

Diversity Investigation of the Seaweeds Growing on the Lebanese Coast

Hussein Kanaan^{1*}, Oksana Belous^{2,3} and Ali Chokr^{4,5}

¹Laboratory of Seaweeds Polysaccharides and Chemical Synthesis, Faculty of Pharmacy, Lebanese University, Beirut, Lebanon

²Pacific Institute of Bioorganic Chemistry, Far Eastern Branch of the Russian Federation Academy of Sciences, Vladivostok, Russia

³Far Eastern Federal Universities, Vladivostok, Russia

⁴Laboratory of Microbiology, Department of Biology, Faculty of Sciences I, Lebanese University, Hadath Campus, Beirut, Lebanon

⁵PRASE, Platform of Research and Analysis in Environmental Sciences, Doctoral School of Sciences and Technologies, Lebanese University, PO Box 5, Hadath Campus, Beirut, Lebanon

Abstract

By specialized underwater cameras we have filmed and collected samples of algae from the following sites along the Lebanese coast: Batroun, Barbara, Manara, Officer's Military club, Saida, Sarafand, Tyre and Naqoura. We have identified ninety-four species of algae that grow along the Lebanese coast and we have established a collection sites map of these algal species. The identification of the samples was done in three steps: (1) Determine the largest group (green, brown and red algae) to which the sample belongs, then continue searching within the most likely group. (2) Seek off in the succession of morphological types which proposed that the sample is approaching. (3) Seek out using the illustrations and descriptions a satisfactory identification. It is worth noting that confirmation cannot be obtained in all cases unless a careful reading of the description is done. (4) We then proceeded to the classification of the collected seaweeds which are distributed as follows: *Rhodophyta* forty one species, *Ochrophyta* twenty two species, *Chlorophyta* twenty six species and *Cyanobacteria* five species. (5) Synthesis: The present study allowed us to establish a primary infrastructure regarding the distribution of the Lebanese seaweeds. Such findings represent an important scientific support concerning the Mediterranean seaweeds, which provides a great assist in algal studies and all its applications. This screening of the Lebanese coastline shows a broad and significant algal distribution. The most common algal types among the identified ones are: *Sargassum*, *Padina*, *Laurencia*, *Ulva*, *Corallina*, *Hypnea*, *Chondracanthus*, *Jania*, *Amphiroa*, *Pterocladia*, *Cladophera*, *Codium*.

Keywords: Chlorophyta; Ochrophyta; Lebanese coastline; Rodophyta; Lebanese seaweeds diversity; Marine algae

Introduction

Over the past decades, an increasing attention to learn more about marine organisms and especially seaweeds has arisen. Seaweeds have shown to produce a variety of compounds whose some of them have been reported for diverse biological activities [1-3].

Seaweeds have become particularly interesting and many studies have been conducted to characterize their contents which have shown great potential in a wide range of biological activities such as anti-inflammatory, anticoagulant, anti-obesity, antibacterial, antiviral, antifungal, antioxidant, antitumoral, antiproliferative [3-21].

Many species of marine algae have long been used in food diet and in traditional oriental medicine [9,22,23].

Seaweeds contain and/or produce a panel of substances that currently received most attention from pharmaceutical, drug development and food companies [3,14,20,21,23-26].

Polysaccharides (carrageenan, cellulose, agar, gepsin, porphyran, fucoidan, alginic acid), carotenoids (fucoxanthin, zeaxanthin, violaxanthin, β -carotene, anthocyanins), fatty acids, amino acids, some trace or oligoelements (K, Ca, Mg, Na, Si, Sr, P, Fe,...) are among these substances [3,9,22,24-28].

Despite the quality and the emerging importance of marine algae, to our knowledge the diversity of the Mediterranean Lebanese coast flora and especially that of its seaweeds has never been investigated.

Since few years, we were the unique researchers in Lebanon who have started investigating some algal species from the Lebanese coast for their chemical composition and some biological activities of some extracted and characterized components.

In total, we have studied five Lebanese seaweeds species (*Padina pavonica*, *Dictyopteris polypodioides*, *Corallina*, *Sargassum sp.* and *Pterocladia*) for the contents of their extracts in polysaccharides (carrageenan, sulfated galactan, fucoidan, laminaran, alginic acid and Mannuronan), aminoacids, fatty acids and some trace and oligoelements (K, Ca, Mg, Na, Si, Sr, P, Fe) and the following biological activities: anticoagulant, antibacterial, antioxidant and antitumoral activity [29-35].

The worldwide emerging interest in seaweeds for their importance in many fields and the promising results obtained from our previous work referenced above have led us to focus our study on the Lebanese seaweeds by highlighting the diversity of the Lebanese coast seaweeds flora.

Thus the objective of our present study is to investigate the diversity of the seaweeds flora inhabiting the Mediterranean Sea in front of the Lebanese coast.

