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Investigation of Species Diversity and Dominant of Decapoda in the Intertidal Zone of Bushehr Rocky Shores

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ABSTRACT: To study the population structure of Decapods in the Intertidal Zone of Bushehr Rocky shores, some random sample collection from four Rocky and rubble shores of Bushehr were done using a 50×50 quadrates sampling unit, in four successive seasons from autumn 2009 to summer 2010. Totally 8 species belonging to 5 family of Decapods were identified and counted. In the whole course of sample collection, the highest frequency rate belongs to *Petrolisthes Rufescence* species with 51%, *pagurus* sp. species with 22%, *Metapograpsus maculates* with 7%, *pilimnus* sp. with 6.5%, *Alpheus lobidens* shrimp with 3% and other species with 10.5% ranked next. The results show a drop in frequency and diversity in cold seasons and the most important factor of those changes is temperature changes. Place frequency of Decapods showed that in sites of Lian and Holeileh (C & D Stations) diversity of Decapods is more due to less pollution, less accessibility, and vast and complex bed.

Key words: Diversity,Dominant,Decapoda, Rocky Shore, Bushehr, Iran

INTRODUCTION

Biodiversity assays containing the adverse effects of pollutants on organisms have been widely studied by researchers during recent decades (Ashraf *et al.,* 2012; Mohebbi *et al.,* 2012; Mhadhbi *et al.,* 2012; Clemente *et al.,* 2012; Madani *et al.,* 2012; Kiteresi *et al.,* 2012; Rahimi *et al.,* 2012; Shwetha *et al.,* 2012; Iribarren *et al.,* 2012; Manju *et al.,* 2012; Blagojevic *et al.,* 2012; Zhang *et al.,* 2012; Farhadi *et al.,* 2011; Mortazavi and Sharifian, 2011; Lee and Mohamed, 2009; Monavari and Momen Bellah Fard, 2010). Rocky shores as biological hard bed has the highest biological diversity in the world after coral reefs. These shores have an abundance of diverse flora and fauna microorganisms especially in temperate Zone. High population in the shores, topographic diversity and high species richness, have attracted many biologist and ecologist. In the recent years those zones are being studied in a classified way and this has increased knowledge about interspecies connection, and how the populations survive and change (Webber and Thurman, 1991).

Decapods, as the most important order among the malacostraca, are investigated and paid more attention in scientific studies and researches, which is caused by their economic importance (especially peneidae shrimps, swimmer crabs and lobsters) and their worldwide dispersion and diversity (Martin and Davis, 2001). Few groups of animals have the shape diversity and big dispersion as Decapods. Decapoda forms are the third segment of food chain (Huner *et al.*, 2003). These are important from different aspects like fishery, food, pharmaceuticals and biology and they play a key role in material circulation and energy transition in different levels of food chain. (Rowe, 2003). The importance of these organisms is not limited just to their consuming role of planktons, but also they control the upper food levels (Huner *et. al*, 2003). The first research concerning the identification and dispersion of Decapods, in the inner ROPME Sea Area and the Sea of Oman was done by Blegvad and Colleagues in 1938 . they selected 156 stations from Khuzestan shores to Chabahar Gulf and 151 Decapods species in intertidal and subtidal zone were identified and studied. The data from this study was

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published in four volumes named "Danish Scientific Investigation in Iran" in Copenhagen and was offered to Iranian government in 1995 . Although some researchers have done many measures concerning ecological study identification and biological study of Benitic animals in the inner RSA waters, it is important to do monitoring studies of sensitive shore spots especially intertidal zones in order to know the animals better and provide an identity certificate of animals population in this region and investigate the vacillation process of the population over successive years. So one of the aims of this study is to prepare the list of the existing Decapods, Comparing rate of frequency and biological diversity of species between the stations over the investigation period and to record the physicochemical factors of water (Salinity, dissolved Oxygen, temperature, PH), in order to study the impression of environmental factors on species frequency.

