INTERNATIONAL JOURNAL OF PLANT, ANIMAL AND ENVIRONMENTAL SCIENCES
IJPAES
Volume-4, Issue-3, July-Sept-2014
ISSN 2231-4490

Coden : IJPAES www.ijpaes.com
Received: 5th May-2014 *Revised: 26th May-2014* *Accepted: 17th June-2014*
Research article

SEASONAL DISTRIBUTION OF OSTRACODA IN THE SOUTHERN CASPIAN SEA (MAZANDARAN- IRAN)

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ABSTRACT: In this study, in order to introducing Ostracoda species and determining their relationship with the sediment factors. Sediment samples were gathered during spring, summer, autumn and winter 2012 from 12 stations (ranging in depths 5, 10, 20 and 50 meters) in the Southern Caspian Sea from Behshahr to Ramsar (Mazandaran-Iran) , The sediment factors (grain size , total organic matter and calcium carbonate concentration)were measured in laboratory. There were 13 species of benthic Ostracoda identified in the whole sampling stations (*Cyprideislittoralis, Amnicytherebacuana, Amnicytherelonga, Amnicytherereticulata, Amnicytherestriatocostata, mnicytherecymbula, Leptocythere* sp., *Darwinulastevensoni, Loxoconchalepida, Loxoconcharhomboidea, Xestoleberisdepressa. Xestoleberisvariegata*, *Amnicythere* sp.) Belong to 6 genera of 5 families. The living *Darwinulastevensoni* was common in the recent research area. Density of benthic Ostracode's had a significantly correlation with season highest density was observed in winter and there is significant difference between spring with summer and winter (p<0.05).
Key words: Ostracoda, Benthic, Caspian Sea

INTRODUCTION

Ostracod faunas of the Caspian Sea are poorly studied. Hence, the objective of the present study is to provide a detailed account on identification and distribution of ostracod species collected from the southern coast of the Caspian Sea at depths ranging from 5 to 50 m.

The Caspian Sea is the largest inland body of water in the world and accounts for 40 to 44% of the total lacustrine waters of the world. The coastlines of the Caspian are shared Azerbaijan, Iran, Kazakhstan, Russia, and Turkmenistan. The Caspian is divided into three distinct physical regions: the Northern, Middle, and Southern Caspian. Our studied area located in southern of The Caspian Sea (fig,1). The Caspian Sea has characteristics common to both seas and lakes. It is often listed as the world's largest lake, although it is not a freshwater lake. The Caspian was once part of the Tethys Ocean but became landlocked about 5.5 million years ago due to plate tectonics The Volga River (about 80% of the inflow) and the Ural River discharge into the Caspian Sea, but it has no natural outflow other than by evaporation. Thus the Caspian ecosystem is a closed basin, with its own sea level history that is independent of the eustatic level of the world's oceans [1]. Ostracods are widely distributed in all types of aquatic environments, from fresh to saline waters, in which they show different tolerances and preferences to various ecological variables. If ecological preferences and tolerance levels of individual species are known, the past, current and future habitat conditions can be estimated [8,9]. Therefore, ostracods are useful as indicators of water quality in different aquatic bodies [12]. Consequently, knowledge of species' current habitat requirements and ecological preferences can also be used to reconstruct past and future ecological conditions. Additionally, ostracods are sensitive to changes in different environmental variables, which can thus affect species composition as a whole.

One of the variation is pollutant that causing adverse effects on physical, chemical and biological factors of water bodies is known as water pollution[18] Detection of such changes in community composition can be used to interpret conditions in any aquatic body within a broader context. This may also allow estimation of possible future changes in species composition. However, certain (i.e. cosmopolitan) species tend to have wide tolerance levels, and therefore they can resist changes in water conditions, at least for a wider range than specialists. In such cases, negative environmental effects on species richness of disturbed habitats may not be recognized due to dominancy of common species. Although it is critically important to know the role of cosmopolitan species in community assemblages, our knowledge is far from complete for ostracods, and many other taxa as well [5].
The aim of this study consists of three parts: (1) documenting the species composition of ostracods Caspian Sea, (2) characterizing the relationships between environmental factors and distribution of ostracods, and (3) highlighting the conservation status of Caspian Sea, along with its environmental problems.

