World Journal of Fish and Marine Sciences 4 (2): 142-149, 2012
ISSN 2078-4589

DOI: 10.5829/idosi.wjfms.2012.04.02.56346

# Horizontal Zonation in Macrofaunacommunity of Bardestanmangrove Creek, Persian Gulf

*[1]Alireza Safahieh, [1]Mohammad-Bagher Nabavi, [2]Amir Vazirizadeh,*
*[1]Mohammad-Taghi Ronagh and [1]Reza Kamalifar*

[1]Department of Marine Biology, Khormashahr Marine Science and Technology University,
Marine Science and Technology Faculty, Iran
[2]Persian Gulf University, Persian Gulf Research and Study Center, Bushehr, Iran

**Abstract:** Mangrove fauna often show horizontal or vertical zonation. Some of them dominate in mud, some on the shrubs and leaves and the others around pneumatophore roots. Several studies have been designed and performed worldwide to investigate macrobenthic community of mangrove ecosystems. Most of them have shown that distribution and zonation of these communities is affected by environmental parameters. Present study was undertaken in a small mangrove forest (Bardestan mangrove creek) located in middle coasts of Iranian side of the Persian Gulf in Bushehr province (51° 57' 28" E and 27° 50' 27"N) to investigate horizontal zonation in the macrofauna communities. Sampling was carried out in four seasons during summer 2008 to spring 2009. Four transect lines across the central canal of the habitat were selected to cover all over the ecosystem. Five distinct tidal levels (stations) were sampled for macrofauna and environmental properties using quadrate and portable instruments, respectively. Analyzed data showed there are at least two or three distinct horizontal zones of macrofauna across central canal in which each zone includes and/or dominate by specific taxa.This composition and zonation was changed during different seasons.Statistical analysis showed significant correlation between environmental parameters (mud content, total organic carbon, dissolved oxygen, salinity and redox potential) and composition or distribution of macrofauna ($P<0.05$). It is suggested that variation of mangrove trees, tidal inundation and sediment properties among varied tidal level may be affected this zonation in Bardestan mangrove forest.

**Key words:** Persian Gulf % Bardestan % Mangrove % Macrofauna % Zonation

## INTRODUCTION

Muddy or sandy sediments of mangrove ecosystems may serve as habitat for a variety of epibenthic, infaunal and meiofaunal invertebrates. Mangrove sediments generally support higher densities of benthic organisms compare to non-vegetated sediments. Mangrove fauna often show horizontal and vertical zonation. Some of them dominate in mud, some on the shrubs and leaves and the others around pneumatophore roots [1]. Distribution of macobenthos is controlled by sediment grain size, salinity and ground water. Hence, the most successful benthic species in mangrove habitats are those organisms that can adapt to environmental properties of these ecosystems [2].

Several studies have been designed and performed worldwide to investigate macrobenthic community of mangrove ecosystems [3-5] in which a few studies reported horizontal zonation in mangrove swamp. However, some researchers have determined various kinds of zonation in mangrove forests. Lee [6] described horizontal and vertical zonation of fauna in mangrove ecosystems. Yijie and Shixiao [7] found three and four mancrobenthic zones in two different transect lines, in mangrove forest of Guangdong, China. This zonation has been affected by characteristicof mangrove community, sediment properties and tidal changes. Chakraborty and Choudhury [8] reported that substrate characteristics, salinity and degree of tidal inundation were effective factors in crabs distribution, that resulted a pattern of

**Corresponding Author:** Reza Kamalifar, Persian Gulf Research and Study Center, Persian Gulf, University, Iran.

zonation in their composition and distribution. Frusher *et al.* [9] also concluded that distribution of sesarmid crabs in mangrove forests follows a pattern, they also reported zonation in density and diversity of grapsid crabs across intertidal zone of these habitats.Some studies also have performed to investigate macrobenthic community of Iranian mangrove [10-12] however there is no study focused on zonation of macrofauna in mangrove habitats of Iranian coasts. Present study was performed to consider probable zonation in macrofauna community of Bardestan mangrove swamp.

