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Study on Mollusk and Algae or Phytoplankton Community in Southeast Waters of Bali

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***Abstract*:** A study was carried out to observe the relation between mollusk with algae or phytoplankton in southeast waters of Bali. The study was conducted at Mertasari, Sindhu, Serangan, Purnama, and Kethewel beach. Shannon-Wiener diversity index was used to analyze the ecological condition, supported by analysis on water quality including dissolved oxygen (DO), biological oxygen demand 5 days (BOD5), water pH, and water salinity. There were 34 species of phytoplankton found in this study. The most predominant phytoplankton species in each beach were *Navicula sp* at Mertasari, *Nitzschia sp* at Sindhu, *Pseudo-nitzschia* sp at Purnama, *Chaetoceros* sp at Kethewel. Observation on macro algae showed that Ulva sp was to be the most predominant species in Serangan, Mertasari, and Sindhu beach (17.95, 16.25, and 17.81%). In mollusk observation, gastropod groups showed to be higher number than bivalve group. *Nassarius* sp showed to be the most predominant in Serangan beach (13.33%), while *Ruditapes* sp was predominant in Mertasari and Sindhu beach (11.59% and 14.81%). The highest diversity index of phytoplankton was shown by Kethewel beach (H = 1.35), while the lowest was shown by Shindu beach (H = 0.95). The highest diversity index of macroalgae was shown by Serangan beach which showed H = 2.08, while the lowest was shown by Purnama beach which showed H = 0.69. Serangan beach showed the highest diversity index (H = 2.72) with E = 0.66 compared to another locations, while Kethewel beach showed the lowest diversity index (H = 0.69 and E = 1). There was a relation between the existences of gastropod as the highest number of mollusk and Ulva sp as the gastropod feed.

***Keywords*:** Mollusk; macro algae; phytoplankton; relationship

1. Introduction

The phylum of Mollusk is the largest and the most diversed groups among animal kingdom. Recently, there are around 30.000 species are found in the sea. Of the seven classes of mollusks, the largest is Gastropoda and followed by Bivalvia (Gosling, 2003; Chase, 2002). Mollusk groups, including bivalves and gastropods are one of the most animal protein sources in food. Dody (2004) stated that result of proximate analysis on bivalve meat showed to contain 50% of protein, 5% of fat, 5% of carbon, and 40% of water content. On the other hand, the other mollusks are known to have ability to increase the human immunity after consumed it (Setyono, 2006). Moreover, in other parts Asia, Tridacna species are known to have ability to improve the sexual desire on human (Ellis, 1999). Species of this group are the member of many sea organisms often used as bio-indicator of heavy metal pollution in a waters, specifically on coastal area which has very low mobility ability (Adriyani and Mahmudiono, 2009). Mollusk on the coastal waters plays an important role to be the member of macro-zoobenthic community. This organism is known to have high diversity compared to other mollusk living in fresh and brackish water (Jabang, 1995; Hendricks, 2007).

The high diversity of marine species, specifically mollusks as macro-zoobenthic in marine environment is highly correlated to its primary productivity (Barnes dan Hughes, 1999). The correlation between mollusk and environmental primary productivity is described through interaction around it food chain, in which mollusks as macrozoobenthic organisms act as consumer and primary productivity is described by the present of algae and phytoplankton in the marine environment which is acted as producer. As the main feed source of mollusk, algae and phytoplankton play an important role in the mollusk habitat ecosystem (Barranguet et al., 1997).

Mollusk, especially gastropod and bivalve groups is the groups existing in various habitat and ecosystem including seagrass, coral, mangrove and also sandy or muddy substrate. These organisms are filter feeder or organism which is having ability to filter their feed in the water column such as phytoplankton and microalgae (Cappenberg et al, 2006). On the other hand, another species of gastropod actively consume the algae or phytoplankton at night by grazing using their teeth (Beesley et al, 1988). Mollusk has ability to determine which kind of feed they could consume through a complicated mechanism involved neuron sensory system could be used to detect the type of food (Hughes, 1986). Moreover, a view species of mollusk with specific consumption only choose its desired food because of its nutrition value or easy to catch (on bivalve) or easy to be grazed (on gastropod).

