Asian Journal of Fisheries and Aquatic Research

Volume 26, Issue 3, Page 107-123, 2024; Article no.AJFAR.114973
ISSN: 2582-3760

Inventory of Seaweeds in Selected Municipalities in the Balicuatro Area of the Province of Northern Samar, Philippines

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2024/v26i3750

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/114973

Original Research Article

Received: 25/01/2024
Accepted: 27/03/2024
Published: 30/03/2024

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ABSTRACT

Seaweeds or marine macroalgae is one of the marine resources that are understudied in the province of Northern Samar, the province have twenty-four (24) municipalities and twenty (20) of them have coastal zone which is ideal for marine researches as well as for aquaculture. This study is focused on the present seaweeds in the three (3) selected municipalities in Balicuatro area in the province of Northern Samar. A total of ninety-four (94) taxa were collected/ found in the three (3) sampling sites. Lavezares got the greatest number of seaweeds with sixty (60) taxa, followed by Biri with fourty-four (44), and the least was in Allen with thirty-four (34) species. Chlorophyta have thirty-nine (39) species which constitute for 39.36% of the total identified seaweeds, followed by thirty-four (34) red seaweeds (36.17%), and, lastly, Brown macroalgae with only twenty-three (23) species which accounts for 24.47%. The most common marine macroalgae in all sampling sites were: Hormophysa cuneiformis which was found in ten (10) sampling sites, followed by Halimeda macroloba, Ulva reticulata, and Sargassum oligocystum which were found in ten (10) sampling sites. In terms of environmental parameters, temperature and salinity of all sampling sites were tested to be within the normal range during the collection period based on established threshold limit. However, in terms of pH, it was detected that two (2) barangays/ sampling sites in Lavezares, namely: Balicuatro and San Juan which only had 7.2 and 7.4 which is below the threshold limit range of seawater pH which is 7.5-8.5. In terms of substrate, rocky substrate is common to all sampling sites which indicates that hard substratum is preferable for the growth, adaptation, and survival of seaweeds.

Keywords: Chlorophyta; phaeophyta; rhodophyta; taxa; environmental parameters.

1. INTRODUCTION

The province of Northern Samar is divided into three areas, namely: Balicuatro, Central, and Pacific area [1]. The coastal marine water of the province is enriched by the nutrients coming from the land and it is also characterized by just the right amount of rain and a warm tropical climate. The intertidal/ shallow water are well were crafted with developed reef that supports the diverse marine flora and fauna, among these intricate floras in the coastal environment are the mangal community, seagrasses, and seaweeds [2].

In general, the Philippines have 1,065 species of seaweeds [3]. Those numbers are broadly grouped based on their nutrient and chemical composition into Chlorophyta (Green algae), Phaeophyta (Brown algae), and Rhodophyta (Red algae). The study of seaweeds in the country began in the 1960's when Filipino phycologists participated in the world's discovery of algae and algal researches, specifically in the field of seaweed taxonomy [4]. It is during 1960's when Menez studied Philippine marine macroalgae in Hundred Islands Menez, [5], Baldia et al*.,* [4]. it was followed by Cordero which brought significant contributions in red algae (Cordero, [6], Baldia et al*.,* [4], and Trono on the marine benthic macroalgae Trono, [7], Baldia et al*.* [4].

At present, there were few published papers and information on the available marine macroalgae in Northern Samar. Out of 24 municipalities in the province, twenty (20) municipalities have shorelines and coastal zones making the province a good place to study seaweeds and since two (2) of the island municipalities are still unexplored when it comes to its seaweed resource. Most recent studies on seaweeds conducted in the province were carried by Baldia et al [4] by which they focused on the diversity assessment of marine macroalgae in Biri and Dalupirit Island and Galenzoga [8] on the present seaweed resource in Biri Island.

Even though seaweeds are primary plants that do not bear flowers, roots, stems, and leaves they are considered as an important food source commodity and income in the Philippines [9]. In another study, the carrageenan extract from seaweeds is also used a precursor in the development of antibacterial biofilms that could be used as an alternative to commercially available biofilms [10,11]. In 2014, Northern Samar ranked 3rd when it comes to seaweed production in Region VIII which accounts for about 353.86 metric tons from 20.3 hectares of seaweed area/ farm in the province [12]. Recently, there are current trends on seaweed as a valuable source of bioactive compounds, polysaccharides, antioxidants, minerals, and essential nutrients such as fatty acids, amino acids, and vitamins that could be used as a functional ingredient [13]. These compounds gave seaweeds a higher value in the individual diet as a food component and as pharmaceutical supplements (Namvar et al., 2013; Choudhary et al. [14].

Therefore, it is the purpose of this research to contribute to the initial information on the present species composition of seaweeds in some areas in Northern Samar. Furthermore, the result of this study will add to the existing information on seaweeds in the Philippines.

2. MATERIALS AND METHODS

2.1 Study Site

This study was conducted in three (3) municipalities in the Balicuatro area of Northern Samar, namely: Allen, Lavezares, and Biri. There were a total of eleven (11) coastal barangays that served as sites for the collection of seaweeds.

Northern Samar is situated in the Eastern Visayas region occupying the eastern section of the Visayas. The province is bordered, clockwise from the North, by the Philippine Sea, Eastern Samar, Samar Sea, and San Bernardino Strait.

2.2 Data Gathering Procedure

In every sampling site, 50-100 meter transect line were laid down perpendicular to the rock shore. Random sampling technique were employed during the sampling wherein all of the seaweeds found along the 50-100 meter intertidal zone were collected and identified. All of the seaweeds collected were placed in a ziplock and brought to the laboratory for proper identification of samples.

