market Pulau Morotai → market traders Ternate. Traders book per day over the phone to Fishermen. If Fishermen have seaweed, then the traders will go directly to the fishing spot, followed by the transaction price. When the deal price is established, then the transaction is done, as well as products change hands from fisherman to the collector. In this position, a product wholly belonged to the collector. Furthermore, traders will bring seaweed to the market in question. Transactions between collectors with market traders in the market, as well as the agreed price on the spot. Collaboration happens in the value chain of suppliers and traders → → The factory is a supplier of levels in the *Cooperative*Collaboration,this level of collaboration that took place not merely

transactional relationship, but already existed inform each other. In practice, the plant already provides information primarily about product specifications required by consumers, both in terms of packaging up to the size of the mainstream. Transaction system of the Fisherman, middlemen, market traders Pulau Morotai, Ternate market traders, using direct payment system. The price is adjusted by the price per day. Middlemen are looking for seaweed to the fisherman, and directly conduct transactions at the fishing spot. Furthermore middlemen sell seaweed to market Morotai Island District or to the supplier. Transaction system from supplier to store using the contract system, with periodic payments. Agreed price per booking period.

The flow of information is an important factor in the value chain. Sharing information is a fundamental base needed to integrate the collaboration of different members, although sometimes regarded as risk-sharing. Besides intermediation, this can lead to asymmetry of information inhibits the clarity of the information and add value to the exchange (Gibson, 2008). Distribution of information both among value chain actors can create a good relationship and transparent so as to increase the confidence and commitment to perform a cooperative relationship. The flow of information between actors must be properly managed jointly to avoid asymmetric information which would impede the effectiveness and potential for fraud in a partnership. Information about the price, the quality of the desired product, the necessary quantity of product markets, technology, and the latest issues of concern in the market, it is absolutely required by each member of the chain. In fact, very difficult to obtain information, particularly about the price of the product. Prices change every day, and each chain must access the daily price. Fishermen usually get information about the price of Morotai Island District market, while market traders Pulau Morotai get information from Middlemen and suppliers. In terms of pricing, there is no honesty about, who sets the price. Characteristics of the value chain are analyzed using methods Collins. Orientation member of the chain can be measured by using performance related eight evaluation criteria, namely: the balance between price and value, the transfer of information, orientation time, the nature of relationships, interactions within the value chain, dependency in the chain, the strength of the chain, as well as the orientation of the members of the chain. Eighth these criteria allows to map the characteristics of the fresh produce chain orientation, activity and behavior of members of the chain, from the addition of a low value, moderate, to fully oriented on the value (Collins, 2009). Based on the characteristics of the activities of the value chain Collins, the production chain in the Village Kolorai Pulau Morotai nature Production Chain Traditional where the balance between price and value, put price and in terms of information transfer there is no information sharing significantly, time spent in the short term and based on a transaction by transaction , the interaction between the chain is the transaction value, dependence is independent, individual strength and maximize yourself. The characteristics of the value chain: (1) the manufacturer - collectors - traders; (2)

the manufacturer - collector - suppliers - traders; and (3) the manufacturer - supplier - traders.

Conclusion

chain commodity valueseaweed*(Kappaphycusalvarezii)*in the village of Pulau Morotai Kolorai nature Traditional Production Chain. The pattern of the value chain from producer to consumer consists of: (1) the manufacturer - collector - Ternate traders; (2) the manufacturer - collector - suppliers - Ternate traders; and (3) the manufacturer - supplier - Ternate traders. The added value given to farmers, namely: harvesting, drying, cleaning, packing. The added value given at the rate of collection, namely: transportation, drying, cleaning, re-packaging, weighing and storage. To see the potential of this commodity into a superior product that can compete in both domestic and international markets it is necessary to develop and promote the production and processed through a pattern of institutional development partnerships

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Genetic Relationship of Flyingfish (*Hirundichthys oxycephalus*, Bleeker) Caught in Pare-Pare and Polman Waters (Makassar Strait) and Takalar and Bulukumba Waters (Flores Sea) Based on Morphometric Characters

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ABSTRACT

The aim of this research was to analyse the genetic relationship between and within schools of flyingfish (*Hirundichthys oxycephalus*) caught in the Makassar Straits (offshore from Pare-Pare and Polman) and the Flores Sea (offshore from Takalar and Bulukumba). The analyses also investigated the possibility of separate sub-populations within the four fishing grounds. Fish were caught using drift gillnets (mesh size 1.00-1.25"), and a sample of 100 specimens was randomly selected from the catch on each fishing trip. These specimens were identified using the flyingfish identification source book. Discriminant analysis was used to determine the difference in morphometric characters between samples (trips/sites). Hierarchical cluster analysis was used to group individual flyingfish into clusters with homogeneous morphometric characters. The Euclidean distance method was used to produce a cluster dendrogram. The analyses indicate that, despite close genetic relationships between flyingfish caught in the four different fishing grounds, there is strong support for the hypothesis that flyingfish found in the Makassar Straits are a separate sub-population from those in the Flores Sea. Based on these results, flyingfish in the Makassar Straits and the Flores Sea should be managed as separate stocks.

Keywords: genetic relationships, morphometric characters, flyingfish, Makassar Straits, Flores Sea.

Introduction

The flyingfish *Hirundichthys oxycephalus* (Bleeker) is an important and valuable fisheries resource in Indonesian waters, especially the Makassar Straits and Flores Sea. The eggs of this species have long been a valued export commodity as well as a source of high quality protein. The eggs are collected during the reproductive phase; it is estimated that around 86% of flying fish caught are in their first spawning season, and thus have not yet reproduced (Ali, 2005). If this activity continues unchecked, flyingfish populations could decline, possibly quite rapidly (Gislason, *et al*., 2000). Several indicators show that this fish species is over-exploited, such as the decreasing trends in annual production and catch per unit effort, threatening this potentially sustainable fisheries resource (Nessa *et al.*, 1993; Ali, 2005). This is a serious problem, requiring a conservation-oriented approach to fisheries management. However the success of such an initiative requires reliable scientific data and information as a basis for formulating appropriate strategies and management interventions.