MATERIALS & METHODS

This study was done on the four Bushehr rocky-rubble shore of Naftkesh zone as station A, Shoqab park as station B, Lian park as station C and Holeileh zone as station D (Fig. 1).

The limits of selected fall between the longitude from 50° 48' 50'' to 50° 52' 41'' and Latitude from 28°56' 30'' to 29°48'51''. Sample collection was done over a year in four seasons (A, B, C, D) from autumn 2009 to summer 2010. The samples were collected by a 50×50 meter quadrates. To collect the samples hammer, forceps, knife and butterfly catching net were used when needed. Samples were transferred to laboratory after being put in plastic bags containing stickers, and fixed with 10% formalin. In laboratory the extra formalin was removed and samples were washed with 560 micron sieve. After washing, samples were separated in highest identification class possible. The exiting Decapods were studied with Stereomicroscope.

The compression of decapods as the number of organism in a cubic meter of the sampled surface was calculated. Margal of Richness Index2 is calculated for each sample and region including the number of identifiable branches. This index is expressed based on the relationship between the number of species (S) and the total number of units forming the species (n). The rate of this index depends on the number of the collected samples and time periods. Simpson Index2 as the first diversity index is used in the ecological studies and it shows the greenery and hemogenisim of the population. The Simpson Index varies from 0 to 1 and shows the possibility rate of the belonging of the two selected unit randomly from the whole population to species. Evenness Index3 shows the frequency rate of the units of species and the way this frequency is distributed in a sample. The Shannon Index4 actually shows the heterogeneousness of the population so the more the number of composing units of a sample is and the more equal the frequency distribution of the units among these species is the more the rate of this index would be and it means more diversity.

Before implementing the statistical analyzing methods, normality of the data and equality of variance were investigated due to the absence of these conditions logarithm change was used. To study the difference between the average of variables in each

Fig. 1. Bushehr Rocky Shore Stations : Naftkesh zone station A, Shoqab park station B, Lian park station C, and Holeileh station D

station and among seasons, one way and two-way variance analysis were used. Variables are frequency and Decapods Shannon biological diversity index in each station, time (season) and station (A, B, C, D) factors. In two-way variance analysis the mutual effect of station and time has also been evaluated. To do the Anova, the data was studied concerning the normal distribution and equality of variances. Normality of the data was investigated using Kolmogorov-Smirnov Test, and the equality of variance was studied using Leven Test.

RESULTS & DISCUSSION

In station A, among the Decapods the highest frequency rate belong to *Pagurus Sp*, *Petrolisthes rufescence*, *M. Maculatus*, and *Pilimnus* sp. with 43, 33, 11 and species, respectively. In station B, highest frequency rate belonged by order to *Petrolisthes Rufescence*, *Paguns* sp. , *Metapograpsus* sp., and *Pilimnus* Sp. , *Neoepisesarma* sp. with 38,33, 8, 6, 3, and Alpheus lobidens shrimp species only 1%, respectively. In station C the highest frequency belonged by order to Petrolisthes rufescence, Pagurus sp. , pillimnus sp., P. Armadas , with 46, 9, 7, 4 and Alpheus lobidense shrimp species, and 2% frequency, respectively. In station D, the highest frequency rate belonged by order to P.Rufescence, Pagurus sp. , Actaea sp. , Metapograpsus maculates and Pilimnus sp. with 65, 6 , 5, 4, and Alpheus lobidense shrimp and 2%, respectively (Table 1).

In the whole sample collection period in station A, from autumn to spring, the frequency rate Of Decapods has been ascending and the highest frequency rate was in spring (450.9 ± 34.28). In station B the frequency changes rhythm from autumn to summer is similar to station A and the highest rate was in spring (582.8 ± 49.40). In station C, from autumn to spring the Decapods frequency change rate has been ascending and the lowest rate was in autumn (402.3 ± 61.06).This rate has ascended in the late winter and spring it has reached its peak but at the end of summer we see the frequency dropping. The frequency of Decapods from autumn to summer in station D is similar to stations A and B, so that the highest frequency in this site was in spring (672.9 ± 65.38) and the lowest frequency was witnessed in autumn (304.6 ± 112.14) (Table 2).