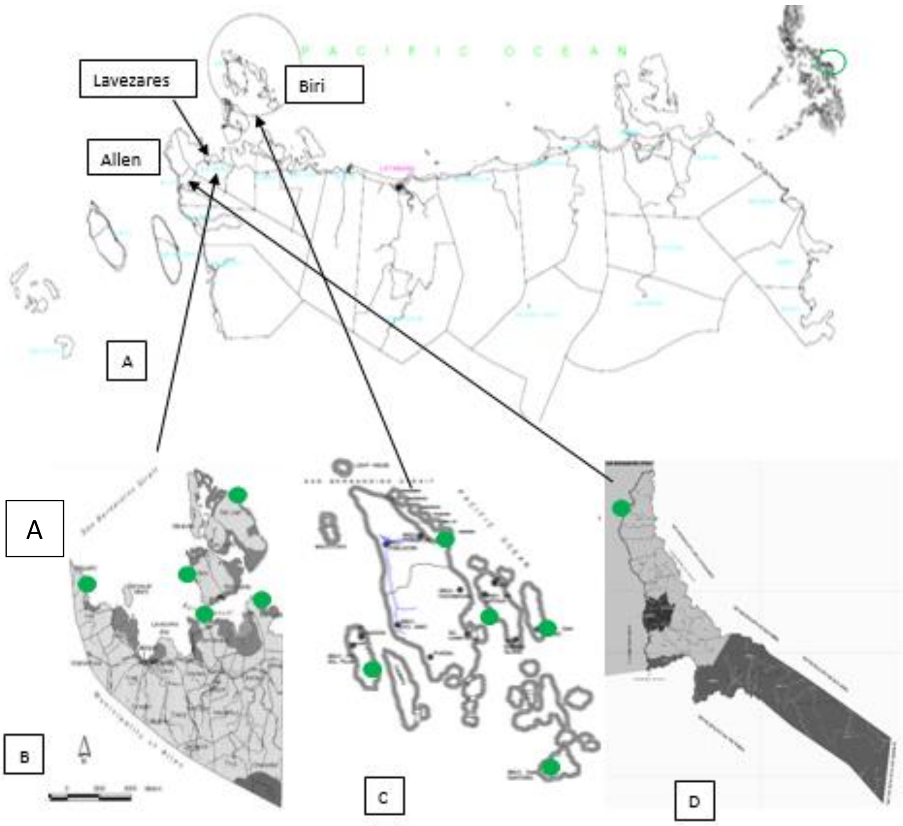

Fig. 1. The map of the sampling sites. A). Map of Northern Samar highlighting the three (3) municipalities in Balicuatro District; B). Map of Lavezares pinpointing the collection sites/ barangays, namely: Balicuatro, Barobaybay, Bani, San Agustin, and San Juan; C). Map of Biri pinpointing the collection sites/barangays, namely: Pio del Pilar, Progress, Mc Arthur, San Pedro, and San Antonio; and D). Map of Allen pinpointing the collection site/ barangay of Guinarawayan. *Maps were taken from the municipal offices of Allen, Biri, and Lavezares.* Northern Samar

2.3 Identification and Authentication of Samples

Some of the seaweeds were identified *in situ* based on morphological criteria. Phenotypic characteristics of the samples were determined and examined using available literature (Dumilag, [9], Dumilag and Javier, [9], Sherwood and Guiry, [15] to identify samples down to species level. The books of Calumpong [16] and Trono [2] were also used for identification and authentication.

2.4 Preservation of Samples

A portion or whole part of the seaweed samples were placed in a plant press which served as voucher specimens. All samples prior to pressing were washed in a running water to rinsed-off the epiphytes, dirt, and other organisms attached to the seaweed sample. Samples with bulky thalli were soaked in rock salt for a few days to dehydrate and facilitate proper drying. After washing, the seaweed samples were then placed in a neat newspaper and a piece of fabric/ cheesecloth was then placed above the samples to prevent it from sticking to the newspaper.

2.5 Determination of Environmental Parameters

Prevailing environmental parameters that characterize the study area were determined during the sampling to the sites, these includes pH, temperature, salinity, and substrate. A water sample was collected at every site and placed in an ice box with ice for its transportation to the College of Science. Bante 900-UK Multiparameter Water Quality Meter was used to determine the pH, temperature, and salinity, while ocular inspection to the sites were conducted regarding the substrate type of the intertidal zone.

3. RESULTS

3.1 Species Composition of Seaweeds

There were a total of ninety-four (94) species of seaweeds identified in three (3) municipalities in the Balicuatro area of Northern Samar. As shown in Table 1, all of the collected samples were represented by the three (3) classes of seaweeds/ macroalgae, namely: Chlorophyta (green algae/ seaweeds), Phaeophyta (brown algae/ seaweeds), and Rhodophyta (Red algae/ seaweeds). Green algae constitute for about thirty-nine (39) (39.36%) out of 94 collected seaweed species, followed by Red algae with thirty-four (34) (36.17%) species, and Brown algae with twenty-three (23) species which accounts for 24.47%.

The most represented genera is *Caulerpa* in green algae with seven (7) species, while *Sargassum* is the most represented genera in brown algae which accounts for eight (8) species of seaweeds, and *Laurencia* is the most represented genera in red algae. Also, in terms of most genera, red algae have a diversified number of twenty-six (26) genera as compared to green algae with seventeen (17) genera, and brown algae with only eight (8) genera.