## MATTERIAL AND METHOD

**Study Site:** Present study was undertaken in asmall mangrove forest (Bardestan mangrove creek) located in middle coasts of Iranian side of the Persian Gulf in Bushehrprovince (51° 57' 28" E and 27° 50' 27" N) (Fig. 1). The narrow mangrove forests, approximately 50-60 m upshore and consisting of patches of mature *Avicennia marina* fringe each side of the creek. The area of thisplace is about oneha in mangrove forest [13]. Central canal of the creek which is lined across the coast of the Persian Gulf, is the only place covered with water in low tide. Distribution of mangrove trees is not alike in two sides of the canal. Most of them are located in the western side and have expanded from north to south along the canal. Only a small patch of trees is visible in south part of the eastern side close to the entrance of the creek. The ecosystem lacks any constant waterway from land and just seasonal runoffs affect this place. Industrial and urban regions have surrounded this habitat, as many homes were visible around the habitat in approximate distance of 200 meters.

**Sampling Design:** Sampling was carried out during four seasonsand was performed in September and November 2008 as well as February and April 2009. For covering the whole habitat including mudflats and mangrove zone, four transect lines were selected. Among them, transects one, two and three were located in western side and transect four was situated in eastern part of mangrove swamp (Fig. 1). With regard to apparent horizontal zonation in sediments, each transect line was divided into five distinct stations from high tide to low tide (Fig. 2 and 3). High tide zone (Ht) was the first station with smooth and even substrate where was located in the highest part of intertidal zone. It would be submerged just a few days a month, during spring tides. Halophilic terrestrial plants are occasionally visible in this station.

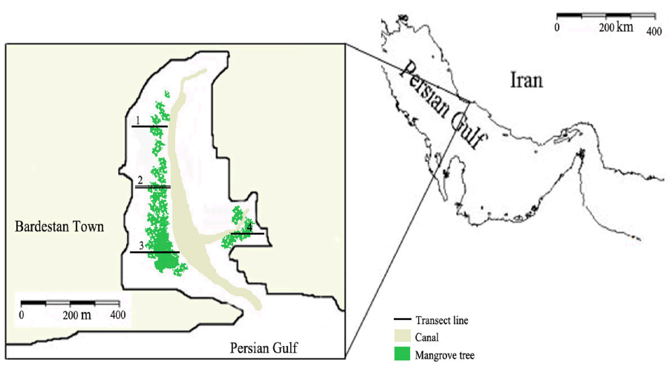



Fig. 1: Study area, Bardestan mangrove swamp.

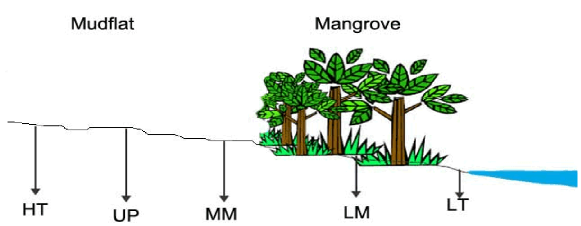



Fig. 2: Schematic view of different stations dispersed within each transectsline.

