Biodiversity index of corals in the shallow reefs of Barangay Bitaug Sta. Cruz, Davao del Sur

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ABSTRACT

This study aimed to identify the biodiversity index of shallow reef forming corals in Brgy. Bitaug, Santa Cruz, Davao del Sur in terms of physicochemical parameters of water, taxonomic classification and biodiversity of the observed species in the site. Corals belong to *Kingdom Animalia* and *Phylum Cnidaria* which include three classes; *Hydrozoa*, *Schypozoa, Anthozoa.* In this study, the researchers used qualitative and quantitative approach. The species were observed by number as well as the quality of the water. Based on the result using a PAST software, the research team concluded that transect 3 was the transect which had the most diverse corals species found in the three-sampling sites in terms of the number of species, followed by transect two and then transect one. Corals in the shallow reefs of Barangay Bitaug Sta. Cruz Davao del Sur were more diverse in the shallow part of the seawater than in the deep seawater. Furthermore, the research team concluded that, these corals were more tolerant to the stored sediments, pH, temperature and chemicals from industrial factories located on the nearby seashore of the sampling site.

Keywords: biodiversity index, corals, shallow reefs, Brgy. Bitaug, Sta. Cruz

INTRODUCTION

Tropical communities are particularly important in global economics of biodiversity because of increasing human population and monetary resource as sources, strand and problem of food production, pollution and environmental changes were more acute. Coral reef resembles rainforest in their biologically generated physical complexity, high species biodiversity, elaborate component of species, and convoked associations between species (Reaka-Kudla, 1997).

Likewise, corals are important locally in supplying coastal protection, sand for beaches and fish invertebrates, seaweeds for harvest, site for Mari culture and other benefits and services to those who lived along the reefs and travel to use their resources (McManus 2002). Moreover corals are some of the most diverse, valuable marine habitat on earth; they provide millions of people with foods, revenue, tourism and coastal protection (Erdmann, 1997).

Carpenter (1977) estimated the area of corals in the Philippines at a range of 12,000 km² - 33,000 km². In Southern Mindanao, particularly in Davao Region where a diverse group of coral marine species was found is considered as one of the premiere sources of profitable marine animals and of breeding site among sea creatures. Corals biodiversity measures ecological balance as a habitat of marine species, especially fish which is one of the major income commodities among Filipino family. Coral reefs were one of the contributors for different source of income especially in tourism.

Generally, this study intends to identify the abundance of corals in the shallow reefs of Barangay Bitaug Sta. Cruz Davao Del Sur. Analysis of the presence or absence of various coral species of this kind will be performed in order to assess biodiversity concerns of the said study area. Hence, this research endeavour emphasizes the importance of coral species in marine environment as well as to the community.

This investigation aimed to identify the current corals in the shallow reefs of Barangay Bitaug Sta. Cruz, Davao del Sur this year 2014-2015. This determined the physicochemical properties of water in Barangay Bitaug, Sta. Cruz, Davao del Sur in terms of location, temperature, and pH. Moreover, this study explored the orders of corals present in the sampling site and the biodiversity indices of the coral reef in terms of Shannon index, Simpson index, richness, and evenness.

METHOD

The researchers used quantitative methods of research to describe and analyze the current condition accurately and accordingly. This study design was created to describe the biodiversity index of coral reefs. It also described the physicochemical of the sea water in terms of pH and temperature.

The study focused on the corals in the shallow reefs of Barangay Bitaug, Sta. Cruz, Davao del Sur with a belt transect technique of sampling in a diameter of 100 meters length as sampling site. The sampling site was located at its starting point of 125° 24' 38.61" E and 6° 49' 37.06" N and ended up to 125° 24' 37.56"E and 6° 49' 33.37" N which was exactly 100 meters length.

Figure 1. *Sampling Site*

This study was measured using a variety of measuring instrument namely; *pool*, a five-meter round bamboo stick to be used as sweeping pool, *2 plastic slate* as

underwater writing pad, *2 pencils* for writing, *2 metal rulers* for underwater measuring tools, *notebooks* as another writing pad, ballpen for writing, *Styrofoam* as floating pad for the GPS, *2 underwater camera* for species documentation, *GPS* for the exact location, parameter and positioning of the species and compass for the exact direction of the given transect line. *Taxonomic Key,* a laminated images of coral species that would be used for species identification,and *2 gallons* for water sample container. To ensure the safety of the research as well as the research team, the research team should be equipped with the following safety materials namely; *first aid kit, snorkel, life vest, sun block lotion, warmer, shoes,* and *leggings.*

After the sampling, the data were calculated and analysed by the researchers through the following computerize computation instruments to have the exact results. **PAST** (Paleontological Statistics) is software for data analysis that can compute Shannon index, Simpson index, Evenness, Richness and plotting the graph of the species diversity distribution by just encoding the sampling data on the software. **Laboratory Analysis.** The researchers took two gallons of water sample from the sampling area which were sent to Davao Analytical Laboratory for analysis and to obtain the physicochemical properties of water in the shallow reef of Barangay Bitaug Sta. Cruz Davao Del Sur. The laboratory result determined certain chemical factors and the water contents that served as the growth hindrances and factors affecting abundance of corals species.

