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MARINE ALGAL SURVEY OF DERNA, SUSA AND TOLMETA AT LIBYA COASTS

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Abstract

Sixty one of the marine macroalgal species (39 genera) were collected and identified from three coasts: Derna, Susa and Tolmeta;-which lie to the eastern of the Libyan coast. Twenty one species of these algae (34.43%) belonged to 13 genera of Chlorophyta, Twenty species of them (32.79%) belonged to 9 genera of the Phaeophyta, and twenty species (32.79%) belonged to 17 genera of the Rhodophyta; with a clear dominance of *Cystoseira* species. The relatively richest coast was Susa which has 38 algal species. Tolmeta coast comes at the second rank with 33 algal species while the poorest one was Derna coast with 12 species only (none of them belonged to Phaeophyta). The ecological status of marine surface waters and its purity could be arranged according to the species enrichment index of these coasts as follows: Susa > Tolmeta > Derna. The three coasts shared together only three green species and one red species (*Hypnea musciformis*). The similarity indices were 24% and 26.67% between Derna coast and both of Susa and Tolmeta, respectively. Meanwhile, the highest similarity value was (57.14%) between Susa and Tolmeta coasts.

Key words: Marine algae, Chlorophyta, Phaeophyta, Rhodophyta, Species richment index, Similarity index.

Introduction

Marine macroalgae have very economic potential as fodder, fertilizers, fuel, chemicals and medicine (**Critchley *et al.*, 1998**; **Dawes**, **1998**; **Faulkner**, **2002** and **Haefner**, **2003**) and antimicrobial activity (**Hafez *et al.*, 2005**; **El-**

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Gahmy, **2007** and **El-Fatemi**, **2008**). It is rich sources of nutritive materials, structurally novel and biologically active metabolites used in many new pharmaceutical industries (**Lima-Filho *et al.*, 2002**; **Ely *et al.*, 2004** and **Inci *et al.*, 2006**). It contains high amounts of carbohydrates, protein and minerals (**Ruoe'rez and Saura-Calixto**, **2001**). At least 500 of macroalgae are suitable for indirect and direct nutrition for human and fish (**Linda and Lee**, **2000**) and others used as ecological and biological indicators of water quality (**Pinedo *et al.*, 2007**). Libya has a very long coast extending over 1935 Km. south the Mediterranean Sea at the eastern north part of Africa. It is rich by economically important marine algal species. Many new species of marine algae at eastern Libyan coast recorded by **Nizamuddin *et al.*** (**1979**), **Nizamuddin and Godeh** (**1989**, **1990 a**, **b** & **c** and **1993**) and **Nizamuddin and El-Menifi** (**1993**).

There are little recent literatures about the marine algae of Libyan coast. **Ardissone** (**1893**) made the first Italian list of Libyan marine algae while, the last list of Libyan marine algae (168 species) was made by **Godeh *et al.*** (**1992**). Therefore, more research~~es~~ still needed for harvesting, identifying and evaluating the Libyan marine algae. From 2007 till now, the authors worked as a team and wrote a series of papers to assess these goals, and to assess the ecological status of marine surface water~~s~~ and its antimicrobial activities.

Material and Methods

The Study area:

The geographical location of study area is illustrated in Figure (1). Derna located about 175 Km. western Tobruk coast at 32° 45' 18.70" N and 22° 38' 17.80" E. It has a completely rocky shore with commercial port protected from winds and waves. The algae are mostly collected from the rocks at different depths and small sandy parts of shore. Susa coast extended 3 Km. and lies at 32° 54' 45.01" N and 21° 58' 31.07" E about 90 Km at the western of Derna. It is a protected shore with some small rocky islands.

Figure (1): Map of the study area.

The algae were collected from the rocks and about 4 meters depths. Tolmeta lies at 32° 41' 45.68" N and 20° 57' 38.99" E, about 200 km. at the western of Susa and about 190 Km. at the eastern of Benghazi. Their open rocky shore has some little sandy shores and some small rocky islands. It has also a small fishing port.