Materials and Methods

By specialized underwater cameras (Canon Digital IXUS 900 Ti, Japan) we have filmed and collected many samples of algae from different sites along the Lebanese coast. These different sites are: Batroun, Barbara,

***Corresponding author:** Dr. Hussein Kanaan, Faculty of Pharmacy, Lebanese University, Campus Hadath, Beirut, Lebanon, Tel: +961 3 703532; E-mail: hkanaan@ul.edu.lb

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Manara, Officer's Military club (Bain militaire in Figure 1), Saïda, Sarafand, Tyre and Naqoura. They are indicated in Figure 1.

The samples were freshly harvested between (Junes-July 2014) from the field at an average distance of 3 m from the coastline and an average depth of 5 m from the water surface. The physicochemical factors determined in these sites together with their average values are summarized in Table 1. They are always carefully picked and taken with their base, the latter often being a fundamental character recognition (case of *Cystoseira*). The fresh samples are kept well in dampened plastic bags. It is thus possible to conserve them in a refrigerator for a few days. The samples were microscopically identified using the stereo microscope (M165C, Leica Microsystems, Buffalo, N.Y., U.S.A) according to the procedure described by [36,37]. After their identification and separation by species, the samples are placed in a flat dish containing seawater. A plate of glass or plastics half immersed allows the spreading of the sample. They are then dried and conserved.

Results

Physicochemical characteristics of the sites of collection

The physicochemical characteristics of the seawater of the sites from which the seaweeds were collected are summarized in Table 1.

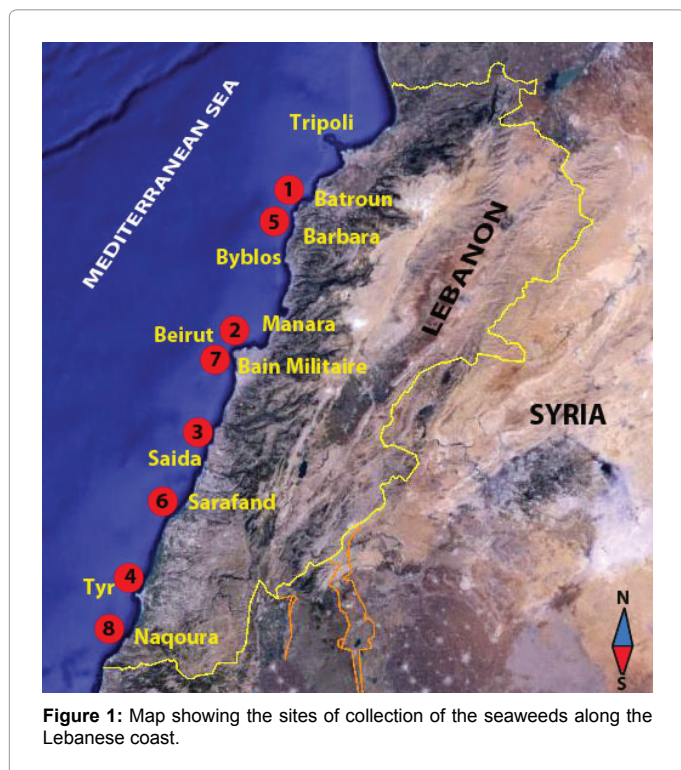


Figure 1: Map showing the sites of collection of the seaweeds along the Lebanese coast.

Factor	Average value
Atmospheric temperature (°C)	23
Water temperature (°C)	20
Oxygen (mL/L)	7.20
[PO ₄] (µg/L)	1.60
NO ₃ (µg/L)	0.40
NH ₄ (µg/L)	2.55
Salinity (%)	40

Table 1: Physicochemical factors of the sites from which the seaweeds were collected.

Identification of the collected seaweeds from the Lebanese coast

We have collected and identified from the Lebanese coast ninety four seaweeds species belonging to the following phyla: Rhodophyta (forty one species), Ochrophyta (twenty two species), Chlorophyta (twenty six species) and Cyanobacteria (five species) (Table 2). The forty one species of **Rhodophyta** belonging to the class Florideophyceae are distributed in the following orders: 1-*Erythropeltidales* (one specie belonging to the family of Erythrotrichiaceae), 2-*Gigartinales* (three species belonging to the family of Cystocloniaceae, one specie belonging to the family of Gigartinaeace and two species belonging to the family of Phylloporaceae), 3-*Corallinales* (seven species belonging to the family of Corallinaceae), 4-*Ceramiales* (eight species belonging to the family of Rhodomelaceae, two species belonging to the family of Ceramiaceae, two species belonging to the family of Dasyaceae and one specie belonging to the family of Spyridiaceae), 5-*Nemaliales* (three species belonging to the family of Liagoraceae and one specie belonging to the family of Galaxauraceae), 6-*Bonnemaisoniales* (two species belonging to the family of Bonnemaisoniaceae), 7-*Gelidiales* (two species belonging to the family of Gelidiellaceae and one specie belonging to the family of Pterocladaceae), 8-*Peyssonneliales* (one specie belonging to the family of Peyssonneliaceae), 9-*Rhodymeniales* (three species belonging to the family of Rhodymeniaceae) and 10-*Hildenbrandiales* (one specie belonging to the family of Hildenbrandiaceae) (Table 2).