The results from the two way variance analysis Tuki showed that stations A and B have significant difference ($P<0.001$) from station D which has highest frequency rate (514.3 ± 86.42). During the whole course there is no significant difference between station A and B concerning frequency ($p>0.05$). The spring season with highest frequency rate (570.7 ± 50.35) showed a significant difference from the winter to

Table 1. The number of collected decapods in all of the stations

Taxa	A	B	C	D
A.Shrimp				
Alpheus lobidens.	---	29	30	25
B.Crabs				
Petrolisthes rufescence	425	812	754	1239
Petrolisthes armatus	---	---	57	---
Actaea sp.	19	---	---	96
Pilimnus sp.	99	120	113	84
Metapograpsus maculatus	135	163	---	84
Neoepisesarma sp	3	68	---	---
Pagurus sp.	551	710	148	112

Table 2. Decapods Frequency total Average xm^2 in Research stations (M±S.E)

Season	A	B	C	D	Total Average
Autumn	239.8±100.52	253.4±210.54	402.3±61.06	304.9±112.14	299.9±121.06
winter	278.1±109.64	401.2±75.69	478.9±98.91	579.6±91.03	434.4±93.81
Spring	450.9±34.28	582.8±49.40	571.5±52.35	672.9±65.38	570.7±50.35
Summer	303.8±79.31	398.9±71.14	412.2±68.76	503±77.14	329.9±74.08
Total Average	318.2±80.94	408.9±118.77	467.2±70.27	514.3±86.42	

summer ($p < 0.001$). The autumn with the lowest frequency (299.9 ± 121.06) showed a significant difference from spring ($p<0.001$) but there is not any significant difference between summer and autumn ($p > 0.05$). The mutual effect between the seasons and stations showed a significant difference ($p < 0.001$). The results from one way variance analysis showed that in autumn station C has a significantly higher frequency than other stations ($p<0.001$) and in the winter season frequency rate of station A was significantly lower than the other stations ($p<0.001$). Frequency rate comparison between stations A and B showed that there is no significant difference in seasons except in winter season. ($p > 0.05$). (Fig. 2 and 3).

