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Short Communication: Temporal and spatial variations of Rhodophyta communities along the Chabahar Coast, Oman Sea

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Abstract. *Jamshidzehi A, Mehdipour N, Jafari N, Azini M. 2017. Short Communication: Temporal and spatial variations of Rhodophyta communities along the Chabahar Coast, Oman Sea. Biodiversitas 18: 619-622.* Monthly sampling of macroalgae was carried out from January 2014 to November 2014 in Iranian Coasts of Oman Sea along Sistan and Baluchistan province coastal waters. Monthly sampling was done by a number of transects with equal distance and in randomly chosen 50×50cm quadrates. The samples were transferred to the lab and after cleaning and separating, identified up to species level. A total of 17 species of Rhodophyta were recognized, and the most observed families included: Gelidiaceae, Gracilariaceae, Hypneaceae and Rhodomelaceae. The maximum algal biomass and of species belonged to *Gracilaria corticata*. *Laurencia obtusa*, *Hypnea valentiae* and *Gracilaria corticata* observed in all stations and seasons. *Laurencia obtusa*, *Hypnea valentiae* and *Gracilaria corticata* observed in all stations and seasons. Comparing to the previous study in the Chabahar Coast, steep decline in the number of observed macroalgae species in this region was observed.

Keywords: Abundance, Chabahar Coast, diversity, Oman Sea waters, Rhodophyta

INTRODUCTION

Benthic macrofauna has major role in ecosystem primary productivity of marine environment (Falkowski and Woodhead 2013). Marine macroalgae have a key role in biogeochemical cycles and energy conversion through photosynthesis for grazing marine animals and invertebrates (Flindt et al. 1999; Melville 2005). Locating in intertidal ecosystems, macroalgae are facing with several environmental hazardous gradients, including fluctuating temperature, salinity, light and nutrient levels and immersion and submersion during tidal cycles (Han and Liu 2014; Williams and Smith 2007; Helmuth et al. 2006). Intertidal marine macroalgae mainly found in the rocky intertidal substrates and have a key role in hard-substrate food chain biota (Kaehler and Williams 1998).

Biotic and abiotic variation in intertidal zone is a common phenomenon of sea (Lubchenco and Menge 1978); and seasonal fluctuation of marine macroalgae were undertaken in different parts of the world (Hull 1997; Babcock et al. 1999; Rubal et al. 2011; Tytlyanov et al. 2014; Mehdipour et al. 2015). Thirty-nine species of macroalgae have been reported from Iranian coastal area of the Persian Gulf and Oman Sea (Gharanjik 2005). However, data on the distribution and seasonal changes of marine macroalgae in the Chabahar Coast is limited (Sohrabipoor and Rabiei 2008). In recent years, anthropogenic activities had serious impacts on macroalgae (Nelson 2009), and globally they are in serious decline with their loss accelerating from about 1% yr^{-1} before 1940 to 7% yr^{-1} presently (Waycott et al. 2009). Therefore, it is essential to understand the species present, measurement seasonal changes, and diversity of macroalgae species in each region.

The aim of this study was to determine the seasonal variation and abundance of hard-substrate intertidal macroalgae and reporting their abundance along the coastline of Chabahar, the Oman Sea. Results of this study can help to better understand the macroalgae distribution and species composition in this region and monitoring programs.

MATERIALS AND METHODS

Study area

This study was conducted in the Sistan-Baluchestan Province waters, Southeast of Iran, in the Oman Sea Waters. Three sampling station selected and sampling performed monthly from January 2014 to November 2015 in Chabahar Coastline, the Oman Sea (Figure 1).

Procedures

A 50×50 cm quadrat (0.05 m^2) was performed on rocky substrate to obtain random samples from macroalgae communities with three replicate and the samples were preserved in 4% formalin. In the laboratory, the seaweeds were sorted, identified up to the species level and counted. The map of studied area plotted with the ggmap package (Kahle and Wickham 2013).