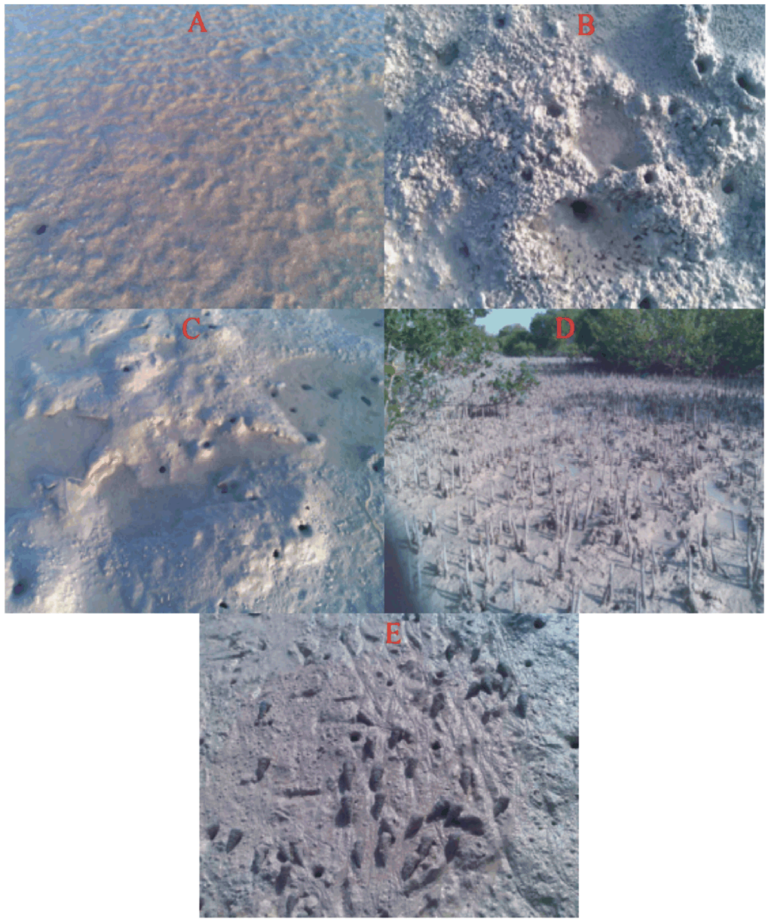



Fig. 3: Apparent features of sediment in five sampling stations. (A: Ht, B: Up, C: Mm, D: Lm and D: Lt).

The second station, Upper mid tide zone (Up), located in lower tidal level with rough surface and many burrows of burrower crabs. The next station was Midtide zone (Mm) with mire substrate and several holes excavated with mudskippers from family gobiidae. Lower mid tide zone (Lm) was the fourth station and was located under the mangrove trees. The surface of this station was covered with algae and mangrove pneumatophores. The latest station was the nearest one to the central canal, between mangrove forest and low tide where has a smooth surface. This station named Lower tidal zone (Lt).

In order to study zonation in macrobenthos community of the habitat, three sediment samples were taken randomly using a 0.25 $m^2$ quadrate framework to the depth of 10 cm of sediments. For Grain Size (G.S) and Total Organic Carbon (TOC) analysis, three samples of sediment were taken from the same places using core sampler. Samples were put into plastic bags and were carried to the ecology laboratory of the Persian Gulf Research and Study Centre (PGRSC) for further laboratory analysis.

Physiochemical factors (including salinity, pH, temperature, dissolve oxygen and redox potential) were determined using portable instruments. The factors were measured through gathered water in hand excavated holes in sediment.

**Sorting and Identification of Macrofauna:** Macrofauna were identified to species or genus level using valid identification key books [14-16].

**Data Analysis:** Pearson correlation test was used in order to determine correlation between biological and physicochemical parameters among various stations. The Bray-Curtis Similarity Index, based on log (x+1) transformation, was calculated to detect the similarity between sampling stations.

## RESULTS

During all sampling seasons, the total numbers of 44 macrobenthic species were identified in all stations. The maximum and minimum number of macrobenthic species was observed in the Winter (35 species) and Summer (13 species), respectively. In the Spring 30 macrobenthic species and in the Autumn 21 species were identified. Macrofauna specimens were belonged to four taxonomic classes including Gastropoda (45.5 %), Malacostraca (25.5 %), Polychaeta (14%) and Bivalvia (14%). Among all identified species only 11 species (i.e. Paphiagalus, Cerithideacingulata, Capitellacapitata, Ucasindensis, Macrophthalmuspectinipes, Onchidiumperoni, Acteocinainvoluta, Umbonium sp.2, Hydrobia sp. Ceratonereissp. and Umboniumvestiarium) were observedduring all seasons. The bivalve *Paphiagalus* followed by the gastropod *Cerithideacingulata*, the polychaet*Capitellacapitata* and the gastropod *Hydrobia sp.* were abundant species throughout the year.

Dominant species varied among different tidal levels (Table 1). In all seasons, *Capitellacapitata* was dominant species of stations Ht and Up. *Capitellacapitata*, *Ceratonereis sp.* and *Macrophthalmuspectinipes* dominated in station Mm. Dominant species of this station plus to *Ucasindensis* and *Perinereiscultrifera* were dominated in station Lm. *Paphiagalus*, *Cerithideacingulata* and *Hydrobia sp.* were dominant species of station Lt.

