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Preliminary Study on Biogeography and Diversity of Red Alga *Halymenia* in Manila Bay, Philippines

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ABSTRACT

Halymenia, a red seaweed is widely distributed all throughout the world. It has wide economic importance; however, its species diversity, abundance, and distribution have been rarely studied. In Philippines, the literature on red alga Halymenia is poorly documented. In this light, this study aimed to investigate the species diversity, abundance, and distribution of Halymenia in Manila Bay. Specifically, it identified and characterized the Halymenia species present in the bay, described its distribution and abundance, determined its density, relative density, frequency, and relative frequency, and determined its species diversity by employing several diversity indices. The line transect method was used to identify and quantify the seaweeds observed in five established stations divided into five quadrates. Purposive and systematic samplings were employed as sampling techniques. The keys suggested by Trono Jr. (1997) and De Smedt et al. (2001) were used to identify and characterize the species observed. Using the scale recommended by Odum (1955), the abundance of species was determined. Density, relative density, frequency, and relative frequency of the species were determined using the appropriate formulae suggested by Baleta and Nalleb (2016). Simpson's index of diversity (1-D) was used in order to determine its species diversity. The study was able to identify four species of Halymenia such as H. dilatata, H. maculata, H. durvillaei, and H. formosa. The most abundant species was H. formosa while the least abundant was H. maculata. These seaweed species were exclusively found in Brgy. Bucana, Ternate, Cavite. Its absence in other stations made its abundance, density, relative density, frequency, relative frequency and species diversity very low during the study period. Findings of the study recommended that sampling should be done in a monthly basis all year round in order to better account its distribution in the bay. Its life cycle should be studied in order to understand better its seasonality in distribution and abundance.

Keyterms: *Abundance; distribution; diversity, Halymenia; Manila Bay*

INTRODUCTION

Philippines being dubbed as "Pearl of the Orient Sea" and "Center of the Mega-diversity" contains various species of marine life. Among the diverse organisms found in the Philippines are the seaweeds. As reported by Trono & Ganzon-Fortes (1988), Philippines has more than 390 species of seaweeds with known economic value. Nevertheless, the lack of information on the identities and diversity of economically important seaweeds species is one of the basic problems that prevents the rapid development of the seaweeds resources in the Philippines (Baleta and Nalleb, 2016). Trono (1991) mentioned that lack of information on the kind of species, the amount of biomass available, where they are found, and when they are most profitable to harvest are the most common problems in the development and exploitation of natural stocks of economically important seaweeds species (Baleta and Nalleb, 2016). In fact, literature on the taxonomy, diversity, abundance, and distribution of commercially-important seaweeds in the country is very limited.

One of the genera of macroscopic red algae that grows in the Philippine oceans which has not been enough emphasis in terms of ecological and physiological is *Halymenia*. It belongs to Phylum Rhodophyta, Subphylum Eurhodophytina, Class Florideophyceae, Subclass Rhodymeniophycidae, Order Halymeniales and Family Halymeniaceae. This genus of seaweed is composed of sixty nine species (Guiry, 2015) which are found in various parts of the world. There is also a dearth of literature concerning the physiological and behavioral aspects of this organism.

Halymenia as a seaweed has been known for its great economic importance. The four major species found in the Philippines such as *H. dilatata, H. maculata, H. durvillaei,* and *H. formosa* serve as sources of fatty acids, proteins, minerals, pigments, and polysaccharides which have been used as raw materials for various industrial and commercial products. Among the minerals found in these algal species are Iodine, Copper, Nickel, Cadmium, and Zinc. This seaweed also contains pigments like carotene, chlorophyll a, chlorophyll d, lutein, *r*-phycocyanin, *r*-phycoerythrin, and zeaxanthin. Furthermore, these contain polysaccharides such as sugars, carrageenan, floridean starch, funoran, furcellarin, and galactan (Trono, 1997). Sewall et al. (2011) observed that *Halymenia* contains lamba-carrageenan, a type of carrageenan that does not gel and it is utilized as as a thickening agent for various dairy products. Fenoradosoa et al (2009) reported that *Halymenia durvillei* collected in the coastal waters of small island of Madagascarwas found as a great potential producer of sulphated galactan. In terms of pharmaceutical value, Amorim et al (2011) observed that crude sulfated polysaccharide *Halymenia floresia* possesses anticoagulant properties.