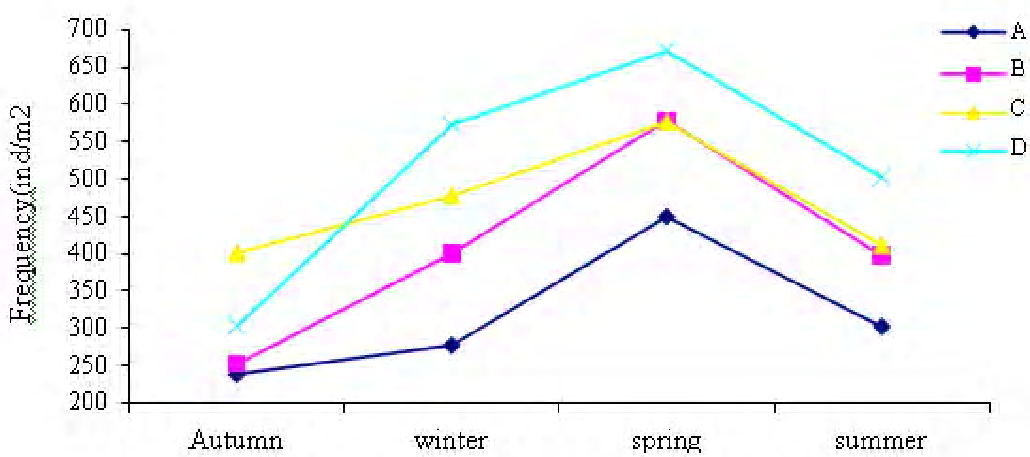

Fig. 2. Decapods Frequency

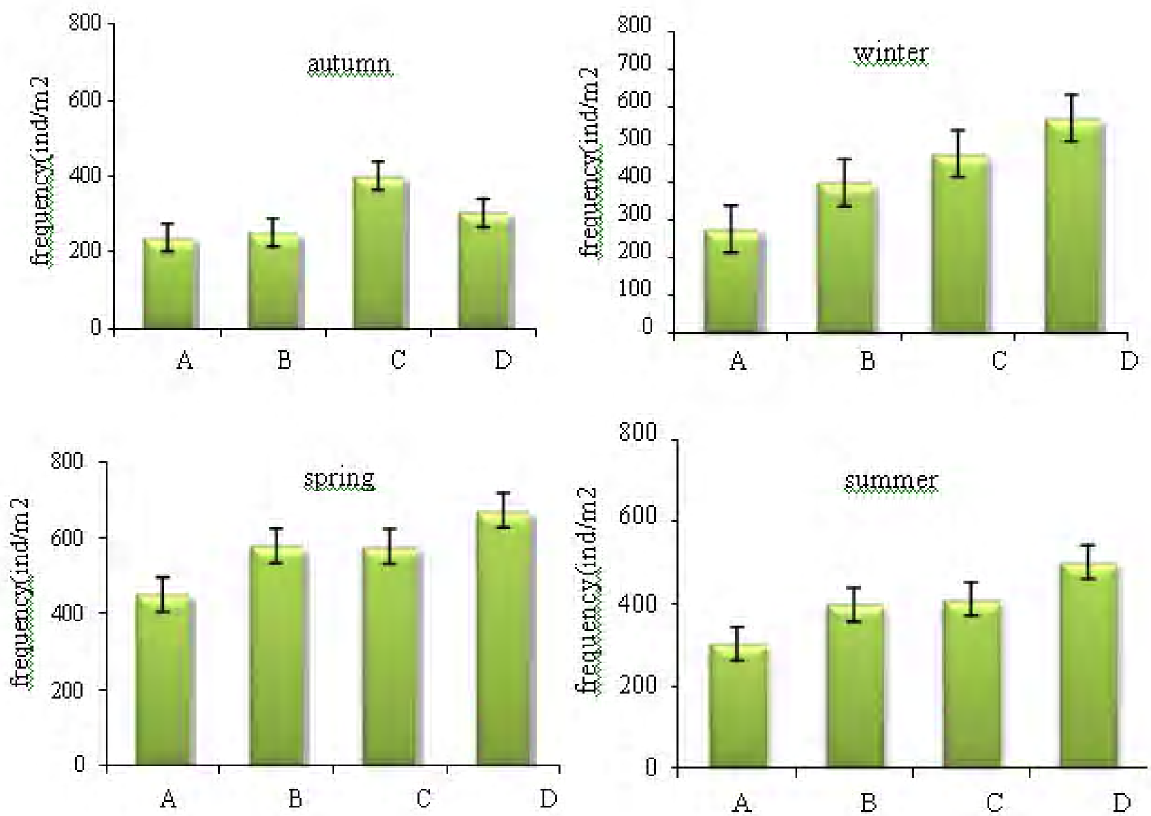

Fig. 3. Decapods Frequency diagram × m_2 on different Stations

Table 3. Biological indexes calculated for Decapods in all of the stations & seasons

Season	Station	Richness Index (R1)	Evenness Index (E1)	Shannon Index (X´)
	A	1.400	0.595	0.628
	B	1.430	0.505	0.599
Autumn	C	2.139	0.399	0.412
	D	2.170	0.401	0.547
	A	0.710	0.693	0.606
	B	1.170	0.613	0.501
winter	C	2.136	0.412	0.279
	D	2.168	0.432	0.452
	A	1.130	0.673	0.423
	B	1.190	0.591	0.490
Spring	C	1.225	0.410	0.675
	D	1.352	0.432	0.729
	A	1.090	0.763	0.280
	B	1.315	0.701	0.391
Summer	C	1.369	0.400	0.588
	D	1.610	0.411	0.606