According to cluster analysis the studied stations in the summer, could be separated into two clusters (Fig. 4). The first cluster includes stations Ht1, Ht2, Ht4 and Up1. Species number and abundance in these stations were low. The second cluster contained other stations. There was no macrobenthic species in station Ht3, so that, this station was omitted from analyzed data. In other seasons three clusters were recognized. Generally, the first cluster included stations located in Up and Httidal level with low diversity and abundance. The second cluster consisted of stations situated in Lm and Mm tidal level, where polychaeta were abundant and dominant taxa. The third cluster included lower tide stations (Lt) with high abundance and diversity of gastropoda and bivalvia. Cluster charts demonstrate that stations with similar position or the same distance to the central canal are more similar (Fig. 4).

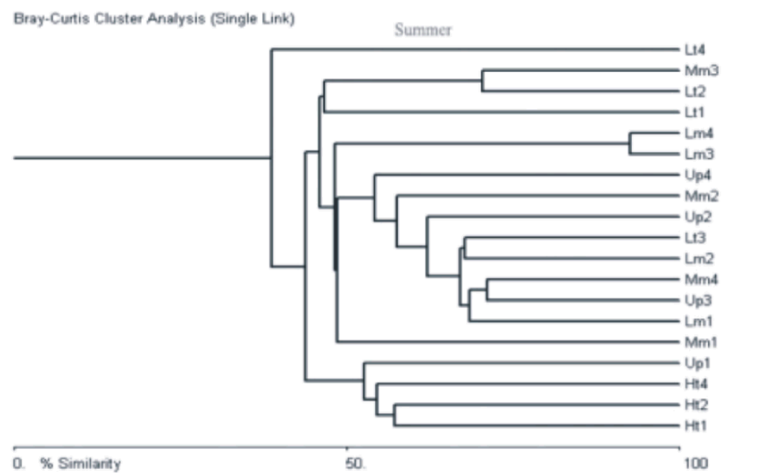
**Each Zone (Cluster) Could Be Described as Follows:** Zone one: this zone was located in mud flats, between land and mangrove trees and constituted stations Ht and Up. Short tidal inundation and long desiccation time were important features of this zone. Sediment in these stations contained low level of TOC and mud as well as high level of DO and Eh (Table 2). This zone is recognizable with low density and diversity of macrofauna. Some malacostraca species such as *Ucasindensis*, *Macrophthalmuspectinipes*, *Ocypode sp.* and polycheat*Capitellacapitata* were abundant in this zone.

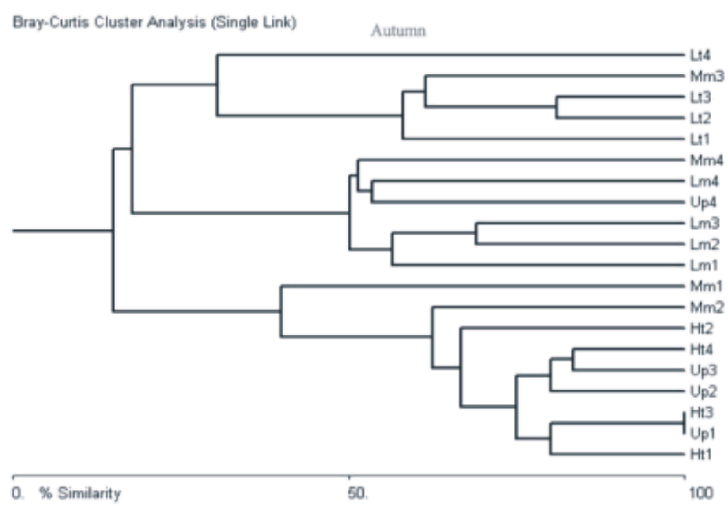
Table 1: Dominant species of different tidal levels in different seasons.