A stock is effectively a sub-population of a given species where individuals share the same growth parameters and mortality, as well as reproductive interaction and a specific geographically bounded habitat (suggest adding a reference). Such population units or stocks can be identified through the analysis

of genotypic or phenotypic markers (morphometric methods) in order to determine the genetic relationships between fish sub-populations. Determination of fish stocks is crucial to fisheries management, because of the strong within-stock connections in terms of population dynamics. However, it was not known whether the flyingfish in these two main fishing grounds formed one joint stock or were separated into two or more or more stock. One of the first steps required in order to plan effective management interventions was to identify appropriate fisheries management units by determining and delimiting the flyingfish stocks in Makassar Strait and Flores Sea.

This research aimed to answer this vital question through an approach with three main components: 1) comparative study of morphometric characters of flyingfish caught in Bulukumba and Takalar waters and in Pare-Pare and Polmas waters; 2) analysis to infer genetic relationships or genetic differences between flyingfish from these areas; 3) phenotypic or morphometric analysis to determine whether the flyingfish sampled came from a common population (same stock) or distinct sub-populations (separate stocks).

Methods

The research was carried out from February to October 2006. Flying fish samples were obtained from four selected fishing grounds (Fig. 1): (1) Pare-Pare and (2) Polmas (representing the Makassar Straits); (3) Takalar and (4) Bulukumba (representing the Flores Sea) using a drift gillnet (mesh size 1.00-1.25 inches). Random samples of 100 individuals were taken from the catch on each sampling trip and identified based on Parin (1999) and consisted mostly of *Hirundichthys oxycephalus,* locally known as *Torani* (Fig. 2).

Figure 1. Study site map

Twenty morphometric characters were measured (Fig. 2): total length (X1), fork length (deeply emarginated) (X2), standard length (X3), dorsal fin length (X4), pectoral fin length (X5), caudal fin height (X6), ventral fin length (X7), anal fin length (X8), caudal fin length (X9), pre-dorsal length (X10), dorsal fin base length (X11), pectoral fin base length (X12), maximum body depth (X13), caudal peduncle height (X14), head length (X15), eye diameter (X16), post-orbital length (X17), pre-orbital length (X18), jaw length (X19), and body circumference (X20). These measurements were then analysed using Euclidean distance analysis and transformed into dendrogram format in order to infer genetic or non-genetic relationships (Wilks, 1995; Bengen, 2000; and Supranto, 2004). The 20 morphometric variables were then displayed as a proximity matrix or contiguity matrix (Table 3) and dendrogram (Fig. 3).

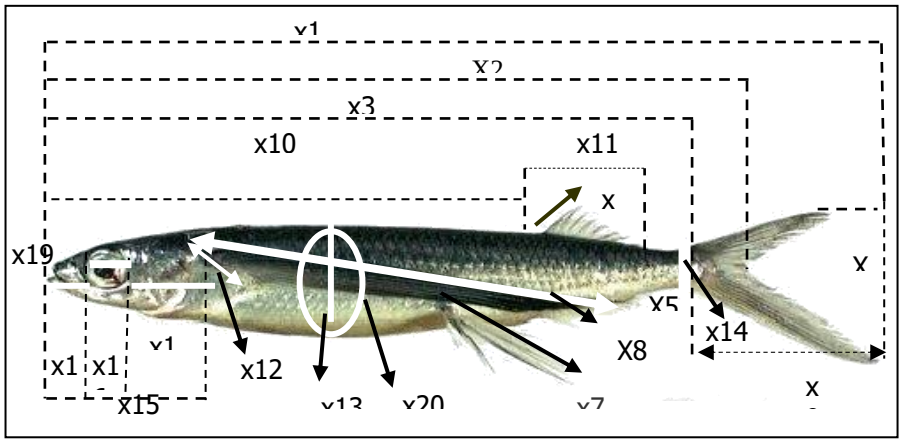

Figure 2. Flyingfish (*Hirundichthys oxycephalus*) showing the 20 morphometric characters measured

Results and Discussion

The results are displayed in the form of a dendrogram (Fig. 3) and indicate that all flyingfish sampled from each sea area (Makassar Strait and Flores Sea) have a close genetic relationship with Euclidian distances in the range of 2.0 - 2.81, respectively. Meanwhile, the Euclidian distance between flyingfish from Pare-Pare and Takalar was higher (3.20) with the greatest Euclidean distance between flyingfish from Bulukumba (3.49). Flyingfish from Polmas and Pare-Pare form one cluster, indicating that they are closely related genetically. Meanwhile, flyingfish from Takalar tended to have similar morphological characters to flyingfish from Bulukumba, and were also considered to form a single cluster. These results indicate that flyingfish from Makassar Strait and the Flores Sea are a segmented population with flyingfish caught near Polmas and Pare-Pare belonging one sub population, and flyingfish caught near Bulukumba and Takalar belonging to another sub population.

The differences between flyingfish sub-population from the Flores Sea and Makassar Strait are most likely due to genetic and environmental factors. Environmental factors can influence phenotype through processes of

morphological adaptation, however phenotype is not just determined by environmental conditions

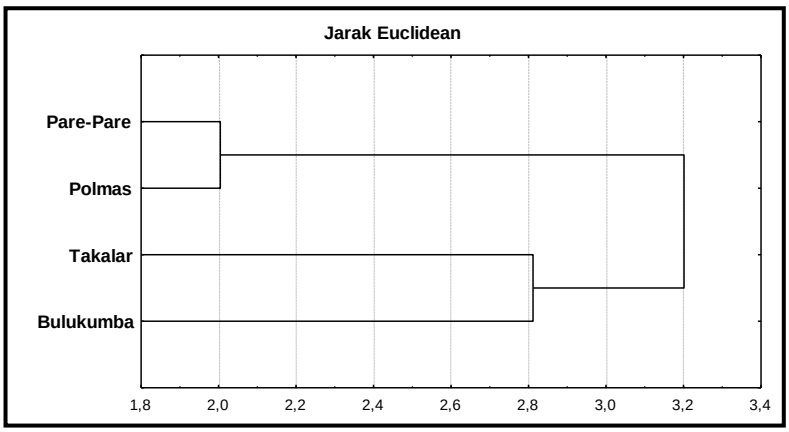

Figure 3. Dendrogram of flyingfish from the four sampling sites based on Euclidean distance between morphometric characters

but is generally a reflection of interactions between environmental and genetic factors (suggest adding a reference). Flyingfish display a characteristic migration behaviour, and according to Gomes *et al*. (2000), oceanographic conditions such as current, wave, temperature surface, salinity and biological factor such as predator may act as barriers to flyingfish migration. Furthermore, geographical distances of less than 890 km may act as barriers to flyingfish migration due to significant differences in regional environmental conditions.

