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The Ecology of The Ostracoda (Crustacea) Species Obtained From Erdek Bay (The Marmara Sea, Turkey)

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ABSTRACT: The aim of this study was to determine the ecology of the Ostracoda species in the sediments collected from the Erdek Bay and to observe the relationship between ecological parameters with the number of Ostracoda species and individual numbers. Sediment and water samples have been collected seasonally from 8 stations of the study area from six different depths (0.3; 1; 5; 10; 20; 30 m). Ecological features (temperature, salinity, dissolved oxygen, mud percentage, total organic carbon, and total calcium carbonate) of 92 Ostracoda species were obtained. The abundance of recent Ostracoda species and their distributional situation according to seasonal environmental factors were evaluated. The highest number of Ostracoda species and individuals were observed between 10-30 m deep stations with the highest salinity and muddy sediments. Loxoconcha rhomboidea and Xestoleberis margaritea species showed a wide distribution in different ecological environments in the research area. Also species and individual numbers of Ostracoda showed a positive correlation with ecological parameters except temperature and dissolved oxygen.

Key words: Ecology, Ostracoda, Crustacea, Erdek Bay, Marmara Sea

INTRODUCTION

Ostracods are small, calcerous bivalved and poorly segmented entomostracan Crusteceans (Griffiths and Evans, 1991). They can be find a variety of aquatic habitats from hot springs to very cold waters, lakes lagoons and deep sea sediments. Ostracods have been suggested to be important biological indicators of water quality changes (Delorme 1991; Zarikian *et al.,* 2000, Külkylüo lu *et al.,* 2012). So it is essential to understand the ecology of individual ostracod species and interspecific variation in habitat preferences. We carried out four seasonal field campaigns to determine the ecology of ostracods in Erdek bay that located in the west of Kapıdag peninsula in the Marmara Sea. The present oceanography of the Marmara Sea is controlled by a permanent two-layer water stratification with a halocline at a depth of 20-25 m The less saline Black Sea water (18 %) flow"s as the upper layer from the Istanbul Strait to the ꞁanakkale Strait, whereas saline Mediterranean waters (38 %) flow as the lower layer in the opposite direction (-nlüata *et al.,* 1990, Meriç and Algan, 2007). Because of its location, Marmara Sea enclosed brackish water together with marine water. So this is effective on the faunal variaitions in the Marmara Sea and also Erdek Bay.

The Erdek Bay is dominated by fishing and agricultural activities, and particularly tourism. In addition, it is observed that the region is affected by terrigenous, natural, and anthropogenic organic substance sources. Also Gnen and Karabiga rivers play an important role in the transport of both natural terrigenous and anthropogenic carbon in the Erdek bay (Balkis and Cagatay, 2001; Aliyev and Sari, 2005). This bay is semi-isolated sedimentary environments, and it is known that the riverine input into this bay is very high (Algan *et al.,* 2004).

The aims of this study are to provide a detailed faunal inventory with the ecology of recent ostracods from Erdek Bay (Marmara Sea, Turkey) and investigate their distributional patterns in relation to seasonal environmental factors. It means that this study has an important place in the observing of seasonal ecological variations and their relationship with Ostracoda fauna and other sea creatures.

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MATERIAL & METHODS

The samples employed in this study were collected using the Van Veen grab and handle net (200 µm) on 32 occasions across eight stations in Erdek Bay (Fig. 1) during four seasonal periods between 2006 and 2007 (November 2006, February 2007, May 2007, August 2007). The Van Veen grab was used at depths of 5-30 m Coordinates of the stations were obtained using a Garmin 60Cx/60CSx model GPSMAP (Fig. 1).

Materials were placed in a 1% formaldehyde solution treated with 1% hydrogen peroxide for a period of 24 hours. The mud and detritus were washed away under pressurized water through sieves with mesh sizes of 1 mm, 250-160µm, and 80 µm. The washed material was preserved in 70 % ethanol. 20 cm3 of Ostracoda-featuring sediment per station was examined under a stereomicroscope. Generic and specific features of carapace and soft parts were examined for species identification. Studies conducted by Mordukhai and Boltovskoi (1969), Barbeito- Gonzales (1971), Hartmann and Purı, (1974), Bonaduce *et al.,* (1975), Breman (1975), Athersuch (1977), Yassini (1979) and Stambolidis (1985) were used to identify the Ostracoda species found.

Ecological parameters like temperature, salinity, dissolved oxygen, mud, total organic carbon, and calcium carbonate percentage in the research area were determined. Temperature was measured by thermometer on the watersampler, salinity by the Mohr-Knudsen method (Ivanoff, 1972), and dissolved oxygen by the Winkler method (Winkler, 1888).

Total calcium carbonate contents were determined using a gasometric-volumetric method (Loring and Rantala 1992). Total organic carbon (TOC) was analyzed using the Walkey-Blake method, which involves titration after a wet combustion of the samples (Gaudette *et al.,* 1974; Loring and Rantala, 1992). Mud percentages of the sediments were defined according to Folk (1974).

The abundance of Ostracoda species was calculated by the formula F = Nax100/Nn., where F is the abundance of the species, Na is the sample number containing the species, and Nn is the total sample. Species were separated according to their abundance: currently sporadic species (1-20 %), rare species (21-40 %), common species (41-60 %), abundant species (61-80 %), and very abundant species (81-100 %) (Kocatas, 1996; Balkıs, 2009).

The relationship between ecological variations and the Ostracoda species and their individual numbers was obtained using Spearman's rank correlation matrix (Siegel, 1956).