In spite of the discoveries of the significant compounds present in red alga *Halymenia* for industrial and pharmaceutical purposes, very rare studies have been conducted pertaining on its abundance, species diversity, and distribution in the Philippines. As far as literature is concerned only De Smedt et al. (2001) identified *Halymenia* species in the Philippines; however, they did not cover its abundance and distribution. In this context, it is high time to study the species diversity, abundance, and distribution of *Halymenia*in Manila Bay. The present investigation identified and characterized the *Halymenia* species present in the bay, described its abundance, determined its density, relative density, frequency, and relative frequency, and determined its species diversity by employing several diversity indices.

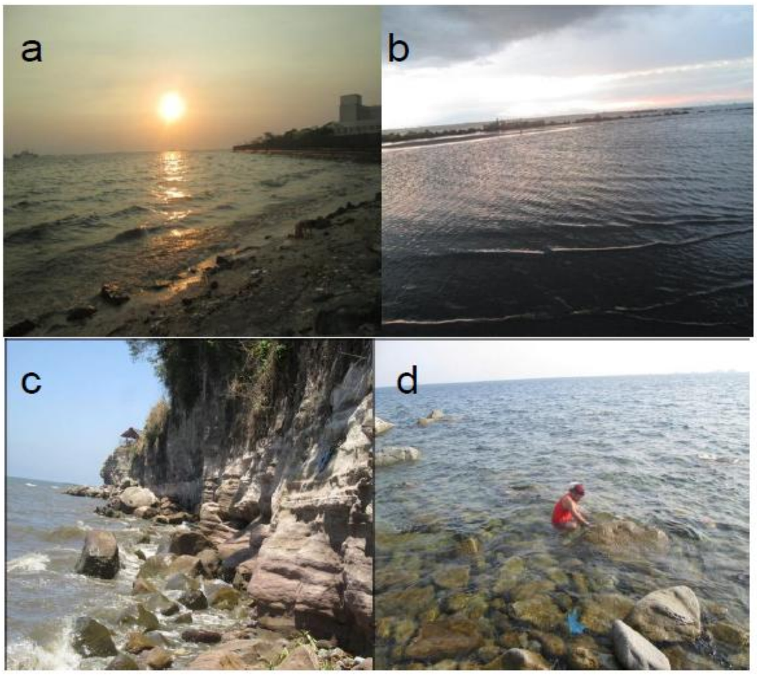

Figure1.*Intertidal zones in Manila Bay, Philippines. a.) Brgy.668, Ermita, Manila; b. Brgy. 8, Cavite City; c.) Brgy.Bucana, Ternate, Cavite; and d.)Brgy.Sisiman, Mariveles, Bataa.*

The findings of the present study will provide baseline data on the abundance, diversity, and distribution of *Halymenia* species in Manila Bay. For the exploration of the potential of the locally available seaweeds in the different islands in the Philippines, academic and research institutions may use this as a baseline information for further algal diversity investigation. The results of this study can also serve as sources of important information to consider in implementing guidelines and policies for coastal resource management and biodiversity conservation. The results may also interest the carrageenan and agar producers to explore *Halymenia* species culture since these have been known as sources of the said compounds.

MATERIALS AND METHODS

Study Area

The study was conducted along the intertidal and sub-tidal zones of Manila Bay, Philippines. The intertidal zone of this marine environment Manila Bay is located in the western part of Luzon island in the Philippines. It is also where the capital city of the aforementioned country is found. Geographically speaking, the bay is bounded by several provinces and cities in few directions: in the north by Bulacan and Pampanga provinces; in the east by Cavite

(Figure 1) is the transition from land to sea. The organisms that live within this zone are exposed to the marine conditions during high tide and to the terrestrial conditions during low tide (Stillman, 2002). Most of the time, the sub-tidal area of this bay has been submerged in water. (Figure 2). During extreme low tides around full moon and new moon events, this zone was exposed briefly to terrestrial condition.

province and Metro Manila, and in the west and northwest by Bataan province (Jacinto, 2006). The substrates in most area of the bay are sandy and rocky; there parts which are muddy and silty (ocular inspection). The bay has an area of 1,994 km^2 (769.9 sq mi), and a coastline length of 190 km (118.1 mi) (Jacinto, 2006).