| | Summer | Autumn | Winter | Spring |
|---|---|---|---|---|
| Ht | *Capitellacapitata* | *Capitellacapitata* | *Capitellacapitata* | *Capitellacapitata* |
| Up | *Capitellacapitata*<br>*Ceratonereis sp.*<br>*Ucasindensis*<br>*Macrophthalmuspectinipes* | *Capitellacapitata* | *Capitellacapitata*<br>*Macrophthalmuspectinipes* | *Capitellacapitata*<br>*Ceratonereis sp.* |
| Mm | *Capitellacapitata*<br>*Ceratonereis sp.*<br>*Hydrobia sp.* | *Capitellacapitata*<br>*Ceratonereis sp.* | *Capitellacapitata*<br>*Macrophthalmuspectinipes*<br>*Ceratonereis sp.*<br>*Phasionellasolida* | *Capitellacapitata*<br>*Macrophthalmuspectinipes*<br>*Ceratonereis sp.*<br>*Perinereiscultrifera* |
| Lm | *Capitellacapitata*<br>*Ceratonereis sp.*<br>*Ucasindensis* | *Capitellacapitata*<br>*Macrophthalmuspectinipes*<br>*Ceratonereis sp.* | *Capitellacapitata*<br>*Macrophthalmuspectinipes*<br>*Ceratonereis sp.*<br>*Phasionellasolida*<br>*Perinereiscultrifera* | *Capitellacapitata*<br>*Macrophthalmuspectinipes*<br>*Ceratonereis sp.*<br>*Perinereiscultrifera*<br>*Onchidiumperoni* |
| Lt | *Cerithideacingulata*<br>*Paphiagalus*<br>*Hydrobiasp* | *Cerithideacingulata*<br>*Paphiagalus*<br>*Hydrobia sp.* | *Cerithideacingulata*<br>*Paphiagalus*<br>*Hydrobia sp.* | *Cerithideacingulata*<br>*Paphiagalus*<br>*Hydrobiasp* |

Table 2: Summary results for some abiotic parameters (mean value ± SD) at different tidal levels.

| | Station | Mud (%) | TOC (%) | T (°C) | DO (ppm) | Salinity (psu) | pH | Eh (mv) |
|---|---|---|---|---|---|---|---|---|
| Summer | Ht | 46.7±22 | 1.6±0.6 | 33.7±0.2 | 4.3±0.27 | 47.2±0.95 | 7.9±0.1 | 66.2±6 |
| | Up | 56.2 ±18.9 | 1.6±0.5 | 33±0.1 | 2.3±0.13 | 42±0.81 | 8.1±0.15 | 66.5±4.7 |
| | Mm | 73.5±15 | 3.7±1.2 | 32.8±0.15 | 2.1±0.06 | 41.2±0.50 | 7.8±0.3 | 43.7±2.5 |
| | Lm | 88±4.8 | 5.9±1.6 | 32.5±0.4 | 1.9±0.18 | 40.2±0.50 | 7.7±0.24 | 30±4.7 |
| | Lt | 39.7±6.3 | 1.4±0.2 | 31±0.05 | 2.6±0.34 | 44.5±0.57 | 7.9±0.1 | 53.5±2.51 |
| Autumn | Ht | 40 ±17 | 4.2±0.6 | 25±0.15 | 6.6±0.50 | 50.2±0.96 | 7.7±0.3 | 57.7±5.37 |
| | Up | 50.5±12 | 2.5±1.2 | 25.2±0.9 | 6.2±0.30 | 43.5±0.57 | 8±0.3 | 73.5±3.69 |
| | Mm | 74±8.3 | 4.2±0.5 | 23.2±0.1 | 3.7±0.40 | 41.2±0.50 | 7.8±0.24 | 67±3.46 |
| | Lm | 88.5±3.4 | 5.4±0.9 | 23.2±0.2 | 2.6±0.50 | 42.5±1.73 | 7.9±0.2 | 54.7±5.9 |
| | Lt | 50.2±31 | 2.8±0.8 | 23±0.26 | 5.8±0.20 | 45.2±0.50 | 8±0.18 | 43.7±10.7 |
| Winter | Ht | 54.7±26 | 14.5±0.4 | 18.8±0.25 | 6.2±0.23 | 51.2±2.88 | 8±0.38 | 70.2±0.5 |
| | Up | 64±22 | 13.6±0.5 | 20.8±0.5 | 5.6±0.43 | 43.7±1.25 | 8±0.33 | 72.2±4.9 |
| | Mm | 74.7±15 | 14.9±0.5 | 22.5±0.13 | 3.9±0.55 | 41.7±1.25 | 7.9±0.16 | 46.5±12.3 |
| | Lm | 82.7±10 | 15.8±0.9 | 24.4±0.6 | 2.9±0.57 | 42±0.81 | 7.9±0.14 | 35.7±12.3 |
| | Lt | 45±28 | 13.2±0.9 | 24.4±0.38 | 5.1±0.60 | 45.5±0.57 | 8±0.12 | 63.2±7.3 |
| Spring | Ht | 48.2±22 | 10.8±2.1 | 26.5±0.64 | 4.7±0.34 | 59±1.15 | 7.8±0.08 | 55.2±14.7 |
| | Up | 62.7±20 | 10.1±0.7 | 26.5±0.4 | 4.4±0.78 | 47.5±0.57 | 7.8±0.17 | 46.7±11.9 |
| | Mm | 68±15 | 11±2 | 24.9±0.15 | 3±1.30 | 46.5±1 | 7.9±0.21 | 38.2±10.9 |
| | Lm | 77±7.4 | 16.1±1.2 | 25.2±0.5 | 2.1±0.74 | 44.5±0.57 | 7.7±0.35 | 26.7±7.9 |
| | Lt | 75±14 | 13.2±2.1 | 24.5±0.17 | 2.8±1.61 | 44.7±0.96 | 8±0.05 | 40.2±14.2 |