MATERIALS AND METHODS

The study was carried out in spring, summer, autumn and winter 2012 Caspian Sea, Mazandaran province, from Behshar to Ramsar (Figure 1, Table 1). Sediment samples were collected from 12 stations, ranging in depth from 5 to 50 m.

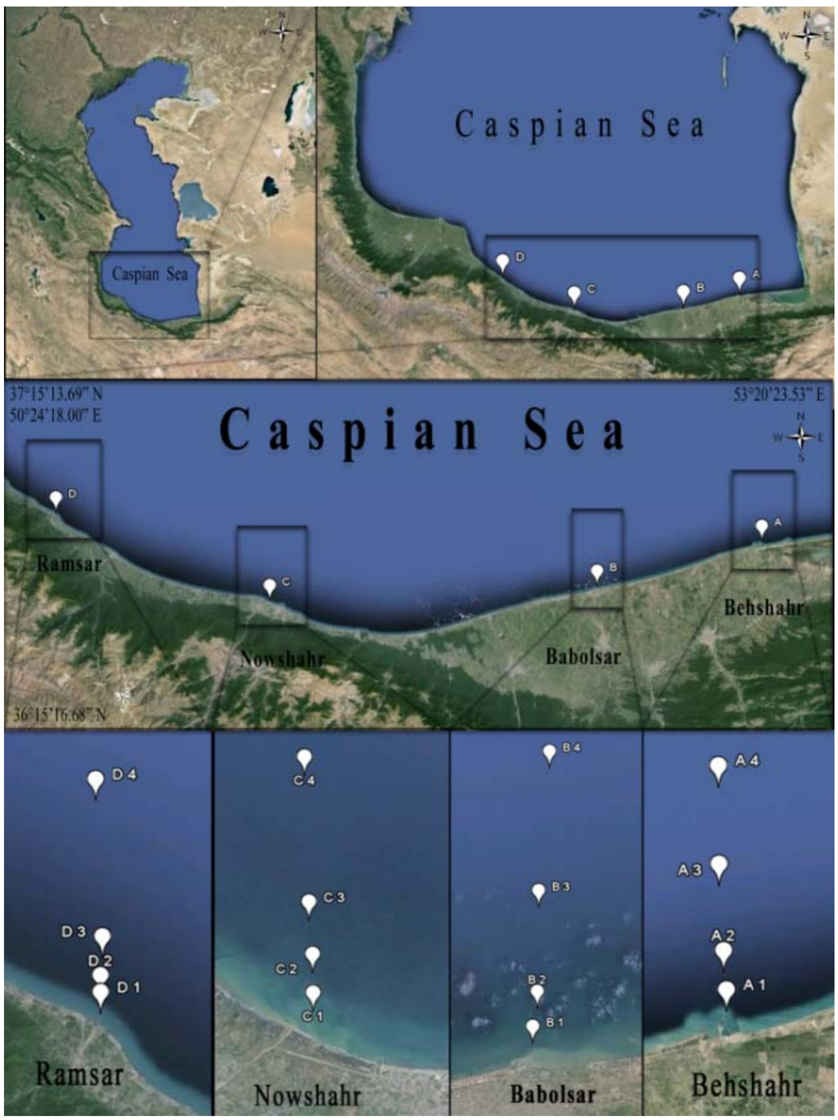

Figure 1.Situation of sampling stations in the Southern Caspian Sea

Table 1.Position of sampling stations

Stations	Longitude (^oN)	Latitude (^oE)
A1	36° 51' 31"	**53° 16' 16. "**
A2	36° 53' 10"	**53° 16' 12"**
A3	36° 56' 48"	**53° 16' 09"**
A4	37° 00' 52"	**53° 16' 16"**
B1	36° 43' 18"	**52° 39' 33"**
B2	36° 43' 58"	**52° 39' 36"**
B3	36° 45' 55"	**52° 39' 28"**
B4	36° 48' 41"	**52° 39' 29"**
C1	36° 40' 32"	**51° 27' 43"**
C2	36° 41' 04"	**51° 27' 44"**
C3	36° 41' 47"	**51° 27' 42"**
C4	36° 43' 47"	**51° 27' 41"**
D1	36° 56' 47"	**50° 39' 20"**
D2	36° 57' 18"	**50° 39' 21"**
D3	36° 58' 29"	**50° 39' 26"**
D4	37° 03' 17"	**50° 39' 16"**