The twenty two species of *Ochrophyta* belonging to the class Phaeophyceae of are distributed in these five following orders: 1-*Ectocarpales* (one specie belonging to the family of Ectocarpaceae, one specie belonging to the family of Scytosiphonaceae, two species belonging to the family of Chordariaceae and one specie belonging to the family of Scytosiphonaceae), 2-*Sphacelariales* (two species belonging to the family of Sphacelariaceae and one specie belonging to the family of Stypocaulaceae), 3-*Fucales* (five species belonging to the family of Sargassaceae), 4-*Dictyotales* (eight species belonging to the family of Dictyotaceae) and 5-*Ralfsiales* (one specie belonging to the family of Ralfsiaceae) (Table 2).

The twenty six species of *Chlorophyta* belonging to the class Ulvophyceae of are distributed in these four following orders: 1-*Cladophorales* (nine species belonging to the family of Cladophoraceae, one specie belonging to the family of Anadyomenaceae and one specie belonging to the family of Valoniaceae), 2-*Ulvales* (four species belonging to the family of Ulvaceae), 3-*Dasycladales* (one specie belonging to the family of Polyphysaceae and one specie belonging to the family of Dasycladaceae) and 4-*Bryopsidales* (four species belonging to the family of Bryopsidaceae, four species belonging to the family of Codiaceae and one specie belonging to the family of Derbesiaceae) (Table 2).

The five species of *Cyanobacteria* belonging to the class Cyanophyceae of are distributed in these two orders: 1-*Oscillatoriales* (two species belonging to the family of Oscillatoriaceae and one specie belonging to the family of Phormidiaceae) and 2-*Nostocales* (two species belonging to the family of Rivulariaceae) (Table 2).

Distribution of the seaweeds along the Lebanese coast

A great number of the identified seaweeds species from the Lebanese coast (59.5% of the ninety four identified species) has the lowest distribution rate (found in ≤ 25% of the examined sites) while only 11.75% of the identified species were found in ≥ 75% of the examined sites. The remaining 28.75% have a middle distribution as

Classification of the collected Lebanese seaweeds				Quantitative distribution of the seaweeds											
Phylum	Class	Order	Family	Species	Batroun	Manara	Saida	Tyre	Barbara	Sarafand	Military club	Naqoura			
RHODOPHYTA	Florideophyceae	Erythropeltiales	Erythrotrichiaceae	<i>Erythrotrichia carnea</i> (Dillwyn) J. Agardh		+									
		Gigartinales	Cystocloniaceae	<i>Hypnea cervicornis</i> J. Agardh	+				+						
				<i>Hypnea musciformis</i> (Wulfen) J.V. Lamouroux	++	++	+	++	++		+	+			
				<i>Hypnea</i> sp.	+			+	+						
			Gigartiniaceae	<i>Chondracanthus acicularis</i> (Roth) Fredericq		++				++					
			Phylloporaceae	<i>Schotteranicaeensis</i> (J.V. Lamouroux ex Duby) Guiry et Hollenberg						+	+				
		<i>Gymnogongrus griffithsiae</i> (Turner) Martius								+					
		ulinales	ulinales	<i>Jania rubens</i> (Linnaeus) J.V. Lamouroux	+++	+++	+++	+++	+++	+++	+++	++	+		
					<i>Jania</i> sp.							+		+	
					<i>Amphiroa rigida</i> J.V. Lamouroux	++	+++	++	++	++					
					<i>Amphiroa cryptarthrodia</i> Zanardini										+
					<i>Corallinaelongata</i> J. Ellis et Solander	+++	+++	+++	+++	+++	+	+	+	+	
					<i>Corallina officinalis</i> Linnaeus	+	++	+	+	++	+	+			
					<i>Pneophyllum fragile</i> Kützinger						+				
					Rhodomelaceae	<i>Palisada perforata</i> (Bory de Saint-Vincent) K.W. Nam = <i>Chondrophycus papillosus</i> (C. Agardh) D.J. Garbary et J. T. Harper	+++	++	++	++	+++				
		<i>Laurencia obtusa</i> (Hudson) J.V. Lamouroux	+	+			+	+							
		<i>Osmundea hybrida</i> (A.P. de Candolle) K.W. Nam	++	++		+	++	++							
		<i>Polysiphonia atlantica</i> Kapraun et J.N. Norris	++												
		<i>Polysiphonia</i> sp.								+					
		<i>Acanthophora muscoides</i> (Linnaeus) Bory de Saint-Vincent		+				+							
<i>Acanthophora nayadiformis</i> (Delile) Papenfuss								+			+				