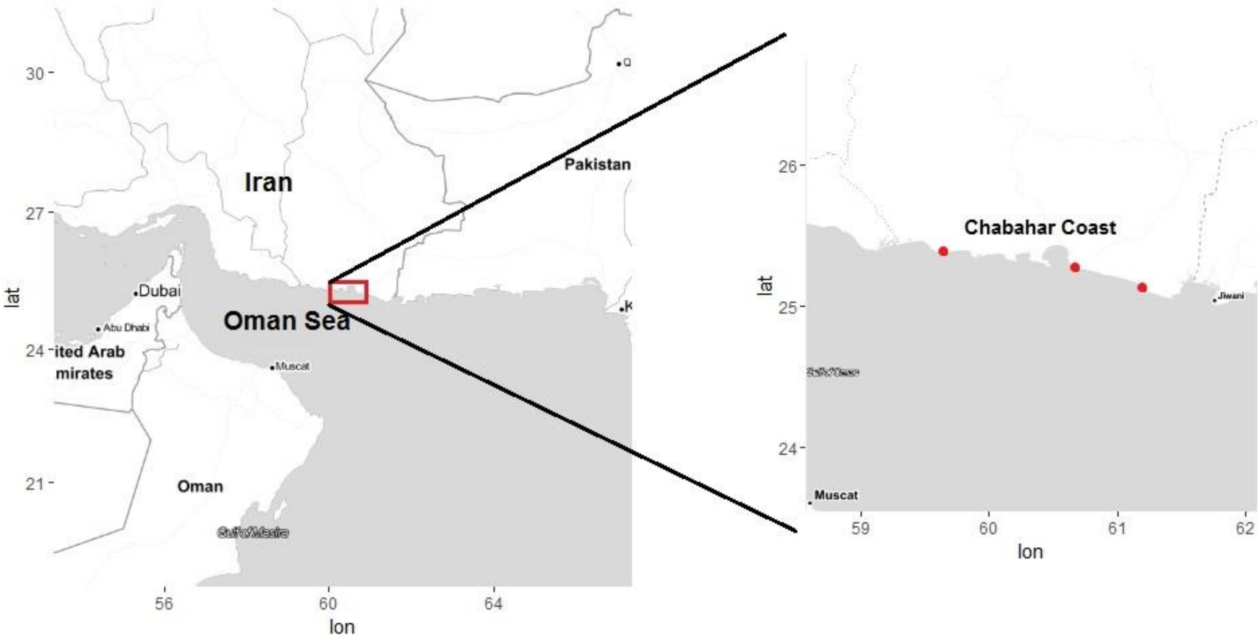

Figure 1. Map of studied area. Red points shows sampling stations in Chabahar Coast (Iran), Oman Sea

Data analysis

All the statistical analyses were carried out with R statistical packages Version 3.3.1 (Ihaka and Gentleman 1996). Kolmogorov-Smirnov test was used prior analysis to test data normality. Non-Multidimensional Scaling (nMDS) were employed to show the location/dispersion of between-group effects based on a matrix of observed macroalgae species in each season, in the following. Relative abundance was employed to identify the indicator species among seasons. The formula is as follows: species abundance / total abundance (Hayek and Buzas 1997). These analyses performed with the vegan and BiodiversityR package (Oksanen et al. 2016; Kindt and Coe 2005). Relative frequency and diversity were calculated throughout the season and station using the Shannon diversity, evenness index and Berger-Parker index (Ludwig and Reynolds 1988).

RESULTS AND DISCUSSION

Total 17 species belong to 10 families of Phylum Rhodophyta were recorded in this study. A total number of seaweed species was maximum in station 2 and three followed by station 1. *Laurencia obtusa, Hypnea valentiae* and *Gracilaria corticata* observed in all stations and seasons. *Laurencia obtusa* in winter and *Gracilaria corticata* in spring, summer and autumn were dominant species in station 1. *Botryocladia leptopoda* in winter, *Hypnea valentiae* in autumn, *Gracilaria corticata* in summer and *Laurencia obtusa* in spring were most observed species in station 2. *Hypnea cervicornis* in winter and *Laurencia obtusa* spring, summer and autumn were dominant species in station 3 (Table 1). For spatial, maximum diversity observed in station 1, and for temporal, the diversity indices of winter followed by autumn, spring and summer. Minimum values of evenness indices found in autumn and spring. Analysis of Berger-Parker index showed that domination was less in winter and high in summer (Table 2). Results of nMDS showed changes in mean-variance relationship between summer, spring and autumn were in dispersion effect, while winter was separated by location effect (Figure 2).

