Identification and estimation of macrofauna in low tides of Bushehr province, Persian Gulf

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Abstract

The present investigation was undertaken to determine temporal and spatial distribution of macrofauna in low tide regions of Bushehr province in the northern Persian Gulf. Sampling was seasonally carried out by a box corer of 0.0225 m^2 in six stations including Genaveh, Farakeh, Shif, Bandargah, Rostami and Asalouyeh from summer 2008 until spring 2009. In this study, 752 specimens belonging to 29 genera were collected. Polychaetes were dominant both in terms of genus number (22) and relative abundance (77.1% of total macrofaunal abundance). The other dominant groups were crustaceans, bivalves and turbellaria. The highest number of *Prinospio* and *Solen* specimens were found in Genaveh, Farakeh, Bandargah, Rostami and Asalouyeh stations with sandy substratum; however *Capitella* sp. and *Nicomache* specimens were collected only in silt–clay substratum of Shif station. The highest (888.89 ind. m^{-2}) and lowest (37.03 ind. m^{-2}) annual average density of macrofauna were found in Farakeh and Asalouyeh regions, respectively. R- square in quadratic Regression equation between temperature and macrofauna density and Shannon wiener species diversity index were assessed to be 0.988 (P= 0.044) and 0.992 (P= 0.09), respectively. The annual Principal Component Analysis indicated that in stations 1- 5, the organic matter content, sediment texture and temperature have had the most influence on the macrofauna assemblage, but comparison of species composition, density and Shannon wiener species diversity index of macrofauna in Asalouyeh with previous recorded data of the region showed that manmade factors such as gas and petrochemical industries have had the most effect on the macrofauna community structure during sampling period.

Keywords: Bushehr, Ecological Indices, Macrofauna, Persian Gulf, Sediment texture

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Introduction

Macrofauna studies are known as the most practical methods for identification of habitats, ecological quality and human disturbance in aquatic ecosystems (Pearson and Rosenberg, 1978; Lindegarth and Hoskin, 2001) so that macrobenthic studies have suggested an important part of standards efforts for the marine habitat quality assessment (Borja et al., 2003; Borja, 2004; Borja et al., 2004; Rosenberg et al., 2004; Mistri and Munari, 2008).

After Fauvel (1911) and WesenbergLund (1949), macrofauna studies were continued by other researchers in two Iranian and Arabic coastlines of the Persian Gulf (Mohammad 1970, 1971, 1975, 1981; Jones 1986; Al-Khayat 2005; Mohammadi Roozbahani et al., 2010). There were no clear numbers of macrofauna species in the region, but within 18 months of sampling, 836 species were identified in the coastline of Saudi Arabia (Coles and McCain, 1990); Also, based on available references, 231 polychaetes species were reported in the Persian Gulf (Wehe and Fiege, 2002). However there were indications of some species misidentification for example Martin and coworkers (2006) confirmed that two previous reports of *Owenia fusiformis* Delle Chiajie (WesenbergLund, 1949; Mohammad, 1971) have been misidentified and mentioned specimens belonged to *Owenia persica* and *Owenia* sp.

Ecological indices assessment and identification of indicator organisms can be major practical tools to assess habitat quality (Washington, 1984). The available references contain limited information on these contexts in the Persian Gulf. Bushehr province with about 713 km coastline is located in the northwest of the Gulf, receives a lot of municipal, aquaculture and industries (especially Gas and Petrochemical) sewage daily. Despite rapid development and various types of environmental risks, macrofauna studies have rarely stretched so far, there are substantial data gaps to interpret any basic ecological quality assessment. In this order the main objectives of our study were (1) to identify macrobenthic specimens (2) to provide a quantitative description of macrobenthic specimens (3) to determine initial condition for future use such as biomonitoring and industrial impact assessment, in Bushehr low tide region.

Materials and methods

The study area is located along the coastline of Bushehr province at northwest of the Persian Gulf; six stations including Genaveh, Farakeh, Shif, Bandargah, Rostami and Asalouyeh were chosen which reflect the natural and manmade ecological variation such as coral reef, bay, estuary, nursery ground, fishing area, nuclear power plant, gas and petrochemical industries, Figure 1 and Table 1.

All collections were made in low tide zone seasonally during 2008-2009; Three replicate samples were collected by a box corer (0.0225 m^2 surface area) at each site and time period; Magnesium chloride diluted in 8% of seawater was added to the faunal samples then they were sieved through 0.5 mm mesh sieves, and retained specimens were fixed in 10% formalin and preserved in 70% alcohol. In laboratory after washing of specimens they were identified to the lowest practical taxonomic

level (generally genus) according to available references (Fauchald, 1977; Jones, 1986; Ruse and Pleijel, 2001).