Table 1. List of Seaweeds in the three municipalities in Balicuatro Area, Northern Samar

Class	Species
	Family Anadyomenaceae
	Anadyomene plicata C. Agardh
	Family Caulerpaceae
	Caulerpa brachypus Harvey
	Caulerpa cupressoides (Vahl) C. Agardh
	Caulerpa lentillifera J. Agardh
	Caulerpa racemosa var. *macrophysa* (Sonder ex Kützing) W.R. Taylor
	Caulerpa racemosa (Forsskål)
	Caulerpa serrulata (Forsskål) J. Agardh
	Caulerpa taxifolia (Vahl) C. Agardh
	Family Cladophoraceae
	Chaetomorpha crassa (C. Agardh) Kutzing
	Family Codiaceae
	Codium geppii O.C. Schmidt
	Codium intricatum Okamura
	Codium vermilara (Olivi) Delle Chiaje

Class	Species
	Family Dasycladaceae
	Bornetella oligospora Solms-Laubach
	Bornetella sphaerica (Zanardini) Solms-Laubach
Chlorophyta (37) 39.36%	*Cymopolia vanbosseae* Solms- Laubach
	Halicoryne wrightii Harvey
	Neomeris annulata Dickie
	Family Dichotomosiphonaceae
	Avrainvillea erecta (Berkeley) A. Gepp & E. Gepp
	Family Halimedaceae
	Halimeda macroloba Decaisne
	Halimeda macrophysa Askenasy
	Halimeda opuntia (Linnaeus) Lamouroux
	Halimeda tuna (Ellis and Solander) Lamouroux
	Halimeda velasquezii W.R. Taylor
	Family Polyphysaceae
	Acetabularia dentata Solms-Laubach
	Acetabularia major Martens
	Family Siphonocladaceae
	Boergesenia forbesii (Harvey) J. Feldmann
	Boodlea composita (Harvey) Brand
	Family Udoteaceae
	Chlorodesmis fastigiata (C. Agardh) Ducker
	Family Ulvaceae
	Ulva australis Areschoug
	Ulva clathrata (Roth)
	Ulva flexuosa Wulfen
	Ulva intestinalis Linnaeus
	Ulva lactuca Linnaeus
	Ulva reticulata Forsskål
	Family Valoniaceae
	Dictyosphaeria cavernosa (Forsskål) Borgesen
	Dictyosphaeria versluysii Weber-van Bosse
	Valonia fastiagata Harvey ex J. Agardh
	Family Dictyotaceae
	Canistrocarpus cervicornis (Kutzing) De Paula and De Clerk
	Dictyota dichotoma (Hudson) Lamouroux
	Dictyota mertensii (Martius) Kutzing
	Padina australis
	Padina gymnospora (Kützing) Sonder
	Padina minor Yamada
	Padina tetrastromatica Hauck
Phaeophyta (23) 24.47%	**Family Sargassaceae**
	Hormophysa cuneiformis (J.F, Gmelin) P.C. Sliva
	Sargassum aquifolium (Turner) C. Agardh
	Sargassum cinctum (J. Agardh)
	Sargassum cristaefolium C.A. Agardh
	Sargassum feldmanii Pham-Hoang
	Sargassum gracillimum Reinbold
	Sargassum hemiphyllum (Turner) C. Agardh
	Sargassum oligocystum Montagne
	Sargassum polyscystum C.A. Agardh
	Sargassum siliquosum J. Agardh
	Turbinaria conoides (J. Agardh) Kützing
	Turbinaria decurrens Bory de Saint-Vincent
	Turbinaria luzonensis Taylor

Class	Species
	Turbinaria ornata (Turner) J. Agardh
	Family Scytosiphonaceae *Colpomenia sinousa* (Mertens ex Roth) Derbs and Solier *Hydroclathrus clathratus* (C.Agardh) Howe
Rhodophyta (34) 36.17%	**Family Bangiaceae** *Trichogloea requienii* (Montagne) Kützing
	Family Champiaceae *Coelothrix irregularis* (Harvey) Borgessen
	Family Corallinaceae *Amphiroa foliacea* *Amphiroa fragilissima* (Linnaeus) Lamouroux *Mastophora rosea* (C. Agardh) Setchell *Jania adhaerens* J.V. Lamouroux
	Family Cryptonemiaceae *Halymenia durvillei* Bory de Saint-Vincent
	Family Cystocloniaceae *Hypnea cervicornis* J. Agardh
	Family Delesseriaceae *Caloglossa cf. beccarii* (Zanardini) De Toni
	Family Galaxauraceae *Actinotrichia fragilis* (Forsskål) Borgesen *Dichotomaria 112piculate* Kjellman *Scinaia hormoides* Setchell *Tricleocarpa fragilis* (Linnaeus) Huisman & R.A.
	Family Gelidiaceae *Gelidiella acerosa* (Forsskål) Feldmann and Hamel
	Family Gracilariaceae *Gelidiopsis intricata* (C. Agardh) *Gracilaria arcuata* Zanardini *Gracilaria salicornia* (C. Agardh) Dawson *Gracilaria textorii* (Suringar) De Toni *Hydropuntia edulis* (S.G. Gmelin) Gurgel & Fredericq
	Family Liagoraceae *Ganonema farinosum* (J.V. Lamouroux) K.C. Fan & Y.C. Wang *Liagora ceranoides* J.V. Lamouroux
	Family Kallymeniaceae *Euthora cristata* (C. Agardh) J. Agardh
	Family Peyssonneliaceae *Grateloupia filicina* (Lamouroux) C. Agardh
	Family Rhizophyllidaceae *Portieria hornemannii* (Lyngbye) P.C. Silva
	Family Rhodomelaceae *Acanthopora muscoides* (Linnaeus) Bory-de Saint-Vincent *Acanthopora spicifera* (Vahl) Borgesen *Laurencia cartilaginea* Yamada *Laurencia nidifica* J. Agardh *Laurencia papillosa* (C. Agardh) Greville *Laurencia tronoi* Ganzon-Fortes *Ohelopapa flexilis* (Setchell) F. Rousseau, Martin-Lescanne, Payri & Le Gall
	Family Solieraceae *Betaphycus philippinensis* Doty *Eucheuma denticulatum* (N.L.Burman) Collins and Hervey *Kappaphycus striatus* (F. Schmitz) L.M. Liao