Research on genetic variation and structure of flyingfish populations in the West Atlantic report three different flyingfish stocks within three different locations: the East Caribbean, South Netherland Antilles and North-east Brazil (Gomes, *et al*., 1998; Gomes, *et al*., 2000). This separation was considered due to a combination of geographical distance and environmental barriers. Furthermore, Oxenford (2004) provides evidence that flyingfish around 24 cm in length cannot migrate very far, with a linier correlation between flyingfish size and their capability to migrate long distances. Environmental factors also influence the time and period of spawning, and this may limit the chances of reproductive interaction between sub-populations, leading to genetic differentiation between flyingfish that inhabit different waters. Apart from environmental factors, over fishing can also result in phenotypic changes and/or loss of genetic diversity.

There are several consequences of environmental and oceanographic factors affecting fish populations, and these include genetic relationships, morphometric characters, and population diversity. Population diversity will tend to increase when genetic flow is occurs as a result of two or more populations interacting with each other via immigration or emigration processes (Soelistyowati, 1996). Within population diversity is a reflection of isolation level due to ecological, physical and geographical conditions (Sumantadinata, 1982 *in* Ghofur, 2003). In addition, populations may become isolated and confined to restricted space(s) due to environmental degradation (Nei, 1987). Lower heterogeneity may occur when populations find it difficult to migrate.

Thus it is possible that differences in environmental conditions between the Flores Sea and Makassar Strait, including physical and oceanographic factors, could result in low or very low interbreeding between sub-populations, and that different genetic strains may be affecting phenotype diversity in flyingfish. The apparently low level of genetic interaction between these flyingfish sub-populations could result from environmental barriers, with oceanographic factors acting as barriers to emigration and immigration between waters with differing characteristics, and even though geographically the two regions are not very far apart the distances involved could be sufficient to make it difficult for flyingfish to migrate between sub-populations.

Data on environmental and oceanographic conditions in the research areas have been collected and recorded for at least 10 years by Ali (2005). These data show that the Flores Sea has higher average precipitation and salinity than the Makassar Strait, whereas the Makassar Strait has higher average atmospheric temperature, wind speed, insolation and sea surface temperature than the Flores Sea. In both February and August, ocean currents are stronger in the Flores Sea than the Makassar Straits. These findings provide a reasonable basis for hypothesising that flyingfish phenotypes may differ between the Flores Sea and Makassar Strait due to differences in environmental factors, forcing ecological adaptation in the flyingfish sub-populations.

Ali (2005) also emphasis that differences in sea surface temperature and salinity between the Flores Sea and Makassar Strait appear to impact flyingfish maturity and spawning times. Those determinant environmental factors are believed to play a key role in stimulating endocrine system and reproduction organ activities that control fish reproductive activity and behaviour (Weatherley and Gill, 1989; Redding and Patino, 1993). Ali (2005) further considered that different spawning times of flyingfish from Flores Sea and Makassar Strait reduces the likelihood of opportunities for interbreeding, and could lead to sub populations with different phenotypes. The results of this research clearly support his hypothesis and indicate that there is more than one sub population of flyingfish between Flores Sea and Makassar Strait. This finding should be an important consideration for flyingfish management and conservation.

Conclusion and Recommendation

Based on the Euclidean distance between samples, flyingfish from Takalar and Bulukumba belong to the same sub population, and flyingfish from Pare-Pare and Polmas both belong to another sub population. Thus fisheries management plans should consider these flyingfish sub-populations as separate stocks.

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Performance of Marron (*Cherax cainii*) Origin Probiotic *Bacillus mycoides* in Earthen Commercial Marron Ponds.

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ABSTRACT

The present study evaluated the performance of marron origin probiotic *Bacillus mycoides* post laboratory scale trials by measuring total haemocyte counts (THC), hepatosomatic indices (Hiw), intestinal bacteria population, gluthathionine peroxide (GPx) enzyme activity, and survival rate (SR) of marron. The probiotic was supplemented to a commercial marron feed (used as basal diet) at 10^8 CFU/mL and given to marron during eleven months feeding trial using a commercial marron ponds (10 x 15 m^2). The ponds were stock with marron juveniles at 3000/pond. The probiotic feed was prepared weekly to ensure its freshness and viability, then kept in refrigerator before using. The results suggested the THC, Hiw and the intestinal bacteria population of marron fed probiotic supplemented diet were significantly higher ($P<0.05$) compared to THC, Hiw and intestinal bacteria population of basal diet fed marron both on day 90th and day 160th. The GPx enzyme activity was detected also significantly higher ($P<0.05$) in marron fed with the probiotic diet both on day 90th and termination of the feeding trial. At termination of the trial, survival rate of probiotic fed marron was significantly higher (74.80±2.52 %) than survival rate of basal diet fed marron (66.15±6.33%). In brief, the customized marron origin probiotic *B. mycoides* worked effectively in vivo (commercial marron ponds) as indicated by a significant improvement of marron immunity and health status (THC, GPx enzyme activity, intestinal bacteria population and Hiw) which in turn enhanced survival rates when compared to basal diet fed marron.

Keywords : marron, probiotic, THC, Hiw, GPx and SR.

Introduction

Today, it has been widely accepted that probiotics play a significant role in aquaculture (Nayak, 2010, Merrifield et al., 2010, Newaj-Fyzul et al., 2014, Hai, 2015) as an ecofriendly method for disease control for sustainable aquaculture (Sihag and Sharma, 2012), however there has been only a few in vivo studies on the use of probiotics in a controlled environment (Tinh et al., 2008). In screening a probiotic candidate, an *in vivo* test is essential (Verschuere et al., 2000, Balcázar et al., 2006, Kesarcodi-Watson et al., 2008, Vine et al., 2004) as in vivo physiology is more complex and different from in vitro monoculture (Tinh et al., 2008). No study has ever compared probiotic beneficial effects in vitro and in vivo (Sahu et al., 2008).

