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MARINE ALGAE OF TUKRA AND TOLMETA COASTS, LIBYA

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Abstract

The present investigation was mainly intended to make a recent data base of marine algal flora of Libyan coast which extend about 1900 Km. Seventy five marine algal species (53 genera) were collected and identified from two sampling stations at Tukra and Tolmeta coasts at the eastern Libyan coast. Eleven species (14.17%) belong to Chlorophyta, Seventeen species (22.67%) belonging to Phaeophyta (with special reference to genera *Cystosiera*) and forty seven species (62.67%) belonging to Rhodophyta which showed clear dominancy. The two coasts shared 17.33% of species (13). Tukra coast was richer of algal species (74.67%) all representing algal groups. It also characterized by 43 dominant species. Meanwhile, Tolmeta coast was relatively poor, only 32 species were found. Regarding to Chlorophyta, the similarity index between the two coasts was relatively high (70.59%). On the other hand, it was relatively low (30%, 15.69 and 27.21%) between Phaeophyta, Rhodophyta and total algae, respectively. Many of the collected algae are good ecological quality indicators having economic importance and need further investigations.

Key words: Chlorophyta, Marine macroalgae, Phaeophyta, Rhodophyta, R/P ratio, Species richness index and Similarity index.

Introduction

The first record of Libyan marine algae was recorded by the Italian scientist Ardissone (1893) then Nizamuddin *et al.* (1979) listed marine algae of Libya. Nizamuddin and Godeh (1989, 1990 a, b & c and 1993) and Nizamuddin and El-Menifi (1993) recorded many new species of marine algae at eastern Libyan coast. The last list of Libyan marine algae (168 species) was made by Godeh *et al.* (1992).

Deep sub tidal rocky habitats of Mediterranean Sea are characterized by assemblages dominated by calcareous organisms which have important role in carbonate cycle (Ballesteros, 2006). In Mediterranean Sea, invasions of exotic macroalgae have caused serious ecological problems in costal areas (Boudouresque and Verlaque, 2002). Most of green, brown and red seaweeds or macroalgae have economic potential (Critchley *et al.*, 1998) and used as ecological quality indicators (Pinedo, *et al.*, 2007) so, more than 500 species safely now used as direct and indirect human and fish food (Dawes, 1998) because they are a rich of nutritive materials, structurally novel and biologically

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active metabolites and used in new pharmaceutical industries (Lima-Filho *et al.:* 2002: Ely *et al.,* 2004 and Tüney *et al.,* 2006) and recently showed antimicrobial activities (Hafez *et al.,* 2005; El-Gahmy, 2007 and El-Fatemi, 2008). The economic success of these crops depends greatly upon detailed basic knowledge of the algae (Linda and Lee, 2000).

More recent researches still needed to collect, identify and evaluate the great importance of marine algae of the very rich Libyan coast which extend about 1900 Km. southern Mediterranean Sea at the eastern north part of Africa. The aim of this paper is to describe the algal species composition and its biodiversity in two different eastern Libyan coasts and to compare them to reference assemblages.

Material and Methods

The Study area:

The geographical location of the study area is illustrated in Figure 1. Tukra coast lies about 100 Km. northern east Benghazi while, Tolmeta coast lies, about 150 Km. northern east Benghazi at 32° 41' 45.68" N and 20° 57' 38.99" E. Their open rocky shores had little sandy shores and some small rocky islands very closed to their beach. They are also had a very small fishing ports without any pollution and human beings activities.