Three replicate samples were collected for determination of sediment texture and organic matter measurement, sediment grain size was determined by Buchannan method (Buchann, 1984) and organic matter percent was estimated by wet oxidation method of Walkley-Black, later as modified by Gaudette and coworkers (1974).

Temperature, oxygen and pH were measured by digital instrument (HACH, HQ40d Portable Meters), and salinity by refractometer (ATAGO S/Mill) in each sampling period. To specify the structure of the macrobenthos aspects, the community indices of Shannon-Wiener species diversity index and Evenness were computed by Ecological Methodology software (Kenney and Krebs, 2001), Bray Courtis similarities plot were drawn by Biodiversity software (McAleece, 1997). The statistical software package (SPSS Software) was used to assess quadratic Regression equation between temperature and macrofauna density and Shannon wiener species diversity index of macrofauna; Principal Component Analysis were done using Canoco software package. At last, historic data of studied region were used to determine manmade effects on the macrofauna assemblage.

Table 1: Sampling stations, position and ecological trait of studied region

No	Station	Longitude	Latitude	Ecological Aspects
1	Genaveh	50°.54'	29°.49'	Fishing area and nursery ground for *Sepia pharaonis*
2	Farakeh	50°.38'	29°.07'	Adjacent to estuary ecosystem
3	Shif	50°.52'	29°.04'	Bay
4	Bandargah	50°.54'	28°.49'	Nuclear power plant (inactive)
5	Rostami	51°.04'	28°.34'	Fishing Area and Petrochemical industries plan (inactive)
6	Asalouyeh	52°.35'	27°.28'	Corals reef, Gas and petrochemical industries (active)