Sampling and sample preparations:

Specimens were harvested generally in the morning in ice tanks in polyethylene bags sprinkled with 4% formalin sea water for mounting on the herbarium sheets, glass bottles and some of them kept freshly at refrigerators for taxonomic identification using Italian list **Ardissone** (**1893**), **Pampanini** (**1931**), **Burrows** (**1991**) and **Aleem** (**1993**). Epiphytes, impurities and salts were removed carefully and quickly at laboratory with tap and distilled waters. The herbarium sheets have been deposited in the Herbarium, Department of Botany, Garyounis University, Benghazi {CHUG nos. FM. 650; 651}. Longitudinal and transverse sections of the axis at the apexes, midfronds and the bases were manually made and stained in 1% KI_2 or anilin blue solution.

Species richness:

Species richness index calculated according to **Wilhm** (**1975**) by the direct counting of different algal species at every sampling site. The decrease in number of species and increase in number of individuals were characteristic features for the polluted water.

Similarity index:

The similarity was calculated as statistical parameter by the equation of **Sorenson** (**1948**) to assess the degree of similarity between algal species of the studied sites which, depends upon the presence or absence of different taxa:

$$\mathbf{IS_s = (2C \times 100) / A + B}$$

Where: IS_s = similarity quotient.

C = number of species common in both sites.

A = number of species in the first site.

B = number of species in the second site.

Results and Discussion

Sixty one marine macroalgal species (39 genera) were identified at the study area with an agreement of the results of **Diaz-Valdes *et al*.** (**2007**) who identified 65 littoral macroalgae using them to assess the environmental quality of Valencian rocky coasts (SE Spain). **Diapoulis and Tsiamis** (**2007**) also found 88 marine benthic macroalgal taxa at the upper infralittoral zone of south Aegean Sea (Greece). Contrarily, Rhodes Island has a total of 155 macroalgal taxa (**Tsiamis *et al*.**, **2007**).

Regarding to the algal divisions at the study area, chlorophyta was represented by 13 genera (21 species, Table 1). The relatively richest coast with the green algae is Susa which had 18 species. Meanwhile Derna and Tolmeta coasts had 7 and 6 species, respectively .This is may be due to the presence of *Caulerpales* which considered as a strong competitors (**David *et al*.**, **2004** and **Piazzi *et al*.**, **2005**) and its production of toxic substances, which inhibit their grazing (**Piazzi *et al*.**, **2005**).

Table (1): Distribution of green marine algae at Derna, Susa and Tolmeta.

Algae	**Coasts**		
Chlorophyta	**Derna**	**Susa**	**Tolmeta**
Acetabularia acetabulum (linn.) Silva	-	+	+
Anadyomene stellata (Wulfen) C. Agardh	+	+	+
Bryopsis hypnoides Lamouroux	-	+	-
Caulerpa prolifera (Forsskål) Lamouroux	+	-	+
Chaetomorpha capillaries (Kütz.) Børgesen	-	+	-
Cladophora pellucida (Huds.) Kützing	-	+	-
Cladophora prolifera (Roth) Kützing	-	+	-
Cladophora pseudopellucida Vanden Hauk	-	+	-
Cladophoropsis modonensis (Kütz.) Børgesen Reinbold	-	+	-
Cladophoropsis (Kütz.) Børgesen Reinbold	-	+	-
Codium corymbosum Nizamuddin	-	+	-
Codium tomentosum (Huds.) Stackhouse	-	+	-
Codium coralloides (Kütz.) C. Agardh	-	+	-
Codium decorticatum (Woodw.) Howe	-	+	-
Dasycladus vermicularis (Scopoli) Krasser	+	+	+
Enteromorpha linza (Linnaeus) J. Agardh	+	-	-
Flabellia petiolata (Turra) Nizamuddin	-	-	+
Halimeda tuna (Ellis et Solander) Lamouroux	+	+	+
Ulva lactuca Linnaeus	-	+	-
Ulva rigida C. Agardh	+	+	-
Ulva reticulata Forsskål	+	+	-
Number of genus	**6**	**10**	**6**
Number of species	**7**	**18**	**6**