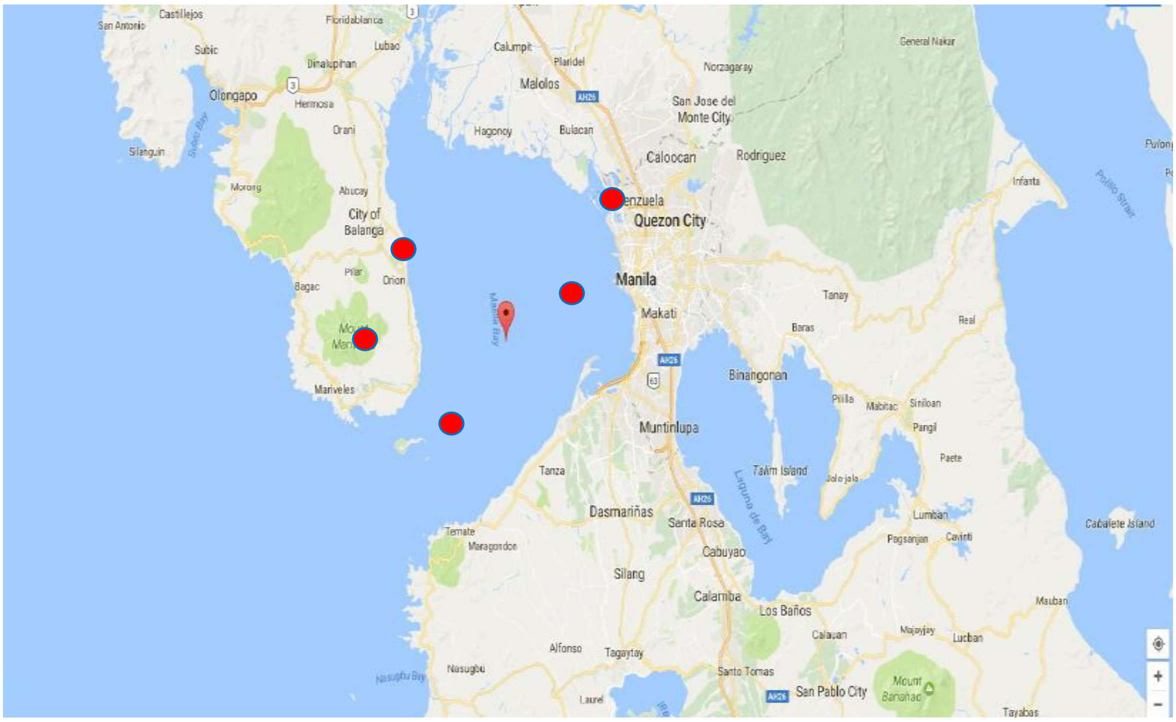

Figure2. *Study area indicating the five sampling sites (**Note:** Map was obtained from https://www.google.com.ph/maps/place/Manila+Bay/@14.5291008,120.4566012,10z/data=!3m1!4b1!4m5!3m4!1s0x33963092fa6e5db9:0x9fcd5f23701e7643!8m2!3d14.5188312!4d120.7579834)*

Table1. *Geographical locations of five sampling sites in Manila Bay, Philippines*

	Sampling areas	***Geographical location*** *Latitude*	*Longitude*
1	Brgy.Sisiman, Mariveles, Bataan	14.42489^0 N	120. 51753^{0}E
2	Brgy.Pag-asa Wawa, Orion, Bataan	14.625554^{0}N	120. 58696^{0}E
3	Brgy.668, Ermita, Manila	14.57505^0 N	120. 97974^{0}E
4	Brgy.8, Cavite City, Cavite	14.46322^0 N	120. 88142^{0}E
5	Brgy.Bucana, Ternate, Cavite	14.28891^0 N	120. 70713^{0}E