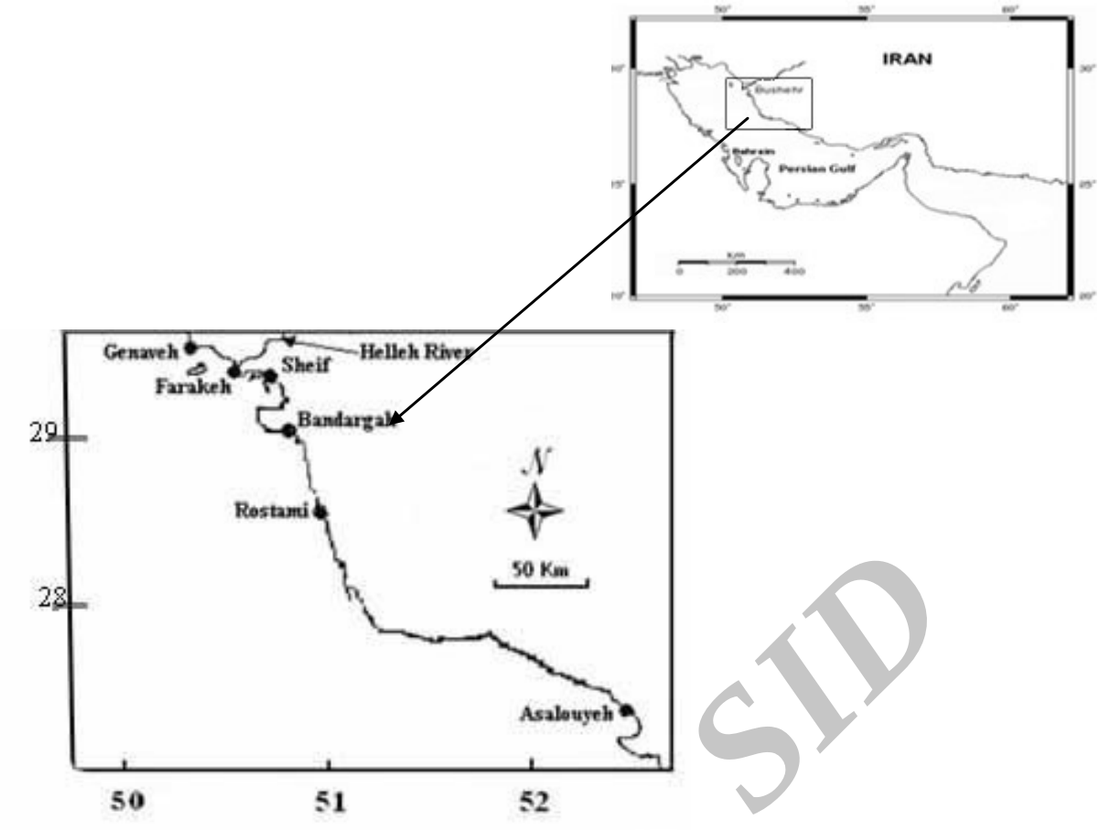

Figure 1: Sampling stations in Bushehr coastal waters

Results

Abiotic parameters have been tabulated in the Table 2. The lowest and highest water temperatures were recorded as 16.37 and 36.05 ºC in Shif and Farakeh in winter and summer seasons, respectively. The maximum of salinity were recorded as 43 g/l in Bandargah in winter sampling but the minimum 38 g/l was observed at Asalouyeh in summer. The water pH ranged from 7.66 to 8.44 in Asalouyeh and Bandargah in winter season, respectively. High and low values of DO were recorded 5.97 to 8.48 mg/l in Genaveh and Rostami stations in spring and winter seasons, respectively. The substrata of all stations except Shif were mainly composed of sand with an admixture of silt and clay but in Shif station the amount of silt and clay were consisted of more than 50% of sediment composition (Table 3). No significant difference was observed between substrates textures seasonally. The total organic matter (TOM) in the sediment ranged from 0.02 to 1.48%. The highest amount of TOM was found in Farakeh region, the major organic matter in this station was mainly associated with terrestrial detritus materials. 752 specimens belonging to 29 genera were collected during the present study. Polychaetes were dominant both in terms

of number of genera (22) and relative abundance (77.1% of total specimens). The other dominant groups were crustaceans (4 genera, 18.4%), bivalves (3 genera, 4.1%) and turbellaria (1 genus, 0.4%).

Faunal similarity based on four season's data of every station (Fig. 2) indicates that two stations of Shif and Asalouyeh are obviously different with others. Genaveh, Farakeh, Bandargah and Rostami with sandy substrate are characterized by surface deposit feeder dominancy such as *Prionospio, Cossura* and *Cyclaspis;* these stations are different in a few limited genera such as *Sabellaria* and *Solen* in Farakeh and Genaveh, *Chaetopterus* and *Polygordius* in Bandargah, *Nematoplana* in Rostami. The Shif station with silt-clay substratum is characterized by dominancy of

Nichomache and *Capitella* specimens. All collected specimens in the Asalouyeh station are similar to Genaveh, Farakeh, Bandargah and Rostami but it has been obviously characterized by low number of species and density of macrofauna (Tables 4 and 5).

The Tables 4 and 6 based on all macrobenthic samples collected throughout the study period, show that the abundance of all genera were noticeably increased in spring and autumn and significantly decreased in summer and winter so that the maximum and minimum of average density were seen in autumn (785.19/m^2) and winter (145.68/m^2), respectively. This pattern can also be seen for other indices (Table 4). Amount of R^2 in quadratic regression equation between temperature with density and Shannon wiener species diversity were assessed 0.988 (P= 0.044) and 0.992 (P= 0.09), respectively (Figs. 3 and 4).

Farakeh region have had the highest community index for macrofauna density in spring season as 1866.67/m^2, in Asalouyeh density of macrofauna was recorded to be 14.815/m^2 and ShannonWiener species diversity index was not assessed due to limitation of number of species (Tables 4 and 5).

The annual PCA indicated that organic matter content in stations 2 and 4, clay and silt in station 3 and amount of sand and temperature in stations 1 and 5 have the most influence on the macrofauna community structure of the study area (Fig. 5).

Table 2: Mean values recorded of physical and chemical parameters in low tide water of Bushehr province during sampling period, (2008-2009)

Parameter	Season	Asalouyeh		Rostami	Bandargah	Shif	Farakeh	Genaveh	Average
Temperature (C^o)	Summer	35.87	34.62	35.87	35.65	36.05	36.00	35.68	
	Autumn	26.53	26.55	27.34	27.37	27.00	25.11	26.65	
	Winter	19.87	19.35	17.42	16.37	16.50	16.50	17.69	
	Spring	26.68	27.54	28.12	27.47	29.13	28.00	27.82	
	Average	27.24	27.02	27.19	26.71	27.17	26.40	26.95	
Salinity (g/l)	Summer	38	39	39	40	40	41	39.50	
	Autumn	40	41	40	41	40	40	40.33	
	Winter	42	42	43	42	41	42	42.00	
	Spring	41	42	40	41	42	42	41.33	
	Average	40.25	41.00	40.50	41.00	40.75	41.25	40.79	
pH	Summer	8.21	8.29	8.30	8.31	8.26	8.38	8.28	
	Autumn	8.18	8.37	8.34	8.34	8.23	8.26	8.29	
	Winter	7.66	8.41	8.44	8.43	8.41	8.42	8.30	
	Spring	8.10	8.32	8.15	8.09	8.36	8.29	8.22	
	Average	8.04	8.35	8.30	8.30	8.32	8.33	8.37	
Oxygen (mg/l)	Summer	8.20	6.79	8.76	7.67	7.08	6.19	7.45	
	Autumn	8.01	7.28	7.79	6.69	6.65	7.14	7.26	
	Winter	7.66	8.48	8.22	7.01	7.74	7.27	7.79	
	Spring	8.23	6.94	7.50	7.43	7.23	5.97	7.22	
	Average	8.03	7.46	8.07	7.20	7.18	6.63	7.43	

