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Ecological Assessment of Intertidal Ecosystems in Khark Island (Persian Gulf) Using Community Structure of Macrobentic Bivalves

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Abstract: The main goals of this study were identification and ecological survey on macrobenthic bivalves in the Khark Island. This study has been done during four seasons through 2010-2011 in five stations around the Khark Island, in each of which three separated transects including supralittoral, eulittoral and sublittoral zones were selected. At each sampling time and site environmental factors such as temperature, salinity and total organic maters (TOM) have been measured. Collected samples were analyzed and according to the results, twelve bivalve species belonging to seven families were identified. The maximum and minimum density and distribution have been found in spring and summer respectively. In our study the most frequent bivalve species in all seasons was *Barbatia lacerate*. Maximum and minimum water temperatures have recorded in summer (35.94±0.28) and in winter (18.34±0.39) and the Maximum and minimum rates of salinity have recorded in winter (44.6±0.14) and spring (37±0.18) respectively. Maximum and minimum percentages of total organic maters (TOM) have observed in summer (9.63±0.71) and winter (3.39±0.15) respectively.

Key words: Bivalves % Khark Island % Intertidal zone % Macrobenthos % Mollusks % Persian Gulf

INTRODUCTION

Coastal habitats with their sensitivity, diversity and having special species are among the important habitats. These areas have got the most complex and rich ecosystems which support a lot of organisms and provide them with nutrition and reproduction shelters. Natural and anthropogenic stresses cause them to be subjected to impacts and reduction of ecological quality [1].

The second greatest animal phylum, Mollusks, occur in various habitats [2]. More than 20000 out of which (the second greatest group of them) constitute *bivalvia* [3].

One of the most strategic islands of the Persian Gulf is Khark. It has a length up to about 7 km, a 3-4 km width and its altitude from the mean sea level is 4m [4].

Although plenty of studies have been carried out on the ecosystems, sites and regions adjacent to the study area [e.g. 5, 6 and 7], only a few studies have been carried out on the benthic communities' structure of Khark Island. In one of the first reports on Mollusks' fauna in the study area, about 216 species were identified and reported [4]. Another investigation has been carried out on the bivalves of the study area [7]. 11 species were identified in the latter study.

Khark Island with its environmental and biological value should be monitored. Biological properties of this Marine Protected Area have not been completely investigated so far. Therefore, in order to ecologically study macrobenthic bivalves of Khark Islands' coast, species diversity along with the influence of environmental factors on this group of organisms were seasonally monitored.

MATERIALS AND METHODS

Khark Island (21 Km^2) which lies between 50°16'E, 29°11'N and 50°20'E, 29°17'N is amongst the important economic zone. Its Petroleum resources consist of three main regions Dorud, Abuzar and Foruzan which support more than 90 percent of global petroleum export [8].

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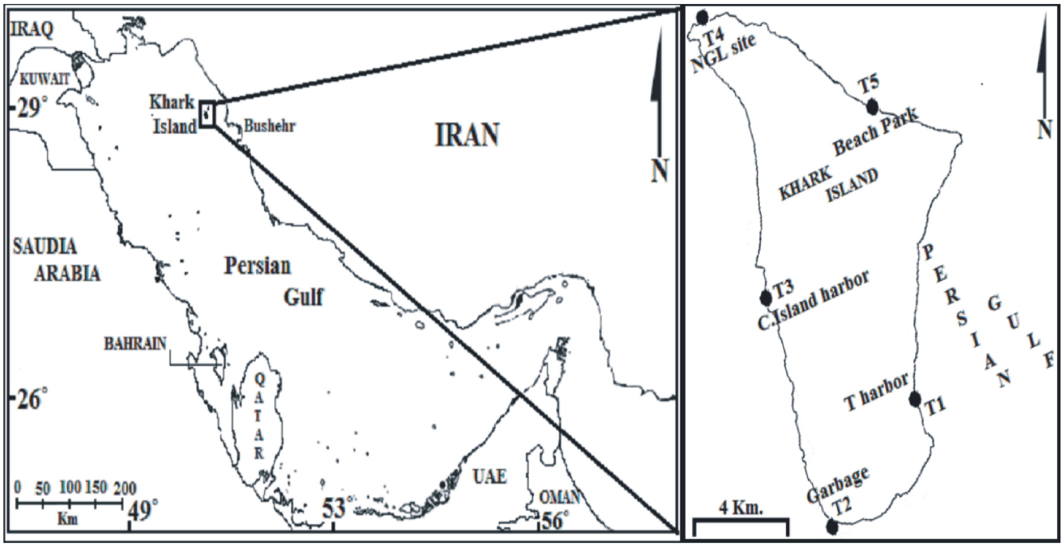