Data were collected by counting the number of both soft and hard coral species observed in its three transects site at Barangay Bitaug Sta. Cruz Davao del Sur. The counted coral species were then subjected to PAST Software in order to identify its diversity indices. Since the study was all about the biodiversity index of corals species of the sampling site, the research team calculated its richness and evenness using these two diversity indices equations; first, Shannon index, was calculated by substituting corals species count to the equation $\mathbf{H} = -\sum_{i=1}^{n} \mathbf{Pi}\,\mathbf{log}\,\mathbf{Pi}$. Where ***pi*** is the frequency **ni/N**. If the data are in the form of counts, for a given species number (**S**) and a sample size (**N**), the minimum ($\mathbf{H}_{min}$) and maximum ($\mathbf{H}_{max}$) possible values for **H** can be calculated with the equations

$$\mathbf{H}min = \log N - \frac{(N-S+1)\log(N-S+1)}{N} \qquad \mathbf{H}max = \log S$$

Also, Simpson index was calculated by encoding the data to its equation

$$H = \sum \frac{N(n-1)}{N(n-1)}.$$

To calculate the different indices of corals in Bitaug Sta.Cruz PAST(Paleontological Software) was used to obtain the biodiversity index of corals in an accurate and convenient way.

RESULTS AND DISCUSSION

Physicochemical properties

Location

The sampling site was located at starting point of 125° 24' 38.61" E and 6° 49' 37.06" N and ended up to 125° 24' 37.56"E and 6° 49' 33.37" N. It was described according to its morphometric characteristic as a rocky with minimal sand substrate for both hard and soft corals embedded with kelps and other underwater plants. It also included coral fishes housing the mass of boulder and soft corals as its bed. Plants underwater resembled symbiotic community for both corals even sea animals. The sampling site had its average sea waves and minimal current water turbidity usually in its clear state. Transect 1 was in a location with which the starting point was on 6°49′24.19″ N latitude 125°24′36.70″ E longitude and an end point of 6°49′27.54″N latitude 125°24′36.87″E longitude and described the substrate as rocky with boulders resembling mountain with less sand. Kelps carpeted on boulder mass of corals.

While transect 2 was situated in starting point of 6°49′28.91″N latitude and 125°24′36.96″E longitude and an end point of 6°49′32.08″N latitude and 125°24′37.34″E longitude. The substrate was less sandy and with the abundance of the Family Alcyoniidae.

Transect 3 was in a starting point of 6°49′33.37″N latitude and 125°24′37.55″E longitude and an end point of 6°49′36.44″N latitude and 125°24′33.87″E longitude with the substrate contained kelps, coral boulder and a settled particles of crashed corals.

Temperature

Through the use of thermometer the actual temperature of Bitaug sea was at 20°C at 11 in the morning of August 09, 2015.Water temperature contributed different intervention on the growth and the status of corals.Over the last few decades, several major ecosystems proved to be vulnerable to future climate changes. Increases in ocean temperature have some of the most visible and dramatic effects because they contributed to the two major causes of coral mortality: coral disease

and coral bleaching (Arceo et al. 2001; Aronson & Precht 2006; Graham et al. 2006).

pH

The pH scale measured how acidic or basic a substance is. The pH scale ranged from 0 to 14. A pH of 7 was neutral. A pH less than 7 was acidic. A pH greater than 7 was basic. Finally, the result of Barangay Bitaug seawater laboratory analysis conducted in Davao Analytical Laboratory, showed that the pH of Bitaug Sea was at 8.11 pH with the use of glass Electrodes method. This result emphasized that the sea water of Barangay Bitaug, Sta. Cruz, Davao del Sur was basic.

Biodiversity Indices

Transect 1 had a total of 773 individuals and each of them was classified according to hard and soft corals. Transect 2 had a total of 905 individuals and transect 3 had 936 species and a total of 2614 coral individuals. The *Sarcophyton* coral species had dominated most of the coral species found in Barangay Bitaug Sta. Cruz Davao del Sur in terms of its quantity with a total count of 532 coral individuals. Second in the rank was the *Acropora* species with a total count of 398 individuals. It was followed by the *Sinularia* coral species with a total count of 348 species. Last, was the *Lobophytum species* with a total count of 187 coral colonies.