Table 3: Seasonal mean of sediments grin size and TOM percentage in the study area, during, 2008-2009

Season	Parameter (%)	Asalouyeh	Rostami	Bandargah	Shif	Farakeh	Genaveh
	Gravel	8.54	2.61	5.41	4.83	0.18	0.40
Summer (2008)	Sand	83.44	85.52	91.98	39.18	93.41	83.50
	Silt	6.70	8.94	2.18	47.83	6.21	15.48
	Clay	1.32	2.93	0.43	8.12	0.20	0.62
	T.O.M	0.05	0.22	0.36	0.27	1.48	1.19
	Gravel	2.74	7.43	4.81	0.96	0.13	0.42
	Sand	80.82	89.41	91.26	44.84	83.55	72.65
Autumn (2008)	Silt	12.56	1.83	3.46	42.59	16.2	26.63
	Clay	3.79	1.33	0.47	11.61	0.20	0.30
	T.O.M	0.06	0.15	0.14	0.35	0.35	0.17
	Gravel	7.49	0.75	5.61	1.34	0.06	0.97
	Sand	81.11	91.72	91.02	35.91	93.24	80.22
Winter (2008)	Silt	10.47	5.00	2.94	45.65	6.61	18.00
	Clay	0.93	2.35	0.43	17.10	0.09	0.81
	T.O.M	0.02	0.05	0.07	0.14	0.35	0.09
	Gravel	3.66	1.91	2.98	1.68	0.06	0.50
	Sand	85.31	87.38	93.41	42.22	88.45	77.54
Spring (2009)	Silt	9.44	7.63	3.16	45.65	11.07	21.76
	Clay	1.59	3.08	0.45	10.45	0.42	0.20
	T.O.M	0.10	0.13	0.16	0.27	0.11	0.15

Table 4: Macrofauna density (ind. m^{-2}),Number of species (n/m^2) Shannon – Wiener species diversity and Evenness indices in low tide water of Bushehr province during, 2008-2009

Season	Parameter		Asalouyeh	Rostami	Bandargah	Shif	Farakeh	Genaveh
Summer (2008)	Density		59.26	192.59	296.29	177.77	251.85	133.33
	Number of species		3	5	6	9	8	5
	Shannon	1.50	1.70	1.72	3.08	2.58	1.88	
	Evenness	0.89	0.48	0.37	0.89	0.56	0.56	
Autumn (2008)	Density	14.81	814.81	800.00	888.88	1170.37	1022.00	
	Number of species		1	8	6	12	14	12
	Shannon	-	2.51	2.43	3.12	3.41	3.13	
	Evenness	-	0.60	0.55	0.59	0.64	0.60	
Winter (2008)	Density	59.26	251.85	133.33	103.70	266.66	59.26	
	Number of species		2	7	3	5	5	3
	Shannon	1.00	2.34	0.99	2.24	1.77	1.50	
	Evenness	1.00	0.57	0.53	0.89	0.53	0.89	
Spring (2009)	Density	14.81	281.48	1051.85	740.74	1866.67	488.89	
	Number of species	1	7	10	9	17	7	
	Shannon	-	2.54	2.71	2.88	3.36	2.34	
	Evenness		-	0.69	0.52	0.72	0.45	0.59

Table 5: Identified Genera and average of density (ind. m^{-2})**, in low tide water of Bushehr province during, 2008-2009**