The complexities encountered by an added probiotic under outdoor conditions include (i) the uncertainty for the probiotic to remain viable in an aquatic environment (Newaj-Fyzul et al., 2014), (ii) interaction with other strains in the host environment (Wong and Rawls, 2012, Mickeniene, 1999), (iii) selection process by the host GIT (Ringø et al., 2007a), (iv) competition with the indigenous GIT inhabitants (Vine et al., 2004), (v) viability during storage (Burr

and Gatlin, 2005). To complicate the issue, not all of the authors examined the viability of the probiotics during the feed preparations after the microbial cells have been added to the feed (Newaj-Fyzul et al., 2014). For these reasons, the host origin (host GIT and its environment) with favourable probiotic properties is preferable by most of the authors for an ideal candidate (Gatesoupe, 1999, Verschuere et al., 2000, Merrifield et al., 2010, Rollo et al., 2006, Hai et al., 2009b, Nayak, 2010) as its efficacy is likely to be highest in the host and particularly in its natural environment (Verschuere et al., 2000, O'Sullivan, 2001).

Bacillus mycoides is a predominated bacterium isolated from a number of healthy adult farmed marron GIT that exhibit favourable probiotic properties such as non-pathogenicity to marron, antagonism ability towards common crayfish pathogens (Vibrio mimicus and V. cholerae non-01), exhibition of a diverse enzyme profiles and non-susceptible to the majority of antibiotics tested (Ambas et al., 2015a), improved immunity (Ambas et al., 2013) and the gastrointestinal health status of marron (Ambas et al., 2015b).

To date, evaluating probiotic performance in vivo studies is limited to tiger shrimp Penaeus monodon (Rengpipat et al., 2000), shrimp Litopenaeus vannamei (Thompson et al., 2010) and beluga Huso huso (Salma et al., 2011). When evaluating probiotics in vivo for its nutritional benefit outcomes in aquatic animals, the probiotic candidates should be added to the diet and its effect evaluated on the growth and/or physiological status of the animals (Verschuere et al., 2000). The present study examined in vivo performance of customized probiotic B mycoides in commercial marron ponds by counting the total haemocyte (THC), hepatosomatic indices (Hiw), intestinal bacteria population, gluthathionine peroxide (GPx) enzyme activity, survival rate and marron pond productivity.

Materials and methods

Experimental marron farm site

The present study was conducted at an existing commercial marron farm located at 432 Boorara Road, Nortchcliffe Western Australia 6262 (Latitude -34.66001 N; Longitude 116° 9' 49.644 W). Six of the 900 m^2 existing commercial marron ponds with an average depth of between 1.6m to 1.7 m were used for the dietary supplemented probiotic feeding trial. As the marron production operation in these commercial ponds was already underway before the commencement of the trial, the commencement of this feeding trial was reflected by shifting the existing marron diets to the test diets (probiotic *B. mycoides* supplemented diet and the basal diet).

Preparation of the diet and feeding

The commercial marron diet supplied by specialty feeds, Glen Forrest Western Australia was used as a basal diet, which was used during previous

laboratory scale studies. The proximate composition of the basal diet was: 26% crude protein, 9% crude fat and 5% crude ash.

Supplementation of the probiotic to the basal diet followed the established method (Hai and Fotedar, 2009). A pure colony of the isolate was grown on blood agar (BA) plates and incubated overnight at 25^{o}C. The overnight growth inoculum was diluted into 20 mL of sterilized normal saline before being sprayed onto the basal diet at a concentration of 108 CFU/g of feed and then immediately covered with aluminium foil and stored in a refrigerator at 4oC to avoid bacterial growth. The probiotic was supplemented at 108 CFU/g of feed and performed on a weekly basis to maintain freshness.

The concentration (CFU/mL) of the probiotic bacterium sprayed onto the feed was determined using an established method (Hai et al., 2007) where optical density (Spectrophotometer, BOECO S-20, Hamburg, Germany) correlates to the bacterial concentration (CFU/mL) and confirmed by performing a total bacterial count using BA plates (Buller, 2004).

Feeding was performed once per day in the late afternoon and adjusted weekly after weight sub-sampling of the marron from each pond, which referred to demand feeding rates obtained from The Second Pemberton Grow Out data set 1990-1993, Department of Fisheries Western Australia.

Data collection

Most of the parameters measured in the present study used a comparable size of the two treatment groups such as hepatosomatic indices (Hiw), intestinal bacteria population, total haemocyte counts (THC), gluthathionine peroxide (GPx) enzyme activity, except for the survival rates and marron productivity in marron pond.

Data collection was performed at day 90th, day 160th and at the harvest (day 310th) for determination of the survival rate, pond production and GPx enzyme activity.

a. Total haemocyte counts (THC)

The total haemocyte count was measured following the established methods used for western rock lobsters Panulirus cygnus (Fotedar et al., 2001). The haemocyte samples preparation was performed on the farm site and mixed with an anticoagulant at a ratio of 1:1, injected into 2 mL cuvette tubes then kept in an iced cool box before taking to the laboratory for THC determination.

In brief, 0.5 mL of haemolymph and anticoagulant mixture was inserted into a haemocytometer (The Neubauer Enhanced Line, Munich, Germany) counting chamber and immediately viewed under 100-fold magnification on a camera-equipped microscope and images were taken for THC. Subsequently, the cells were counted in both grids, and the mean was used as the haemocyte count. The total haemocyte count was calculated as THC = (cells counted x dilution factor x 1000)/volume of grid (0.1 mm^3).

b. Hepatosomatic indices (Hiw)

The hepatosomatic index (Hiw) of marron fed basal and B. mycoides supplemented diets were calculated as per established equations (Jussila, 1997, Fotedar, 1998). In brief, the hepatopancreas of marron from each treatment group were removed, placed in foil and weighed. Determination of the hepatosomatic indices (Hiw) used the following equation;

$$Hiw = Wwh \times 100\ W_t^{-1}$$

where: Hiw = Wet hepatosomatic indices (%); Wwh = Weight of wet hepatopancreas (g); W_t = Total weight of marron (g)

c. Intestinal bacteria population(million CFU g^{-1} of gut)