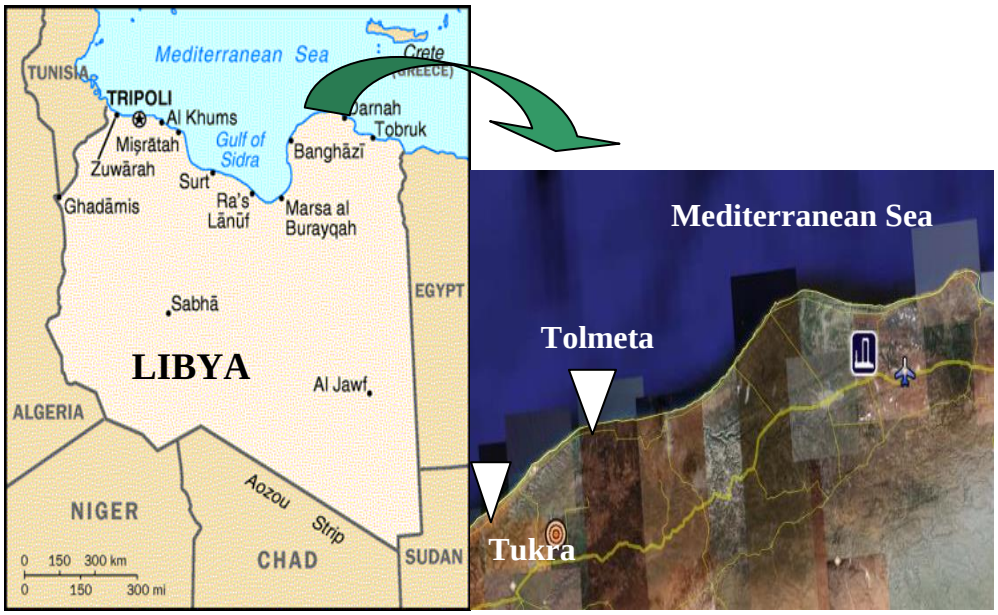

Figure 1. Maps of Libya and the study area.

Sampling and sample preparations:

Specimens were harvested generally in the morning in ice tanks at nylon or polyethylene bags sprinkled with 4% formalin sea water solution for mounting on the herbarium sheets, glass bottles and some of them kept freshly at refrigerators for future use and subsequent taxonomic identification using Ardissone Italian list (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 hand made and stained in 1% KI_2 or Anilin blue solution.

Species richness:

Species richness index calculated according to Wilhm (1975) by direct count of different algal species (taxa) at every sampling site where, the decrease in number of species and increase in number of individuals is a characteristic feature of 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 composition of pairs of stations under investigation 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 to both site.

A = number of species in the first site.

B = number of species in the second site.

Results and Discussion

A total of 75 macroalgal species and 54 genera were found at the study area. The results were more or less qualitatively and quantitatively similar to those 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 which can be considered relatively richer had a total of 155 macroalgal taxa (Tsiamis *et al*., 2007).

Chlorophyta were represented by Just eleven species (14.67%), nine genera (16.67%) of the total recorded algae (Table 1), The reduction of green species may be due to the presence of *Caulerpales* which considered 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 macroalgae at Tukra and Tolmeta coasts.

Chlorophyta	**Tukra**	**Tolmeta**
***Acetabularia* Lamouroux 1817**		
Acetabularia acetabulum (lamx.) Silva	+	+
***Anadyomene* Lamouroux 1812**		
Anadyomene stellata (Wulf.) C. Agardh	+	+
***Caulerpa* Lamouroux 1809**		
Caulerpa prolifera (Forsskål) Lamouroux	+	+
Cladophora Kützing 1843		
Cladophora prolifera (Roth) Kützing	+	-
Cladophora nigrescens Zan. éx Frauenfeld	+	-
***Codium* Stackhouse 1797**		
Codium decorticatum (Woodw.) Howe	+	-
Codium difforme (Kützing) Kützing	+	-
***Dasycladus* C. Agardh 1828**		
Dasycladus vermicularis (Scopoli) Krasser	+	+
***Flabellia* Reichenbach (*Udtea* Lamouroux)**		
Flabellia petiolata (Turva) Nizamuddin	+	+
***Halimeda* Lamouroux 1816**		
Halimeda tuna (Ellis ét Solander) Lamouroux	+	+
***Ulva* Linnaeus 1753**		
Ulva lactuca Linnaeus	+	-
Number of genus	**9**	**6**
Number of species	**11**	**6**

Seventeen species (22.67%), eight genera (14.81%) of them were belonging to Phaeophyta (Table 2). Genus *Cystosiera* are the most abundant ones at both coasts. *Cystosiera* species are usually the dominant element of the benthic vegetation on unpolluted hard substratum (Peres and Picard, 1964) and could used as an additional important argument for securing a more wise and sustainable use of the coastal ecosystem that they indeed play a critical role in the conservation of species and habitat diversity (Turk *et al.*, 2007).