Southeast part of Bali island waters is one of marine environment which is acted as buffer of human life in Bali. A lot of live activities in this area cause their marine typical characteristic differ to another part of Bali waters. Characteristic of algae and phytoplankton communities related to the community structure of mollusks in marine environment are not known clearly. Therefore, the various kind of mollusk feeds become an interesting thing to be studied, in order to observe the relation between algae and phytoplankton species existing in southeast part of Bali waters related to their community structure.

2. Material and Method

This study was conducted in coastal region of southeast Bali waters. Sampling was carried out in the intertidal area of the bay, including: Mertasari beach, Sindhu beach, Serangan beach, Purnama beach and Kethewel beach. A random determination was used to determine the location used in this study. Phytoplankton, macroalgae and mollusk samples were collected in June 2013.

2.1. Phytoplankton samples collection

Phytoplankton were collected based on method used by Keteresi et al (2012), whether phytoplankton concentrated samples filtered by using a 20 µm phytoplankton net from a volume of 20 liters water. Thus, a volume of 150 ml water samples containing concentrated phytoplankton were fixed in 5% lugol solution in order to preserved the morphological condition of the phytoplankton. After that, it was kept undisturbed up to three days till showed the completed the sedimentation.

Concentrated phytoplankton samples, then, were counted by using a haemocytometer under microscope visualization. Firstly, a cover glass was placed over both of the haemocytometer. Thus, with a soft motion, the concentrated phytoplankton samples were gently inverted approximately 10-20 times to ensure the sample was mixed thoroughly. Each chamber of haemocytometer was loaded by holding pipette at a 30 to 45 degree angle with the open dispensing tip in the V-shaped glass, and allowing the pipette tip to touch the slot slowly when drop the sample. As a result, a capillary action affected the sample to fill the chamber. The number of phytoplankton cell and the number of squares counted, then, were noted after observation under microscope. The average of number cells per square could be calculated by using formula bellow:

$$P = \frac{\sum N}{\sum S} \quad (1)$$

P represents the average number of cells per square, N represent the total cells had been observed, and S represent number of large 1 mm squares. The average cell number, then, was multiplied by 10,000 in order to obtain the final number cells per ml.

2.2. Sample collection

Macroalgae and mollusk sample were collected by using quadrate method using transect 1 x 1 meter. Samples were taken in many stations at Mertasari beach, Sindhu beach, Serangan beach, Purnama beach and Kethewel beach. Macroalgae and mollusk samples were taken from zero point (the bound of lowest tidal zone) to 100 meters to the sea. The interval used in this study was 10 meter per plot, and each plot was placed randomly.

After the plot placed, beach substrate was then taken around 20 cm of substrate depth, and then was filtered in a 0.5 cm filter. Mollusk found inside of the plot was collected in a collection bottle containing 4% of formaldehyde solution in order to preserve the tissue of mollusk samples. Macro algae found inside of transect was collected directly into a sample bottle and preserve in a 40% of ethanol, while phytoplankton samples were preserve in a combination of 4% of formaldehyde and lugol 10%. The samples were then identified at the Laboratory of Aquatic Resource Management at the Faculty of Marine Science and Fisheries, Udayana University. The data was then used to analyze the diversity of mollusk and macro algae at southeast waters of Bali.

2.3. Data analysis

The data of phytoplankton, macro algae, and mollusk were expressed as the ecological indicator in order to describe the community and structure of organisms around the coastal environment. The parameters used in this study were abundance, diversity, and evenness index of phytoplankton. Species abundance could be taken from the total number taxa found in the samples. Thus, diversity of the phytoplankton was calculated by adapted method developed by Shannon (1948) using formula bellow:

$$H = -\sum \frac{ni}{N} \log \frac{ni}{N} \quad (2)$$

H represents the diversity index of the phytoplankton, *ni* represent the number of the individuals of the i^{th}, and *N* represent the total number of individuals. On the other hand, the evenness index was calculated using formula bellow:

$$E = \frac{H}{\ln S} \quad (3)$$

H is the Shannon Wiener's species diversity index, while *S* represents the species richness (number of species found).