The intestinal bacterial population of marron from the different feeding groups was determined following our previous work (Ambas et al., 2015b). Before aseptic removal of the GIT, the marron was anaesthetized by placing the animal at -20^{o}C for 5 minutes. Subsequently, the dorsal shell was cut-off from tail to head until the intestines were exposed, then the intestine was collected and placed in a sterilised pestle, weighed and homogenised. The homogenates of intestines were diluted serially (from 10^{-1} to 10^{-6}) using a sterile normal saline. Fifty microliters of each serial dilution was inoculated onto a blood agar (BA) plate and incubated overnight in a CO_2 incubator at 25^{o}C. A colony count was performed for each dilution to determine the total number of aerobic bacteria (Buller, 2004).

d. Gluthathionine peroxide enzyme activity

The gluthathionine peroxide enzyme activity was determined followed the established method (Rotruck et al., 1973). In brief, the marron muscle tissue was diluted with a physiological saline at a ratio of 1:1 and stored at 4^{o}C until used. To calculate GPx activity, 0.2 mL muscle tissue homogenates (homogenized in 0.4 M sodium phosphate buffer, pH 7.0), 0.1 mL 10 mM sodium azide, 0.2 mL 0.2 mM reduced glutathione, and 0.1 mL 0.2 mM hydrogen peroxide were mixed, then incubated for 10 minutes at 37°C after which 0.4 mL of 10% trichloroacetic acid (TCA) was added to stop the reaction. Subsequently, the mixtures were centrifuged at 3200 rpm for 20 minutes. The supernatant was assayed for glutathione content using Ellman's reagent (9.8 mg 5,5′ -dithiobis-[2-nitrobenzoic acid] [DTNB] in 100 mL 0.1% sodium citrate). The GPx enzymes activity of the samples was measured at the Biochemistry Laboratory, Department of Agriculture and Food, Western Australia. The GPx activity was expressed as micrograms of GSH consumed per minute per milligram of protein.

e. Survival rate (%) and pond production

The survival rate of marron from each pond and treatment group was measured using the established equation as follows;

$$SR\ (\%) = Nt/No \times 100$$

where: SR = survival rate (%); Nt = No of marron at measurement (ind); No = No of marron at initial stocking

In addition, the pond production from each pond was determined by counting and weighing total marron at harvest using the following equation;

$$\text{Pond production (kg/m}^2\text{)} = \text{Total weight (kg)/pond size (m}^2\text{)}$$

Whereas the average marron weight at harvest was calculated as follow;

$$\text{Mean weight (g)} = \text{Tw/Tn}$$

where Tw = total weight of marron each pond (g); Tn = Total number of marron (ind)

f. Temperature (^{o}C)

The temperature fluctuation was recorded by placing a temperature data logger (Onset HOBO) in each pond. In addition, each pond was equipped with two paddle wheels to ensure sufficient dissolved oxygen especially during critical periods.

Data analysis

The data were analysed using T-test Microsoft Excel for windows version 2010. The difference of means between the two treatment groups was determined at 0.05 level of significance.

Results

Total haemocyte counts (THC)

The THC of marron fed basal and probiotic, *B. mycoides* supplemented diets was not significantly different (P>0.05) at day 90th of marron rearing, however on day 160th the THC of probiotic diet fed marron was significantly higher (P<0.05) than the THC of basal diet fed marron (Figur 1).

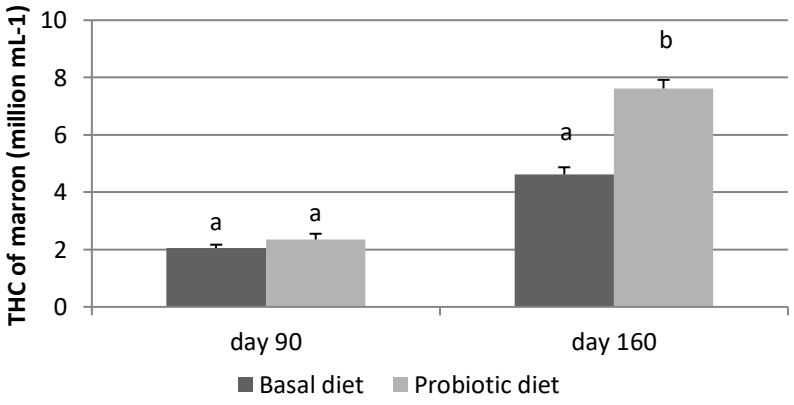

Figure 1. THC of marron (million cells mL^{-1}) fed basal and probiotic diets. *=Different letters over bars indicates significantly different at 0.05.

Wet hepatosomatic indices (%)

In the present study, the wet hepatosomatic indices (Hiw) of probiotic diet fed marron was significantly higher (P<0.05) both at day 90th and day 160th of measurements (Figur 2) than the Hiw of basal diet fed marron. The Hiw of basal diet fed marron was lower at day 90th than the Hiw at day 160th .

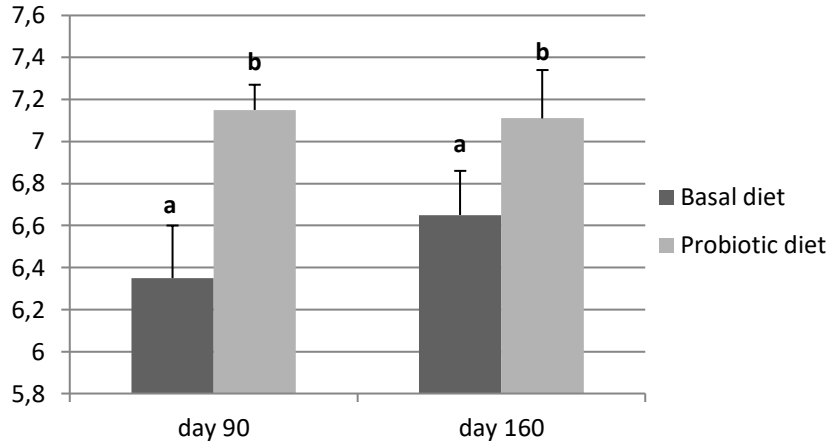

Figure 2. Hepatosomatic indices (Hiw) of marron fed basal and probiotic diets. *=Different letters over bars indicates significantly different at 0.05.