Fig. 1: Position of Khark Island in Persian Gulf and sampling transects

Table 1: Geographical positioning coordinates of five transects

Transect	Latitude	Longitude
T harbor (T1)	29°13' 72"	50°19' 69"
Garbage Deposition site(T2)	29°12' 49"	50°18' 66"
C Island Harbor(T3)	29°14' 50"	50°17' 75"
NGL Site(T4)	29°16' 38"	50°17' 28"
Beach Park(T5)	29°16' 13"	50°18' 47"

This study has been carried out 2010-11 (May, July, October and January). The best sampling situation with the widest tidal range were chosen. Samples were collected during low tide from 5 transects (three replicate for each of high, mid and low tide) (Fig. 1). Geographical coordinates of each transect were recorded using a GPS CX120 (Table1).

Seasonal sampling of bivalves was done using a 50×50 quadrate. Epifaunal individuals (directly) and infaunal ones (after passing sediment through a 0.5mm sized sieve) were fixed. Specimens were fixed in buffered formalin (5% solution diluted by local sea water with sodium tetra borate) [9]. A mixture of 70% ethanol and 5% glycerin was also used for permanent storage in the laboratory [10]. Rose Bengal (1.00 g lG^{1}) vital staining was chosen to identify infaunal assemblages [11] under stereomicroscope Olympus sz60).

Valid Taxonomic textbooks and keys were applied to identify the individual down to the least taxonomic limits [e.g. 12-18].

Environmental variables (temperature, salinity, pH and dissolved oxygen) were simultaneously measured using German Wisseschaflich-Technische Werkstatten GmbH sets. In order to measure Total Organic Matter (TOM), Van Veen grabs collected three replicate from each tidal zone and then ice-surrounded sediment containing packs were transferred to the laboratory. Total Organic of sediments in all sampling points were carried out according to standard methods [11, 19].

Normal distribution of the recorded and measured data was tested through Shapiro-Wilk Test of normality. After that parametric One-Way ANOVA and non-parametric Kruskal-Wallis tests were employed to determine the significant differences between environmental factors and TOM of different stations and also abundance of different seasons respectively. All the statistical analyses were done in SPSS 15.0 for windows software. In order to measure Shannon-Wiener (*H'*) diversity index, PRIMER5 software was applied.

RESULTS

Average temperature in spring, summer, autumn and winter were respectively 26.5±0.18, 35.94±0.28, 22.18±0.13 and 18.34±0.39°c.

Salinity values in above seasons were 37.00±0.18, 39.6±0.22 and 42.13±0.15 and 44.6±0.14 psu.

One-way ANOVA indicated that there was a significant spatiotemporal (transects and seasons) difference in TOM values ($P<0.05$). Meanwhile the highest and lowest amounts of TOM were measured in summer (9.63±0.71) and autumn (3.39±0.15).

About 12 species belonging to 12 genera and 7 families were utterly identified. The highest abundance occurred in spring and the lowest one in summer. The most abundant bivalve species in Khark intertidal zone during the whole study period was *Barbatia lacerate*.

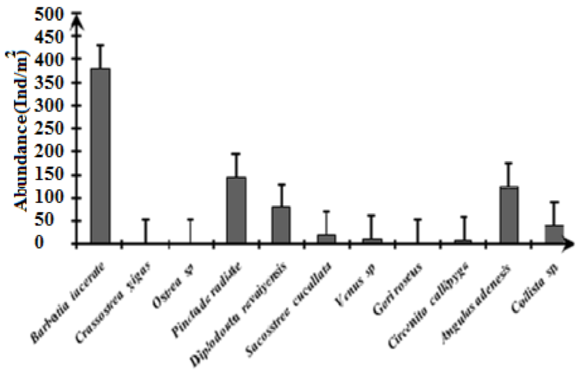

Fig. 2: Abundance (Ind.m-2) of identified Mollusks in Khark Island intertidal zone

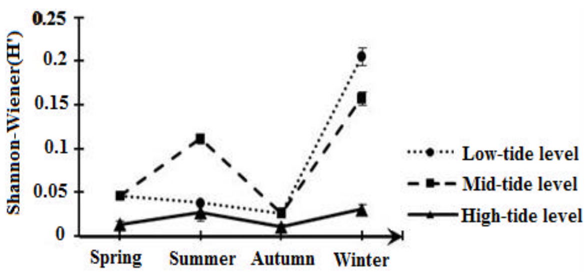

Fig. 2: Shannon-Wiener diversity Index measured from different stations during four seasons.