	Ceramiales		<i>Rytiplaeactinctoria</i> (Clemente) C. Agardh						+					
		Ceramiaceae	<i>Centroceras clavulatum</i> (C. Agardh) Montagne	+	++	+	++	++						
			<i>Ceramium cimbricum</i> H.E. Petersen											+
		Dasyaceae	<i>Dasya corymbifera</i> J. Agardh	+	++		+	++						
			<i>Dasya</i> sp.	+										
		Spyridiaceae	<i>Spyridia filamentosa</i> (Wulfen) Harvey											+
	Nematales	Liagoraceae	<i>Nemalion helminthoides</i> (Velle) Batters	++					++					
			<i>Liagora viscida</i> (Forsskål) C. Agardh						+					
			<i>Liagora</i> sp.						+					
		Galaxauraceae	<i>Galaxaura rugosa</i> (J. Ellis et Solander) J.V. Lamouroux	++	+	+	+	++						
Bonnemaisoniates	Bonnemaisoniaceae	<i>Asparagopsis armata</i> Harvey	+	++				+						
		<i>Falkenbergiarufolanosa</i> (Harvey) F. Schmitz [stage of <i>Asparagopsis armata</i>]		+		+	+					+		
Gelidiales	Gelidiellaceae	<i>Gelidiella acerosa</i> (Forsskål) Feldmann et G. Hamel											+	
		<i>Gelidiella</i> sp.		++										
	Pterocladaceae	<i>Pterocladia lacapillacea</i> (S.G. Gmelin) Santelices et Hommersand		+++		+	+++							
Peyssonneliales	Peyssonneliaceae	<i>Peyssonnelia</i> sp.				+	+	+						
Rhodymeniales	Rhodymeniaceae	<i>Botryocladia botryoides</i> (Wulfen) Feldmann		+		+	+							
		<i>Rhodymenia holmesii</i> Ardissone						+						
		<i>Chondria</i> sp.											+	

OCHROPHYTA		Phaeophyceae												
	Hildenbrandiales	Hildenbrandiaceae	<i>Hildenbrandia rubra</i> (Sommerfelt) Meneghini							+				
		Ectocarpales	Ectocarpaceae	<i>Ectocarpus siliculosus</i> (Dillwyn) Lyngbye	+									
		Scytosiphonaceae	<i>Colpomenia sinuosa</i> (Mertens ex Roth) Derbès et Solier	++	++	+	++	++	+	+			+	
	Sphacelariates	Chordariaceae	<i>Cladosiphon occidentalis</i> Kylin							+				
			<i>Leathesia marina</i> (Lyngbye) Decaisne	+										
		Scytosiphonaceae	<i>Hydroclathrusclathratus</i> (C. Agardh) M.A. Howe	+	+		+	+						
		Sphacelariaceae	<i>Sphacelaria tribuloides</i> Meneghini	+	+	+	+	+						+
			<i>Sphacelaria</i> sp.							+				+
		Stypocaulaceae	<i>Halopteris filicina</i> (Grateloup) Kützing	+	+	+	+	+	+	+	+			+
	Fucales	Sargassaceae	<i>Sargassum</i> sp.	++	++	++		++						
			<i>Sargassum vulgare</i> C. Agardh			+	++							+
			<i>Cystoseirabarbata</i> (Stackhouse) C. Agardh					++						
			<i>Cystoseira compressa</i> (Esper) Gerloff et Nizamuddin				++	++						+
			<i>Cystoseira tamariscifolia</i> (Hudson) Papenfuss	++	+	+	+++	++	+	+				+
			<i>Dictyopteris polypodioides</i> (A.P. De Candolle) J.V. Lamouroux	++			++	++						
		<i>Dictyota fasciola</i> (Roth) J.V. Lamouroux				++	+					+		
		<i>Dictyota spiralis</i> Montagne							++			+		

CHLOROPHYTA	Ulvothlyceae	Dictyotales	Dictyotaceae	<i>Dictyota</i> sp.							++				
				<i>Taoniaatomaria</i> (Woodward) J. Agardh	++	++	+	++	++				+		
				<i>Padina pavonica</i> (Linnaeus) Thivy	++	+	+	++	++	+++	+	+			
				<i>Lobophora variegata</i> (J.V. Lamouroux) Womersley ex E.C. Oliveira	+	+	+	+	+						
				<i>Stypodium schimperi</i> (Kützing) M. Verlaque et Boudouresque				++	++						
	Ulvothlyceae	Cladophorales	Ralfsiaceae	Ralfsiaceae	<i>Ralfsia verrucosa</i> (Areschoug) Areschoug	+									
					Cladophoraceae	<i>Rhizoclonium tortuosum</i> (Dillwyn) Kützing	++								
						<i>Rhizoclonium</i> sp.		+							
						<i>Cladophora aegagropila</i> (Linnaeus) Trevisan		+		+	+				
						<i>Cladophora laetevirens</i> (Dillwyn) Kützing	++			+	++				
						<i>Cladophora albida</i> (Nees) Kützing		+							
						<i>Cladophora prolifera</i> (Roth) Kützing				+					
						<i>Cladophora pellucida</i> (Hudson) Kützing				+					
						<i>Cladophora catenata</i> (Linnaeus) Kützing					+				
						<i>Cladophora</i> sp.							+++		
					Anadyomenaceae	<i>Anadyomene stellata</i> (Wulfen) C. Agardh				+		+		+	
						Valoniaceae	<i>Valoniautricularis</i> (Roth) C. Agardh	+			++	++	+	+	+
							Ulvales	Ulvaaceae	<i>Ulva linza</i> Linnaeus			+++			
					<i>Ulva compressa</i> Linnaeus	+++					+++	+++			
<i>Ulva clathrata</i> (Roth) C. Agardh						+									
<i>Ulva lactuca</i> Linnaeus = <i>Ulva fasciata</i> Delile	++	+++	+	++	+										