Stations depths were measured with echo sounder and sampling latitudes were recorded with the Global Positioning System. At each station, a 0.1 m^2 Van-Veen grab sampler was used to collect bottom sediments. Three sets of samples were taken at each station by a 6.60 cm^2 area core sampler with 5cm depth and were stored in plastic boxes. Each sediment for ostrcodes studies (33 cm^3 volume) was treated with 1 g/L Rose Bengal solution immediately after its arrival on boat to distinguish living specimens, and then being mixed with 5% concentrated formalin solution [14,15,20].

Ostracoda Analysis

For determining Ostracoda, in the laboratory, wet samples were washed through 63 µm mesh sieve to remove any excess stain and were then Oven dried (75ºC, 8 h)[21].floated by the heavy liquid CCl4 and the upper layer of the liquid consist of floated forams were filtered by paper and allowed to dry. A stereomicroscope and several studies [2 ,16] were used for studying and determining of living Ostracoda.

Environmental Factor

The benthic environmental factors including temperature, dissolved oxygen, salinity and pH were measured by CTD during the sampling time. Sediment grain size; Total Organic Matter (TOM) and calcium carbonate concentration ($Caco_3$) were measured. For the grain-size analysis, 100 g of dried sediments (70°C, 8h) in Oven was mixed with 250 ml of tap water and 10 ml of sodium hexametaphosphate (6.2 g/L) to disaggregate the sediment. the sediment were stirred mechanically (15 min), allowed to soak (8 h), stirred mechanically (15 min) and dried again (70°C, 24 h). 50 g of dried material transferred in to the uppermost of a stacked series of graded sand sieves with 4, 2, 1, 0.5, 0.25, 0.125 and 0.063 mm mesh. Then the material that remained on the sieves was removed and weighed carefully. Finally the percentage of each particle was calculated [14,15].

The total organic matter (TOM) in each sample was measured by calculating the loss of weight during combustion. The sediment samples crucible was weighed and half filled with wet sediment and dried in an oven (70°C) to constant weight (about 24 hrs.). After removal from the oven, it was allowed to cool and was reweighed (A). It was then placed in a Muffle furnace (550°C – overnight), removed, cooled and reweighed again (B). The total content of organic matter (TOM) was determined by the loss of weight on ignition at this temperature. [%TOM =100(A-B) / (A-C)] [14,15].

Calcium carbonate concentration was measured based on the reaction with HCl. Twenty-five grams (W1) of dried sediment (7 – 8hrs.) was mixed with HCl (0.1.N) and stirred until no CO_2 bubbles were discernable, and allowed to soak (24 hrs.). The upper liquid phase was discharged and the remaining sediments were filtered (with filter paper), dried (7 – 8 hrs.) and reweighed again (W2).Calcium carbonate percentage was measured by the following formula [%CaCO3= 100 (W1-W2) / W1] [13].

Data Analysis

We applied Principal component analysis (PCA) for 7 variable collected during cruises of the year 2012 (temperature, pH, dissolved oxygen, salinity, %TOM, % $CaCO_3$ and granulometry). One Way ANOVA was performed to test for possible differences.

RESULTS AND DISCUSSION

There were 13 species of benthic Ostracoda identified in the whole sampling stations (*Cyprideislittoralis, Amnicytherebacuana, Amnicythere longa, Amnicytherereticulata, Amnicytherestriatocostata, Amnicytherecymbula, Leptocythere* sp, *Darwinulastevensoni, Loxoconchalepida, Loxoconcharhomboidea, Xestoleberisdepressa. Xestoleberisvariegata*, *Amnicythere* sp.) That 9 species of benthic Ostracoda were live and 4 species of them were empty shell. *Cyprideislittoralis, Amnicytherecymbula, Xestoleberisvariegata* and *Leptocythere* sp.