+: present -: absent

Phaeophyta (Table 2) was represented by 9 genera (20 species) with clear dominance of ten *Cystoseira* species, where its assemblages are very good ecological and biological indicators of environmental quality (**Arévalo *et al*.**, **2007**; **Ballesteros *et al*.**, **2007** and **Pinedo *et al*., 2007**). Derna coast lack completely any brown algal species so, it could be considered a polluted site. On

the other hand, both of Susa and Tolmeta had 14 species at least half of them *Cystoseira* species so, it could be considered more pure and stable sites. **Mubina and Nausheba** (**1992**) identified 48 brown species at Karachi coast. Therefore, the study area could be considered poor of Phaeophyta.

Table (2): Distribution of brown marine algae at Derna, Susa and Tolmeta.

Algae	Coasts		
Phaeophyta	**Derna**	**Susa**	**Tolmeta**
Colpomenia sinuosa (Mertens ex Roth) Derbés ét Solier	-	+	-
Cystosiera barata (Stackhouse) C. Agardh	-	+	+
Cystosiera cinitophylla Ercegovic	-	+	+
Cystosiera compressa Gerloffi ét Nizamuddin	-	+	+
Cystosiera elegans Sauvageau ét Feldmann	-	+	+
Cystosiera erica-marina (Gmelin) Naccari	-	+	-
Cystosiera discors (Linn.) C. Agardh emend Sauvageau	-	-	+
Cystosiera gerloffi (Nizamuddin)	-	+	+
Cystosiera susanensis (Nizamuddin)	-	+	-
Cystosiera stricta (Montagne) Sauvageau	-	-	+
Cystosiera mediterranea var. valiante Sauvageau	-	+	-
Dictyopteris membranacea (Skackhouse) Batters	-	+	+
Dictyopteris tripolitanea Nizamuddin	-	-	+
Dictyota dichotoma (Hudson) lamouroux	-	+	+
Dictyota fasciola var. reoeus (J. Ag.) Feldmann {*Dilophus fasciola* (Roth) M.A. Howe}	-	+	-
Halopteris scoparia (Linnaeus) Sauvageau	-	+	-
Padina pavonica (Linnaeus) Lamouroux Thivy	-	+	+
Sargassum hornscuchii C. Agardh	-	-	+
Scytosiphon lomentaria (Lyngbye) Lamouroux	-	-	+
Taonia atamaria (Woodward) J. Agardh var. atamaria	-	+	-
Number of genus	**0**	**7**	**6**
Number of species	**0**	**14**	**14**

+: present -: absent

Meanwhile, Rhodophyta was represented by 17 genera and 20 species (Table 3). The richest coast of red algae was Tolmeta which had 13 species while Susa and Derna coasts had only 6 and 5 species, respectively. All of these coasts are relatively poor by Rhodophyta if compared with South Aegean Sea (Greece) which qualitatively dominated by 60 red algal taxa (**Diapoulis and Tsiamis**, **2007**).

Table (3): Distribution of red marine algae at Derna, Susa and Tolmeta.