CYANOBACTERIA	Cyanophyceae	Oscillatoriales	Oscillatoriaceae	<i>Oscillatoria</i> sp.	+										
		Dasycladates	Polyphysaceae	<i>Parvocaulisparvulus</i> (Solms-Laubach) S. Berger, U. Fettweiss, S. Gleissberg, L.B. Liddle, U. Richter, H. Sawitzky & G.C. Zuccarello									+		
		Dasycladates	Dasycladaceae	<i>Dasycladus vermicularis</i> (Scopoli) Krasser									+		
		Bryopsidales	Bryopsidaceae	<i>Pseudobryopsis</i> sp.	++									+	
				<i>Bryopsismuscosa</i> J.V. Lamouroux											+
				<i>Bryopsis</i> sp.											
				<i>Bryopsisishypnoides</i> J.V. Lamouroux											+
			Codiaceae	<i>Codiumadhaerens</i> C. Agardh											
				<i>Codiumtomentosum</i> Stackhouse											
				<i>Codiumvermilara</i> (Olivi) DelleChiaje	++	++									
		Derbesiaceae	<i>Codiumdecorticatum</i> (Woodward) M.A. Howe												
			<i>Derbesia marina</i> (Lyngbye) Solier											++	
		Phormidiaceae	<i>Symploca atlantica</i> Gomont												
			<i>Lyngbya confervoides</i> C. Agardh ex Gomont												
		Nostocales	Rivulariaceae	<i>Rivulariabullata</i> Berkeley ex Bornet et Flahault	++										
				<i>Calothrixscopulorum</i> C. Agardh ex Bornet et Flahault	+										

Table 2: Classification and quantitative distribution of seaweeds collected from the Lebanese Coast.

they were found in between 25% and 75% of the examined sites in the Lebanese coast (Table 3 and Figure 2).

The widest distributed species (eleven/ninety four) in the examined sites are: four species belonging to *Rhodophyta* (*Hypnea musciformis*, *Jania rubens*, *Corallinaelongate* and *Corallina officinalis*), six species belonging to *Ochrophyta* (*Colpomenia sinuosa*, *Sphacelaria tribuloides*, *Halopteris filicina*, *Cystoseira tamariscifolia*, *Taoniaatomaria* and

Padina pavonica) and one specie belonging to *Chlorophyta* phylum (*Valoniautricularis*) (Tables 2,3 and Figure 2).

The most diversified sites are Barabara (fifty nine species), Tyre (forty three species) and Batroun (forty one species) followed by Manara (thirty four species), Naqoura (twenty five species) and Saida (twenty one species) having a moderate diversity and the least diversified sites are Sarafand (fourteen species) and Military club (thirtiespecies)

Number of identified species										
Distribution (n=94)			Rhodophyta (n=41)		Ochrophyta (n=22)		Chlorophyta (n=26)		Cyanobacteria (n=5)	
	n	%	n ^R	% ^R	n ^O	% ^O	n ^{Cl}	% ^{Cl}	n ^C	% ^C
High	11	11.75	4	9.76	6	27.27	1	3.85	0	0
Middle	27	28.75	13	31.71	7	31.82	6	23.07	1	20
Low	56	59.5	24	58.53	9	40.91	19	73.08	4	80

Table 3: Distribution/Phylum of the collected seaweeds species.