The municipality with the most number of seaweeds collected was in Lavezares with sixty (60) species as shown in Table 2, followed by Biri with forty-four (44) collected seaweeds species, and Allen with thirty-four (34) collected seaweeds. Among all the barangay sampled, the most numerous was in Barangay Pio del Pilar, Biri with thirty-six collected seaweeds while the least was Barangay Balicuatro, Lavezares with only twelve seaweeds collected.

Table 2. Species composition of Seaweeds in Allen, Biri, and Lavezares, Northern Samar

Class	Species	Sampling Sites										
		Biri (44)					Lavezares (60)					Allen (34)
		1	2	3	4	5	6	7	8	9	10	11
Chlorophyta	**Family Anadyomenaceae**											
	Anadyomene plicata C. Agardh				/	/					/	
	Family Caulerpaceae											
	Caulerpa brachypus Harvey					/						
	Caulerpa cupressoides (Vahl) C. Agardh							/				
	Caulerpa lentillifera J. Agardh							/	/			
	Caulerpa racemosa var. *macrophysa* (Sonder ex Kützing) W.R. Taylor									/		
	Caulerpa racemosa (Forsskål)	/	/		/						/	/
	Caulerpa serrulata (Forsskål) J. Agardh	/	/		/				/		/	
	Caulerpa taxifolia (Vahl) C. Agardh	/	/									
	Family Cladophoraceae											
	Chaetomorpha crassa (C. Agardh) Kutzing	/	/	/	/	/						
	Family Codiaceae											
	Codium geppii O.C. Schmidt							/		/		
	Codium intricatum Okamura										/	/
	Codium vermilara (Olivi) Delle Chiaje								/			
	Family Dasycladaceae											
	Bornetella oligospora Solms-Laubach							/	/		/	
	Bornetella sphaerica (Zanardini) Solms-Laubach	/	/			/		/		/	/	
	Cymopolia vanbosseae Solms-Laubach									/		
	Halicoryne wrightii Harvey					/		/			/	
	Neomeris 113nnulate Dickie								/		/	
	Family Dichotomosiphonaceae											
	Avrainvillea erecta (Berkeley) A. Gepp & E. Gepp	/										
	Family Halimedaceae											
	Halimeda macroloba Decaisne	/	/	/	/	/		/	/		/	/
	Halimeda macrophysa Askenasy										/	
	Halimeda opuntia (Linnaeus) Lamouroux	/	/	/	/	/		/	/		/	
	Halimeda tuna (Ellis and Solander) Lamouroux							/	/			
	Halimeda velasquezii W.R. Taylor							/				/
	Family Polyphysaceae											
	Acetabularia dentata Solms-Laubach											/

Class	Species	Sampling Sites										
		Biri (44)					Lavezares (60)					Allen (34)
		1	2	3	4	5	6	7	8	9	10	11
	Acetabularia major Martens									/		
	Family Siphonocladaceae											
	Boergesenia forbesii (Harvey) J. Feldmann	/	/			/	/				/	/
	Boodlea composita (Harvey) Brand							/		/		/
	Family Udoteaceae											
	Chlorodesmis fastigiata (C. Agardh) Ducker							/	/		/	/
	Family Ulvaceae											
	Ulva australis Areschoug							/				
	Ulva clathrata (Roth)	/	/									
	Ulva flexuosa Wulfen											/
	Ulva intestinalis Linnaeus		/		/					/	/	
	Ulva lactuca Linnaeus	/	/	/	/	/	/	/		/		/
	Ulva reticulata Forsskål	/	/	/	/	/		/		/	/	/
	Family Valoniaceae											
	Dictyosphaeria cavernosa (Forsskål) Borgesen											/
	Dictyosphaeria versluysii Weber-van Bosse		/			/			/	/		/
	Valonia fastiagata Harvey ex J. Agardh											/
	Family Dictyotaceae											
	Canistrocarpus cervicornis (Kutzing) De Paula and De Clerk	/	/		/	/		/		/		
	Dictyota dichotoma (Hudson) Lamouroux		/					/	/	/		/
	Dictyota mertensii (Martius) Kutzing										/	
	Padina australis											/
Phaeophyta	*Padina gymnospora* (Kützing) Sonder	/	/	/		/						
	Padina minor Yamada	/	/	/	/	/	/	/	/		/	
	Padina tetrastromatica Hauck									/		
	Family Sargassaceae											
	Hormophysa cuneiformis (J.F, Gmelin) P.C. Sliva	/	/	/	/	/		/	/	/	/	/
	Sargassum aquifolium (Turner) C. Agardh		/		/	/						
	Sargassum cinctum (J. Agardh)	/	/		/	/						
	Sargassum cristaefolium C.A. Agardh							/			/	
	Sargassum feldmanii Pham-Hoang											/
	Sargassum gracillimum Reinbold		/			/						
	Sargassum hemiphyllum (Turner) C. Agardh	/	/									
	Sargassum oligocystum Montagne	/	/	/	/	/	/		/	/	/	
	Sargassum polyscystum C.A. Agardh	/	/	/			/	/	/	/		/
	Sargassum siliquosum J. Agardh	/	/			/						
	Turbinaria conoides (J. Agardh) Kützing	/	/	/	/	/						