Intestinal bacteria population (million CFU/g of gut)

Supplementation of a marron-origin probiotic, *B. mycoides* to the diet significantly (P<0.05) improved the intestinal bacteria population of marron compared to intestinal bacteria population of the basal diet fed marron, both on day 90th and day 160th. In addition, there is an increase of intestinal bacteria population in both treatment groups on day 160th compared to day 90th (Figur 3).

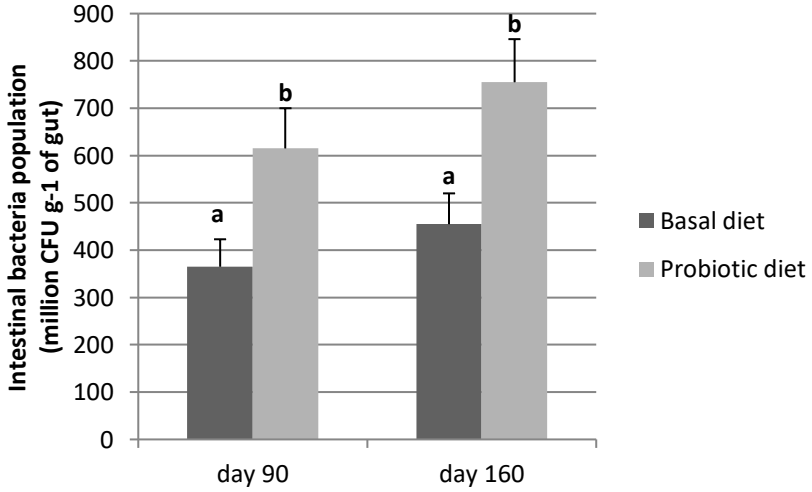

Figure 3. Intestinal bacteria population of basal and probiotic diets fed marron. *=Different letters over bars indicates significantly different at 0.05.

Gluthathionine peroxide (GPx) enzyme activity of tissue muscle

The GPx enzyme activity was significantly higher (P<0.05) in the marron tail muscle tissue fed with the probiotic *B. mycoides* supplemented diet compared to the GPx acitivity of basal diet fed marron both on day 90th and termination of the feeding trial (Figur 4).

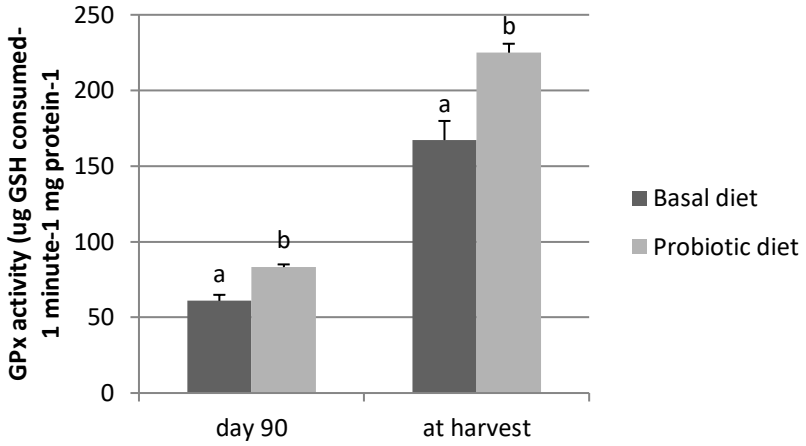

Figure 4. GPx enzyme activity in tissue muscle of basal and probiotic diets fed marron. *=Different letters over bars indicates significantly different at 0.05.

Survival rate (%) and pond production (kg/m2)

The present study demonstrated that the survival rate (%) of probiotic fed marron ranged between 74.80±2.52 (%), which was significantly higher (P<0.05) than the survival rate of marron from the ponds fed with basal diets (66.15±6.33%) (Figur 5).

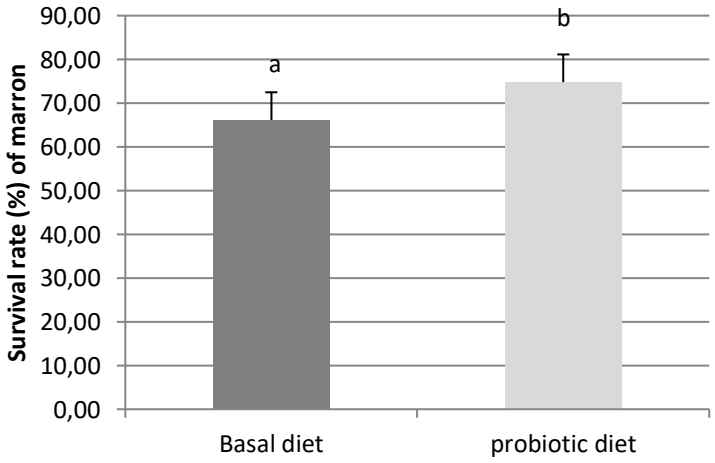

Figure 5. Survival rate (%) of marron fed basal and probiotic supplemented diets. *Different letters over bars indicates significantly different at 0.05.

Meanwhile, the average pond production of the basal diet was 258.3±32.6 g/m^2 whereas the average pond production of the probiotic diet fed marron was 215±26.1 g/m^2 (Table 1).

Table. 1. Survival (%) and production (g/m^2) of marron fed basal and probiotic diets

	Basal diet			Probiotic diet		
	1	**2**	**3**	**1**	**2**	**3**
Initial stocking (n)	3200	3000	3200	3100	3200	3200
Total harvest (n)	1662	2287	2249	2139	2472	2474
Survival (%)	51.94	76.23	70.28	69.00	77.25	78.16
Weight harvest (kg)	137.64	195.8	363.8	192.65	148	241.3
Average weight (kg)	0.083	0.086	0.162	0.090	0.060	0.098
Production (kg/m^2)	0.153	0.218	0.404	0.214	0.164	0.268

Temperature

The water temperature in each pond fluctuated daily, but greater water temperature (**º**C) fluctuation occurred in November (Figure 6). The highest water temperature in marron ponds in average was observed in January and February with an average of 25.61ºC to 25.84**º**C, whereas the lowest (13.05±1.2**º**C) was observed in July. In addition, a very extreme temperature fluctuation was detected on 21**st** November where the temperature at night (2400 hours) ranged between 12.7ºC to 13.9ºC but during the day time (1200 hours) jumped to 36.3ºC to 52.7ºC which caused high mortality especially in the basal diet fed marron ponds.

