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The study of seaweeds biomass from intertidal rocky shores of Qeshm Island, Persian Gulf

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ABSTRACT: Rocky shores are one of the most important habitats of marine environment in coastal areas. They host marine organisms including seaweeds because of existence of strong and stable substrate for their growths. Intertidal rocky shores are a prominent feature on coastal areas of Qeshm Island located at the northern part of Strait of Hormuz. In order to study biomass of seaweeds on rocky intertidal flats of this island, four stations in the south and one station in the northern part of the island were selected. Sampling was done for two periods, summer and winter. It was done during the low spring tide using a quadrate thrown manually and randomly at three times at upper, middle and lower parts of the flats with three replicates. Altogether 73 species of algae were collected and identified. These include 20 Chlorophyta, 10 Phaeophyta and 43 Rhodophyta. The maximum and minimum algal biomass of all stations was recorded in S4 station (117 g.m-2) and S5 station (24 g.m-2) with significant difference between the two stations ($P<0.05$). Also, the maximum algal biomass was observed for red algae (126g.m-2).

Key words: *Biomass; Persian Gulf; Qeshm Island; Rocky shores; Sea weeds*

INTRODUCTION

Qeshm Island, the largest Island in the Persian Gulf with many rocky shores, is located in the northwestern part of Hormuz Strait. It varies from 10 to 30km in width and 115km in length. Seaweeds are the most abundant group of organisms in the rocky shores, which is their most suitable habitat. These shores provide a strong and stable substrate for growth and desirable condition for the development of seaweeds (Sava *et al.*, 2011). Seaweeds are the most economically important plants in marine ecosystems around the world and serves as the best habitats, shelter and food sources for other organisms. Factors like light, wave action, food, sedimentation and desiccation can affect the abundance and distribution of seaweeds (Prathep, 2005). Moreover, they enhance water quality in rocky shores by nutrients absorption (Yoo, 2003). Several studies have been conducted on marine algae in a systematic in the Persian Gulf (Boergesen, 1939; Basson, 1998). Sohrabipour and Rabei, (1999) identified 153 species of marine algae in province of Hormozgan. In a previous study on diversity of algae species in the habitat of red algae Gracilaria salicornia in the northern coast of Qeshm Island, Rabei *et al.*, (2005) identified 49 species of marine algae. Rohani Ghadikolaeli (2006) reported 77 species of marine algae in the Persian Gulf coast. Gharanjik (2011), identified 150 species of the Persian Gulf and Oman Sea. The aim of this research is to investigate the biomass of seaweeds in some Qeshm Island places.

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MATERIALS AND METHODS

In Qeshm Island, most of rocky shores are distributed around the south part. Four stations were determined in south part of Qeshm Island and one station was also surveyed in north part of the Island (Table 1 and Fig. 1). Seaweeds were collected during seasons of summer and winter. The second half of each season was selected for sampling. Three transects were considered in each stations and three areas (High tide, mid tide and low tide) were selected in each transects. At each station, 27 quadrates (50×50cm) were randomly thrown. After washing mud and initial separation, seaweeds were frozen to prevent their degradation, and then transported to the laboratory. The species isolated with under a light microscope and a stereomicroscope and they were identified by using identification keys of Coppejans (2010), Jha (2009), Jones (1989), Tseng (1984) and Gharanjik (2011). After identification, they were dried at 70°C for 24 hours and then weighed on a digital scale. One-Way ANOVA analysis was employed to explore significant differences among stations followed by Tukey test. Statistical analysis was performed by Microsoft Excel and SPSS.

RESULTS AND DISCUSSION

The Results of biomass of seaweeds in each station during two seasons in the Qeshm Island are shown in Fig. 2, and Table 2 to 4. Each table is shown the name of identified species of seaweeds and their biomass. Results of the biomass of seaweeds from summer 2011 to winter 2011 in different stations are shown in Fig. 2. Furthermore, results of seaweeds biomass during both seasons revealed green algae in summer, brown and red algae in winter which had the highest biomass. Letters of A, B and C showed the results of analysis of variance. The highest biomass of green algae (20 $g.m^{-2}$), brown algae (47 $g.m^{-2}$) and red algae (50 $g.m^{-2}$) were observed in S4 station. The highest (117 $g.m^{-2}$) and the lowest biomass (24 $g.m^{-2}$) were observed in S4 station and in S5 station, respectively.