Class	Species	Sampling Sites										
		Biri (44)					Lavezares (60)					Allen (34)
		1	2	3	4	5	6	7	8	9	10	11
	Turbinaria decurrens Bory de Saint-Vincent							/				/
	Turbinaria luzonensis Taylor											/
	Turbinaria ornata (Turner) J. Agardh						/	/	/	/	/	/
	Family Scytosiphonaceae											
	Colpomenia sinousa (Mertens ex Roth) Derbs and Solier										/	/
	Hydroclathrus clathratus (C.Agardh) Howe								/	/	/	
Rhodophyta	**Family Bangiaceae**											
	Trichogloea requienii (Montagne) Kützing											/
	Family Champiaceae											
	Coelothrix irregularis (Harvey) Borgessen	/										
	Family Corallinaceae											
	Amphiroa foliacea	/	/	/	/	/						
	Amphiroa fragilissima (Linnaeus) Lamouroux										/	
	Mastophora rosea (C. Agardh) Setchell	/				/	/					/
	Jania adhaerens J.V. Lamouroux								/			
	Family Cryptonemiaceae											
	Halymenia durvillei Bory de Saint-Vincent								/			
	Family Cystocloniaceae											
	Hypnea cervicornis J. Agardh		/	/								/
	Family Delesseriaceae											
	Caloglossa cf. beccarii (Zanardini) De Toni										/	
	Family Galaxauraceae											
	Actinotrichia fragilis (Forsskål) Borgesen							/	/			
	Dichotomaria 115piculate Kjellman									/		
	Scinaia hormoides Setchell								/			
	Tricleocarpa fragilis (Linnaeus) Huisman & R.A.		/	/				/	/	/	/	/
	Family Gelidiaceae											
	Gelidiella acerosa (Forsskål) Feldmann and Hamel	/	/		/		/					
	Family Gracilariaceae											
	Gelidiopsis intricata (C. Agardh)							/				
	Gracilaria arcuata Zanardini									/		
	Gracilaria salicornia (C. Agardh) Dawson	/	/	/	/	/	/					
	Gracilaria textorii (Suringar) De Toni											/
	Hydropuntia edulis (S.G. Gmelin) Gurgel & Fredericq	/	/				/	/			/	/
	Family Liagoraceae											
	Ganonema farinosum (J.V. Lamouroux) K.C. Fan & Y.C. Wang											/

Class	Species	Sampling Sites										
		Biri (44)					Lavezares (60)					Allen (34)
		1	2	3	4	5	6	7	8	9	10	11
	Liagora ceranoides J.V. Lamouroux									/		
	Family Kallymeniaceae											
	Euthora cristata (C. Agardh) J. Agardh				/							
	Family Peyssonneliaceae											
	Grateloupia filicina (Lamouroux) C. Agardh										/	
	Family Rhizophyllidaceae								/			
	Portieria hornemannii (Lyngbye) P.C. Silva	/	/									/
	Family Rhodomelaceae											
	Acanthopora muscoides (Linnaeus) Bory-de Saint-Vincent		/	/		/						/
	Acanthopora spicifera (Vahl) Borgesen								/			
	Laurencia cartilaginea Yamada						/					
	Laurencia nidifica J. Agardh											/
	Laurencia papillosa (C. Agardh) Greville		/		/							/
	Laurencia tronoi Ganzon-Fortes	/	/		/							
	Ohelopapa flexilis (Setchell) F. Rousseau, Martin-Lescanne, Payri & Le Gall						/	/			/	
	Family Solieraceae											
	Betaphycus philippinensis Doty							/				
	Eucheuma denticulatum (N.L.Burman) Collins and Hervey			/	/							
	Kappaphycus striatus (F. Schmitz) L.M. Liao							/		/	/	

Legend:
1- Progress
2- Pio del Pilar
3- McArthur
4- San Pedro
5- San Antonio
6- Balicuatro, Lavezares
7- Barobaybay, Lavezares
8- San Agustin, Lavezares
9- Bani, Lavezares
10- San Juan, Lavezares
11-Guinarawayan, Allen

In Lavezares, the barangay with the most number of seaweeds was in Barangay Barobaybay with thirty-one (31) species, followed by Barangay San Juan with twenty-eight (28) seaweed species, Barangay San Agustin have twenty-four (24) seaweeds and Barangay Bani with twenty-three (23), and as mentioned Barangay Balicuatro were the least with only twelve (12) species of seaweeds collected. Biri, as mentioned Barangay Pio del Pilar have the most number of seaweeds with thirty six (36) collected seaweeds, followed by Barangay Progress with thirty (30) number of seaweeds, while the number seaweeds collected in Barangays San Antonio, San Pedro, and McArthur were 26, 22, and 17, respectively. In addition, the only barangay sampled in Allen was Guinarawayan with thirty-four (34) number of seaweeds collected and identified.