Algae	Coasts		
Rhodophyta	**Derna**	**Susa**	**Tolmeta**
Acrosorium uncinatum (J. Agardh) kylin	-	-	+
Amphiroa rigida Lamouroux	-	-	+
Botryocladia botryoides (Wulf.) Feldmann	-	-	+
Centroceras clavulatum (C. Agardh) Montagne	+	-	-
Chondriopsis mediterranea (Kütz.) J. Agardh	-	-	+
Chrysmenia ventricosa (Lamour.) J. Agardh	-	-	+
Corallina granifera (Ellis ét Solander)	-	+	-
Corallina mediterranea	+	-	-
Dermatolithon pustulatum (Lamouroux) Foslie	-	-	+
Hypnea musciformis (Wulfen) Lamouroux	+	+	+
Jania adhaerens Lamouroux	-	-	+
Jania rubens (Linnaeus) Lamouroux	-	-	+
Laurencia obtusa (Hudson) Lamouroux	-	+	-
Laurencia papillosa (Forsskål) C. Agardh	-	+	+
Liagora viscida (Forsskål) C. Agardh	-	+	-
Lophocladia lallemandii (Montagne) Schmitz	-	+	-
Mesophyllum lichenoides (Ellis ét Solmander) Lemoine	-	-	+
Peyssonnelia elegella Harvey	-	-	+
Pseudolithophyllum expansum (Philippi) Lemoine	+	-	-
Rytiphlaea tinctoria (Clemente) C. Agardh	+	-	+
Number of genus	**5**	**5**	**12**
Number of species	**5**	**6**	**13**

+: present -: absent

Table (4) illustrated that species of Chlorophyta came at the first by 34.43% while species of both Phaeophyta and Rhodophyta came next by 32.79% for each. These percentages were more or less similar to the finding of eastern Libyan coast recorded by **Godeh *et al*.** (**1992**). Most of these algae were recorded also at the Turkish Urla coast (**Inci *et al*., 2006**) may be due to the same weather conditions.

Species richness index of different coasts were calculated by direct count of different marine algal species (Figure 2). Derna coast could be considered the poorest and more polluted coast of the study area where it had 12 species only (none of them belong to Phaeophyta). Meanwhile; Susa coast had 38 algal species and could be considered the relatively richest coast. Tolmeta coast had 33 different algal species. So, according to the species richness index, the purity of these coasts could be arranged as: Susa > Tolmeta > Derna. **Wilhm** (**1975**) and **El-Ayouty *et al*.** (**1999**) evaluated that, the decrease in number of species and the increase in number of individuals is a characteristic feature of polluted water.

Said (**2004**) and **Said *et al***. (**2005**) also used the species richness parameters to evaluate the purity and pollution state of different eight and four water bodies, respectively. It was mostly correlated with Chlorophyta for its dominance and variation of its taxa like the present study area. These coasts belong to Pleistocene deposits, continuously exposed to rough conditions and fluctuating cold to mild weather and generally poor in algal growth (**Nizamuddin**, **1985**).

Table (4): Distribution of algal genera and species* at Derna, Susa and Tolmeta coasts.

Algae \ Coasts	Present at one coast only						Shared at tow coasts only						Shared at the three coasts		Total	
	Derna		Susa		Tolmeta		Derna & Susa		Derna & Tolmeta		Susa & Tolmeta					
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Chlorophyta																
genus	**1**	7.69	**5**	38.46	**1**	7.69	**1**	7.69	**1**	7.69	**1**	7.69	**3**	23.08	**13**	33.33
	33.33		55.56		8.33		50		50		14.29		75			
species	**1**	4.76	**12**	57.19	**1**	4.76	**2**	9.52	**1**	4.76	**1**	4.76	**3**	14.29	**21**	34.43
	25		54.54		5.88		100		50		10		75			
Phaeophyta																
genus	**0**	0.00	**2**	22.22	**2**	16.67	**0**	0.00	**0**	0.00	**5**	55.56	**0**	0.00	**9**	23.08
	0.00		22.22		16.67		0.00		0.00		71.42		0.00			
species	**0**	0.00	**6**	28.57	**6**	28.57	**0**	0.00	**0**	0.00	**8**	40	**0**	0.00	**20**	32.79
	0.00		27.27		35.29		0.00		0.00		80		0.00			
Rhodophyta																
genus	**2**	11.76	**2**	11.79	**9**	52.94	**1**	5.88	**1**	5.88	**1**	5.88	**1**	5.88	**17**	43.59
	66.67		22.22		75		50		50		14.29		25			
species	**3**	15	**4**	20	**10**	50	**0**	0.00	**1**	5	**1**	5	**1**	5	**20**	32.79
	75		18.18		58.82		0.00		50		10		25			
Total																
genus	**3**	7.69	**9**	23.08	**12**	30.77	**2**	5.13	**2**	5.13	**7**	17.95	**4**	10.26	**39**	
species	**4**	6.56	**22**	36.07	**17**	27.87	**2**	3.28	**2**	3.28	**10**	16.39	**4**	6.56	**61**	

*: Bold figures (No.) = are number of genus and species.