Table 2. *Biodiversity Indices Results through PAST software*

	Transect 1	Lower	Upper	Transect 2	Lower	Upper	Transect 3	Lower	Upper
Taxa S	38	37	38	40	39	40	41	40	41
Individual	773	773	773	905	905	905	936	936	936
Dominance_D	0.07818	0.06566	0.0803	0.05842	0.0546	0.06422	0.05663	0.05306	0.06191
Simpson_1-D	0.9281	0.9194	0.9343	0.9416	0.9358	0.9454	0.9434	0.9381	0.9469
Shannon_H	3.011	2.928	3.066	3.133	3.065	3.177	3.157	3.092	3.203
Evenness_e^H/S	0.5345	0.4932	0.5665	0.5735	0.5371	0.6011	0.5734	0.5384	0.6021

The table above showed the result of diversity indices using a software called PAST (Paleontological Statistics). It showed a result of Shannon diversity index, Simpson diversity index, the Evenness, Abundance and Richness of a species.

Biological Profile of Bitaug Sea Water

Presented in Table 2 diverse coral species present in three sampling transect in a diameter of 100 meters length as sampling site. The sampling site was located at its starting point of 125° 24' 38.61" E and 6° 49' 37.06" N and end up to 125° 24' 37.56"E and 6° 49' 33.37" N which exactly 100 meters length transects showed that Family *Alcyoniidae* which includes *Sarcophyton Species*, *Sinularia Species* and *Lobophytum species* dominated the highest count among hard and soft coral families observed in on the above-mentioned sampling site. And total of 2,640 different of individual was found on the final calculation of every individual. Coral reef diversity can be seen in their different ecological and economic functions by protecting coastline and shoreline erosion as it holds and protect the underwater substrate from movement (Crosby et al, 2010)

Table 2. *Taxonomic Classification by Order of Corals in Bitaug Sea Water*

SPECIES	***PICTURE***	***DESCRIPTION***
Acropora sp.1		These are soft corals with soft corallites. They form a plate – like or tabulate colonies.
Acropora sp. 2		These are hard species of acropora. They are seen as white in colour. They form a flat colony
Acropora sp.3		These are spiny hard corals. They are seen as pink in colour, forming circular colonies. They are attached in hard substrate.

Acropora sp.4		These are hard branching corals. The corallites at the tip of each branch usually appear spiny and pinkish in colour.
Acropora sp 5		These are hard corals with corallites. They usually appear brown in colour in the middle of the colony and light at the edge. They form a plate – like or tabulate colonies.
Acropora sp. 6		These are colonies of cylindrical branches that branch in three dimensions, often forming a dense tangle.
Agariciidae sp.1		These are hard corals which have deep walls. They are seen as brown in their surface and white in the edge.
Lobophytum sp.1		These are soft corals with tiny white polyps on their surface. They are as yellow in colour and will form a thick and wide colony.

Lobophytum sp. 2		These are soft corals with thin walled valleys and widely spaced septa. They form a flat plate – like colony.
Poritidae sp.1		These are massive hard corals. They are seen as brown in colour. They form a huge colony enveloping their substrate.
Sarcophyton sp.1		These are soft corals. They are hairy and they have valleys on their groovy surface. They are seen yellow in colour. They form thick and wide colony.
Sarcophyton sp.2		These are soft corals. They are usually seen as white or yellow or green in colour
Sarcophyton sp.3		These are soft corals which are yellow in colour and they have white polyps on their surface. They form a wide wavy colony.
Sarcophyton sp.4		These are species of soft corals. They are seen as white colour and they have branches.

Sarcophyton sp.5		These are hairy soft corals with polyps. They are brown and yellow in colour. They form thick and wide colonies with valleys in their surfaces.
Sarcophyton sp.6		These are soft corals with narrow walls and flat surface. They are seen white in colour, forming a flat colony.
Lobophytum sp. 2		These are soft corals with thin walled valleys and widely spaced septa. They form a flat plate – like colony.
Sarcophyton sp.4		These are species of soft corals. They are seen as white colour and they have branches.
Sarcophyton sp.5		These are hairy soft corals with polyps. They are brown and yellow in colour. They form thick and wide colonies with valleys in their surfaces.
Sarcophyton sp.6		These are soft corals with narrow walls and flat surface. They are seen white

		in colour, forming a flat colony.
Sarcophyton sp. 7		These are soft corals with flat surface. They are seen as light yellow in colour. And they form a flat colony.
Sinularia sp. 1		These are soft corals with soft corallites. They form a plate – like or tabulate colonies.
Sinularia sp.2		These are soft corals with soft corallites which are seen as yellow or white in colour.
Sinularia sp. 3		These are soft white corals forming a plate or tabulate colonies with taller branch.
Sinularia sp.4		These are soft corals. They are seen as yellow in colour. They resemble as thick plate – like colony.