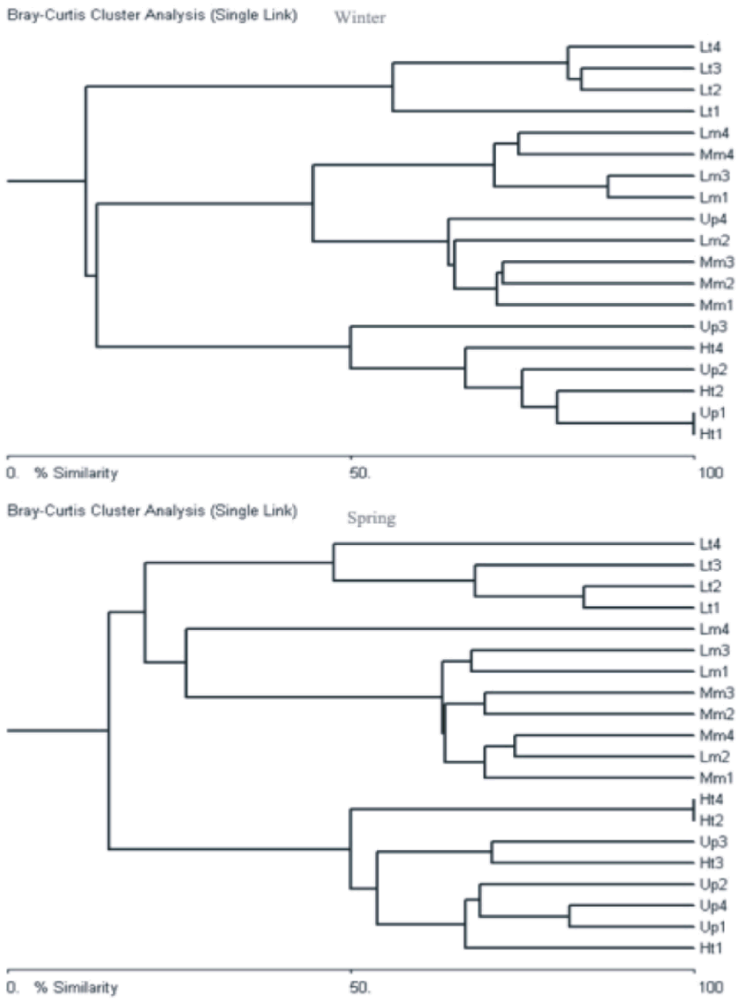



Fig. 4: Cluster analysis of different stations based on macrobenthic species, Spring.

**Zone Two:** This zone included stations Mm and Lm, close to mangrove trees. This zone is affected by litter fall and high density of macroalgae and pneumatophore roots. The mangroves cast shadow on the substrate of this zone and decrease sun exposure. High level of TOC and mud was observed in this station, whereas the lowest level of DO and Eh was occurred in there (Table 2) Polychaets*Ceratonereis sp.* and *Perinereiscultrifera* were dominant species of this zone. Several studies have reported that polychaets are dominant macrobenthic taxa of mangrove habitats [1 & 5].