On the whole13 ostracod species have been recognized, that 4 have been left in open and empty of the valves. *Darwinulastevensoni* was dominance species (47.56%) in this research**.** Little is known about the biology and ecology of the Darwinulidae. Living species occur in a wide range of habitats from fresh to brackish water, but also in (semi-)terrestrial environments [17]. .Darwinulidaeis thought to have low dispersion capacity, as drought resistant stages. Nevertheless, most darwinulid species have intercontinental distributions; for example, *Darwinulastevensoni* is cosmopolitan and ubiquitous, comparing the present diversity of Cytheroidea and Cypridoidea[12]. *Cyprideislittoralis* (Brady, 1864) is regarded as a brackish water ostracod which tolerates a wide range of salinity and from fresh water ponds to hypersaline lagoons and had been most frequency after *Darwinulastevensoni*. It occurs in great numbers at salinities between 2 and 16‰, being a useful ecological indicator of the paleoenvironment. The species is also eurythermic, and can easily endure freezing. This species is cosmopolitan. *(Cyprideislittoralis)* is a major constituent of several of the biofacies in the present Sea of Azov described by [3, 23] and in the Caspian Sea Under these relic sea conditions, with salinities about one-third (ll-12°/o) .The Pearson correlation analysis was conducted to clarify the relationships between different season and abundance of Ostracoda. The result of Pearson correlation showed the abundance of ostracoda had a significantly correlation with season (at $P<0.05$) and Highest density of ostracoda was observed in winter. Grazing is One of important factors that effecting on distribution of ostracoda. In the winter we had most abundance of them because the grazer is going to depth water then pressure on them is decreased.

Environmental Factor

The results of Environmental Factor were showed in figures (3, 4 and5). The temperature of the water near the bottom was nearly similar in all stations (17.54 to 18.52). The results of measuring dissolved oxygen concentration indicated enough oxygen in water near the bottom and the high average of dissolved oxygen concentration was in Ramsar transect. Salinity was also had low difference between stations (10.94 to 11.28) and increased with the depth increasing. pH was nearly equal in all stations (8.28 to 8.43).

The grain size analysis of the sediments showed that the structure of the sediment samples mostly consisted of; sand, silt and clay and seldom grovel. The grain size decreased with water depth. The silt and clay rate increase with depth in all stations (figure, 2).

Total Organic Matter (TOM) was higher in station Behshahr (10.59) and increased with depth 50m (14.56%).Calcium carbonate concentration was high in station Behshahr in depth of 20 m.

The grain size analysis of the sediments showed that the structure of the sediment samples mostly consisted of sand; silt and clay that are probably related to nonexistence of rivers follows, which causes reduced the coarse grain-size in this confined. The grain size decreased with water depth, according to [6] a slight decrease of grain size observed with water depth in the Whittard Canyon area (NE Atlantic). In the this area, such as previously study in Thailand golf the grain size of the sediments does not play a significant role on the foraminifers distribution and according in [13].

Total Organic Matter (TOM) was higher in station in stations D4 in spring that is related to increasing silt-clay rate, because according to [14, 20] organic compounds increased in silt-clay sediments. The result of Pearson correlation showed the significantly positive correlation with depth and TOM (at $P<0.05$) [22].

Data Analysis

The result of PCA showed that Granulometry, %TOM and % $Caco_3$had been important role (tabl,7 and fig4).

ANOVA results showed no significant differences (at $P>0.05$).Most density of ostracoda was observed in Babolsar station in depth of 20 m. Babolsar (B) station had a good situation for living there. This station had Babolriver that cause different situation in this area. Almost animals prefer oxygenated water according [11], It is also known that *D. stevensoni* prefers oxygenated environments. Nevertheless, significant tolerance for oxygen depletion by adults has been demonstrated [7, 19]. In this research highest density was observed in winter. As you know in the winter dissolve oxygen is higher because water temperature is down then oxygen consent ration was been high (table, 2).