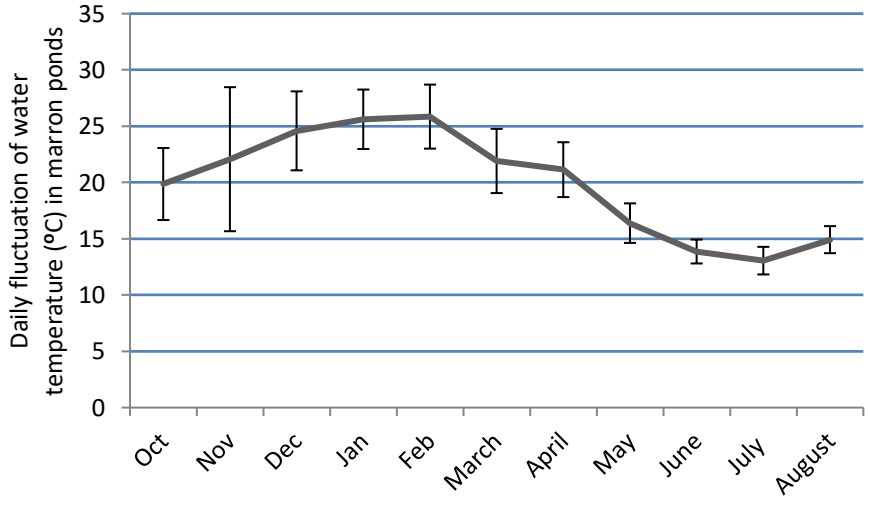

Figure 6. The average water temperature in marron ponds during feeding trial.

Discussion

In aquaculture, the higher immune status of an animal is crucial as the animal is exposed to a series of stress conditions including the natural rhythms of the environment (Rollo et al., 2006, Tapia-Paniagua et al., 2014) and the link between stress and higher susceptibility to diseases is conclusive (Tapia-Paniagua et al., 2014). Therefore, the improved immunity of the aquatic animal (Nayak, 2010, Hai, 2015, Ridha and Azad, 2015) is particularly important to reduce mortalities which lead to significant economic losses (Dagar et al., 2010) and to ensure a profitable aquaculture operation (Bachere, 2000). The present in vivo study suggested that customized probiotic B. mycoides significantly improved

marron immunity and health status (THC, Hiw, intestinal bacteria population and GPx enzyme activity), which in turn improved the survival rate of marron.

The THC of marron fed B. mycoides supplemented diets improved significantly showing that the probiotic B. mycoides remained effective during the entire feeding trial and was able to play a crucial role in marron immunity. It has been proposed by most authors that the host origin probiotic candidate is preferred as its efficacy is likely to be highest in the host and environment from where it has been isolated (Verschuere et al., 2000, O'Sullivan, 2001). Improved THC by feeding probiotic diets has also been observed in many crustaceans such as tiger shrimp Penaeus monodon (Rengpipat et al., 2000), western king prawns P. latisulcatus (Hai et al., 2010), shrimps P. japonicus (Zhang et al., 2011) and Litopenaeus vannamei (Li et al., 2009). Moreover, the haemocytes have been successfully used as an immune indicators in various crustacean such as shrimps (Lorenzon et al., 2001, Van de Braak et al., 2002), lobsters (Lorenzon et al., 2007, Fotedar et al., 2001, Jussila et al., 1997), crabs (Lorenzon et al., 2008) and crayfishes (Persson et al., 1987, Soderhall et al., 1984) including marron (Jussila et al., 1999, Sang et al., 2009) as the haemocytes are involved in various defence mechanisms including recognition, phagocytosis, encapsulation, storage and release of the proPO system and cytotoxicity (Soderhall and Cerenius, 1992, Johansson et al., 2000, Sritunyalucksana and Soderhall, 2000).

It has been documented that the hepatopancreas of crustacean is not just an organ responsible for metabolism but it is an integrated part of immunity (Rőszer, 2014). The hepatopancreas is an important organ for absorption and storage of large amounts of energy particularly lipids and can synthesize digestive enzymes for food digestion (Wang et al., 2014). It has also been used as an indicator of the marrons' condition (Jussila, 1997, Fotedar, 1998). As the hepatopancreas also serves as source of various enzymes, the larger hepatopancreas of crayfish could be an indicator of greater digestive enzyme activities (Hammer et al., 2000). In the present study, B. mycoides significantly improved Hiw of marron compared to Hiw of basal diet fed marron both on day 90th and day 160th which suggested that a supplemented probiotic in the marron diet was able to improve the metabolism and energy availability for the animals. These results are in line with Tapia-Paniagua et al. (2014) who suggested that probiotics increases energy availability of animals and thus improve stress tolerance.

In addition to hepatopancreas, the intestinal bacteria population also plays a significant role in metabolism and immunity. The beneficial bacteria not only protect the animal from the pathogen invasion, but also reflect the nutritional status of the animal (Ringø et al., 2007b, Denev et al., 2009, Gaggìa et al., 2010). The present study demonstrated that B. mycoides significantly improved the intestinal bacteria population of the marron and also that there was an increase in bacteria population both in basal and probiotic diets fed marron as the marron size increased on day 160th. Ringø et al. (2003) suggested that there is a progressive increase of intestinal bacteria population of small intestines to larger intestines of

aquatic animals. Modulation of the intestinal bacteria population have also been demonstrated in many groups of aquatic animals such as Atlantic cod (Lazado et al., 2014), Mediterranean teleosts (Dimitroglou et al., 2011) and Salmonids (Merrifield et al., 2010).

GPx is another immune parameter of marron, which was improved by feeding with a probiotic supplemented diet. The GPx of marron fed with a probiotic diet was significantly higher than the GPx of basal diet fed marron. Our previous study also revealed a progressive increase of GPx tail muscle tissue of marron with time from one to four weeks feeding. Improved antioxidant enzyme activity by feeding with probiotics have been detected in shrimp Litopenaeus stylirostris (Castex et al., 2010). GPx enzyme activity plays a crucial role in maintaining cellular homeostasis of crayfish (Borković et al., 2008) protects the body from oxidation by free radicals (Chiu et al., 2010), which can cause cellular damage and oxidative stress (Parrilla-Taylor and Zenteno-Savín, 2011). The GPx activity has also been detected higher in haemocyte of marron (Nugroho and Fotedar, 2013). In addition, probiotics especially lactic acid bacteria exhibit various antioxidant activity which is capable of limiting excessive amounts of reactive radicals in vivo and thus potentially contributes in preventing and controlling several diseases associated with oxidative stress (Amaretti et al., 2013).