Sinularia sp.5		These are hard corals with branches which are seen as yellow or white in colour.
Sinularia sp.6		These are hairy soft corals having long tentacles which appear yellow in colour. They are not a branching type of soft coral.
Species 1		These are hard species of corals. They are seen as gray in colour with branches forming a colony.
Species 2		These are soft corals. Which have shallow walls without any hairs or polyps. They appear purple in colour.
Species 3		These are species of fan – like structure of hard corals. They have bumpy massive plate or crust.
Species 4		These are hard corals forming a massive colony. They appear as green in colour with a circular shape.

Species 5		These are boulder hard corals. They are seen as dark brown or gray in colour.
Species 6		This is a hard massive brain coral with wide sharp/ narrow upper edge. It forms a groove on the top of the walls.
Species 7		These are hard coral species with branches and single stems. They form a circular colony.
Species 8		These are soft coral. They are seen as yellow in colour. They form a flat plate – like colony with valleys in the surface.
Species 9		These are hard corals, seen as rocky and gray in colour. They form a massive circular colony.
Species 10		These are hard corals, resembling species 26, but they form a flat and not a circular colony.

Species 11		These are hard corals. They are also brain corals with sharp grooves and deep walls. They are seen as white in colour.
Species 12		These are hard corals resembling species 6 and 24, butr they have deep walls and distinct holes. They could be yellow or white in colour.
Species 13		These are soft corals resembling species 4, but they have smaller branches than species 4. They are seen as yellow in colour with white hairs.
Species 14		These are hard corals, type of brain corals that have narrow walls and grooves. They usually form a huge circular colony.
Species 15		These are corals, with deep valleys. They form a circular colony. They usually appear as gray in colour.
Species 16		These are species of soft corals having an ear - like structure. They appear dark green in colour.

Species 17		These are hard corals with shell – like structures. They resemble mushroom corals.
Species 18		This is a hard corals which appears purple in color and has a short and thick branches.
Species 19		This is a flat hard coral species. It appears white and Looks like a bee's nest.

Table 3. Abundance of corals through its counts

Species	**Transect**		
	1	2	3
Acropora sp. 1	10	12	18
Acropora sp. 2	1	2	7
Acropora sp. 3	40	53	2
Acropora sp.4	58	97	78
Acropora sp.5	5	8	15
Acropora sp.6	0	3	7
Agariciidae 1	30	10	7
Lobophytum sp.1	39	45	47
Lobophytum sp.2	11	27	18
Poritidae sp.1	10	45	5
Sarcophyton sp.1	45	23	47
Sarcophyton sp.2	48	48	28
Sarcophyton sp.3	11	8	13
Sarcophyton sp.4	9	31	22
Sarcophyton sp.5	10	3	18
Sarcophyton sp.6	7	23	9
Sarcophyton sp.7	20	35	56
Sinularia sp.1	23	27	32
Sinularia sp.2	55	55	83

Table 3. Abundance of corals through its counts (cont.)

Sinularia sp.3	5	7	8
Sinularia sp.4	0	2	1
Sinularia sp.5	13	7	1
Sinularia sp.6	4	19	12
Species 1	2	5	2
Species 2	5	7	8
Species 3	9	6	5
Species 4	3	5	10
Species 5	95	101	90
Species 6	1	0	3
Species 7	4	2	11
Species 8	9	3	0
Species 9	5	10	2
Species 10	1	2	8
Species 11	0	1	1
Species 12	125	96	104
Species 13	8	1	12
Species 14	1	26	3
Species 15	9	27	37
Species 16	35	30	48
Species 17	3	41	10
Species 18	1	2	1
Species 19	0	0	3
Species Total	770	955	892

Table 4. *Shannon Diversity Index*

	Transect 1	**Transect 2**	**Transect 3**	**Interpretation**
Effective Number of Species (ENS)	3.011	3.133	3.157	
Shannon Evenness	20.308	22.943	23.5	equally common species
e^H/S	0.5345	0.5375	0.5812	value closer to 1 is more even
Simpson's Index of Diversity (1-D)	0.9281	0.9416	0.944	probability of finding a different species when two individuals are