From the entire stretch of the bay, fives tations were purposively selected (Fig. 1). These stations include Brgy. Sisiman, Mariveles, Bataan; Brgy.Pag-asa Wawa, Orion, Bataan; Brgy.668, Ermita, Manila; Brgy. 8, Cavite City, Cavite; and Brgy. Bucana, Ternate, Cavite. The geographical location of each sampling site is

given in Table 1.Its exact longitudinal and latitudinal locations were determined using the GPS MAP 78S (GARMIN). The sampling sites in Lubao, Pampanga and Hagonoy, Bulacan were not included because its coastal substrates were silty and muddy in which the target organisms do not usually thrive

Figure3. *Line transect laid in one of the sampling sites*

The line transect method was used to collect, identify, and enumerate the seaweed samples from the intertidal and sub-tidal regions (Fig. 2). For each sampling site, 5 quadrats measuring 10m x 10m were selected. The distance of one quadrat from the next is 30 meters. Two sampling techniques such as purposive sampling and systematic sampling were used for selecting the sampling sites. Purposive sampling was used to select the rocky intertidal and sub-tidal zones. On the other hand, systematic sampling was employed in assigning the quadrats (Fig. 3). From these quadrats, *Halymenia* species were collected, identified, and enumerated. Field work was done from April 13- May 10, 2017.

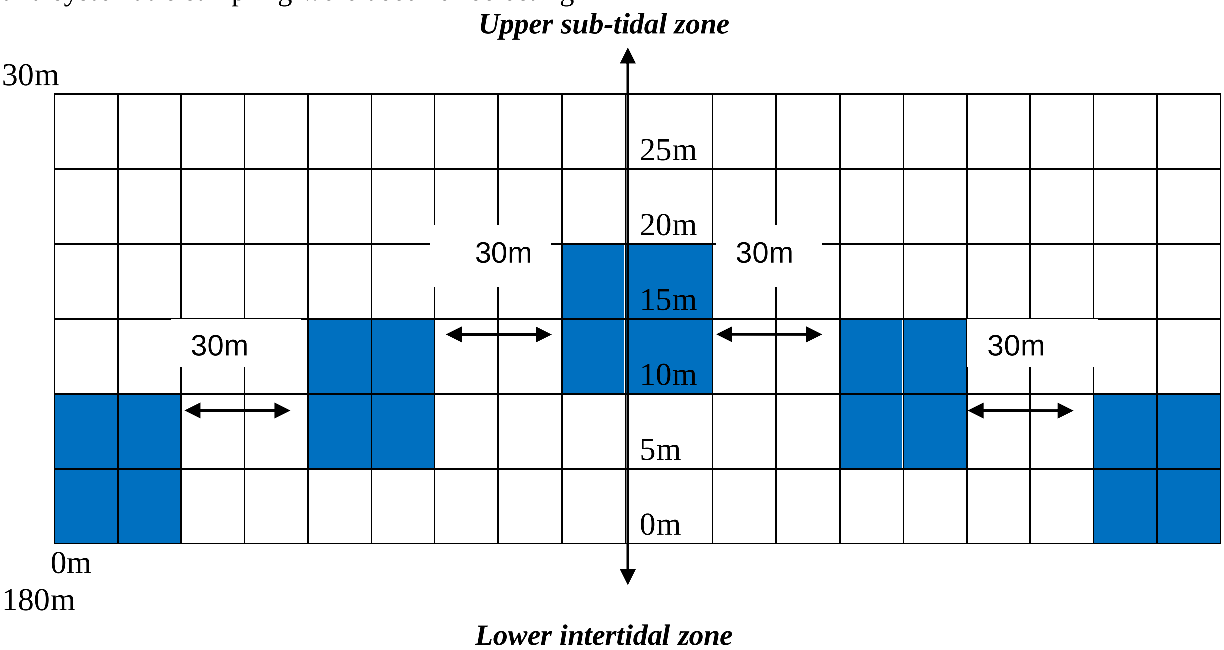

Figure4. *Sampling design of the study*

(Note: This figure was not drawn into scale. This was illustrated for the purpose of showing the quadrats considered for enumeration of the samples.)

Taxonomic Identification

The collected *Halymenia* samples were identified using the keys suggested by De Smedt et al (2001) (Table 2). The distinguishing feature of *H. formosa* was obtained from the description described by Trono Jr. (1997). Photographs were taken for documentation purposes.