Survival rate and growth are critically important for a profitable aquaculture practices. In the present study, the average survival rate (74.8%) of B. mycoides diet fed marron was significantly higher than the survival rate (66.2 %) of basal diet fed marron as the probiotic was able to improve immunity and stress tolerance of marron when the culture condition extreme. An extreme fluctuation of water temperature on the 21st of November ranged between 12.78oC to 13.94 oC at night (2400 hours) and between 36.29 oC to 52.72 oC during the day time (1200 hours) in the marron ponds triggered high marron mortality on that day and the following days. However, higher immune status particularly the Hiw of probiotic fed marron suggested the animals were more adaptable to this chronic environmental stress situation which resulted in a higher survival rate compared to the basal diet fed marron. Jussila et al. (1999) observed a decreased Hiw of marron during a post simulated transport stress test, which suggested that high energy utilization (hepatopancreas) induced by this stress conditions (Cruz et al., 2012).

Though immunity and the health status of marron given a probiotic fed diet were significantly higher than basal diet fed marron as described above, the average pond production was still relatively low. This could be partly attributed to a broad spectrum of juvenile size and/quality and their sources used at the initial stocking of the experimental ponds. The basal diet fed ponds were initially stocked with the juveniles produced from the same experimental ponds, whereas most of the juveniles for the probiotic fed marron ponds were obtained from the non-experimental ponds and out sourced and were relatively smaller in size than the

juvenile sizes of basal diet fed marron. Lack of juvenile's sources at initial stocking time contributed to the relatively larger variations in sizes and quality. Therefore, further study is required by using only one source of equal sized juveniles as an initial stocking to evaluate the performance of probiotic diets on marron in commercial marron farms. A comparable size of animal from treatments groups is recommended by some authors when measuring a particular parameters as several parameters vary greatly according to animal size or organs such as bacteria density and microvilli of similar size GIT (Ringø et al., 2003, Cerezuela et al., 2012).

Conclusion

In summary, the customized marron origin probiotic *B. mycoides* worked effectively in vivo (commercial marron farm) as indicated by a significant improvement of marron immunity and health status (THC, GPx enzyme activity, intestinal bacteria population and Hiw) which in turn enhanced survival rates when compared to basal diet fed marron.

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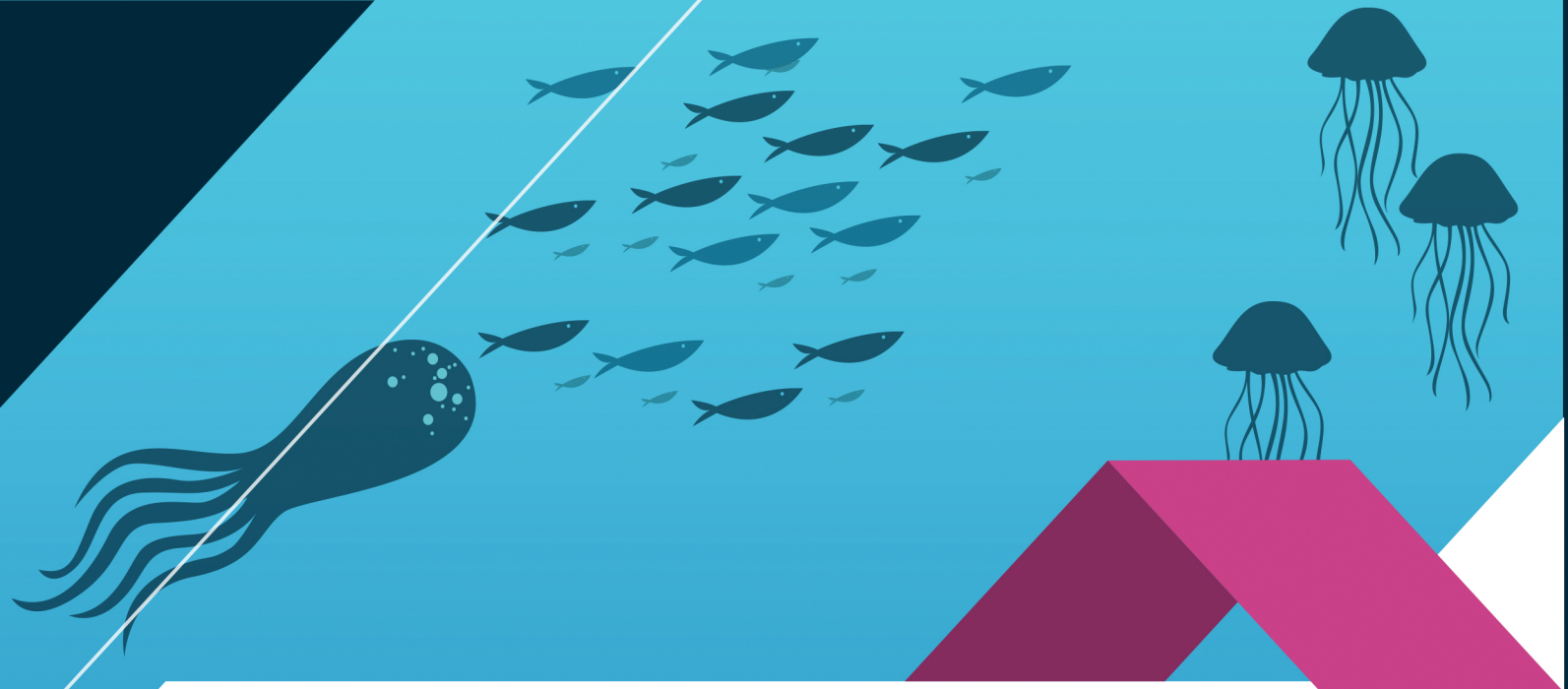

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