CONCLUSION

This study assumes that the biomass of seaweeds has recently changed due to red tide. Results of previous researches, particularly Sohrabipour and Rabei, (1999), showed that the diversity of seaweeds was more than species identified in this research. Previous studies which are mostly done on a monthly basis show changes in the species of algae population and their fluctuations throughout the year. Therefore, some species may disappear during the year and their biomass has a lot of changes over the years.

The present study shows that seaweeds have a large variety in intertidal rocky shores of Qeshm Island (73 species). Red algae have the highest species diversity than the other groups of seaweeds identified with 43 species. Red algae indicated more species more than two other algae groups (Table 2). Red algae are less influenced by some factors such as temperature, drought, wind and tides of the other groups of algae (green and brown) (Dowes, 1981). In particular, some of the genuses like Laurencia and Polysiphonia have

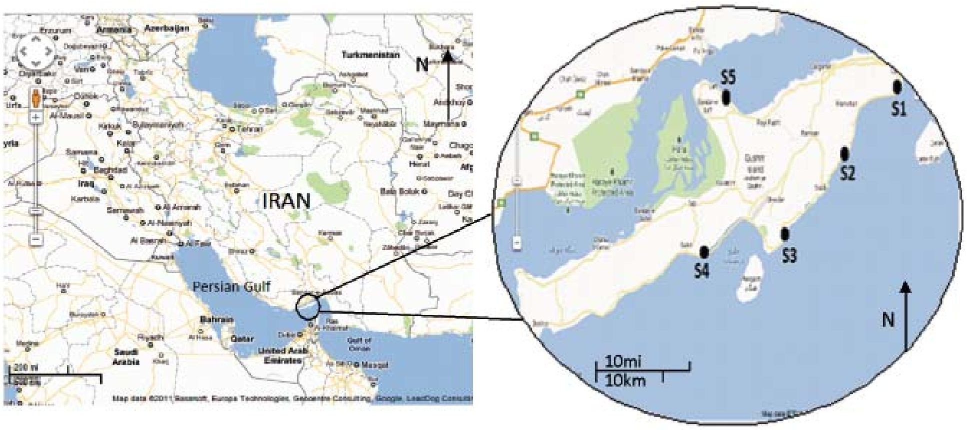

Fig. 1: The Qeshm Island and sampling stations

Table 1: sampling stations

Name	Station No.	Latitude
Cinema darya	S1	26°56'3.26"N , 56°16'31"E
Biotechnology	S2	26°52'55.1"N , 56°9'25.7"E
Shibderaz	S3	26°41'38.5"N , 55°57'2.5"E
Salakh	S4	26°40'55.87"N , 55°44' 10.48"E
Laft	S5	26°55'02"N , 55°49' 58"E