**Zone Three:** This zone included a narrow band at the canal ward fringe of Bardestan mangrove swamp (station Lt). Long inundation period and high wave exposure are the most important features of this zone. Low level of TOC and mud and also high level of DO were observed in this zone (Table 2). Bivalves such as *Paphiagalus* and gastropods like *Cerithideacingulata* and *Hydrobia sp.* dominated in this zone. Generally, suspension feeders (bivalvia and some gastropoda) are abundant in lower tidal levels of intertidal zone. Exposure to tidal current and waves provide food (suspended matters) for these organisms and lead to increase of their abundance [17].

## DISCUSSION

The results showed spatial and temporal variation in distribution and composition of macrofauna in Bardestan mangrove swamp. This variation is not unusual in intertidal zone [4]. Dominance of varied species in various stations consideration of cluster analysis indicated that there were at least two or three different horizontal zones in macrofauna community of Bardestan mangrove swamp.Statistical analysis showed significant correlation between environmental parameters and composition and/or distribution of macrofauna ($P<0.05$). Composition of Gastropoda and Bivalvia was correlated to mud content, Malacostrata was correlated to TOC percent, abundance and composition of Polychaeta showed significant correlation to Eh, Salinity, Mud content, TOC percent as well as to concentration of Oxygen (DO). Faiza [18] reported the same zonation for polycheates in the south part of Suez Canal.

Variation of biotic and a biotic properties makes varied niches and habitats with specific environmental features along intertidal zonefor settlement of different macrofauna [6,19,20]. Each macrobenthic species according to its ecological requirement, life cycle and feeding habits, inhabit specific zone. For example, deposit feeders (polychaets and some crabs) settled in Lm tidal level, near mangrove trees, where great amount of detritus exists and can use them as a good source of food. Suspension feeders (Bivalves and some Gastropods) inhabited in Lt tidal level, close to central canal, where suspended materials were abundant. Frequency and duration of tidal flood are reported as affective factors in determining zonation, distribution and composition of speciessettled in mangrove forests [21]. Chakraborty and Choudhury [8] and also Yijie and Shixiao [7] reported environmental features such as sediment or substrate properties, mangrove community and tidal inundation as important factor on zonation of macrofauna inhabited through mangrove forests. It is suggested that threshold level of environmental factors may act as an inhibitor factor for settlement of some organisms in the various zones of the habitat. For instance, decrease of DO in zone two or increase of desiccation in zone one may cause to remove ofsensitive organismsor settlement of adapted ones to those conditions. For example, high desiccation condition in zone one makes harsh condition forepibenthic gastropod*Onchidiumperoni*and restrict it under canopy of mangrove trees in Lm tidal level.Predation and competition also are introduced as limiting factors in distribution of macrofauna [17, 22]. It is suggested that mangrove trees and pneumatophore roots in zone two can provide sheltered condition for*Onchidiumperoni* against predators including birds.

It seems variation of mangrove trees, tidal inundation and sediment properties among varied tidal levels lead to formation of this zonation in Bardestan mangrove forest. With regard to this point that Bardestan creek contains small patch of mangrove trees which is affected with a main and central canal, it was concluded that this zonation could be found across a supposed perpendicular line across main canals. Therefore, in wide and complex mangrove habitats, zonation of macrofaunawill be observed just along a perpendicular line to each canal, so that it is assumed that a complex network of zonation line could be found in wide mangrove habitats with several main canals.

## ACKNOWLEDGMENT

Present study was funded by Persian Gulf Research and Study Center. I'd like to thank Mr. Amir Vazirizadehand Dr. Mehdi Mohammadi for providing the facilities to carry out the project. I'm grateful to my colleagues and friends for their helps in sampling and laboratory works.