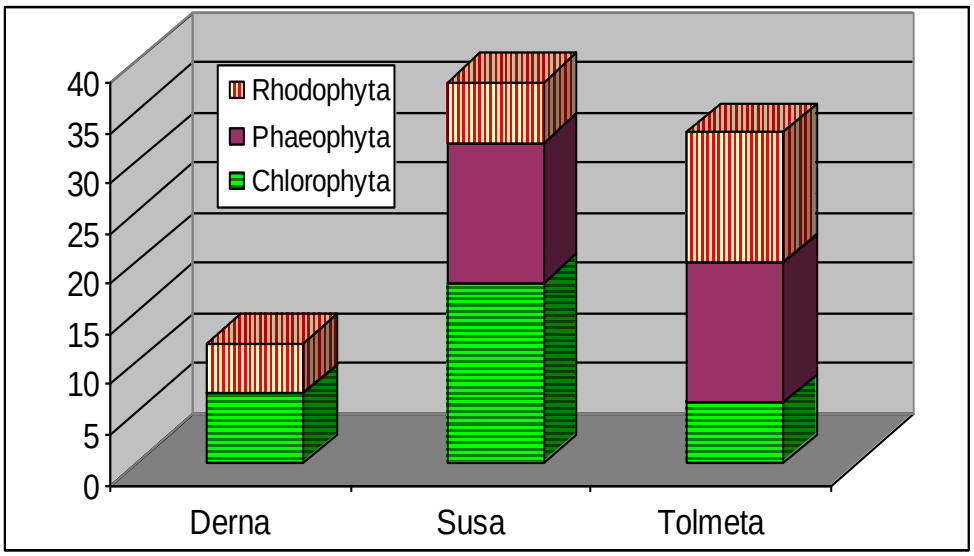

Figure (2): The presence of different marine algal groups at Derna, Susa and Tolmeta coasts.

There are some marine algal species found only at every coast while, others were shared at two coasts (Table 4). Just four (6.56%) algal species (3 genera) were present only at Derna coast (the relatively poorest coast). Twenty two (36.07%) marine algal species (9 genera) found only at Susa coast (the relatively richest coast). Seventeen (27.87%) marine algal species (12 genera) found only at Tolmeta coast (the relatively moderate coast). Just two (3.28%) algal species (2 genera) were shared at Derna coast and both of Susa and Tolmeta coasts while ten (16.39%) algal species (7 genera) were common in both coasts of Susa and Tolmeta. Surprising was that, there are only four (16.39) algal species (4 genera) shared at the three coasts; three species of them belonged to Chlorophyta (*Anadyomene stellata, Dasycladus vermicularis* and *Halimeda tuna*) and just one species of Rhodophyta (*Hypnea musciformis*). **Godeh *et al***. (**2009**) reported that, Tobruk had a rich coast characterized by thirty six species of different marine algae at relatively similar area and conditions.

It seemed more convenient to produce more one matrix to evaluate the similarity parameters between Derna, Susa and Tolmeta coasts according to Chlorophyta, Phaeophyta, Rhodophyta and Total algae using the equation of **Sorenson** (**1948**) depending on the presence or absence of different taxa. The degree of similarity among green species recorded the highest percentages especially between Derna and Tolmeta (61.54%).

Of course there was no similarity between brown species of Derna and any other coasts due to the complete absence of Phaeophyta while it was relatively

high (59.26%) in Susa and Tolmeta coasts (Table 5). The degree of similarity between red species were relatively low (around 20%) in all coasts. Logically, due to the complete absence of Phaeophyta of Derna, the degrees of similarity among all algal species were also relatively low between all coasts.