Rhodophyta showed clear dominancy (Table 3) by forty seven species (68.52%), thirty seven genera (67.92%). The result was slightly similar to South Aegean Sea (Greece) which dominated by 60 red algal taxa (Diapoulis and Tsiamis, 2007).

Table (2). Distribution of brown marine macroalgae at Tukra and Tolmeta coasts.

Phaeophyta	Tukra	Tolmeta
***Cystosiera* C. Agardh 1820**		
Cystosiera barbata (Good ét Wood) J. Agardh	+	+
Cystosiera cinitophylla Ercegovic	-	+
Cystosiera compressa Gerloffi ét Nizamuddin	+	+
Cystosiera elegans Sauvageau ét Feldmann	-	+
Cystosiera discors (Linn.) C. Agardh emend Sauvageau	-	+
Cystosiera gerloffi Nizamuddin	-	+
Cystosiera susanensis Nizamuddin	+	-
Cystosiera stricta (Montagne) Sauvageau	-	+
***Dictyopteris* Lamouroux 1809**		
Dictyopteris membranacea (Skackhouse) Batters	-	+
Dictyopteris tripolitana Nizamuddin	+	+
***Dictyota* Lamouroux 1809**		
Dictyota dichotoma (Hudson) lamouroux	-	+
***Ectocarpus* Lyngbye emend. Hamel**		
Ectocarpus confervoides (Roth) Kiellman	+	-
***Padina* Adanson 1763**		
Padina pavonia (Linnaeus) Lamouroux	-	+
***Sargassum* C. Agardh 1820**		
Sargassum acinarium C. Agardh	+	-
Sargassum hornscuchii C. Agardh	-	+
***Scytosiphon* C. Agardh 1820**		
Scytosiphon lomentaria (Lyngbye) Lamouroux	-	+
***Taonia* J. Agardh 1848**		
Taonia atamaria (Woodward) J. Agardh var. atamaria	+	-
Number of genus	**5**	**6**
Number of species	**7**	**13**

Tukra coast is richer of algal species than Tolmeta coast (Table 4 and Figure 2). Tukra characterized by 43 species (57.33%) and 30 genera (55.56%). Chlorophyta represented by 5 species (11.63%) and 3 genera (10.00%), Phaeophyta represented by 4 species (9.30%) and 2 genera (6.67%) and Rhodophyta represented by 34 species (79.07%) and 25 genera (67.76%). At relatively similar area and conditions, Godeh *et al*. (2008) reported that, Tobruk coast characterized by thirty six species of different marine algae.

Meanwhile, Tolmeta characterized alone by only 19 species (25.33%) and 11 genera (20.37%). There are no any characterized species of Chlorophyta,

Table (3). Distribution of red marine macroalgae at Tukra and Tolmeta coasts.