3.2 Most Abundant Seaweed Species

The most abundant seaweed species that was collected and observed in ten (10) sampling sites was *Hormophysa cuneiformis* which was found abundantly growing in current-exposed area in the lower intertidal, it was followed by *Halimeda macroloba* which was found growing abundantly in almost all the sampling sites, though *Ulva lactuca* was found in nine (9) sampling sites they are found growing only in patch and solitary which is in comparison with *Ulva reticulata* which were only found in eight (8) sampling sites but they grow lavishly in all of the sampling sites to where it was collected. *Padina minor* were also collected and observed in almost all the sampling sites, it is present in nine (9) sampling sites and was found widely distributed with other seaweeds in all sampling sites to where it is observed. *Sargassum oligocystum* and *S. polycystum* were found in nine (9) and eight (8) sampling sites, respectively, they were found abundantly in lower intertidal zone. The most abundant red macroalgae were *Tricleocarpa fragilis* which was found in seven (7) sampling sites and *Hydropuntia edulis* which was found in six (6) sampling sites, *H.edulis* were found widely distributed entangled with other red macroalgae. *Bornetella sphaerica* and *Canistrocarpus cervicornis* were also found in six (6) sampling sites. *B. sphaerica* were found growing in cluster of dead coral rubles.

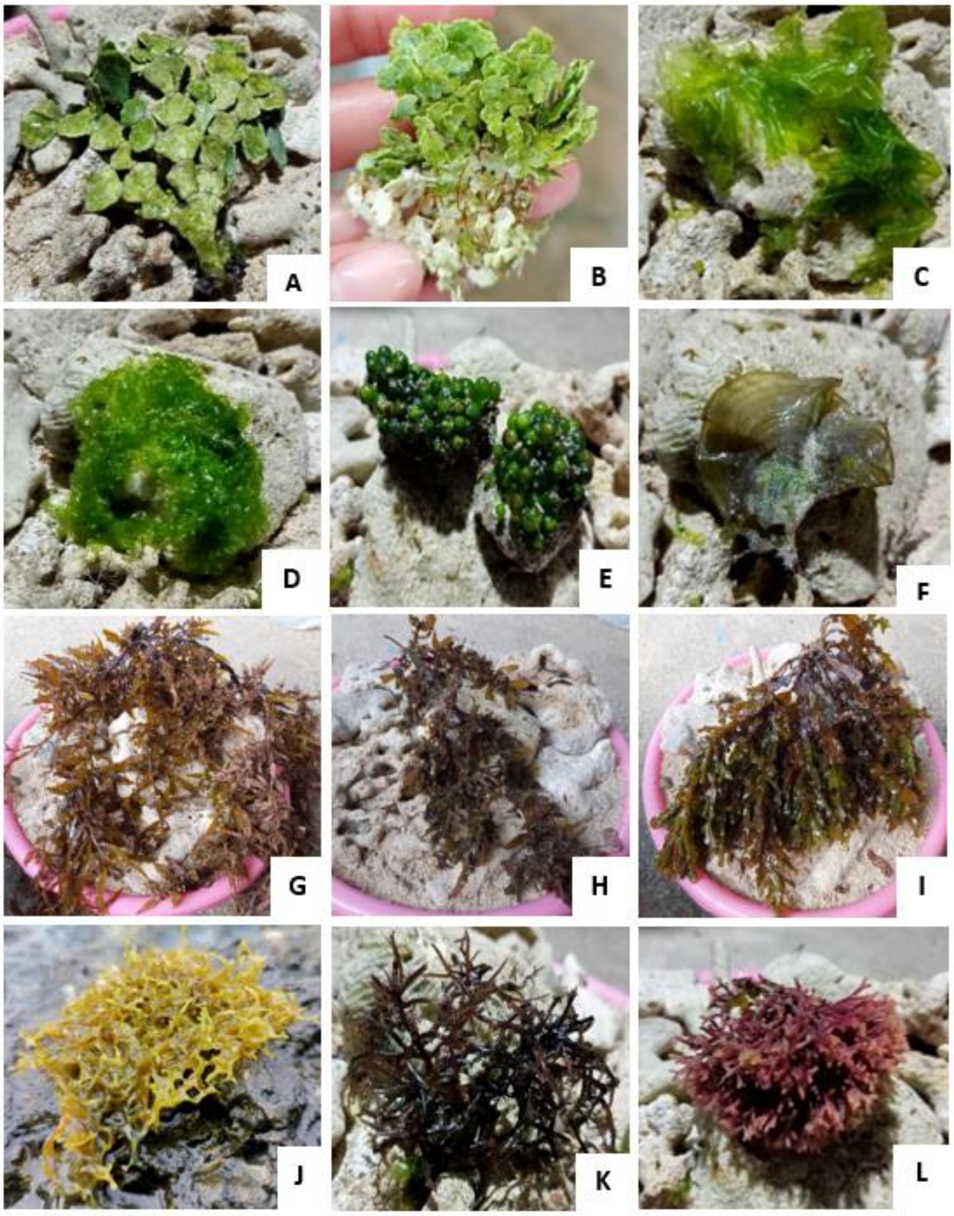

Fig. 2. Most abundant seaweed species: (A). *Halimeda macroloba*; (B). *H. opuntia*; (C). *Ulva lactuca;* (D). *U. reticulata;* (E). *Bornetella sphaerica*; (F). *Padina minor;* (G). *Sargassum oligocystum*; (H). *S. polyscystum*; (I). *Hormophysa cuneiformis*; (J) *Canistrocarpus cervicornis;* (K). *Hydropuntia edulis*; (L). *Tricleocarpa fragilis*