Simpson's Reciprocal Index (1/D)	13.91	18.36	17.86	commonly selected determine the presence of dominant species

Table 5. *Biodiversity Indices Results through PAST software*

	Transect 1	Lower	Upper	Transect 2	Lower	Upper	Transect 3	Lower	Upper
Taxa S	38	37	38	40	39	40	41	40	41
Individual	773	773	773	905	905	905	936	936	936
Dominance_D	0.0718	0.06566	0.0803	0.05842	0.0546	0.06422	0.056 63	0.0530 6	0.0619 1
Simpson_1-D	0.9281	0.9194	0.9343	0.9416	0.9358	0.9454	0.943 4	0.9381	0.9469
Shannon_H	3.011	2.928	3.066	3.133	3.065	3.177	3.157	3.092	3.203
Evenness_e^H/S	0.5345	0.4932	0.5665	0.5735	0.5371	0.6011	0.573 4	0.5384	0.6021

CONCLUSIONS AND RECOMMENDATIONS

The study dealt with the Biodiversity Index of Corals in the Shallow Reefs of Barangay Bitaug Sta. Cruz Davao del Sur. Specifically, determined and identified the quantity of current diverse corals species present in Barangay Bitaug Sta. Cruz Davao del Sur.

The research team used a quantitative observation method in identifying the corals species on the sampling site. The data also were derived from the laboratory results obtained from the service of Davao Analytical Laboratory, Davao City for the chemical parameter of the above-mentioned sampling site.

Based on the result using a PAST software, the research team concluded that transect 3 was the transect which had the most diverse corals species found in the three sampling site in terms of the number of species, followed by transect two and then transect one. Corals in the shallow reefs of Barangay Bitaug Sta. Cruz Davao del Sur were more diverse in the shallow part of the seawater than in the deep seawater. Furthermore, the research team concluded that, these corals were more tolerant to the stored sediments, pH, temperature and chemicals from industrial factories located on the nearby seashore of the sampling site.

Based on the results and conclusions presented, the research team recommended to identify ecotypes in the research site, conduct gene extraction to determine why these corals have survived and became tolerant to different environmental factors, and conduct a similar research on a different site to validate the results of this study

REFERENCES

Atkinson, M.J., F. Marubini 1999. Effects of Lowered Ph and elevated Nitrate on Coral Calcification.Marine Ecology Progress Series.Hawaii USA.

Carpenter, K.E.1997 Philippine coral reef fisheries resources.Philipp Fish.JFish. 15(1):95-125.

Eakin, C.M.,J.Klypas and O.H.Culdberg 2008. Global climate change andcoral reefs:Rising temperature, Acidification and needs for resilient reef.

English, S.A.,C.Wilkinson and V.J.Baker(eds). 1994. Survey manual for tropicalmarine resources. ASEAN Australia Marine Science Project, Australian Institute for Marine Science, Townsville Australia

Erdmann M.R.,J. Gibson Jr., S.C. Jamejon, J.R. Karr and K.W. Potts 1997. Charting a course towards a diagnostic monitoring: A ContuingReview of Coral Reef Attributes and Research Strategy for Creating Indices Biotic Integrity Coral Reef

Fabry, V.J.,J.Klypas, M.Feely, C.Larydon,C.S.Sabine and L.L.Robbins 2oo6impact of ocean acidification in coral reefs and other marinecalcifiers Guide for Future Research

Larned, S.L.1998. Marine Biology (1998) 132: 409±421S pringer-Verlag 1998

McManus, J.W.1992. The spratly Islands: a marine park alternative. Naga IICLARM Quarterly (july). Pp. 4-7.

McManus, J.W., 1994. The spratly islands: a marine park? Ambio 23(3):181-186 Ministry of Tourism, Government of Israel 2011DOI: 10.1146/annurev.es.03.110172.000543

Palaganas, V.P., Sy and P.Alino. 1985. Coral Communities Of The Tubbataha Reef National Marine Park (Philipinnes)

Reaka-Kudla, M.L.,1997 Understanding and protecting our Biologicalresources. The Global Biodiversity of Coral Reefs :A Comparisonwith Rainforest.university of Maryland, College Park.

Tacio, H.D.,2012. Corals in Davao. Sunstar Davao Philippines. Vandermeer J.H Niche Theory Annual Review of Ecology and SystematicsVol. 3: 107-132 (Volume publication date November 1972)

World Meteorological Organization 2010. Climate , Carbon and coral reef.Weather,Water, Climate.WMO no. 1063 CH-1211 Geneva 2, Switzerland.