Table 2. *Distinguishing characteristics of each species of Halymenia (adopted from De Smedt et al., 2001)*

1.a. Thallus branched, blade surface smooth or with pointed proliferations; or bladelets, not mottled; inner cortex >3 cell layers and >25 µm thick; length of surface cells in cross section of the thallus>8µm; medulla >200µm thick……… ……………………***H. durvillaei***
1.b. Thallus foliose, blade surface smooth or with rounded proliferations or mottled; inner cortex ≤ 3 cell layers and ≤ 25 µm thick; medulla ≤200 µm thick………………………………..………**2**
2.a. Surface cells elongated on cross section (>4x as long as wide); surface mottled, often with proliferations, spines or small bladelets; margin regularly lobed (like jig-saw pieces) or denticulate; thallus stiff, cartilaginous……………….............***H. maculata***
2.b. Surface cells spherical to sub-spherical (<3x as long as wide); surface smooth or with small proliferations; margins smooth or with minute teeth; thallus supple……………**3**
3.a. Margins smooth, sinudoidally undulated; more or less orbiculate……....***H. porphyraeformis***
3.b. Margins smooth or with minute teeth; blade irregular in outline………..…………..***H. dilatata***

Note: *H. formosa* is almost similar to *H. durvillaei* but the frond is finely branched, very bush, measuring 10-20 cm in height. (Adopted from Trono Jr., 1997)

Determination of the Abundance and Distribution

Using the scale recommended by Odum (1955): - Not found; + Rare- more than 1; ++ Few- more than 10 ; +++ Many- more than 20; ++++ Abundant- more than 50; the abundance of species was determined by counting the total population of *Halymenia* species in each station.

The following parameters suggested by Baleta and Nalleb (2016) were determined in order to describe the diversity, richness, and abundance of *Halymenia* species.

Density

This was measured by counting the total number of individuals divided by the total area (Baleta and Nalleb, 2016).

Relative Density

Relative density of a species was measured by counting the number of one kind of species and comparing these species against the total number of different species (Baleta and Nalleb, 2016).

Frequency

Frequency was measured by counting the number of quadrates that contains individuals of a species (Baleta and Nalleb, 2016).

Relative Frequency

This was measured by counting the frequency of one species expressed as a percentage of the sum of frequency values for all species present (Baleta and Nalleb 2016).

Simpson's Index (D)

This parameter measures the probability that two individuals randomly selected from a sample will belong to the same species (Baleta and Nalleb, 2016). With this index, 0 represents infinite diversity and 1, no diversity. That is the bigger the value of D, the lower the diversity (Simpson 1949). This index was computed by using the formula as indicated below:

$$D = \frac{\Sigma n (n-1)}{N (N-1)}$$

Where: n = the total number of organisms of a particular species

N = the total number of organisms of all species.

Simpson's Index of Diversity (1-D)

This refers to the value ranging between 0 and 1; the greater the value, the greater the sample diversity (Baleta and Nalleb, 2016).

Simpson's Reciprocal Index (1/D)

The value of this Index starts with 1 as the lowest possible figure. This figure would represent a community containing only one species. The higher the value, the greater the diversity. The maximum value is the number of species in the study area (Simpson, 1949).

RESULTS

The current study was able to identify four species of *Halymenia* in Manila Bay (Table2). These species include *H. dilatata, H. maculata, H. durvillaei*, and *H. formosa.*

Table 2.*Summary of identified Halymenia species in Manila Bay, Philippines*

Division	Class	Order	Family	Scientific Name
Rhodophyta	Florideophyceae	Halymeniales	Halymeniaceae	*Halymenia dilatata*
				Halymenia maculata
				Halymenia durvillaei
				Halymenia formosa

Table 3.*Morphological-anatomical descriptions of Halymenia species found in Manila Bay, Philippines*