No	Genus	Asalouyeh	Rostami	Bandargah	Shif	Farakeh	Genaveh
1	*Angulus*	0.00	66.67	0.00	0.00	29.63	0.00
2	*Capitella*	0.00	0.00	0.00	51.85	0	0.00
3	*Ceratonereis*	0.00	11.11	0.00	18.52	11.11	0.00
4	*Chaetopterus*	0.00	0.00	11.11	0.00	0.00	0.00
5	*Cossura*	11.11	33.33	59.26	3.70	114.81	48.15
6	*Cyclaspis*	11.11	88.89	144.44	0.00	0.00	3.70
7	*Nematoplana*	0.00	11.11	0.00	0.00	0.00	0.00
8	*Diogenes*	0.00	0.00	55.55	25.92	0.00	114.81
9	*Eocuma*	0.00	11.11	7.41	0.00	7.41	3.70
10	*Eunice*	0.00	0.00	3.70	0.00	11.11	25.92
11	*Flabelligera*	0.00	7.41	11.11	55.55	37.04	18.52
12	*Glycera*	0.00	7.41	3.70	44.44	48.15	7.40
13	*Goniadopsis*	0.00	3.70	3.70	40.74	96.29	18.52
14	*Lumberneris*	0.00	0.00	25.92	48.15	18.52	25.92
15	*Magelona*	0.00	0.00	0.00	33.33	18.51	18.52
16	*Marphysa*	0.00	0.00	0.00	0.00	3.70	3.70
17	*Nephtys*	0.00	14.81	70.37	62.96	74.07	18.52
18	*Orchestia*	0.00	33.33	3.70	0.00	0.00	0.00
19	*Owenia*	0.00	0.00	0.00	29.62	11.11	0.00
20	*Paphia*	0.00	7.41	0.00	0.00	0.00	0.00
21	*Perinereis*	7.41	11.11	22.22	14.81	44.44	77.77
22	*Nicomache*	0.00	0.00	0.00	37.04	0.00	0.00
23	*Platynereis*	0.00	0.00	0.00	3.70	7.41	0.00
24	*Polygordius*	0.00	0.00	22.22	0.00	0.00	0.00
25	*Prionospio*	7.41	77.78	118.52	3.70	159.26	11.11
26	*Sabellaria*	0.00	0.00	0.00	0.00	148.15	0.00
27	*Scololepis*	0.00	0.00	0.00	0.00	25.93	0.00
28	*Scoloplos*	0.00	0.00	7.41	3.70	11.11	25.92
29	*Solen*	0.00	0.00	0.00	0.00	11.11	3.70

Table 6: Identified Genera, seasonal average density (ind. m^{-2}) **and macrofauna frequency (%) in low tidewater of Bushehr province during, 2008-2009**

No	Genus	Summer		Autumn	Winter		Spring	frequency
1	*Angulus*	24.69		22.22	9.88		7.41	3.33
2	*Capitella*	4.94	9.88	2.47	17.28	1.86		
3	*Ceratonereis*	2.47	9.88	2.47	12.35	1.46		
4	*Chaetopterus*	0.00	4.94	0.00	2.47	0.39		
5	*Cossura*	19.75	64.20	14.81	81.48	9.72		
6	*Cyclaspis*	37.04	91.36	17.28	19.75	8.92		
7	*Nematoplana*	0.00	0.00	0.00	7.41	0.35		
8	*Diogenes*	4.94	86.42	7.41	32.10	7.06		
9	*Eocuma*	0.00	9.88	0.00	9.88	1.07		
10	*Eunice* 2.47	17.28	2.47	4.94	1.46			
11	*Flabelligera*	14.81	51.85	0.00	19.75	4.66		
12	*Glycera*	7.40	39.05	4.90	22.22	3.99		
13	*Goniadopsis*	4.94	56.79	2.47	44.44	5.86		
14	*Lumberneris*	0.00	19.75	0.00	59.26	4.26		
15	*Magelona*	0.00	32.10	0.00	14.81	2.52		
16	*Marphysa*	0.00	2.47	0.00	2.47	0.27		
17	*Nephtys* 9.88	79.01	12.34	59.26	8.66			
18	*Orchestia*	0.00	19.75	4.94	0.00	1.33		
19	*Owenia* 7.41	7.41	0.00	12.35	1.46			
20	*Paphia* 2.50	0.00	2.50	0.00	0.27			
21	*Perinereis*	22.22	51.85	0.00	44.44	6.39		
22	*Nicomache*	2.47	4.94	0.00	17.28	1.33		
23	*Platynereis*	0.00	2.5	0.00	4.94	0.40		
24	*Polygordius*	0.00	0.00	0.00	14.81	0.80		
25	*Prionospio*	9.88	74.05	37.04	130.86	13.58		
26	*Sabellaria*	2.47	0.00	24.69	71.60	5.33		
27	*Scololepis*	0.00	0.00	0.00	17.28	0.93		
28	*Scoloplos*	2.47	19.75	0.00	0.00	1.73		
29	*Solen*	2.47		7.41	0.00		0.00	0.53