Table 4. Shannon index (X´) rate for Decapods on Bushehr shores

Season	A	B	C	D	Total Average
autumn	0.77±1.97	0.81±2.14	1.09±1.24	1.12±1.97	0.99±1.83
winter	0.88±2.12	0.99±1.44	1.04±2.07	1.34±1.24	1.06±1.71
spring	0.93±2.52	1.13±2.57	1.54±1.24	1.65±2.53	1.31±2.21
summer	0.89±1.83	1.14±1.56	1.49±2.12	1.59±1.56	1.27±1.76
Total Average	0.86±2.11	1.01±1.92	1.29±1.66	1.42±1.82	

Table 5. Environment factors rate on different stations & seasons

Season	Station	Temperature (°c)	Salinity (ppt)	Dissolve Oxygen	PH
	A	28.4	33.3	7.1	8.33
	B	28.2	34	7.7	8.8
	C	28.2	33.9	7.7	8.6
autumn	D	28	34.8	4.7	8.55
	A	23.5	28.2	7.3	8.33
	B	22.9	27.6	7.4	8.13
	C	22.8	28.4	7.1	8.65
winter	D	22.7	28.9	7.7	8.65
	A	23.7	31.3	6.4	7.92
	B	24.3	32.4	7.3	8.88
	C	24	32	7.1	8.11
spring	D	23	31.5	7.1	8.53
	A	32	36.7	6.4	7.60
	B	33.2	35.6	6.5	8.5
	C	33.3	35.3	6	8.76
summer	D	33.7	35.9	5.7	8.82