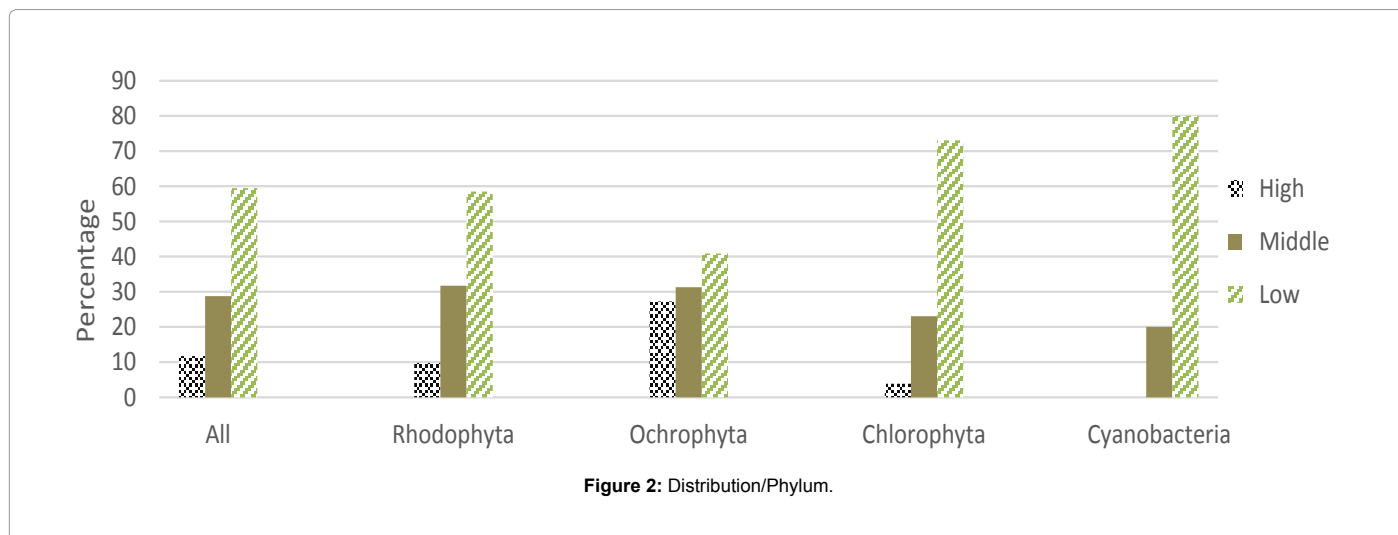


Figure 2: Distribution/Phylum.

Number of identified species										
Site	Distribution (n=94)		Rhodophyta (n=41)		Ochrophyta (n=22)		Chlorophyta (n=26)		Cyanobacteria (n=5)	
	n	%	n ^R	%	n ^O	%	n ^{Cl}	%	n ^C	%
Batroun	41		17	41.46	13	31.71	7	17.08	4	9.75
Manara	34		19	55.88	9	26.47	6	17.65	0	0
Saida	21		10	47.62	9	42.86	2	9.52	0	0
Tyre	43		18	41.86	13	30.23	10	23.26	2	4.65
Barbara	59		30	50.85	16	27.11	11	18.64	2	3.39
Sarafand	14		4	28.57	6	42.86	4	28.57	0	0
Military club	13		5	38.46	4	30.77	4	30.77	0	0
Naqoura	25		10	40	11	44	4	16	0	0

Table 4: Distribution/site of the collected seaweeds species.

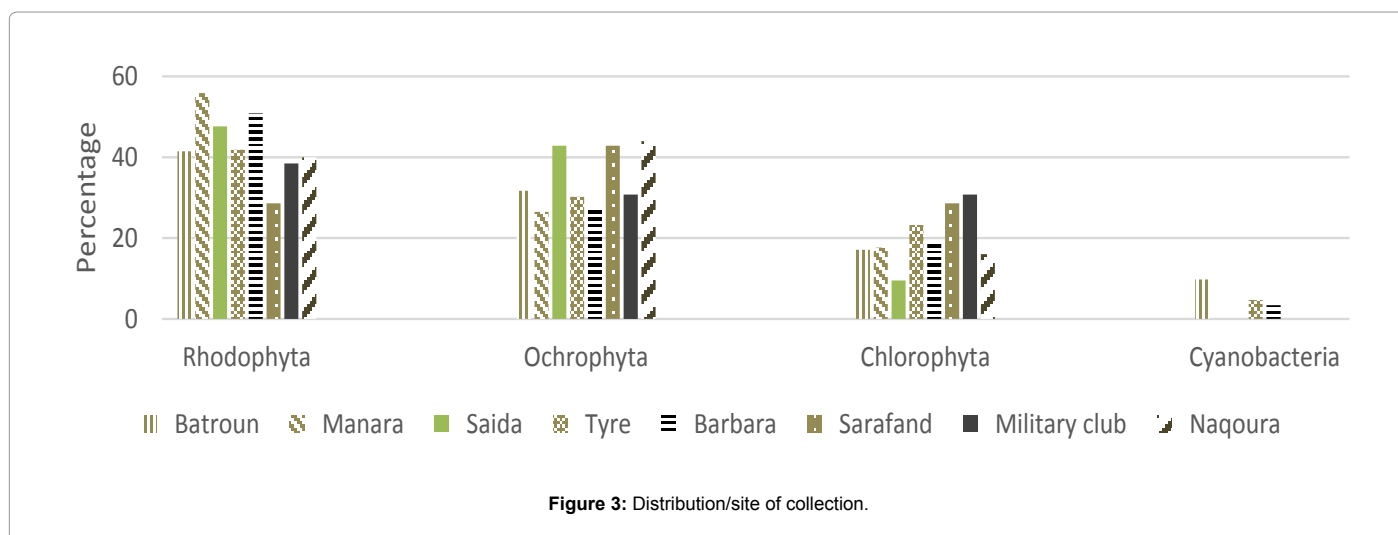


Figure 3: Distribution/site of collection.

(Table 4 and Figure 3). The distribution is as follow in all the sites: *Rhodophyta* > *Ochrophyta* > *Chlorophyta* > *Cyanobacteria*, except in Sarafand and Naqoura where there is more *Ochrophyta* species than *Rhodophyta*ones (Table 4 and Figure 3).

Frequency of the seaweeds along the Lebanese coast according to the sites of collection

In all phyla the frequency of the species between the sites is as follow: the species having the lowest distribution rate (found in ≤ 25% of the examined sites) are the most frequent followed by those having a middle distribution rate (found in between 25% and 75% of the examined sites) then by those having a high distribution rate (found in ≥ 75% of the examined sites). According to *Rhodophyta*, this is true for all the sites except at Manara (where the species having the middle distribution rate are the most frequent followed by those of low distribution rate then by those of high distribution rate), Sarafand and Naqoura (where the species having the high distribution rate are more frequent than those having the middle distributionrate) (Table 5 and Figure 4).