Rhodophyta	**Tukra**	**Tolmeta**
***Acrosorium* Zanardini 1869**		
Acrosorium uncinatum (J. Agardh) kylin	-	+
***Alsidium* C. Agardh 1827**		
Alsidium coraillinum (Tur.) Kützing	+	-
Alsidium helmithochooton (Tur.) Kützing	+	-
***Amphiroa* Lamouroux**		
Amphiroa rigida Lamouroux	-	+
***Borgeseniella* Kylin**		
Borgeseniella purfruticulos (Wulf.) Kylin	+	-
***Botryocladia* Kylin 1931**		
Botryocladia botryoides (Wulf.) Feldmann	-	+
***Ceramium* Roth 1797**		
Ceramium diaphanum var. elegans (Roth) Feldmann ét Mazoyer	+	-
***Chondria* C. Agardh 1817**		
Chondria coerulescens (Stackhouse ét Wood word) Falkenberg	+	-
Chondria dasyphylla (Stackhouse ét Wood word) J. Agardh	+	-
***Chondriopsis* J. Agardh 1863**		
Chondriopsis mediterranea (Kütz.) J. Agardh	+	+
***Chrysmenia* J. Agardh 1842**		
Chrysmenia ventricosa (Lamour.) J. Agardh	-	+
***Corallina* Linnaeus 1758**		
Corallina granifera Ellis ét Solander	+	-
Corallina officinalis Linnaeus	+	-
***Dasya* C.Agardh 1822**		
Dasya lallemandii Moneghne	+	-
Dasya villosa Harvy	+	-
Dasya rigidula (Kütz.) Ardissone	+	-
***Dermatolithon* Forslie**		
Dermatolithon pustulatum (Lamouroux) Foslie	-	+
***Digenia* C. Agardh 1822**		
Digenia simplex (Wulf.) C. Agardh	+	-
***Fosliella* Howe**		
Fosliella farinose (Lamour) Howe	+	-
Fosliella lejolisii (Ros.) Howe	+	-
***Gracilaria* Greville 1830** (Hud.)		
Gracilaria verrucosa (Hud.) Papenfuss	+	-
***Griffithsia* C. Agardh 1817**		
Griffithsia barbata (Huds.) C. Agardh	+	-
***Halopitys* Kützing Itys 1849**		
Halopitys incurvus (Hud.) Batters Itys	+	-
***Halurus* Kützing 1843**		
Halurus equisetifolius (Lightf.) Kützing	+	-

***Herposiphonia* Nageli 1846**		
Herposiphonia secunda (C. Agardh) Ambronn	+	-
***Hypnea* Lamouroux 1813**		
Hypnea musciformis (Wulf.) Lamouroux	+	+
***Hypoglossum* Kützing 1843**		
Hypoglossum crispum Kützing	+	-
***Jania* Lamouroux 1812**		
Jania adhaerens Lamouroux	-	+
Jania rubens (Linnaeus) Lamouroux	-	+
***Laurencia* Lamouroux 1813**		
Laurencia liophora Kützing	+	-
Laurencia obtusa (Hudson) Lamouroux	+	-
Laurencia paniculata (C. Agardh) Kützing	+	-
Laurencia papillosa (Forsskål) C. Agardh	+	+
***Liagora* Lamouroux 1812**		
Liagora viscida (Forsskål) C. Agardh	+	-
***Lophosiphonia* Falkenberg 1897**		
Lophosiphonia obscura (C. Agardh)	+	-
***Mesophyllum* Lemoine**		
Mesophyllum lichenoides (Ellis ét Solmander) Lemoine	-	+
***Neogoniolithon* Setchell ét Mason**		
Neogoniolithon mamiilusum (Hauck) Hewe	+	-
***Peyssonnelia* Decaisne 1842**		
Peyssonnelia elegella Harvey	-	+
***Phyllophora* Greville**		
Phyllophora nervosa (De Cand.) Greville	+	-
***Plocamium* Lamouroux 1913**		
Plocamium cartilagineum (Lann.*)* Dixon	+	-
***Polysiphonia* greville 1830**		
Polysiphonia castilliana Denotaris ét Dufour greville	+	-
***Ricardia* Derbes et Solier 1856**		
Ricardia montagnei Derbes ét Solier	+	-
***Rhodochorton* Nageli 1862**		
Rhodochorton floridulum (Dillwyn) Nageli	+	-
***Rytiphlaea* C. Agardh 1824**		
Rytiphlaea tinctoria (Clemente) C. Agardh	+	+
***Sphaerococcus* Stackhouse**		
Sphaerococcus coronopifolius Stackhouse ét Wood Word	+	-
***Viladia* Lamouroux 1822**		
Viladia volubilis (Linn.) J. Agardh	+	-
***Wrangelia* C. Agardh**		
Wrangelia penicillata (C. Agardh) C. Agardh	+	-
Number of genus	**29**	**12**
Number of species	**38**	**13**

Phaeophyta represented by 10 species (52.63%) and 3 genera (27.27%) and Rhodophyta represented by 9 species (47.37%) and 8 genera (72.73%).