Halymenia species	Morphological-anatomical Characteristics	Illustration
Halymeniadilatata Zanardini	Thalli have delicate blades. These appeared as purplish red with shades of green, gelatinous-membranous, 10-15 cm tall, attached by means of small scutate disc. This seaweed is sessile or shortly stipitate; when stipitate the stipe is robust; with a large transversely expanded blade broadly oblong, undulate-curled, simple or lobed; base mostly reniform; margin entire, crenulate, subdentate-sinuose or fimbricate with ligulate lobules.	 *Halymenia dilatata* in Brgy.Bucana, Ternate, Cavite
Halymeniamaculate J. Agardh	Thalli are foliose, membranous, purplish to greenish, arising from a scutate holdfast with a short stalk. Segments are irregularly proliferuous with narrow stalks arising from margin of initial basal blades; branching may be sub-dichotomous especially at the distal portion of the blade. The blade margin is entire, sometimes with irregularly shaped proliferations.	 *Halymenia maculata* in Brgy.Bucana, Ternate, Cavite
*Halymeniadurvillaei*Bory de Saint-Vincent	The ultimate branchlets are slender and linear with acuminate tips, sometimes furcipate. The margins of the fronds are serrate. Surfaces of the axis are beset with few spine-like projections.	 *Halymenia durvillaei* Brgy.Bucana, Ternate, Cavite
Halymenia formosa Harvey ex Kutzing	This seaweed is almost similar to H. durvillae but the fronds are finely branched and very bushy measuring 10-20 cm high.	 *Halymenia Formosa* in Brgy.Bucana, Ternate, Cavite

Note: *Descriptions were adopted from Trono, (1997).*

The four species observed in Manila Bay from April13-May 10, 2017 are given in Table 3. These are described according to its morphological and anatomical characteristics. The actual illustrations were taken in the intertidal zone of the sampling site where the organisms were seen.

Table 4 depicts the abundance and distribution of *Halymenia* in Manila Bay, Philippines. Findings of the study showed that four species were only found in station 5 (Brgy. Bucana, Ternate, Cavite). These organisms were not observed in other stations (Brgy. Sisiman, Mariveles, Bataan; Brgy. Pag-asa Wawa, Orion, Bataan; Brgy.668, Ermita, Manila, and Brgy.8, Cavite City, Cavite in the course of data gathering. During the sampling period, *Halymenia dilatata (10 individuals) and Halymenia maculata (9 individuals)* were found to be rare. Few species of *Halymenia durvillaei* (12 individuals) and *Halymenia formosa* (17 individuals) were found in the study area (Brgy. Bucana, Ternate, Cavite).

The density, relative density, frequency, and relative frequency of four species of *Halymenia* found in Manila Bay, Philippines are indicated in table 5. The density of *H. dilatata*, *H. maculata*, *H. durvillaei*, and *H. formosa* were 0.0040, 0.0036, 0.0048, and 0.0068 individual per m^2 ; respectively. The relative density of every species was as follows: 0.2083 for *H. dilatata*; 0.1875 for *H. maculata*, 0.2500 for *H. durvillaei* and 0.3542 for *H. formosa*. Findings also showed that *H. dilatata* appeared in 4 quadrats while *H. maculata*, *H. durvillaei*, and *H. formosa* existed in 5 quadrats. It was also depicted in the results that *H. dilatata* had a relative frequency of 16 while *H. maculata*, *H. durvillaei*, and *H. formosa* had a relative density of 5; respectively.

Table 4. Abundance and distribution of Halymenia in Manila Bay, Philippines

Halymenia	*Station*				
species	1	2	3	4	5
H. dilatata	-	-	-	-	+
H. maculata	-	-	-	-	+
H. durvillaei	-	-	-	-	++
H. formosa	-	-	-	-	++

Legend: - *not found; + rare (more than one); ++ (few) more than ten; +++ (many) more than twenty; ++++ abundant (more than fifty) adopted from Odum (1955)*

Table 5. *Density, relative density, frequency, and relative frequency of Halymenia in Manila Bay, Philippines*

Species composition	Density ($n/2500\ m^2$)	Relative density (d/Dx100)	Total frequency	Total relativeFrequency(f/Fx100)
H. dilatata	0.0040	0.2083	*4*	16.00
H. maculata	0.0036	0.1875	*5*	20.00
H. durvillaei	0.0048	0. 2500	*5*	20.00
H. formosa	0.0068	0.3542	*5*	20.00
Total	0.0192	100.00	*19*	76.00

Table 6 shows the diversity *Halymenia* species in Manila Bay, Philippines. Results of the investigation revealed that stations 1, 2, 3, and 4 had a D value of 1 while station 5 had a D value of 0.251. The mean D value for the entire Manila Bay was 0.85. The Simpson's index of diversity value for station 5 was 0.749 while the rest of the stations had 1-D value of 0.749. The mean Simpson's index of diversity value for the entire area was 0.15. Moreover, findings showed that Simpson's reciprocal index value for all stations was 1 except for station 5 which was 3.984. The mean 1/D value for the entire study area was 1.597.