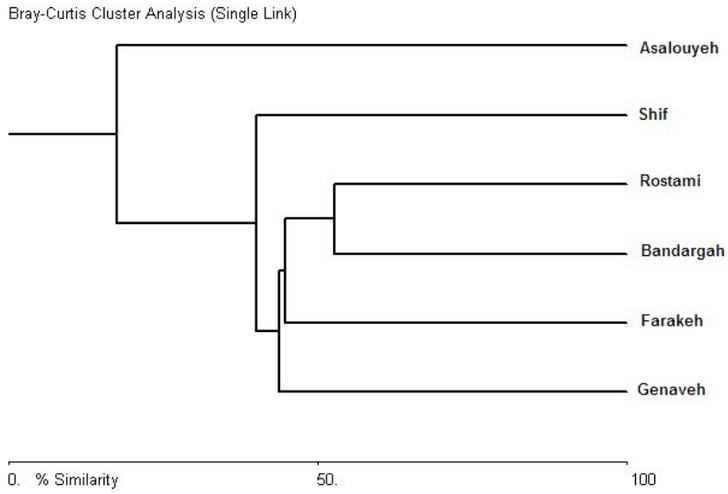

Figure 2: Dendrograms illustrating relation between different stations

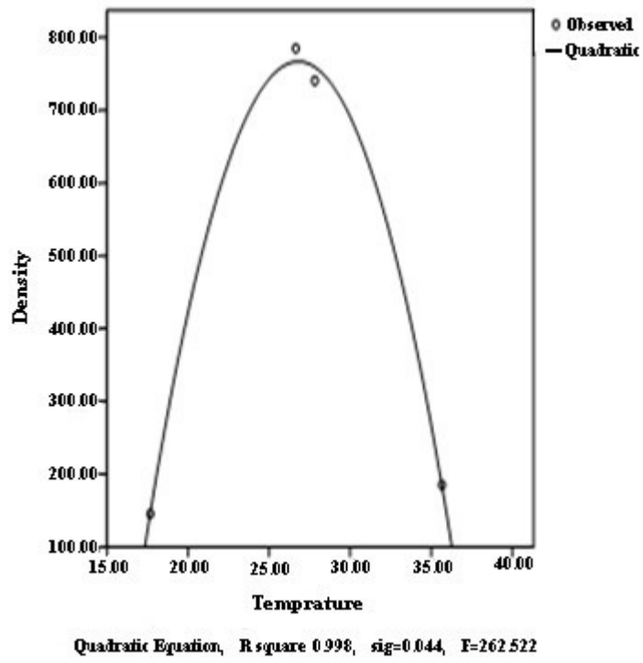

Figure3: Scatter plot with quadratic regression line between temperature and Macrofauna Density

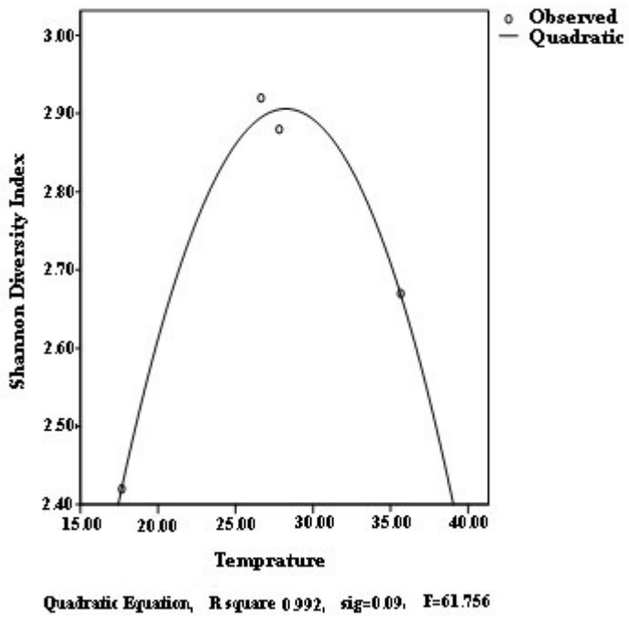

Figure 4: Scatterplot with quadratic regression line between temperature and Shannon wiener species diversity index