Regarding *Ochrophyta*, the exception appears in Tyre and Barbara sites (where the species having the middle distribution rate are the most frequent followed by those of low distribution rate then by those of high distribution rate) (Table 5 and Figure 4).

Concerning *Chlorophyta*, the exception appears in Batroun (where the species having the middle distribution rate are more frequent than those of low distribution rate) and Saida (where the species having the high distribution rate are more frequent than those having the middle distribution rate) (Table 6 and Figure 5).

Pertaining to *Cyanobacteria*, the species belonging to this phylum exist in only three sites. The exception appears in Tyre (where the species having the middle distribution rate constitute 100%) (Table 6 and Figure 5).

Discussion

This present work was conducted to study the diversity of the seaweeds found in the Mediterranean Lebanese coast which has never been investigated.

Worldwide, there is an increasing importance given to learn more about seaweeds for their diverse biological activities such as anti-inflammatory, antimicrobial and anticancer [5,7-9,11,15,17-20] and the importance of some species of marine in food diet [9,21,22] as well as their contribution in pharmaceutical, drug development and food processing fields [3,14,20,23-25].

For these reasons we started to investigate the diversity of the flora of the Lebanese coast in marine algae.

On the other hand some studies have shown that when grown extensively, microalgae may produce harmful effects on marine or freshwater ecology and fishery resources [38].

Geographical distributions are more sensitive to environmental changes, especially water temperature because physiological activities of marine organisms depend on water temperature, Especially seaweeds [39,40].

Other studies show that climatic factors such as temperature, surrounding waters as rivers, etc. could influence the distribution of marine algae [41-46].

Photoperiod, along with temperature, regulates seaweed reproduction [45-47] Shipping, pollution and many other factors may play key roles in marine algae distribution, a change in their metabolism and then in their chemical composition and their biological activities.

This screening of the Lebanese coastline shows a broad and significant algal distribution. Our findings represent an important scientific infrastructure concerning the Mediterranean seaweeds,

Frequency		Number of identified species									
		Rhodophyta (n=41)		Ochrophyta (n=22)		Chlorophyta (n=26)		Cyanobacteria (n=5)			
n	%	n ^R	% ^R	n ^O	% ^O	n ^{Cl}	% ^{Cl}	n ^C	% ^C		
High	11	11.75	5	12.2	2	9.09	4	15.38	0	0	
Middle	36	38.25	11	26.83	13	59.09	9	34.62	3	60	
Low	47	50	25	60.97	7	31.82	13	50	2	40	

Table 5: Frequency/Phylum of the collected seaweeds species regardless their distribution in at least one of the sites where they are found.