Among all seasons relatively the higher and lower values of Shannon-Wiener Index were measured in spring (0.12) and summer (0.024) respectively.

In addition, this index showed the higher (0.085) and lower (0.02) values in mid- and high-tide respectively. Transect 1 was also most diverse (0.124) transect compared with all others.

Pearson and Spearman Correlation between environmental factors and the abundance of mollusk species in the study area (Table 3) showed that temperature and salinity were significantly correlated (negatively) with mollusk's abundance ($P<0.05$), whereas TOM was, in contrast, positively correlated with that variable ($P<0.05$). Temperature and salinity had also got significant positive correlation with each other ($P<0.01$).

Table 2: Abundance (Ind.m^{-2}) of identified Mollusk species during different season in Khark Island intertidal zone

Species	Spring	Summer	Autumn	Winter
Barbatia lacerate	152	24	108	96
Callista sp.	4	0	0	36
Circenita callipyga	4	4	0	0
Crassostrea gigas	4	0	0	0
Diplodonta ravaiyensis	8	0	64	8
Gari roseus	4	0	0	0
Ostrea sp.	4	0	0	0
Pinctada radiate	80	40	20	4
Sacosstrea cucullata	12	8	0	0
Tellina capscoides	0	0	4	0
Venus sp.	4	0	8	0
Total	336	120	224	134

Table 3: Correlation between biotope and abundance of Mollusks (0.05* and 0.01** confidence levels)

	Temperature	Salinity	TOM	Abundance
Temperature	1.00	0.774**	0.187	-0.079*
Salinity		1.00	- 0.249	-0.219*
TOM			1.00	0.246*
Abundance				1.00

DISCUSSION

In assessment and study of the effects of environmental factors on abundance, dispersal and diversity of benthic assemblages, all various factors' influence should be considered rather than a single one. The lowest abundance of studied organisms in this study during the warmest season of the year indicated that the higher temperature of the environment, the more metabolic rate and cause the biochemical reactions and oxygen demand to be accelerated so that there are only tolerant organisms could persist in the described conditions [20].

The salinity maxima belonged to autumn and winter. During these seasons, prevalent northwesterly wind (Shamäl) usually blows with a relatively higher velocity in the Persian Gulf and because of lower relative humidity in the atmosphere than summer, the evaporation values and consequently salinity increase [21].

The highest abundance of organisms was observed in spring and autumn. The direct relationship between benthic abundance and food content seems to be the main cause of this fact [22].

Patterns of macrobenthic abundance in Hormuz Island (Persian Gulf) indicated the highest during spring, according to the present study [23]. Results of Imam in 2006 also suggested the lowest abundance of intertidal bivalves in summer. The highest abundance among the identified organisms belonged to *Barbatia lacerate.* This may because of adaptatioal specialization strategy that this species made. It attaches to the space under rocks to overcome heat fluctuations, desiccation and other stressors [24].

Increasing diversity of macrobenthic assemblages in spring may caused by beginning of reproduction season [23]. Rough environmental condition such as heat increase may cause decreasing the diversity in summer [25]. TOM is very important factor affecting the diversity [26]. They have got a reverse relationship with each other. According to Welch Pattern, H'>3 indicated unpolluted environment, 1< H'<3 moderate pollution and H'<1 is the indication of much polluted environment. In this study, Average H' was lower than 1 indicated high pollution level in the study area [27].

Another activities affecting biodiversity are physical disturbances (for example, fishing activities) [26]. Lacking or decreasing in habitat heterogeneity and also interspecific competition may cause decrease in biodiversity [27].

Generally, Oil production and emerged establishments can cause disturbance and degradation of benthic environments [27]. Average H' index measured from mid- and low-tidal showed a decreasing trend with going up to high-tidal levels. This may because of long desiccation period, lacking of nutrition materials and increasing wave actions [28].

Having rocky, sandy and broad coral reef habitats, transect 1 in the present study was more diverse than other ones. It has also been in another study that the more heterogeneity and complexity in the substrate, the more biological diversity [28].

There were only two species (*Pinctata radiata* and *Calista sp.*) in common with the previous studies carried out in the study area [4, 5]. The supporting reason for this difference may be due to various factors e.g. sampling time, time interval between two sampling, mortality caused by invasion of alien species come through ballast water, oil-originated pollutions and hazardous events such as Persian Gulf wars.

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