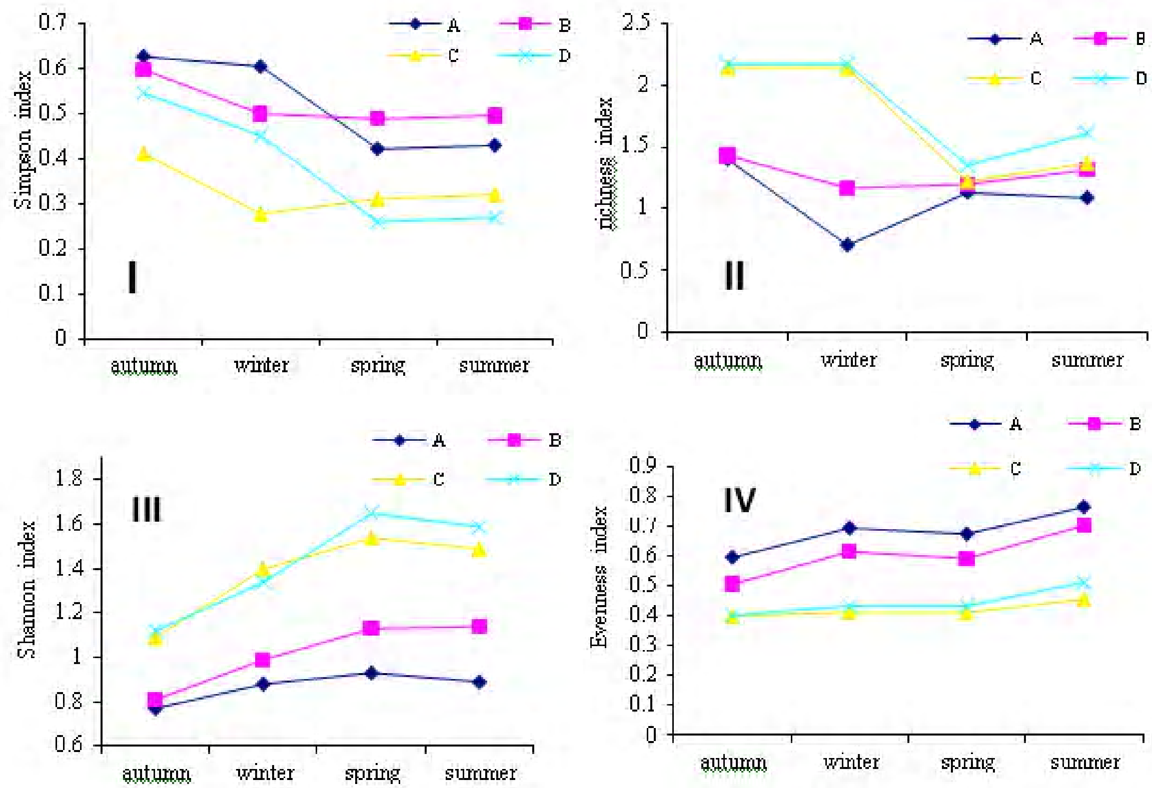

Fig. 4. Decapods Biological index rates on different seasons

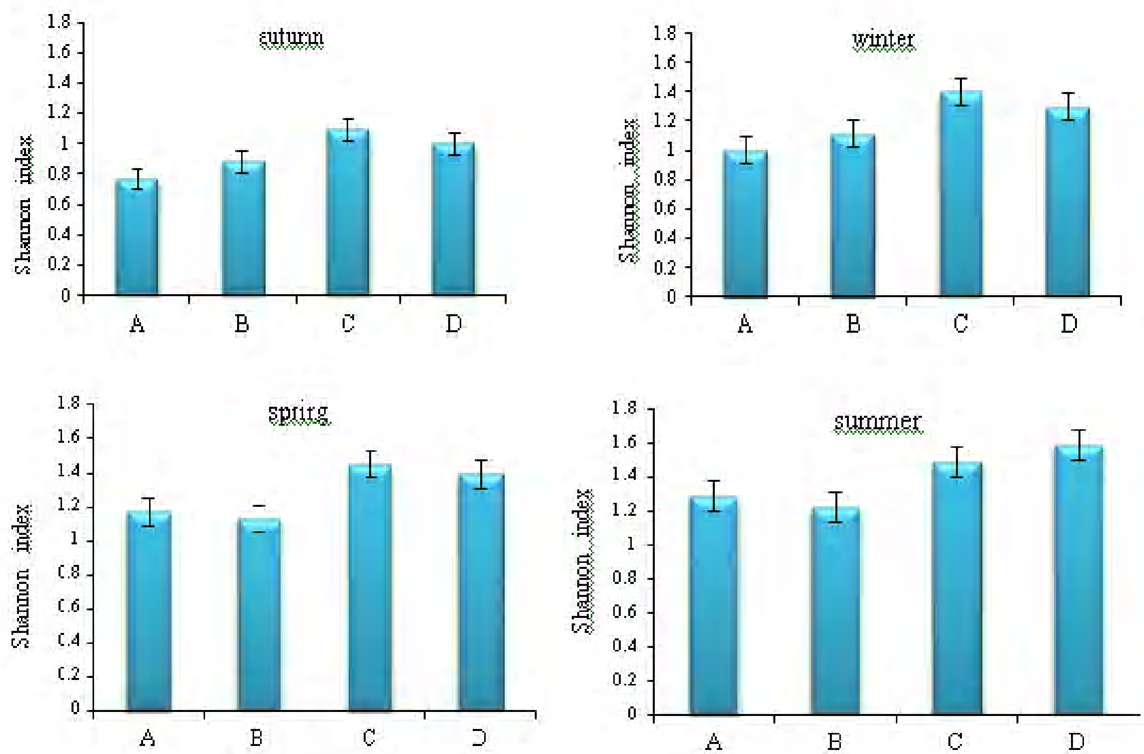

Fig. 5. Decapods Shannon index rate diagram on different stations and seasons

In all of the stations the Simpson Index has a descending rhythm from autumn to spring and it has an ascending rhythm from spring to summer (Fig.4,part I). Biological richness index in stations A and B showed a descending rhythm from autumn to winter and an ascending rhythm from winter to spring(Fig. 4,part II). On the other hand in stations D and C there is no significant difference in biological richness index rate from autumn to winter but from winter to spring we saw a decrease in biological richness index rate. The highest index rate among all of the stations belongs to station D in autumn (2.70) and the lowest rate belongs to station A in winter (0.710). Shannon Index shows an opposite rhythm compared to Simpson index in all of the stations. This index shows an ascending rhythm from autumn to spring and a descending rhythm in summer in stations all except station B. In station B the lowest indexrate was reported in autumn (0.81) and the highest one was reported in summer (1.14). Shannon index rate change domain like Simpson index has a similar intensity compared to each other in all stations (Figure 4,part III). The highest and lowest index rates for station C, (1.59) and (1.09), were recorded in summer and spring, respectively(Table 3). Like the other stations, station D had the highest and lowest index rates in spring (1.65) and autumn (1.12), respectively. Evenness index in station A ascended at the end of summer. The highest index rate is in summer (0.763) and the lowest index rate is in autumn (0.595). In station B the dispersion similarity index differences domain is similar to station A. It has a small increase from autumn to spring and a small decrease in spring. The lowest and highest rates of this index were in autumn (0.505) and summer (0.701), respectively(Table 4). Stations D and C had a small increase in Evenness index from autumn to summer. The highest index rate happened in stations D and C, 0.400 and 0.411, respectively, while the lowest index rates for these stations were 0.399 and 0.401, respectively. (Fig. 4, part IV) .

The results obtained from two way variance analysis Tuki test showed a significant difference between stations A with C ($p<0.001$). There is no significant difference between stations A and B concerning biological diversity ($p>0.05$), also there was no significant difference between stations D and C ($p>0.05$). Season comparison showed that there is a significant difference between spring with highest index rate (1.31) and autumn with lowest