DISCUSSION

Seaweeds are mostly distributed in the lower intertidal to the shallow subtidal zones in the marine environment wherein light energy is very much available. Generally, the large forms are mainly observed in areas at, or a few meters below the 0 datum level (Baleta and Nalleb, 2016). The adaptability of the seaweeds to the ambient conditions in the habitats reflects the differences in its vertical and horizontal distribution. Because of its location in the ocean, seaweeds are very important components of the marine environment. These serve as primary producers in the coastal communities because these organisms are capable of performing the process of photosynthesis through the aid of light. Many of these species play significant roles in the ecological processes of the seas. Its interaction with other marine organisms makes ocean ecosystem a dynamic one.

Table 6. *Diversity of Halymenia species in Manila Bay, Philippines*

Diversity parameters	Station1	Station2	Station3	Station4	Station5	Mean
Simpson's index (D)	1	1	1	1	0.251	0.850

Simpson's index of diversity (1-D)	0	0	0	0	0.749	0.150
Simpson's reciprocal index(1/D)	1	1	1	1	3.984	1.597

In the Philippines, including many species of Cyanophyta, Trono (1999) reported that there are about 820 species of marine macrobenthic algae. Among the species, Rhodophyta comprise the bulk which is 57.6%, followed by Chlorophyta which is 26.1%, and lastly by Phaeophyta which is 16.3% (Trono, 1999). Most of these seaweeds in the Philippines have great economic importance. These have used as food items, sources of industrial products like bioactive and nutritional natural products, growth promoting substances, and polysaccharides (Trono, 1999). Hurtado et al. (2013) reported that an abundance of marine algae along the Philippines' long, irregular coastline (36,289 km) has made it inevitable for Filipinos to exploit algae for food, feeds, medicine, or other purposes. In terms of medicinal application, Fantonalgo (2017) explored the potential hypoglycemic and laxative activities of *Sargassum* species. For fertilizer production, Fantonalgo and Salubre (2017) utilized *Sargassum* species as substrate for production.

Due to the popularity of the economic value of seaweeds, the effects of climate change in the marine environment, deteriorating water quality of some marine habitats, and the outbreak of some diseases to marine organisms, biodiversity studies of the seaweeds captured the interest of the marine scientists in most recent times. For instance, Baleta and Nalleb (2016) determined the species composition, abundance and diversity of seaweeds found along the intertidal zone of Nangaramoan, San Vicente, Sta. Ana, Cagayan. They were able to identify 31 different species of seaweeds in the study area belonging Rhodophyta (Galaxauraceae, Gelidiellaceae, Corallinaceae, Gracilariaceae, Solieriaceae, Lomentariceae, Rhodomelaceae, Rhodymeniaceae),Phaeophyta (Dictyotaceae, Cystoseiraceae, Scytosiphonaceae, Sargassaceae) and Chlorophyta (Ulvaceae, Anadyomenaceae, Siphonocladaceae, Caulerpaceae, Halimedaceae, Dasycladaceae).

Camaya et al. (2014) did three comprehensive studies in 1994, 2004 and 2010 on the seaweed community in San Miguel Island, Lagonoy Gulf, Philippines. They observed twenty three (23) species of seaweeds in 1994, five (5) species in 2004, and (11) species in 2010. Two previous investigations did not focus much on the distribution and abundance of *Halymenia* species.

In view of the shortage of literature on the abundance, diversity, and distribution of the seaweeds in Manila Bay, this present study was put into realization. Findings indicated that this bay contains four species of *Halymenia* which include *H. dilatata, H. maculata, H. durvillaei,* and *H. formosa*. Among the species observed, *H. formosa* was the most abundant while *H. maculata* was the least abundant. These seaweeds grow attached to rocky substrates in the lower intertidal area or in upper sub-tidal zone exposed to moderate water movement. The findings of this study are supported by the reports of Trono (1997); in which, these four species of *Halymenia* are mainly found in the Philippines. De Smedt et al. (2001) also identified four species of *Halymenia* in the Phillippines however they did not find *H. formasa*. The four species recognized were *H. dilatata*, *H. durvillei*, *H. maculata*, and *H. porphyraeformis*. In this investigation, they did not mention the places where they specifically acquired their specimens.