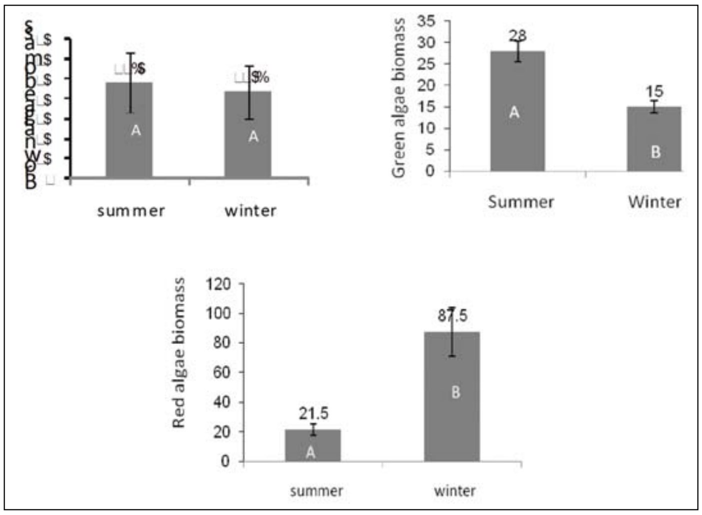

Fig. 2: Average biomass (g.m^{-2}) of identified seaweeds in two seasons

Table 2: Average biomass (g.m^{-2}) of green algae in each station

Station / Spicies	S1	S2	S3	S4	S5	Total
Enteromorpha flexuosa	1	0.5	0	2	0.01	3.5
E. clathrata	0.2	0.6	0.01	0.6	1	2.4
E. ovata	0	5.2	0	2.5	0	8
E. compressa	0	0	0	0.5	0	0.5
Blidingia marginata	0	0.005	0	0	0	0.005
Ulva fasciata	0	0	0	0	0.005	0.005
Chaetomorpha aerea	0.5	0.1	0	7	0	7.5
C. spiralis	0	0.5	0	2	0	2.5
Cladophora koiei	1.2	0.2	0	2.2	0.5	4.2
C. aokii	0	0.2	0	0	0	0.2
C. sp.	0	0	0	0.05	0	0.05
Cladophoropsis fasciculata	6	0.05	0.05	2	2	11
Rhizoclonium implexum	0	0	0	1	0	1
Dictyosphaeria cavernosa	0.2	0.01	0.2	0	1.2	1.6
Caulerpa sertularioides	0	0	0	0.05	0.5	0.5
C. taxifolia	0	0	0	0.02	0	0.02
C. sp1.	0	0.1	0	0	0	0.1
Caulerpa Sp2.	0	0.001	0	0	0	0.001
Acetabularia moebii	0.01	0.01	0	0	0	0.02
Codium sp.	0	0	0.2	0	0	0.2
Total	9	8	1	20	5	43

secondary compounds which change their tastes and make them to be less eaten (Nascimento and Rosso, 2001). So red algae were more richness than the others. Brown algae have the lowest species richness with 10 species and are less present than the other identified groups. Previous studies investigated in the Persian Gulf (Sohrabipour and Rabei, 1999; Gharanjik 2011; Rohani Ghadikolaei, 2006) demonstrate higher diversity of brown algae and in some cases even more than green algae. Some species of brown algae are very sensitive to environmental perturbations, substrate type, and slope, so in some areas which are affected by

Table 3: Average biomass (g.m^{-2}) of brown algae in each station

Station / Spicies	S1	S2	S3	S4	S5	Total
Padina australis	0.05	3	0	25	4	32
P. crassa	0	0.1	0	15	3	18
P. boergeseni	0	10.1	0	1	0	11.2
P. minor	0	2	0.05	0	0	2
P. sp.	0	0	0	0.2	0	0.2
Dictyota cervicornis	0.005	0.2	0	0	0	0.2
Iyengaria stellata	0.01	1	4	5	2.5	12.5
Colpomenia sinuosa	0	4	0.5	1	6.5	13
Cystoseira myrica	0	0.2	0.05	0	0	0.2
Sphacelaria sp.	0	2.5	0	0.1	0	2.5
Total	0.06	23	4.6	47	16	92

stress factors Sargassum cannot be found. In this trail, rocky shores were a little steep, much of the shore were out of water when the tide coming in, so the site was not suitable for the development of Sargassum. These algae are indicators of a healthy environment and their absence in harsh environments, as we investigated here, could be due to the stressors such as disturbance or pollution (Orfanidis *et al*., 2001).

In this study green algae had maximum biomass in summer and One-Way Analysis of variance showed significant differences ($P<0.05$) between the biomass of them in two seasons. The favorable climatic conditions, good light are the reasons for the high growth of green algae, especially they have high level of resistance to become dry. But biomass of brown algae between two seasons were not show a significant difference ($P>0.05$) because there were some Padina's species which has the most abundant in summer and the morphology and size of them were larger than brown algae species in winter, so they were caused high biomass in summer. But in winter they abundant and therefore the biomass of them were reduced and other species of brown algae like Colpomenia sinousa and Iyengaria stellata which have flourished in this season, have been replaced them.

The result of algal biomass at different species shows the highest biomass in S4 station. One of the most important factors in species distribution and abundance in tidal areas is their exposure to waves. Wave intensity affects on algae and their distribution pattern. Calm waters with low current waves allow a stable community with higher diversity (Prathep *et al*., 2004). Most algal species cover areas with brackish water and the least exposure. Unlike, the lowest abundant of algae is observed in areas that are exposed to waves (Southward and Orton, 1954) so the lowest biomass is observed. S4 station, near the Salakh Pier and bay, is located in an area that the waves are safe. That rocky shore was located in a protected and sheltered area, so high abundant and biomass of seaweeds were observed. In mid tidal zone of this station, a lot of tidal pools and crevices which could cause high biomass of seaweeds were observed. It seems that, there were amounts of nutrients such as phosphorus and nitrogen which are so necessary and useful for the growth and development of seaweeds like green algae. Therefore, the existence of abundant green algae might be attributed to that shore (Debore *et al*., 1989). So, nutrient enrichment and low wave action can increase the growth and development of annual opportunistic seaweeds like green algae (Kraufvelin *et al*., 2009). This rocky shore might be affected by the pollution from sewage containing large amounts of nutrients and increases the biomass of the green algae and the other groups of seaweeds. The lowest biomass was observed in the S5 station. Results of One-Way Analysis of variance showed significant differences ($P<0.05$) between the biomass of S4 and S5 Stations. Although low tidal zone is the main habitats for the growth and abundance of the red algae, this area in S5 station was muddy with high water turbidity. This might be implicated to the limited algal cover in this zone of S5 station. Rocky shores are more transparent than muddy ones and stone substrate is an important factor affecting the distribution and the presence of different algal species, usually high biomass of algae in these areas can be seen.