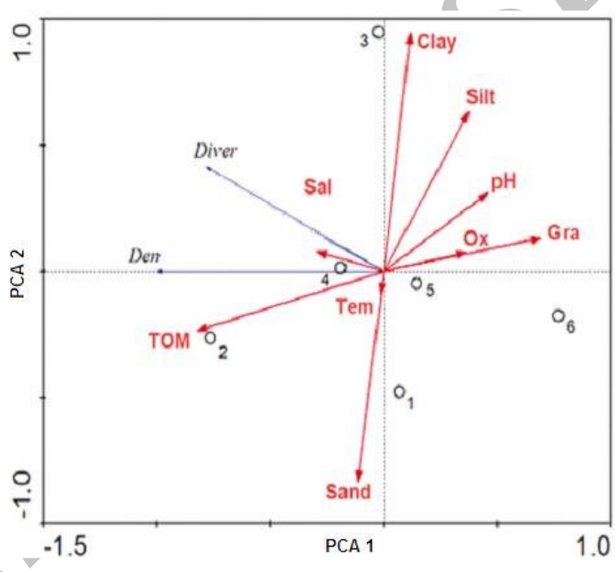

Figure 5: Annually PCA ordination of sampling stations (o_1-o_6) and biotic and abiotic parameters, abiotic parameters include Salinity (Sal), temperature (Tem),Total organic matter(TOM), Oxygen (OX), Clay, Silt, Sand and Gravel, biotic parameters Shannon wiener Diversity (Diver) and Density (Den).

Discussion

Among identified genera except Polygordiuos and Nematoplana, the other ones have also been observed by other authors in the northwest of the Persian Gulf (Jones, 1986; Valavi, 1997; Jones and Hayes, 2008; Mooraki et al., 2009). About 77.1% of total identified specimens belonged to Polychaets, Such dominancy were also reported by Behroozi Rad and Ahmadi, (1996) in macrobenthose study of Tiab and Minab seashores. Other macrofauna investigation in the tidal creeks of Khore-Moosa revealed that polychaetes with 62.1% of the total number are the most abundant specimen in the study area (Mooraki et al., 2009). But in other benthic organism study in the seagrass and sand/silt coastlines of Saudi Arabia (Coles and McCain,1990), 144000 organisms belong to 835 species were identified, about 107000 of total specimens occurred in sea grass samples. Composition abundance of major groups was recorded as following respectively: Pelecypods and Gastropods 60.2%, Polychaetes 25.8%, Crustaceans 5.7%, Echinoderms 1.0% and others 7.4%. Investigator believed that there is significant increase of density and species number in sea grass stations (e.g. O'Gower and Wacasey, 1967; Edgar, 1992), therefore the above macrofauna difference between Arabian and Iranian coastlines can be related to the type of studied habitat and biological interaction among different communities.

On the basis of faunal cluster analysis (Fig. 2) it can be concluded that study region have had 3 major habitats, consist of Asalouyeh, Shif and 4 other stations (Genaveh, Farakeh, Bandargah and Rostami).On the other hand the annually PCA have indicated that in stations 1 - 5 sediment texture, organic matter content and temperature had the most influence on the macrofauna community structure.

Sediment texture is one of the important factors in macrofauna assemblage (Gray, 1974; McLusky and McIntyre, 1988; Capaccioni-Azzati et al., 1991); Sediment analysis showed that 5 of 6 target stations have sandy texture, and it is somehow similar with "sandy beaches constitute approximately three-quarters of the world's shorelines (Bascom, 1980). Shif station with annual average of 45.43% silt and 40.53% sand showed obvious difference with other sandy stations; As expected, sediment texture can affect on species composition in the study area, so that *Capitella*, *Flabelligera*, *Nicomache* have only found in Shif station; presence of these genera in such silty substrates were reported by others (Fauchald and Jumars, 1979).

Macrofauna Composition in other stations were mainly represented by *Prionospio*, *Cyclaspis* and *Cossura* these genera were previously reported as a surface deposit feeders in sandy bottom (Barnes, 1987; Paiva, 1991; Rouse and Pleijel, 2001).

Some genera were observed in both types of sediments including *Magelona*, *Lumberneris*, *Ceratonereise*, *Glycera*, *Goniadopsis*, it seems that they can distribute in varied sediment between silt clay to coarse sand. However Fauchad and Jumars (1979) introduced genus *Magelona* as a sand bottom deposit feeders but this result and other observations by other workers (Lana, 1986; Brasil and Silva, 2000) confirm that some species of genus *Magelona* can distribute in silt/clay and

sandy sediments. Other common genera such as *Glycera*, *Lumberneris*, *Eunice*, *Marphysa* and *Platynereis* are carnivores or omnivores according to Fauchad and Jumars (1979) they can be in varied sediment texture between medium and coarse sand.