Table 3. Environmental Parameters in different sampling sites

Environmental Parameters	Sampling Sites											Permissible Limit
	Biri					Lavezares					Allen	
	1	2	3	4	5	6	7	8	9	10	11	
pH	7.8	7.8	7.6	7.9	7.9	7.2	7.6	7.6	7.8	7.4	7.7	7.5- 8.5 (Water watch, 2022)
Salinity	34 ppt	35 ppt	35 ppt	33 ppt	34 ppt	35 ppt	35 ppt	35 ppt	34 ppt	35 ppt	34 ppt	30- 35 ppt (Water watch, 2022)
Temperature	26°C	27°C	27.5°C	27.5°C	28°C	28.0°C	26.5°C	26.5°C	26.5°C	26.5°C	26.5°C	26-28 °C (Johnson & Xie, 2010)
Substrate	Rocky	Rocky	Rocky-corally	Rocky	Rocky-corally	Rocky	Rocky-corally	Muddy & Sandy	Sandy	Rocky & Sandy	Rocky-corally	

Legend:
1- Progress
2- Pio del Pilar
3- McArthur
4- San Pedro
5- San Antonio
6- Balicuatro, Lavezares
7- Barobaybay, Lavezares
8- San Agustin, Lavezares
9- Bani, Lavezares
10- San Juan, Lavezares
11-Guinarawayan, Allen

3.3 Environmental Parameters

Selected environmental parameters were measured (Table 3) using Bante 900-UK Multiparameter Water Quality Meter. These environmental parameters are all critical for the adaptation, growth, and survival of most aquatic plants and animals. In terms of pH, the highest was measured in barangay San Pedro and San Antonio, Biri which had 7.9. which within the normal range of 7.5-8.5 (Water watch, [17]. Meanwhile, two (2) barangays in Lavezares tested to be below the threshold limit for pH, it was measured in barangay Balicuatro and San Juan which had 7.2 and 7.4, respectively. In terms of salinity, all of the salinity levels of the sampling sites conform to the threshold range for the seawater which is 30-35 ppt [17].

Furthermore, in terms of water temperature all of the sampling sites also conform to the threshold limit of 26-28°C for seawater. On the other hand, the most common substrate among all the sampling sites was rocky-corally in which it was observed that some macroalgae preferred to have a hard substratum and rocks can provided hard attachment of seaweeds.

4. DISCUSSION

Recently, Lastimoso and Santianez [3] reported that there were one-thousand sixty five (1,065) taxa of seaweeds in the Philippines, majority of which is red seaweed with six hundred (600) taxa, followed by green seaweed with two-hundred seventy two (272) taxa, and brown seaweed with one hundred ninety-three (193) taxa. In the present study, ninety-four (94) taxa or species were identified and collected which will be added as new record or information on the available literature of marine flora and presence of some macroalgae in Northern Samar.

There were thirty-seven (37) green seaweeds that were collected in all three (3) sampling sites. Green algae/ seaweeds have a variety of living areas including coral debris, muddy corals, dead corals, muddy sand, mangroves (Harborne et al*,* [18] Ghazali et al*,* [19], Cahyanto et al, [20] one very best example of this, is the genus *Ulva* that have higher abundance than other genus in the intertidal zone. The genus *Ulva* had filamentous thallus that can withstand environmental stress. This genus is also known to be able to live on saltwater or freshwater and has a high salinity tolerance and high reproductive capability [20]. The abundance of *Ulva* are also dictated by other two factors like nuisance due to anthropogenic activities (Littler and Littler, [21], Choi et al*.,* [22], Kim et al*.,* 2016; Baldia et al*.,* 2017) and the effect influence of lunar cycle [23]. It was observed that all sampling sites have residential areas near the beaches, effluent from houses which contains organic waste might contribute to the abundance of members of family Ulvaceae [24], since *Cladophora* and *Ulva* are dominant and can thrive in an unstable or polluted environment (Littler and Littler, [21], Choi et al*.,* 2008; Kim et al*.,* 2016; Baldia et al*.* [4]. Also, as shown in Table 1 and 2, the genus *Caulerpa* was represented by seven (7) species, in Brgy. Guinarawayan, Allen, *Caulerpa racemosa* was abundantly growing near the reef-edge and gleaners were also observed harvesting *C. racemosa*, it was also observed that the *C. racemosa* present in the area have strong short erect branches with crowded ramuli with spherical tips, which is a clear indication that the area is exposed to strong wave actions and current [2]. However they are only distributed in the lower intertidal zone due to environmental stress (e.g. desiccation, temperature extremes, and inundation by rain), thus, desiccation sets the upper limit to the species distribution of the genus *Caulerpa* [25].

In addition, the genus *Halimeda* was also composed of five (5) species with *H. macroloba* and *H. opuntia* being two of the most abundant (Fig. 2) and distributed seaweed in almost eight (8) or nine (9) sampling sites, since as a matterof fact *Halimeda* is one of the most abundant algal taxa in the tropical seas [26]. The presence of aragonite which is a natural form of Calcium carbonate on its skeletal structure which is a form plasticity that enables certain species of *Halimeda* to adapt to fluctuating environmental conditions (Vroom et al*.* [27], Price et al*.* [26] that might contribute to their great abundance in the sampling sites.