Table 4: Average biomass (g.m^{-2}) of red algae in each station

Station / Spicies	S1	S2	S3	S4	S5	Total
Ceramium tenerrimum	1	1	0.005	0.01	0	2
C. truncatum	0.004	0.003	0	0	0	0.007
C. sp.	0.003	0	0	0	0	0.003
C. upolense	0.001	5	0	1.5	0	6.5
Centroceras clavulatum	0	0.006	0.2	0	0	0.2
Crouania attenuata	0	0	0	0	0	0
Spyridia filamentosa	0	0	0	0.2	0	0.2
Dasya sp.	0.1	0	0	0	0	0.1
Laurencia papilosa	2.5	5	2.5	0.07	2	12
L. undulata	0	0.5	0.02	0	0	0.5
L. obtusa	0	0	1.5	0	0	1.5
L. sp1.	0	0	0	0.02	0	0.02
L. sp2.	0	0.001	0	0	0	0.001
L. sp3.	0	0	0.02	0	0	0.02
Digenea simplex	0	0	0.03	0	0	0.001
Acanthophora spicifera	0.002	0.04	0.01	0.002	0	0.05
Polysiphonia sp1.	4.5	13	0.01	44	0	61.5
P. sp2.	0	0	0	0.003	0	0.003
Tolypiocladia glomerulata	0	0	0.1	0	0	0.1
Leveillea jungermannioi-des	0	0.1	0	0	0	0.1
Champia parvula	5	2.5	5.5	0.5	0.5	14
C. globulifera	0	0.5	0.006	0.5	0	1
Hypnea pannosa	0.5	0.05	0.5	0.02	0.02	1
H. cervicornis	0.001	0	0	0	0	0.001
H. cornuta	0.01	1	0.02	0.2	0.2	1.4
H. sp1.	0	0.003	0.02	0.1	0	0.1
H. sp2.	0	0.01	0	0.003	0	0.01
Gelidium chilense	0.5	0.01	6	0.7	0	7.2
G. pusillum	0	0.001	0	0	0	0.001
G. sp1.	1.4	0	1.2	0	0	2.6
G. sp2.	0	0.01	0	0	0	0.01
G. sp3.	0	0	0	0.01	0	0.01
Gelidiella acerosa	1	0	0.2	0	0	1.2
G. ramellosa	0	0	0.001	0	0	0.001
Wurdemannia miniata	0.2	0.02	0.3	0.06	0.1	0.6
Gelidiopsis sp.	0	0.1	0	0	0	0.1
Gracilaria corticata	0.05	0.5	0.2	1	0	1.7
G. arcuata	0.5	0	0.2	0.05	0	0.7
G. foliifera	0	0.02	0	0.02	0.01	0.05
G. canaliculata	0	0	0	0.02	0	0.02
Jania adhaerens	0.3	6	0	0.2	0	6.5
J. rubens	0	0	0.5	0.5	0	1
Chondracanthus acicularis	0.1	0.4	0	0	0.001	0.5
Total	18	36	19	50	3	126

S3 station detected the lowest biomass after the S5 station. The high tidal zone of the station was quite sandy and devoid of any algal covers, in particular the green algae. In this station, seaweeds biomass was quite lower than other stations. Moreover, the lowest biomass of algal species might be related to the animal species like sea urchin as well as a mutual relationship between this animal and algal abundance. Many grazers are observed in the rock pools. Sea urchins are the most common grazers of seaweeds (Castro and Huber, 2008). If sea urchin is removed from the environment, macro-algal density can be increased and macroscopic algae can permanently be replaced. So, higher abundance of sea urchin in this area might be the second reason influencing on seaweeds assemblages (Tanio, 2010). The dominant presence of algal grazers might cause variations in biomass of seaweed species in intertidal zone and limit their biomass on rocky shore.

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