Table 2.The Mean of Temperature, Salinity, DO, pH, Total Organic Matter (TOM) and Caco3 in different Seasons the southern Caspian Sea from Behshahr to Ramsar (±SD).

Factors / Season	Temperature(C^0)	Salinity(ppt)	DO(mg/l)	pH	%TOM	%$Caco_3$
spring	20.74±0.02	11.01±0.01	10.23±0.04	8.27±0.01	7±1	9±4.47
summer	23.93±0.008	11.22±0.005	8.17±0.014	8.56±0.005	8.52±1.64	9.61±3.29
autumn	17.34±0.007	11.14±0.01	8.1±0.007	8.11±0.051	8.08±1.03	9.19±2.22
winter	9.52±0.009	11.39±0.02	10.53±0.01	8.41±0.01	8.23±1.6	9.72±3.92

Table 3.The Mean of Temperature, Salinity, DO, pH, Total Organic Matter (TOM) and Caco3 in different Seasons the southern Caspian Sea from Behshahr to Ramsar (±SD).

Factors / Depth	Temperature(C^0)	Salinity(ppt)	DO(mg/l)	pH	%TOM	%$Caco_3$
5	20.83±0.011	11.08±0.019	8.71±0.034	8.28±0.016	3.41±0.66	3.33±0.653
10	20.71±0.023	11.2±0.008	8.72±0.015	8.29±0.019	6.43±1.14	7.09±1.968
20	18.8±0.019	11.25±0.009	8.6±0.03	8.35±0.03	7.86±0.881	13.4±5.873
50	11.27±0.013	11.21±0.04	9.20±0.007	8.48±0.01	14.56±2.77	12.76±4.572

Table 4.The Mean of Temperature, Salinity, DO, pH, Total Organic Matter (TOM) and Caco3 in different Depths in the southern Caspian Sea from Behshahr to Ramsar (±SD).

Factors / Stations	Temperature(C^0)	Salinity(ppt)	DO(mg/l)	pH	%TOM	%$Caco_3$
A	18.52±0.34	10.97±0.032	8.69±0.036	8.4±0.024	10.59±1.88	14.73±6.26
B	18.18±0.011	11.24±0.024	8.42±0.036	8.3±0.033	7.78±1.1	7.95±2.59
C	17.37±0.01	11.28±0.014	9.01±0.007	8.43±0.013	7.04±0.95	7.27±1.66
D	17.54±0.017	11.24±0.01	9.1±0.006	8.28±0.005	6.85±1.52	6.63±2.544