On the other hand, red macroalgae were also present in all sampling sites, as a matter of fact they are the more diversified when it comes to number of genera which accounts for about twenty-seven (27), but when it comes to number of species, there were thirty-four (34) in all sampling sites. According to Lee [28], there are more red seaweeds as compared to any major seaweed groups in the world, this was supported by Lastimoso and Santianez (2020) that 56 % of seaweeds in the country is red seaweeds. Although they can be seen in all latitudes, but red macroalgae are limited to polar and subpolar regions of the world [4]. As observed, this group were present in current exposed area due to their multicellular rhizoidal holdfast that serves as a strong attachment of thalli to substrates. In addition, Rhodophyceae have multiple life stages that help in their adaptation for survival. Their triphasic life cycle also explains why compared to brown and green algae, red algae are the most adaptable and morphologically diverse (Lee, [23], Baldia et al*.* [4]. As shown in Table 2, *Tricleocarpa fragilis* were present in seven (7) sampling sites by which they are observed growing abundantly, Islam et al [29] has recounted that *T. fragilis* is commonly found attached to rocks, dead corals and shells in shallow areas, moderately exposed to wave action, where it forms large solitary clumps.

In addition, the least group of macroalgae was brown seaweeds which accounts for twenty-three (23) species. As mentioned by Lee [29] that majority of the brown algae are found in temperate region rather than in tropical region, it is expected that Philippines has low species diversity of brown algae. Even though there is a low species diversity of brown seaweeds in the province, they can be seen to have the greatest cover in all sampling sites. Most brown algae grows on rocks/ hard substratum which is commonly observed in all sampling sites. Brown macroalgae exhibits larger biomasses (especially *Sargassum*) as compared to other group of marine macroalgae (green and red) which is evident due to their larger size (Johnston, 1969; Baldia et al*.,* [4]. *Sargassum* is the most represented brown macroalgae which is composed of nine (9) species, identification of *Sargassum in situ* is difficult due to its phenotypic plasticity [30], aside from its variability *Sargassum* have tougher thallus, strong holdfast, and air bladder as compared to other seaweeds that makes them adapt to the harsh wave actions and currents [31].

The presence of genus *Padina* in almost all of the sampling sites as well as its variability in cover, might be indicative of anthropogenic nutrient loading from domestic and agricultural runoff. All sites were near populated areas with poor sewage system, and a few backyard pig pens were observed in some of the barangays that served as sampling sites. Fresh and dried biomass of *Padina* have high adsorbing potential for various pollutants [32]. Aside from being indicator the wide distribution of the *Padina* can be suspected to its lifecycle and reproduction which is through sporophyte generation. The sporophyte dominance may be due to its greater resistance (longevity of individuals) to water movement that helps them establish their population (Allender, [33], Baldia et al*.* [4], this might be the reason of its great abundance and distribution in almost all sampling sites.

As shown in Table 3, the sampling site which had the lowest pH was detected in barangay Balicuatro in Lavezares which only had 7.2 which is lower against the threshold range for seawater pH of 7.5-8.5 Water watch [17]. This lower pH in this site could be attributed to lesser number of seaweeds in the area by which there were only twelve (12) identified seaweeds. According to Water watch [17], human activities such as sewage overflows or runoff, can cause significant short-term fluctuations in pH and long-term impacts can be extremely harmful to plants and animals. Extreme changes in pH, can stress local organisms and may ultimately lead many species to leave the area or die. Aside from pH, salinity and seawater temperature can also be affected by the human activities. The average salinity of ocean water is 35 ppt, but the range from 30-35 ppt can still considered as accepted, as much as possible monitoring of salinity is very important since salinity levels control local species composition. Changes in salinity in a specific area/ region can occur as a result of weather patterns, such as droughts or storms, or they can alert us to events such as increased urban runoff and sewer discharge [17]. Also, as shown in Table 3, the temperature value in all sampling sites were within the normal range of 26-28°C, however, there are some variations of seawater temperature depending on the sites, since as mentioned by Johnson & Xie [34] that the troposphere may have become less stable and casting doubts on the possibility that the sea surface temperature threshold increases substantially with global warming, by which it can be correlated to human activities.

Rocky substrate was observed to be common in all sampling sites, it is much preferable for the seaweeds to grow (Tsuda, [35], Wreede, [36], Baldia et al*.* [4] since it gives them a hard attachment. The most common seaweed genera collected near the rocky substrate was *Sargassum* by which even at the reef edge they grow abundantly since according to Hurtado [31] that macroalgae found in exposed intertidal zone are tougher and shorter with narrower thalli, therefore they are more prone to wave motion compared to those growing in calmer areas [37-39].

5. CONCLUSION AND RECOMMENDATIONS

Based on the result of the study there were more seaweeds that belongs to Chlorophyta, followed by Rhodophyta, and the least was Phaeophyta. In terms of the municipality with the most number of seaweeds, Lavezares had the most with sixty (60) taxa identified, followed by Biri with fourty-four (44), and Allen with thirty-four (34) species. With the result of the measurement of the environmental parameters, pH of seawater really determines the availability seaweeds since some of them are sensitive to variation of pH. As a matter fact it is evident in barangay Balicuatro, Lavezares wherein the pH value fell below the threshold limit and only few seaweeds were collected during the sampling. Thus, based on the above mentioned result, the availability of seaweeds in an area can be dictated if the environmental parameters favor for the growth and survival of some seaweeds.

It is recommended to conduct similar studies in other island municipalities of Northern Samar, to determine the uniqueness of the taxa in the province.

ACKNOWLEDGEMENT

The authors would like acknowledge the participation of LGU especially the Municipal Agricultural Office (MAO) and the Office of the Mayor in all three (3) municipalities for the release and approval of prior informed consent (PIC) prior to sampling. Also, the participation of some individuals during the collection of seaweeds in the sampling sites. Lastly, great appreciation to the CHED-LAKAS for funding.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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