Table 4. Distribution of algal genera and species at Tukra and Tolmeta coasts.

Algae \ Coasts		Recorded at Tukra only		Recorded at Tolmeta only		Shared at both coasts		Total	
		No.	%	**No.**	%	**No.**	%	**No.**	%
Chlorophyta	**genus**	**3**	33.33	**0.0**	0.00	**6**	66.67	**9**	16.67
		10.0		0.00		46.15			
	species	**5**	45.45	**0.0**	0.00	**6**	54.54	**11**	14.67
		11.63		0.00		46.15			
Phaeophyta	**genus**	**2**	25	**3**	37.5	**3**	37.5	**8**	14.81
		6.67		27.27		23.08			
	species	**4**	23.53	**10**	58.82	**3**	17.65	**17**	22.67
		9.30		52.63		23.08			
Rhodophyta	**genus**	**25**	67.76	**8**	21.62	**4**	10.81	**37**	67.92
		83.33		72.73		30.77			
	species	**34**	72.34	**9**	19.15	**4**	8.51	**47**	68.52
		79.07		47.37		30.77			
Total	**genus**	**30**	55.56	**11**	20.37	**13**	24.07	**54**	
	species	**43**	57.33	**19**	25.33	**13**	17.33	**75**	

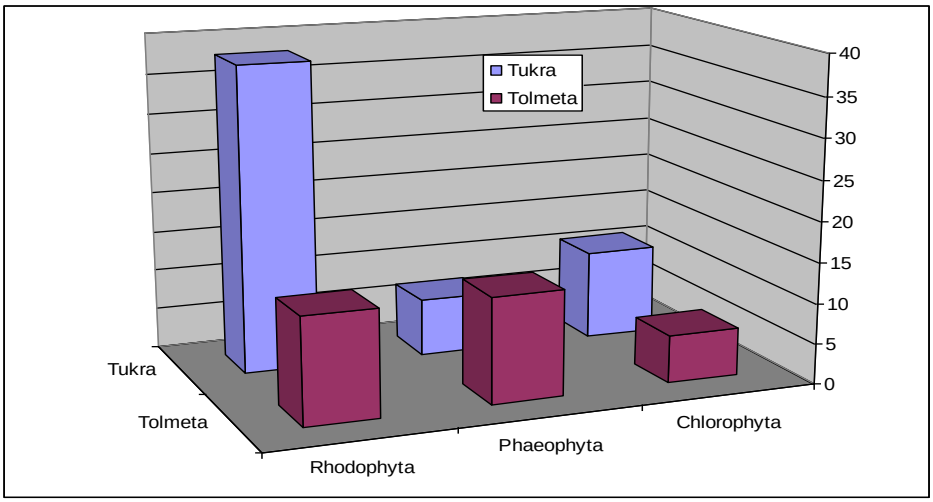

Figure 2. The presence of different marine algal groups Tukra and Tolmeta coasts

According to the species richness indication of Wilhm (1975) one could conclude that, Tukra coast is more pure and sustained than Tolmeta coast. Said *et al.* (2005) used the species richness parameters carefully to evaluate the purity and pollution state of different four water bodies.

Both coasts shared together by 13 species (17.33%) and 13 genera (24.07%). Six species (46.15%) and 6 genera (46.15%) belonging to Chlorophyta, 3 species (23.08%) and 3 genera (23.08%) belonging to Phaeophyta and 4 species (30.77%) and 4 genera (30.77%) belonging to Rhodophyta (Table 4).