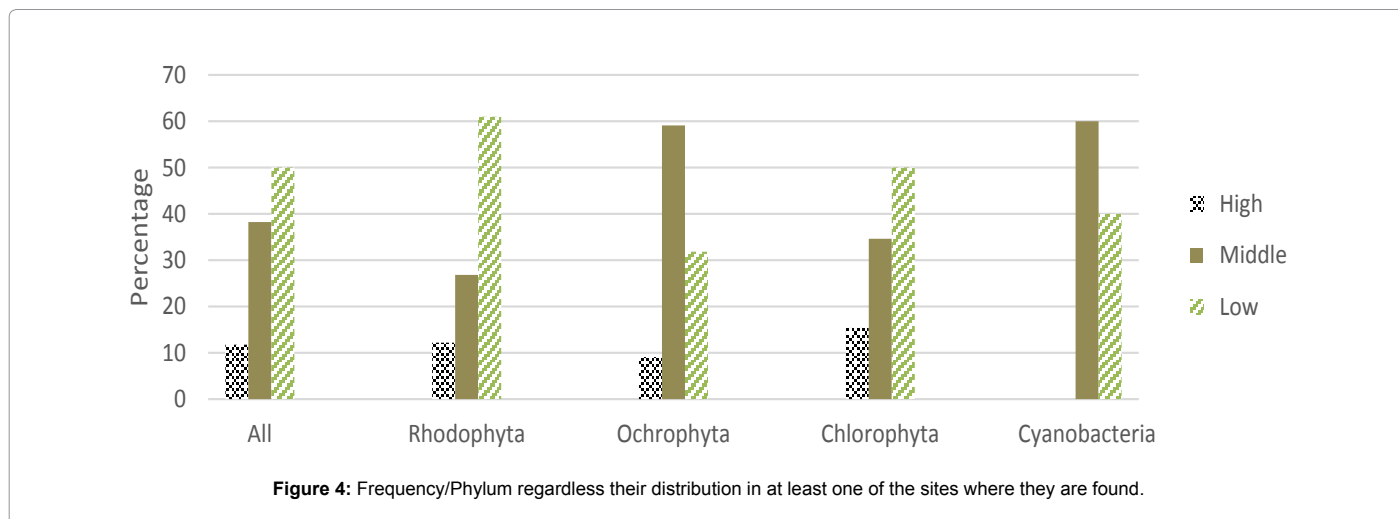
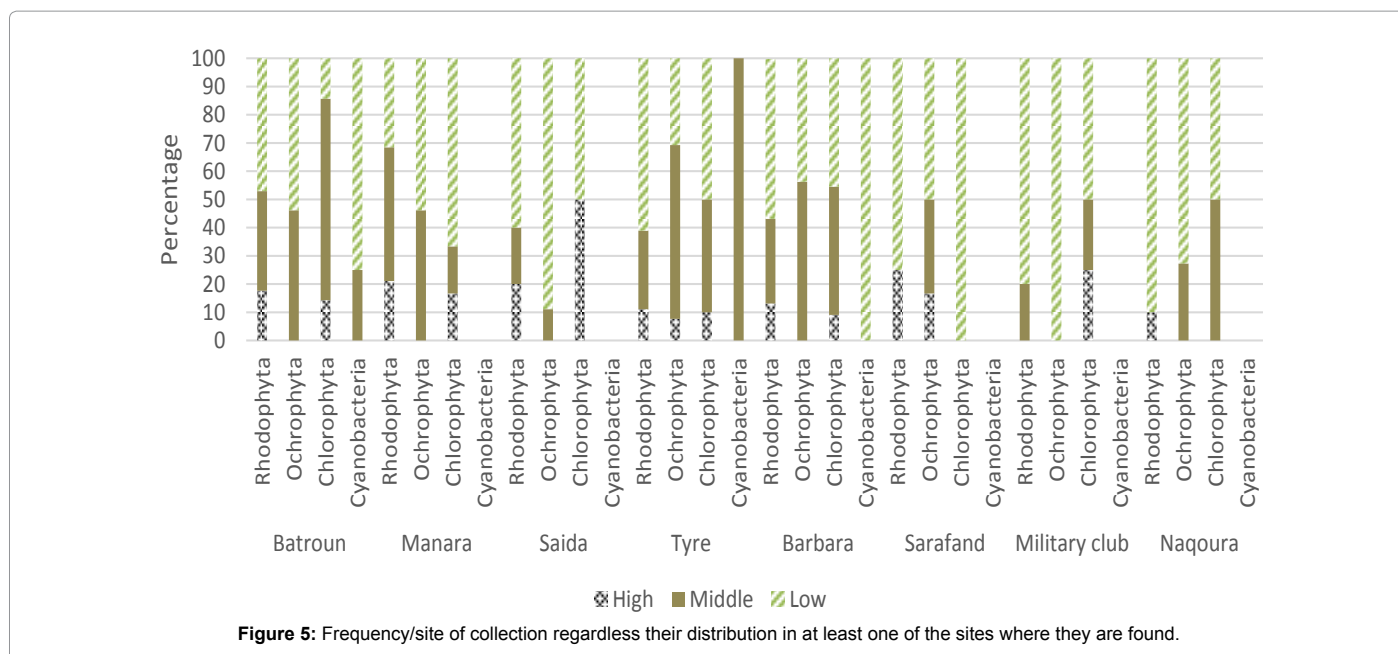


Figure 4: Frequency/Phylum regardless their distribution in at least one of the sites where they are found.

		Batroun	Manara	Saida	Tyre	Barbara	Sarafand	Military club	Naqoura	
Rhodophyta	n ^R	17	19	10	18	30	4	5	10	
	H	n	3	4	2	2	4	1	0	1
		%	17.65	21.06	20	11.11	13.33	25	0	10
	M	n	6	9	2	5	9	0	1	0
		%	35.3	47.37	20	27.78	30	0	20	0
	L	n	8	6	6	11	17	3	4	9
%		47.05	31.57	60	61.11	56.67	75	80	90	
Ochrophyta	n ^O	13	9	9	13	16	6	4	11	
	H	n	0	0	0	1	0	1	0	0
		%	0	0	0	7.69	0	16.67	0	0
	M	n	6	3	1	8	9	2	0	3
		%	46.15	33.33	11.11	61.54	56.25	33.33	0	27.27
	L	n	7	6	8	4	7	3	4	8
%		53.85	66.66	88.89	30.77	43.75	50	100	72.73	
Chlorophyta	n ^{Cl}	7	6	2	10	11	4	4	4	
	H	n	1	1	1	1	1	0	1	0
		%	14.29	16.67	50	10	9.09	0	25	0
	M	n	5	1	0	4	5	0	1	2
		%	71.42	16.67	0	40	45.45	0	25	50
	L	n	1	4	1	5	5	4	2	2
%		14.29	66.66	50	50	45.45	100	50	50	
Cyanobacteria	n ^C	4	0	0	2	2	0	0	0	
	H	n	0	0	0	0	0	0	0	0
		%	0	0	0	0	0	0	0	0
	M	n	1	0	0	2	0	0	0	0
		%	25	0	0	100	0	0	0	0
	L	n	3	0	0	0	2	0	0	0
%		75	0	0	0	100	0	0	0	

Table 6: Frequency/site of the collected seaweeds species regardless their distribution in at least one of the sites where they are found.



which provides a great assist in algal studies and all its applications in an interactive way by understanding the effect of the above mentioned factors as examples beside other important factors on them.

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