## REFERENCES

1. Mauris, C., 2005. The biology of mangrove ecosystems and estuaries, Biology of habitat. Oxford publication. pp: 280.
2. Guerreiro, J., S. Freitas, P. Pereira, J. Paula and A. Macia, 1996. Sediment macrobenthos of mangrove flats at Inhaca Island, Mozambique. Cahiers de Biologie Marine, 37: 309-327.
3. Netto, S.R. and F. Gallucci, 2003. Meiofauna and macrofauna communities in a mangrove from the Island of Santa Catarina, South Brazil. Hydrobiologiam, 505: 159-170.
4. Chapman, M.G., 2006. Relationships between spatial patterns of benthic Assemblages in a mangrove forest using different Levels of taxonomic resolution. Marine Ecology Progress Series, 162: 71-78.
5. Saravnakumar, A., J. SeshSerebiah, G.A. Thivakaran and M. Rajkumar, 2007. Benthic Macrofaunal Assemblage in the Arid Zone Mangroves of Gulf of Kachchh-Gujarat. J. Ocean University of China, 6(3): 303-309.
6. Lee, S.Y., 2008. Mangrove macrobenthos: assemblages, services and linkages. J. Sea Res., 45: 40-54.
7. Yijie, T. and T. Shixiao, 2007. Spatial zonation of macrobenthic fauna in Zhanjiang Mangrove Nature Reserve, Guangdong, China. Acta Ecologica Sinica, 27(5): 1703-1714.
8. Chakraborty, S.K. and A. Choudhury, 1992. Population ecology of fiddler crabs (*Uca spp.*) of the mangrove estuarine complex of Sunderbans, India. Tropical Ecol., 33(1): 78-88.

9. Frusher, S.D., R.L. Giddins and T.J. Smith, 1994. Distribution and Abundance of Grapsid Crabs (Grapsidae) in a Mangrove Estuary: Effects of Sediment Characteristics, Salinity Tolerances and Osmoregulatory Ability. Estuaries, 17(3): 647-654.
10. Vazirizadeh, A., 1997. Study of macrofauna status in intertidal zone of Bushehr province's coasts. MSc thesis, KhoramshahrmarineSicence and Technology University, Marine Biology Department. pp: 194.
11. Eksisri, F., H. Emadi, M.P. Nabavi, G. Vosoughi, 2004. Investigation of polychaeta assemblage diversity in Laft and Khamir ports. Research and study on animals and Aquatic Organisms. 5: 70-84.
12. Dehghanmediseh, S., 2007. Identification of sensitive and impacted area in Khozestan's Creeks using eologic and biologic indices. PhD thesis. KhorramshahrMarine Science and Technology University. Department of Marine Biol., pp: 140.
13. Safyari, S., 2003. Mangrove forests. Research Institute of forests and Grasslands. pp: 510.
14. Hosseinzadeh, H., B. Daghoghi and H. Rameshi, 2001. Atlas of the Persian Gulf mollusks. Iranian Fisheries Research Organization (I.F.R.O). pp: 208.
15. Bosh, D.T., S.P. Dance, R.G. Moolenbeek and P.G. Oliver, 1995. Seashells of eastern Arabia, Motivative Publishing, pp: 296.
16. Emerson, W.K. and M.K. Jacobson, 1974. Guide to shells. ALFRE A. Knopf. pp: 482.
17. Little, C., 2000. The biology of soft shores and estuaries, Biology of Habitat. Oxford Publication. pp: 252.
18. Faiza, A.A.E., 2009. New Records of Polychaetes from the South Part of Suez Canal, Egypt. World J. Fish and Marine Sci., 1(1): 7-19.
19. Gray, J.S. and M. Elliot, 2009. Ecology of marine sediments. 2th ed. OXFORD University Press. pp: 225.
20. Ramkumar, R. and J.M. Jaikumar, 2010. Macrobenthic community structure on Tutucorin coastal water, Gulf of Mannar, Southeast coast of India. World J. Fish and Marine Sci., 2(1): 70-77.
21. Kathiresan, K. and B.L. Binghamnd, 2001. Biology of mangroves and mangrove ecosystems. Advances in Marine Biol., 40: 81-251.
22. Ysebaert, T., P.M.J. Herman, P. Meire, J. Craeymeersch, H. Verbeek and C.H.R. Heip, 2003. Large-scale spatial patterns in estuaries: estuarine macrobenthic communities in the Schelde estuary, NW Europe. Estuarine Coastal and Shelf Sci., 57: 335-355.