index rate ($p<0.001$). There was a difference of 0.05 between winter and summer which was not significant and finally we noticed a significant difference of 0.001 between autumn and spring concerning biological diversity. Results obtained from variance analysis showed no significant difference between stations A and B in autumn and summer ($p>0.05$). The highestindex rate was recorded in spring in station D which shows a significant difference from station A in the same season ($p<0.001$).

As shown in Table 5, the highest and lowest temperatures were recorded in station D. The highest salinity was recorded in summer in station A and the lowest salinity was recorded in winter in site B. The salinity and temperature shows an ascending rhythm from winter to summer. The maximum dissolved oxygen in water happens when temperature drops so in summer oxygen decreases with rising temperature and in autumn and winter it rises. The maximum PH was recorded in autumn in sites B and D and the minimum PH was recorded in summer in site A.

RESULTS & DISCUSSION

In the present study we investigated and compared decapods species composition in the four stations of Bushehr rocky shore we found many similarities between them concerning species composition. The highest parentage of Decapods during the whole year belonged to *petrolisthes* sp. species. Oliveira and Masunari (1999) founded that the compression of *petrolisthes* sp.species from porcellanidae family is 350 units per square meter. This compression was the highest population rate of Chinese lobsters identified in that region. The above cases show that this kind of bed as an appropriated ecology causes the mentioned species composition to increase through increasing ecological corner. Rocky Shores have some advantages compared to other beds including increasing reliefs and roughness on the bed and having more surface for living beings to connect and grow; having more stable bed compared to ever changing beds; having gaps and holes in the structure; diversity of ecologies and micro-ecologies for living beings to settle and for moving beings like decapods to hide and avoid being hunted. Any pollution sources, human activity on shores, dumping of waste water and sewage into shores can affect the biological populations living on shores (Loya *et al*.,2004). Factors such as human activities on shores, waste water and sewage dumping and pollution caused by native people on shores possibly affect the water physical factors quality in research stations. Relini (1989) stated that the difference in quality parameters of waters may affect the tolerance level of the species in closed population and the populations react to these conditions by changing the composition and frequency.