The measurement on water quality around Jimbaran Bay Waters had performed on Dissolved Oxygen (DO), Biological Oxygen Demand 5 Days (BOD5), Water Acidity Level (pH) and Water Salinity. DO and BOD5 was measured in mg/L by using Dissolved Oxygen Meter (Lutron DO 5509) registered from Lutron Electronic Enterprise Co. Ltd which have accuracy range of ± 0.4 mg/L (after calibration within 23 ± 5oC). Water acidity level (pH) during the study was measured by using Pen pH meter (Lutron pH-222) registered from Lutron Electronic Enterprise Co. Ltd which have accuracy range of ± 0.02 pH (after calibration). In addition, water salinity was measured in ppt by using Hand-held Refractometer (Atago-MASTER-S/MillM 2493) registered from Atago Co. Ltd.

3. Results and Discussion

3.1. Result

1. Phytoplankton abundant

Observation of phytoplankton in southeast waters of Bali showed that there were a total 34 species of phytoplankton had been found in this study and a total 347 individual of phytoplankton. The highest diversity index was shown by Kethewel beach (H = 1.35), while the lowest was shown by Shindu beach (H = 0.95). On the other hand, the diversity of phytoplankton among all of site location showed H = 1.03. Thus, analysis on the evenness of phytoplankton in each location showed that the highest result was shown by Kethewel beach (E = 0.31), while the lowest result was shown by Sindhu beach (E = 0.23) (Table 1). On the other hand, evenness of phytoplankton among all of location showed E = 0.18. Based on the result of diversity and evenness index it could be expected that the location had a medium diversity level, moderate productivity, and lightly influence by environmental pressure.

Table 1. Species of Phytoplankton and the diversity index

Phytoplankton	Serang-an	Merta-sari	Sin-dhu	Purna-ma	Kethe-wel	Tot-al
Melosira sp	1	4	0	0	3	8
Nitzschia sp	5	7	25	4	5	46
Pseudo-nitzschia sp	0	0	0	17	4	21
Biddulphia sp	0	2	0	0	4	6
Navicula sp	3	16	12	3	7	41
Ardissonia sp	1	0	0	0	2	3
Chaetoceros sp	3	2	1	3	11	20
Skeletonema sp	3	2	2	5	4	16
Thalassiosira sp	3	3	1	3	2	12
Thalassionema sp	0	3	1	3	2	9
Coscinodiscus sp	3	0	1	3	1	8
Actinocyclus sp	0	3	2	3	4	12
Pleurosigma sp	1	1	1	0	0	3
Rhizosolenia sp	1	1	0	3	1	6
Licmophora sp	21	2	7	0	4	34
Grammatophora sp	4	3	2	0	2	11
Amphora sp	2	4	2	3	2	13
Guinardia sp	10	1	2	3	5	21
Paralia sp	2	1	0	0	1	4
Striatella sp	2	0	0	0	2	4
Cerataulina sp	1	0	1	3	1	6
Caloneis sp	1	0	0	0	0	1
Trachyneis sp	2	7	4	3	1	17
Aulacoseira sp	3	0	0	0	2	5
Porosira sp	1	1	0	0	1	3
Podosira sp	0	1	2	0	4	7
Bellerochea sp	1	0	0	0	0	1
Cocconeis sp	0	1	0	0	0	1
Diploneis sp	1	0	0	0	0	1
Donkinia sp	0	0	0	0	1	1
Achnanthes sp	0	0	0	0	1	1
Asterionellopsis sp	0	0	1	0	1	2
Ditylum sp	0	0	0	0	1	1
Dictyocha sp	0	0	1	0	1	2
Total	75	65	68	59	80	347
Diversity (H)	1.15	1.14	0.95	1.05	1.35	1.03
Evenness (E)	0.27	0.27	0.23	0.26	0.31	0.18
Dominance (D)	0.12	0.11	0.19	0.12	0.06	0.06

Licmophora sp was predominantly found at Serangan beach compared to the other species, while species dominantly exist in Mertasari beach is Navicula sp. Thus, under microscopy enumeration, the highest number of phytoplankton in Sindhu, Purnama and Kethewel beach was shown by Nitzschia sp, Pseudo-nitzschia sp, and Chaetoceros sp, respectively. Licmophora sp showed to be predominant with 28% of individual existence in Serangan beach. On the other hand, Navicula sp which is predominant exist at Mertasari beach showed a number 24.62% of total individual found in the location. Nitzschia sp, Pseudo-nitzschia sp, and Chaetoceros sp which predominant at Sindhu, Purnama and Kethewel beach showed percentage of individual existence at 36.76%, 28.81% and 13.75%, respectively.