A total of 17 observed macroalgae in this study was reported in the last checklist of the marine macroalgae of Iran (Kokabi and Yousefzadi 2015). However, Sohrabipoor and Rabiei (2008) reported 74 identified species in the Chabahar Coast, although they studied 8 sampling sites from 2000 to 2003. On the other hand, *Laurencia obtusa*, *Cotonella filamentosa, Melanothamnus somalensis* and *Champia kotschyana* were observed in this study which was not reported by Sohrabipoor and Rabiei (2008).

Maximum diversity of macroalgae observed in winter and autumn. This might be results of lower temperature in winter and autumn. Santos (1993) declared that temperature is an important environmental factor that determines macroalgal distributions. In addition, the temperature has long been recognized as a major factor governing species distribution in other intertidal communities (McQuaid and Branch 1984), and Mehdipour and Gerami (2016) reported that temperature has indirect effect on the abundance of hard substrates inter-tidal communities. It is well known that high-temperature regimes are less in winter and autumn than spring and summer in the Chabahar Coast as it considers as a tropical region (Rahimi et al. 2015). Indeed, in this study, explicit temporal and spatial variation in macroalgal observed (Table 1, Figure 2). Similar patterns of temporal variation in algal diversity were also reported by Sohrabipour et al. (2004) and Dadolahi-Sohrab et al. (2012) in the Persian Gulf.

Table 1. Temporal and spatial variation in relative abundance (%) of macroalgae in Chabahar Coast, Oman Sea. Maximum relative abundance in each season are bold

Species	Season			
	Winter	Spring	Summer	Autumn
Station 1				
Laurencia obtusa	**31**	23.7	14	19.5
Cotonella filamentosa	27.9	-	-	-
Hypnea valentiae	25.1	15.8	26	19
Gracilaria corticata	16	**40**	**50.4**	**39.2**
Melanothamnus somalensis	-	10.2	-	9.5
Champia compressa	-	5.6	-	7.7
Hypnea musciformis	-	4.7	9.5	5.1
Station 2				
Botryocladia leptopoda	**24.7**	--	--	
Hypnea valentiae	14.8	10.5	32.9	**26.1**
Champia compressa	14.2	--	--	8.6
Gracilaria corticata	13.3	19.1	**41.3**	9.5
Hypnea charoides	11.1	--	--	8.1
Champia kotschyana	9.5	--	--	
Laurencia snyderiae	7.1	--	--	
Laurencia obtusa	5.3	**30**	25.7	15.3
Hypnea musciformis	--	23.7	--	20.2
Gelidium pusillum	--	16.8	--	4.2
Polysiphonia sp				8
Station 3				
Hypnea cervicornis	**31.5**	--	--	5.9
Gelidium pusillum	23.1	--	--	2.8
Gracilaria corticata	19.8	25.3	12.9	7.8
Champia compressa	11.3	7.7	12.2	17.3
Grateloupia somalensis	5.5	--		
Gelidiella acerosa	4.3	7.1	6.9	4.7
Laurencia obtusa	2.3	**26.8**	**31.2**	**28.9**
Hypnea valentiae	2.2	19	22.9	12.7
Jania adhaerens	--	9	--	--
Hypnea musciformis	--	5.1	13.8	19.9

Table 2. Temporal and spatial variation in diversity indices of macroalgae in Chabahar Coast, Oman Sea

Diversity indices	Temporal			
	Winter	Spring	Summer	Autumn
Shannon	2.325	1.835	1.553	2.00
Berger	0.172	0.295	0.305	0.213
Evenness	0.787	0.696	0.788	0.672
Simpson	0.888	0.801	0.762	0.838
	Spatial			
	Station 1	Station 2	Station 2	
Shannon	2.304	1.808	1.848	
Berger	0.235	0.254	0.248	
Evenness	0.668	0.762	0.705	