The R/P ratio of Tukra is very high (5.43) due to the clear dominancy of Rhodophyta. Meanwhile, it is equal at Tolmeta due to the balance of both Rhodophyta and Phaeophyta (13 species of each). Nearest to these of Rhodes Island, Greece (3.5), this suggests a warm-temperate aspect of macroalgal flora (Tsiamis, 2007). This value corresponding to other macroalgal studies of the Greek coasts (Lazarido, 1994; Tsirika, 2005). Nizamuddin (1985) evaluated that eastern Libyan coasts were generally poor in algal growth and continuously exposed to rough conditions and fluctuating cold to mild weather because they belong to Pleistocene deposits. According to the finding of Diaz-valdes *et al.* (2007) and Pinedo, *et al.* (2007) many of the identified marine algal taxa considered as indicators to the good and very good ecological quality waters like, *Cystoseira*, *Corallina*, *Hypnea*, *Jania* and *Laurencia.*

Regarding to the similarity index between the two coasts (Tables 5and6), using the equation of Sorenson (1948) depending upon the presence or absence of different taxa, is relatively high (70.59%) only between Chlorophyta, while it is relatively low (30%, 15.69% and 27.21%) between Phaeophyta, Rhodophyta and total algae, respectively. Godeh *et al.* (2008) evaluated that, the similarity index between the total algae of Tolmeta coast and some eastern Libyan coasts like Derna and Susa were 24% and 57.14%, respectively.

Table 5. Similarity index between Tukra and Tolmeta coasts according to Chlorophyta (above diagonal) and Phaeophyta (below diagonal).

Coasts	**Tukra**	**Tolmeta**
Tukra	100%	**70.59%**
Tolmeta	**30%**	100%

Table 6. Similarity index between Tukra and Tolmeta coasts according to Rhodophyta (above diagonal) and Total algae (below diagonal).

Coasts	Tukra	Tolmeta
Tukra	100%	**15.69%**
Tolmeta	**27.21%**	100%

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الطحالب البحرية بشاطئى توكرة وطلميثة, ليبيا

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يهتم البحث أساسا بعمل قاعدة بيانات حديثة للطحالب البحرية الليبية بالساحل الليبي الذى يمتد حوالي 1900 كم. خمسة وسبعون نوعا من الطحالب البحرية (53 جنس) جمعت وعرفت من منطقتين شاطئيتين بالساحل الليبي الشرقي هما توكرة وطلميثة. كان أحد عشر نوعا طحلبيا منهم (14.17%) ينتمي للطحالب الخضراء، سبعة عشر نوعا (22.67%) تنتمي للطحالب البنية (خاصة جنس *Cystosiera*) وكذلك سبعة وأربعون نوعا (62.67%) تنتمي للطحالب الحمراء التى أظهرت سيادة واضحة. اشترك الشاطئان معا فى تواجد ثلاثة عشر نوعا بكل منهما (17.33%). شاطئ توكرة كان هو الأغنى بالطحالب البحرية حيث تواجد به 56 نوعا (74.67%) من كل المجموعات الطحلبية واختص منهم منفردا بوجود 43 نوعا (57.33%). فى حين كان شاطئ طلميثة الأفقر نسبيا حيث تواجد 32 نوعا فقط (42.67%) من كل المجموعات الطحلبية واختص منهم منفردا بوجود 19 نوعا فقط (25.33%). معامل التماثل بين الشاطئين كان عاليا نسبيا (70.59%) بناء على التشارك فى الطحالب الخضراء فيما بينهما، بينما كان منخفضا نسبيا (30, 15.69 و 27.21%) بين الطحالب البنية، الحمراء والطحالب الكلية على التوالي. هذا وكان كثير من الطحالب المجمعة من منطقة الدراسة مؤشرات بيئية للجودة وذات أهمية اقتصادية كبيرة تحتاج للمزيد من الدراسات المستقبلية.