2. Macroalgae abundant

Macro algae had found in a total of 13 species in the location, while a total number of 214 individuals had been found among location. The highest diversity index of macroalgae was shown by Serangan beach which showed H = 2.08, while the lowest was shown by Purnama beach which showed H = 0.69 (Table 2). On the other hand, a comparison among all of location showed that the diversity index in this environment showed H = 1.05, and E = 0.20. Based on the result of diversity and evenness index it could be expected that the location had a medium diversity level, moderate productivity, and lightly influence by environmental pressure. Ulva sp showed to be the most predominant species in Serangan, Mertasari, and Sindhu beach (17.95, 16.25, and 17.81%). On the other location, Codium sp showed as the highest number at Kethewel beach. The lowest individual number was shown by Purnama beach that found 2 species only.

Table 2. Species of Macroalgae and the diversity index

Macro algae	Serang-an	Merta-sari	Sin-dhu	Purna-ma	Kethe-wel	Tot-al
Gracilaria sp	5	8	7	0	4	24
Ulva sp	7	13	13	2	4	39
Boergesenia sp	0	8	7	0	0	15
Acantophora sp	1	2	2	0	0	5
Padina sp	7	5	5	0	0	17
Turbinaria sp	5	10	9	0	0	24
Dictyopteris sp	4	3	2	0	0	9
Sargassum sp	5	6	5	2	2	20
Rhodymenia sp	3	9	8	0	0	20
Hypnea sp	0	2	2	0	0	4
Cladophora sp	0	3	2	0	3	8
Caulerpa sp	2	9	7	0	0	18
Codium sp	0	2	4	0	5	11
Total	39	80	73	4	18	214
Diversity (H)	2.08	1.86	1.82	0.69	1.57	1.05
Evenness (E)	0.57	0.42	0.42	0.5	0.54	0.20
Dominance (D)	0	0.10	0.10	0.5	0.22	0.1

3. Mollusk abundant

A total 217 individual of mollusk had been found in the location from a total of 19 species (Table 3). Gastropod group was predominantly exist in the location (13 species), while Bivalve groups showed total 6 species in the location. Serangan beach showed the highest diversity index (H = 2.72) with E = 0.66 compared to another locations, while Kethewel beach showed the lowest diversity index (H = 0.69 and E = 1). Based on the result of diversity and evenness index it could be expected that the location had a medium diversity level, moderate productivity, and lightly influence by environmental pressure. Nassarius sp showed to be the most predominant in Serangan beach (13.33%), while Ruditapes sp was predominant in Mertasari and Sindhu beach (11.59% and 14.81%). On the contrary, a small number of mollusk were observed in Kethewel and Purnama beach.

Table 3. Species of Mollusk and the diversity index

Mollusk	Serang-an	Merta-sari	Sin-dhu	Purna-ma	Kethe-wel	Tot-al
Gastropod						
Cypraea sp	7	6	8	1	2	24
Engina sp	3	3	5	0	0	11
Pseudovertagus sp	4	7	5	0	0	16
Rhinoclavis sp	2	2	1	0	0	5
Pyrene sp	5	4	6	0	0	15
Conus sp	3	4	4	0	0	11
Vexillum sp	1	3	3	0	0	7
Morula sp	1	2	1	0	0	4
Nassarius sp	8	7	9	0	0	24
Polinices sp	2	1	2	0	2	7
Natica sp	1	2	1	0	0	4
Strombus sp	3	2	2	0	0	7
Calthalotia sp	1	0	2	1	1	5
Bivalve						
Anadara sp	2	4	4	0	0	10
Acrosterigma sp	7	8	8	0	0	23
Fragum sp	2	2	3	0	0	7
Mactra sp	1	0	2	0	0	3
Ruditapes sp	5	8	12	0	0	25
Amusium sp	2	4	3	0	0	9
Total	60	69	81	2	5	217
Diversity (H)	2.72	2.68	2.71	0.69	1.05	1.19
Evenness (E)	0.66	0.63	0.62	1.00	0.66	0.51
Dominance (D)	0.08	0.08	0.08	0.50	0.36	0.07

4. Water quality and substrate characteristic

Measurement on the water quality among location had showed that temperature at location was ranging from 26 – 27.3oC, while BOD was ranging from 0.7 – 1.5 ppm. Water salinity also showed a varied result which was ranging from 28.3 – 29.3 ppt (Table 4).