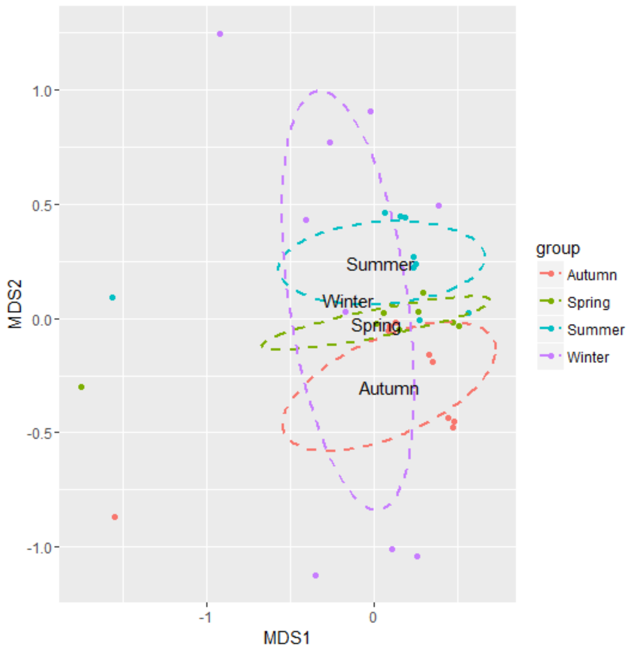

Figure 2. n-MDS ordination by seasons of the root-transformed macroalgae abundance data for the Chabahar Coast, Oman Sea. Stress value is 0.1 in the analysis.

According to the results, *Laurencia obtusa*, *Hypnea cervicornis, Botryocladia leptopoda*, *Hypnea valentiae* and *Gracilaria corticata* were dominant species in different seasons and stations. Domination of Rhodophyta in the Chabahar Coastline has been reported by Sohrabipoor and Rabiei (2008). In addition, *Laurencia obtusa* in Belizean barrier reef (Littler et al. 1987), *Hypnea cervicornis* (=*H. boergesenii*) in Papua New Guinea (Hejis 1987), *Gracilaria corticata* and *Hypnea valentiae* in the south-eastern coast of India (Satheesh and Wesley 2012) were the most abundant species in macroalgae communities as well. However, no literature data was available for domination of *Botryocladia leptopoda* in macroalgal communities. Domination of *Gracilaria corticata* and *Laurencia obtusa* in summer shows that these two species has a preference for high temperatures. Raikar et al. (2001) reported that optimum temperature level for *Gracilaria* spp. Is 20° C and Nishihara et al. (2005) revealed that higher irradiances and temperatures improved *Laurencia* nitrate uptake *in vitro*.

Macroalgal community structure can reflect the ecological status of a coastal environment (Guinda et al. 2012). Results of diversity indices show poor ecological status in station 2 and 3 compared to station 1 (Table 2). Macroalgal growth is highly controlled by the availability of nutrients and light distribution in habitats (Lüning 1990). Although in none of the environment nutrients investigated in this study, based on field observations, habitats in different stations were not uniform. Spatial variation in macroalgae communities based on different habitats reported by researchers (Levin 1993; Cruz-Motta et al. 2010; Han and Liu 2014; Han et al. 2014; Sangil and Guzman 2016).

To conclude, this study revealed the spatial and temporal variation of macroalgae species along Chabahar Coastline. Maximum diversity of macroalgae found in winter and followed by autumn. *Laurencia obtusa*, *Hypnea boergesenii, Botryocladia leptopoda*, *Hypnea valentiae* and *Gracilaria corticata* were dominant species in different seasons and stations. Comparing to the previous study in the Chabahar Coast, steep decline in the number of observed macroalgae species in this region was observed. However, the effect of environmental parameters in macroalgae communities distribution in this region has still remained unknown.

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