During the study period (April 13-May 10, 2017), *Halymenia* species were poorly distributed in Manila Bay. The organisms were solely found in station 5 (Brgy. Bucana, Ternate, Cavite). It is not surprising that these species were not found in two stations in Bataan because these seaweeds are expected to appear during the month of October (Trono, 1997). Even though all sampling sites considered in the current study were the intertidal and subtidal zones with rocky substrates; yet, it did not guarantee the existence of *Halymenia* in most areas of the study site. For sure in natural habitats, nature of the substrates is not only the factor that determines the distribution, abundance and diversity of the seaweeds. In the case of *Halymenia*, some important physical and chemical factors such as pH, temperature, salinity, dissolved oxygen, nutrients, and turbidity perhaps potentially affected its distribution and abundance, although these parameters were not directly determined in this current study. These parameters are very dynamic. These have been changing every now and then due to natural and anthropogenic causes. Possibly, the water quality of this bay has been deteriorating since this has become a site for rapid urbanization.

Absence of *Halymenia* in four sampling stations (Brgy. Sisiman, Mariveles, Bataan, Brgy. Pag-asa Wawa, Orion, Bataan, Brgy. 668, Ermita, Manila, and Brgy. 8, Cavite City, Cavite) resulted to very low total density, total relative density, total frequency, total relative frequency of and total diversity of *Halymenia* in Manila Bay. Very high mean Simpson's index (D) value (0.85) and very low Simpson's index of diversity (1-D) value (0.15) are manifestations that the diversity of *Halymenia* in Manila Bay was very low.

The nature and the condition of the environment itself determine the distribution of the seaweeds (Luning, 1990). Generally speaking, it is a rule of thumb that everything is found everywhere but the environment selects. In tropical setting, the ecological factors which influence the biology of the seaweeds can be categorized as primary or secondary (Doty 1946 as cited in Baleta and Nalleb, 2016). Major phenomena such as monsoons and tides, observable as large- scale changes in earth's surface, exerting its effect on considerably large areas and affecting a number of the requirements of the seaweeds serve as the primary factors (Baleta and Nalleb, 2016). On the other hand, environmental factors such as temperature, light, turbidity, salinity and grazing are considered as secondary factors (Baleta and Nalleb, 2016). The effects of these factors to the organismal abundance and distribution are more limited and specific because these are generally subjected to the fluctuations with the primary factors. In the natural environment, the effects of the secondary factors are known to be interactive; thereby its effects cannot be isolated from one another. In the context of multidimensional niche of the species, Ganzon-Fortes (1991) reported that the growth of the seaweeds is the outcome of the synergistic or antagonistic interaction of the several factors acting together.

Conclusions

The present investigation in Manila Bay was able to identify four species of *Halymenia* such as *H. dilatata, H. maculata, H. durvillaei,* and *H. formosa*. Among the species identified, the most abundant species was *H. formosa* while the least abundant was *H. maculata*. These seaweed species were exclusively found in Brgy. Bucana, Ternate, Cavite; not in other four stations. Its absence in other stations made its abundance, density, relative density, frequency, relative frequency and species diversity very low during the study period as indicated by the results of the indices. Therefore, it can be inferred that the species of *Halymenia* was poorly distributed in the intertidal and subtidal zones of Manila Bay, Philippines.

Recommendations

From the significant findings of the current study, it is highly recommended indeed, that sampling will be done in a monthly basis all year round in order to better account the distribution of *Halymenia* species in Manila Bay. The life cycle of the said species should be studied both in the laboratory and in the field in order to understand its seasonality in distribution and abundance. Furthermore, more sampling stations will be considered in the future studies. Regular monitoring of the physico-chemical parameters of coastal waters should be done so that its potential effects to the distribution and abundance of *Halymenia* can be determined.

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