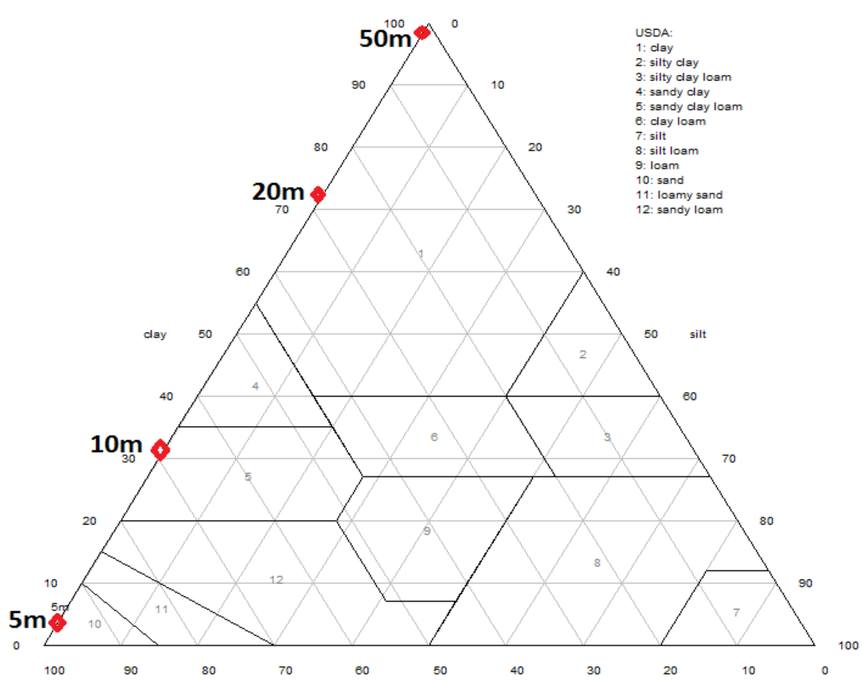

Figure 2: Percentage of grovel, sand and silt and clay in different depth in the southern Caspian Sea from Behshahr to Ramsar.

Table 3.Density of stained Ostracoda (individual /0.1m^2) of southern Caspian Sea (Mazndaran) (spring, 2012) (±SD).

Station / Ostracoda	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
Amnicytherelonga							2.79 +4.32									
Amnicytherebacuana *Amnicytherereticulate*							5.58 – 8.65									
Amnicytherestriatocostata		2.79 –4.32				5.58 ± 4.32	8.38 = 0									
Loxoconchalepida																
Loxoconcharhomboidea															2.79 ± 4.32	
Xestoleberisdepressa		2.79 ± 4.32	5.58 ± 4.32			19.55 ± 4.32	2.79 +4.32									
cyprideislittoralis						2.79 ± 4.32	11.17 = 11.44		2.79 ± 4.32			2.79 ± 4.32			2.79 ±: 4.32	
Darwinulastevensoni											13.96 ⊥ 4.32				16.76 – 19.83	

Table 4. Density of stained Ostracoda (individual /0.1m^2) of southern Caspian Sea (Mazndaran) (summer, 2012) (±SD).

Station / Ostracoda	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
Amnicythere longa																
Amnicytherebacuana		2.79 ±4.32										2.79 ±4.32				
Amnicytherereticulate																
Amnicytherestriatocostata *Loxoconchalepida*							13.96 ± 24.19					2.79 ±4.32				
Loxoconcharhomboidea *Xestoleberisdepressa*			8.38 + 7.49			19.55 ± 15.6								22.34 ± 17.3		
cyprideislittoralis							50.28 ± 22.17									
Darwinulastevensoni								4.19 ± 4.34		8.38 ± 7.49						

Table 5.Density of stained Ostracoda (individual /0.1m^2) of southern Caspian Sea (Mazndaran) (autumn, 2012) (±SD).

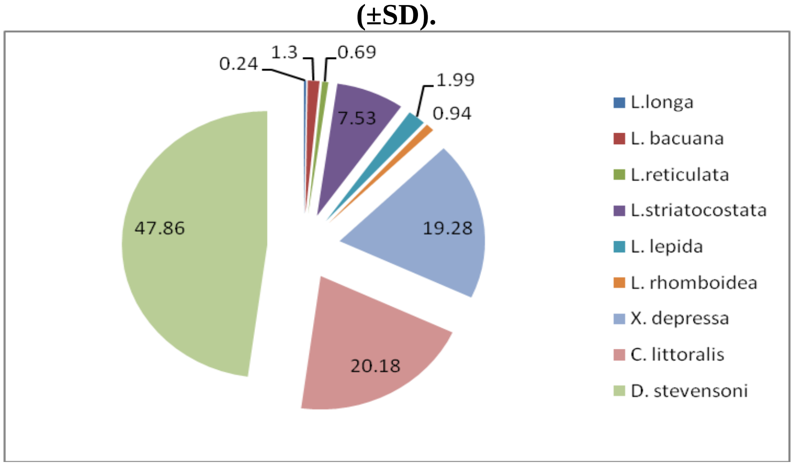

Figure-3: Percent of Ostracoda Density (individual /0.1m^2) of southern Caspian Sea (Mazndaran)

Station / Ostracoda	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
Amnicythere longa																
Amnicytherebacuana																
Amnicytherereticulate																
Amnicytherestriatocostata	8.38 ± 0						2.79 ± 4.32									
Loxoconchalepida				5.58 ⊥ 8.65												
Loxoconcharhomboidea Xestoleberisdepressa																
cyprideislittoralis							22.34 ± 34.61								19.55 = 15.6	
Darwinulastevensoni	16.76 ± 0					2.79 = 4.32	2.79 ± 4.32		5.58 = 4.32	19.55 ± 8.65	2.79 ± 4.32					

Table 6.Density of stained Ostracoda (individual /0.1m^2) of southern Caspian Sea (Mazndaran) (winter, 2012) (±SD).