Some genera only found in limit region or in one season including *Sabellaria*, *Nematoplana and Polygordius*, *Scoloplos*, *Cheatopetrous* and *Solen* such limiting in distribution are surprising, however available results cannot explain these occurrences but, whereas suspended materials is necessary for building of *Sabellaria,* tubes (Rouse and Pleijel, 2001), it seems that limit distribution of *Sabellaria* in Farakeh station may be related to provision of suspended material by Helleh river.

Except Asalouyeh station, the mean macrofaunal abundances recorded during the present study were varying between 137 and 850 ind. m^{-2}. These values are somewhat similar to 400–500 ind. m^{-2} reported by Jones and coworkers (2008) for Saudi Arabia sandy beaches. The maximum Shannon- wiener species diversity values was recorded 3.36 in Farakeh region in spring, it is close to 3.17 in Bahrekan Bay (Mohammadi Roozbahani et al., 2010), 2 in tidal creek in Khore-Moosa (Mooraki et al., 2009) and 3 for intertidal waters of Bushehr (Vazirizadeh and Arebi, 2011).

Available references reported that swash, climate condition and sediment texture are the major factors that affect on species composition in sandy beaches (McLachlan, 1990; McLachlan et al., 1996; Nybakken, 2001). Whereas there isn't obvious change in temporal sediment texture in the shoreline of Bushehr province it can be concluded that both factors of swash and sediment cannot be important effective factors in annual macrofauna density and diversity variations. But other factors such as temperature variation may have more impact on the annual macrofauna assemblage. So that annual temperature range (16-36ºC) in investigated region showed clear seasonal patterns, characteristic of subtropical regions. This finding agrees with other observations in the north region of the Persian Gulf (Jones and Clayton, 1983; Sheppard et al., 1992; Reynolds, 1993; Mohammadi Roozbahani et al., 2010), Figs 3 and 4 also clearly show that relation between temperature with macrofauna density and Shannon wiener diversity indices; while temperature has a fundamental effect in metabolic reactions and mortality rate (Nybakken, 2001; Kröncke and Reiss, 2010), high annual temperature variation can be more natural effective factors on the macrofauna community in the northwest of Persian Gulf .

PCA analysis confirms that organic matter content is another effective factor on macrofauna assemblage. High relatively Shannon wiener species diversity index were observed in Bandargah, Shif and Farakeh stations with highest recorded amount of TOM. These regions are enriched by Helleh river, municipal sewage, aquaculture effluent and land run off so that a part of sediment texture of these regions comprise of land detritus materials; As reported and discussed in other region (Largier, 1993; Manini et al., 2002), it seems that environmental enrichment may be one of

the major factors contributing to the fauna richness in the study region .

Although Asalouyeh region occurs in protected area of Nayband Bay undoubtedly, according to the lowest amount of density, species number and Shannon wiener species diversity indices, this region has been the poorest macrofauna habitat, during all samplings in the region. Asalouyeh region have marsh lands, mangroves, sea weeds and coral reefs communities adjacent together.

Some macrofauna species such as *Perinereis nuntia, Perinereis dumerilii, Prionospio rotalis, Prionospio pinnata, Glycera covoluta* and *Naineris laevigata* were reported in intertidal region previously (Valavi, 1997). Many industries and production facilities for wet gas and petrochemical products were made by the Iran National Oil Company after the discovery of oil in 1990. In addition, large quantities of industrial effluent without suitable treatment release into coastal waters daily (AeinJamshid et al., 2005). Unfortunately coincided with fast development of the region, the reports of environmental problems and fish mortality were suddenly increased such as destruction of marsh lands, mangrove forest, coral reefs, seaweeds and sea grass beds (Nourinezhad and Omidi, 2009) low level of pH, high concentration of Mercaptan and fish mortality

(AeinJamshid et al., 2005) extensive mortality of green turtles (Busher Department of Enviroment,2010; Nourinezhad, 2010). According to the above instances and negative effects of pollution and stress on the ecological indices, it seems that gas and petrochemical effluent and disturbances within the area can be the major problems of macrofauna communities in Asalouyeh region.

Finally, it can be concluded that polychaetes, crustaceans and bivalves are the major macrofauna groups in low tides of studied region, also the temperature variation, sediment texture and manmade factors of gas and petrochemical industry have had the most effects on the macrofauna community structure in the study region within sampling periods.

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