In this study, the lowest frequency was recorded in stations A and B and this could be due to several reasons. Since these two stations are located inside the Bushehr and different types of sewage enters the west coast through underground canals from houses on south of the stations A and B, low composition and low compression of some of the species in these two sites is possibly due to the reaction of decapods to different quality parameters of water in these stations. Sewage dumping rate in the stations A and B until year 1381 has been recorded 3400 and 1200 M^3 per day (Vazirizadeh , 2004). Also the extent and amount of rubble stones and rocks in stations C and D were more than that of stations A and B. so that reason of the composition and compression of species low in stations A and B compared to stations C and D can be related to the size difference and decrease, low extent and dispersion of rocks in the two late stations. Frequency rate in station A in all seasons was significantly lower than the frequency rate in stations D and C and the mutual effect of environment and time was significant. This station was rocky - sandy on its bed. On up areas it was completely sandy and towards sea and on down areas it was rocky. So the dispersion extent of the rocks was limited on this site. On the other hand the quality of the water and existence of pollutants and justify the lower frequency in this station compared to other stations. The highest decapods total frequency rate in all stations was in spring (570.7± 5.35) and the lowest frequency rate was reported in autumn (299.9±121.06).

Since the temperature has a controlling effect on the other physiochemical parameters of water, the changes of these parameters is dependent on temperature oscillation. So temperature is regarded the most important environmental factor and it should be studied elaborately in all ecological studies. The temperature changes process in different seasons shows the ascending rhythm from late winter to summer. In autumn the temperature has had a descending rhythm (Table 5). In summer as temperature raises very high, the decapods frequency drops. In spring, due to the appropriate temperature and consequently normal PH and salinity, the number of decapods will increase significantly. Bed stability is an effective factor in flora and fauna diversity, so high biological diversity on rocky shores can be a result of stability of bed (Sanders, 1968). High biological diversity in stations D and C compared to stations A and B can be justified due to less accessibility, more stability and sustainability, being free from any pollution and bed structures' more complexity. Considering the location of stations A and B inside the Busherh, accessibility and dumping of any pollutant and sewage in this area, biological diversity in these two stations can confirm the inappropriate environment and effect of pollution on biological populations in the region.

CONCLUSION

As stability on bed and proper condition can bloom and diversify the living beings on bed, any pollution and dumping any environment interfering factor on the bed can decrease the biological diversity. Seasonal changes can affect the bed's biological populations. Due to temperature changes and temperature drop in autumn the biological diversity rate decreased in stations, and in spring as environmental conditions improved in the same time the decapods reproduction season begins, the populations and diversity increased. Biological balance index or species dispersion Evenness reached its lowest rate in autumn as the temperature decreased. Contrary to this the biological richness and Simpson index (number and species prevalence) showed the highest rate in this season. Bed texture, plant materials, and water temperature effect the dispersion and diversity of Macrobenthic (Ansari *et al.*,1994). In the studied stations as time passes from autumn to spring Shannon index or biological diversity shows ascending rhythm and Simpson index shows descending rhythm. So the lowest Simpson index rate occurred in spring and the highest Simpson rate index occurred in spring and winter. The change in diversity index rate in an ecosystem in successive periods shows the change in environmental condition of bed (Wendth *et al.*,1998). In stations D and C due to ecological similarity, the interaction between the living beings had the highest rate and biological diversity oscillation in these two sites is dependent on biological processes, interaction and dynamics of population. Despite this we did not notice any difference in biological diversity in these two sites.

Regarding the results of the whole period, we can say that biological interactions on a bed will not be a key factor in changing the populations' diversity and population interaction in a bed is completely natural and it is roughly on balance. So oscillation and change in bed, more than any other factor is dependent on change in the environmental and climate conditions dominant on the bed and threats from any external factor in the region. Station D next to Bushehr nuclear power plant is the cleanest and the most intact station regarding the pollution which in a near future will be threatened seriously by the plants activities. So the present study can be a background for the future biological studies in these regions.

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