Station / Ostracoda	A1	A2	A3	A4	B1	B 2	B 3	B4	C1	C2	C3	C4	D1	D2	D3	D4
Amnicythere longa																
Amnicythereb acuana																
Amnicytherere ticulate																
Amnicytherest riatocostata																
Loxoconchale pida				2.79 + 4.32				2.79 − 4.32				2.79 + 4.32				2.79 − 4.32
Loxoconcharh omboidea																
Xestoleberisde pressa																
cyprideislittor alis																
Darwinulastev ensoni	5.58 = 8.65	2.79 = 4.32	41.9 ± 54.58	2.79 ± 4.32	5.58 ± 8.65	2.79 = 4.32	41.9 = 54.58	2.79 +4.32	5.58 ± 8.65	2.79 ± 4.32	62.85 ± 62.89	2.79 = 4.32	5.58 ± 8.65	2.79 = 4.32	41.9 ± 54.58	2.79 = 4.32

Table-7: Component Matrix[a] (PCA)

	Component		
	1	2	3
Granulometry	.901	.143	.011
TOM	.834	.148	.023
Caco3	.770	.261	-.180
temperature	-.618	.611	-.072
DO	.222	-.648	.608
Salinity	.309	.554	.332
pH	.245	-.421	-.704

Extraction Method: Principal Component Analysis.
a. 3 components extracted.

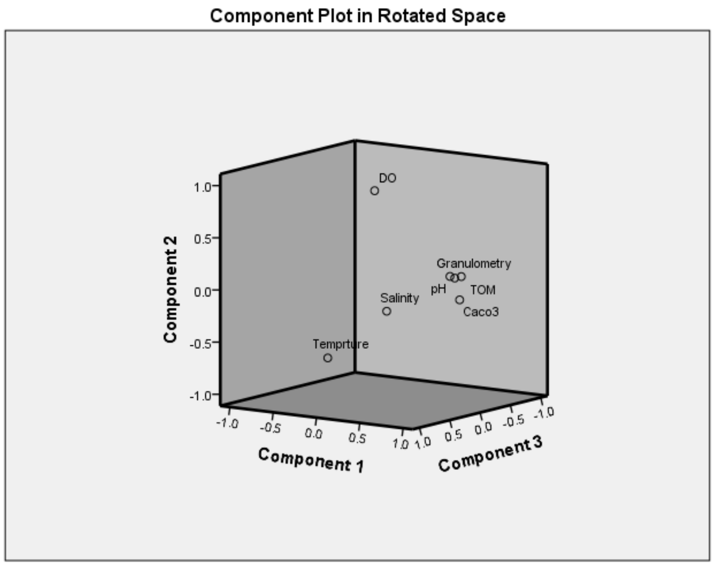

Figure 4: PCA of environmental factors

CONCLUSION AND RECOMMENDATION

This study shows that the recent ostracoda of Capian Sea are characterized by a group of common brackish water.. The results have 13species, pertaining to 6 genera has been identified. The frequent dominance of brackish-water species were *Darwinulastevensoni* and *Cyprideislittoralis*. In the area, the Environmental Factors of the sediments do not play a significant role on the ostracoda's distribution. Recommended that had done research in other area in south of Caspian sea for example in Guilan and Golestan provinces and in deep water (more than 50m) and to do phylogenetic experiments on ostracoda species.

ACKNOWLEDGEMENTS

We would like to acknowledge this support that we got from Professor David Horne (University of Queen Mary London) in approving the ostracod's samples and their valuable suggestions.

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