4. Discussion and Summary

Water quality is known to have significant influence to varied mollusk, including gastropod and bivalve Water temperature is one of many factors influencing the distribution of certain species in an aquatic environment. According to Levinton (1982), all of marine organisms (except mammals) are not able to manage their body temperature. Result showed that water temperature in the location was ranging from 26 - 27oC, while pH was ranging from 7.5 - 9. Water temperature and pH in this range is could be tolerated and optimal for the growth of mollusk (Barley, 1992). The present of a species and all of community environment tend to be varied depending on the metabolism activity and the reproduction of mollusk (Hutabarat and Evans, 1995). It supposed to influence the different composition and abundant of bivalve ecologically. Salinity is known to be able to influence the distribution of organism, even vertically or horizontally (Odum, 1993). Water salinity at location are known to be varied from 28 – 32 ppt. Water salinities could give influence directly to the gastropod population because every gastropod had a tolerance level to the salinity level depending on the ability of the organism to control their osmotic pressure (Astuti, 1990).

Gastropod is the most abundance group of mollusk in the southeast Bali waters. Gastropod class is one of mollusks class commonly known as snail. Size and form of the body is very varied. On the other hand, gastropod has a single whorl shell and complemented by tentacle and eye (Pechenik, 2000). The other group found in the location is bivalve. This group is belonging to mollusk group having two valve of shell and commonly bilateral symmetry (Pelecypoda). The two valve of bivalve is able to open and close by move their adductor and redactor mussel. In the dorsal part, there are hinge teethes and ligament. Bivalve are having varied habit, and mostly are free living. The habitat of this organism is including sea water, brackish water, river, pond and lake (Dharma, 1988). Gastropod in known to have high number of species compared to the bivalve group because they have a high ability to tolerate in high fluctuation of environmental parameters, especially is salinity. On the other hand, this group is able to live in high temperature and anoxic condition (Hogarth, 1999). Gastropod is highly found in the southeast waters of Bali are Cypraea sp. This species is known to have a thin shell, with a thick lips and wide aperture. In early

Table 4. Water quality of southeast Bali waters

Coordinate		Serangan	Mertasari	Sindhu	Ketewel	Purnama
	S	08°44.442’	08°42.801’	08°41.110’	08°38.669’	08°37.109’
	E	115°14.493’	115°14.994’	115°15.885’	115°16.907’	115°18.621’
Temperature (^{o}C)		26.0	27.3	26.0	26.2	26.5
pH		9.3	7.6	9.1	9.6	9
DO1(ppm)		4.5	4.4	6.7	3.1	3.5
DO5 (ppm)		3.2	3.5	5.2	2.4	2.5
BOD (ppm)		1.3	0.9	1.5	0.7	1.0
Salinity (ppt)		29.3	28.3	31.7	28.3	30
Substrate		White Sandy and Muddy	White Sandy and Muddy	White Sand	Black Sand	Black Sand

development, their spire will be formed slowly. However, at maximum the length, the last whorl will be folded making circle form and commonly are covering the spire. The lips is folded inside, and teethes is formed along the side of aperture (Wilson, 1998).

The high number of gastropod species in the location is related to the existence of macro algae present. Ulva sp has been found to be predominant in the location. Ulva sp is commonly found in a low level of wave energy. Beside Ulva sp, there is also another species having high number of individual (Gracilaria sp). Commonly gastropod species is prefer to consume this macro algae species. According to Corazani and Illanes (1996), there are 3 factors to be considered in choosing the algae to be consumed by the gastropod (metabolite compounds, the hardness of the algae, and nutrient level of the algae).

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