Table (5): Similarity between Derna, Susa and Tolmeta coasts according to Chlorophyta (above diagonal) and Phaeophyta (below diagonal).

Coasts	Derna	Susa	Tolmeta
Derna	100%	**40**	**61.54**
Susa	**0.00**	100%	**33.33**
Tolmeta	**0.00**	**59.26**	100%

The highest value (57.14%) was recorded between Susa and Tolmeta (Table 6). **Said** (**2004**) and **Said *et al***. (**2005**) evaluated the similarity parameters according to different algal groups between eight and four different water bodies, respectively.

Table (6): Similarity index between Derna, Susa and Tolmeta coasts according to Rhodophyta (above diagonal) and Total algae (below diagonal).

Coasts	Derna	Susa	Tolmeta
Derna	100%	**18.18**	**22.22**
Susa	**24**	100%	**21.05**
Tolmeta	**26.67**	**57.14**	100%

The R/P ratio was 0.43 and 0.93 at Susa and Tolmeta coasts respectively, which lower than those of subtropical like, Turkish coast (2.0) which recorded by **Güven and Özting** (**1971**), the eastern coast of Libya (2.05) which recorded by **Godeh *et al***. (**1992**) and Tobruk coast (1.45) which recorded by **Godeh *et al***. (**2009**). The R/P ratio of Derna coast could not calculated due to the absence of Phaeophyta. This intertidal zone and rocky coasts always exposed to low tides and the collection of algae was done at "stable water" with agreement of same conditions at Robe coast of south Austria (**Dawes**, **1998**). Rhodophyta exceeded brown and green algae at temperate and tropical regions only (**Lee**, **1999**). The value of R/P ratio in Rhodes Island and south Agean Sea (Greece) is 3.5 and 3.2 respectively, suggested a warm-temperate aspect of macroalgal flora (**Diapoulis and Tsiamis**, **2007** and **Tsiamis *et al***., **2007**).

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الطحالب البحرية بشواطئ درنة،سوسة و طلميثة- ليبيا.

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استهدفت الدراسة تجميع وتعريف الطحالب البحرية النامية على شواطئ درنة و سوسة وطلميثة على الساحل الشرقي الليبي, وتحديد نسب التماثل بين المناطق الثلاث والحالة البيئية لكل منهم. تم تجميع وتعريف 61 نوعا (39 جنسا) من الطحالب البحرية من شواطئ درنة, وسوسة و طلميثة ووجد بينهم 21 نوعا يتبع الطحالب الخضراء (34.43%), 20 نوعا يتبع الطحالب البنية (32.79%) و20 نوعا يتبع الطحالب الحمراء (32.79%), مع سيادة واضحة لعدة أنواع من طحلب سيستوسيرا ولقد وجد ان شاطئ سوسة هوالأغنى بكل المجموعات الطحلبية (38 نوعا) تلاه شاطئ طلميثة (33 نوعا). بينما كان شاطئ درنة الأفقر نسبيا-(12 نوعا فقط) مع غياب كامل للطحالب البنية. أمكن ترتيب الشواطئ الثلاثة حسب درجة نقاء مياهها كالتالى سوسة > طلميثة > درنة طبقا لمعامل الوفرة الخاص بالأنواع ذات المدلولات الحيوية منها. كان من اللافت للنظر عدم اشتراك المناطق الثلاثة إلا فى ثلاثة طحالب خضراء فقط, إضافة إلى طحلب أحمر واحد فقط هو هيبنيا موسيفورميس. بناء على الأنواع الطحلبية الكلية,فقد وجد أن نسب التماثل بين المناطق الثلاث قليلة نسبيا حيث كانت بين درنة وكل من سوسة و طلميثة 24 % و26.67%, على التوالي. بينما كانت نسبة التماثل أكبر نسبيا (57.14%) بين سوسة و طلميثة.