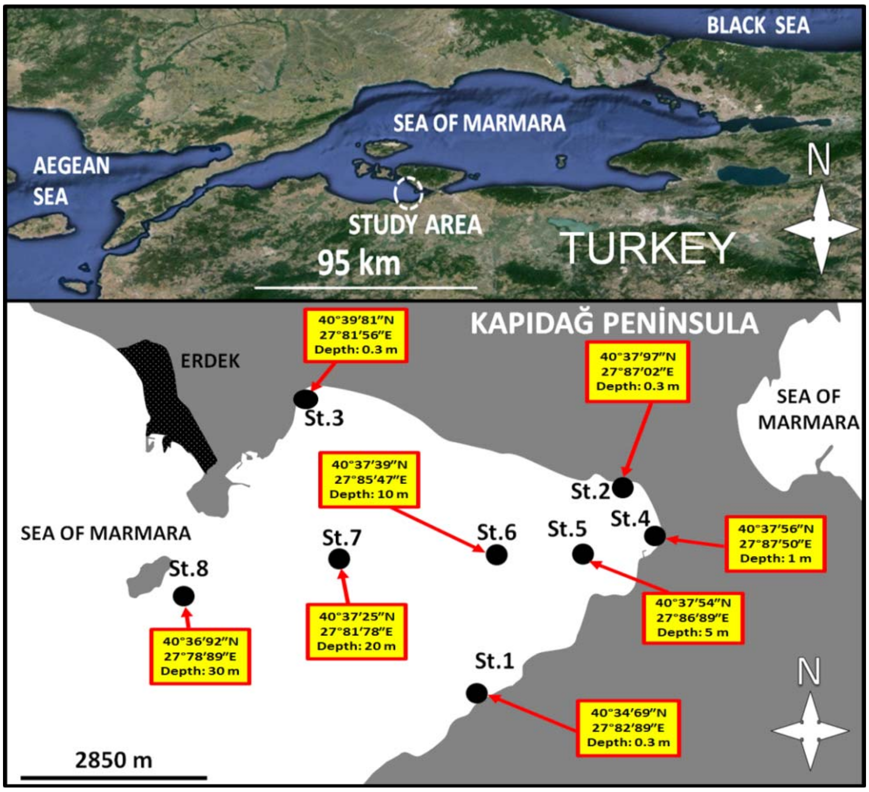

Fig.1. Locations of the study area

RESULTS & DISCUSSION

The ecology of 92 Ostracoda species belonging to 18 families with 39 genera from Erdek Bay was analyzed seasonally. Systematic list of these Ostracoda species was printed by Perçin-Paçal and Balkıs (2012).

The number of Ostracoda species was at its highest in the fall eventhough individual numbers was the lowest and species number was lowest in the spring also individual numbers was the highest in this season (fall: 69 species; 2886 individuals, winter: 56 species; 5034 individuals, spring: 47 species; 7070 individuals, summer 51 species; 4986 individuals). The highest individual numbers were observed from Cytheridea neapolitana (3878); Pterigocythereis jonesii (2243); Costa punctatissima (2139); Hiltermannicythere rubra (1350); Loxoconcha rhomboidea (1177); Carinocythereis carinata (1169) during all seasons (Table 1).

The highest individual number has observed from Costa edwardsii in fall (385 individuals). Cytheridea neapolitana has the highest individuals in other seasons (821 in winter; 1526 in spring; 1151 in summer) (Fig.2).

L. rhomboidea was observed as very abundant species during fall and winter seasons (81-100 % Table 1). H. rubra, L. agilis, P. jonesii, X. communis, C.carinata and X. margaritea were observed as abundant species during fall (61-80 %, Table 1). X. margariea was also abundant during winter and summer seasons either. A. convexa was observed as a abundant species in winter (Table 1).

L. rhomboidea A. convexa, C. carinata, L. agilis, P. jonesii, H.rubra, X. communis and X. margaritea have shown high diversity than other species. Because this species observed different stations with different seasons. Also we can say these species had adapted well to this study area (Table 1).

Ecological parameters have shown variations during four seasonal periods (Table 2) Temperature was the highest in summer (27°C) at station 1 (with 6 species and 31 individuals) and station 2 (with 2 species and 5 individuals) also the lowest in Winter (8.9°C) at station 1 (with 3 species and 30 individuals).

Measurements of the water salinity was the highest in winter (37.3 ‰) at station 8 (with 34 species and 3210 individuals) also the lowest in spring (21.9 ‰) at station 2 (with 3 species and 3 individuals). According to dissolved oxygen measurements, it was the highest in summer (13.26 ml/l) at station 2 (with 2 species and 5 individuals) also the lowest in spring (4.03ml/l) at station 8 (with 22 species and 5328 individuals).

We determined the highest total organic carbon amount in spring (1.93 %) at station 8 (with 22 species and 5328 individuals) also the lowest in summer (0.07 %) at stations 2 (with 2 species and 5 individuals) and station 3 (with 5 species and 16 individuals) from the sediment analyzes.

The highest total organic carbon amount of the sediment was observed in winter (82.02 %) at station 6 (with 16 species and 125 individuals), also the lowest again in winter (0.39 %) at station 2 (with 1 species and 3 individuals).

The mud percentage of the sediment was the lowest at station 3 in 0.3m depth. The species numbers and the individual numbers were also very low in this station in during four seasonal periods. The highest mud percentage was observed at station 8 from 30m depth. At the same time the species numbers and individual numbers were very highest in all seasons.

According to spearman's rank correlation species and individual numbers of ostracoda have shown positive correlation with ecological parameters except dissolved oxygen and temperature (Table 3).

The relationship with dissolved oxygen was negative with species number and individual number. And there was no relationship observed with temperature (Table 3).

We worked between depths of 0.30 m and 30 m, sampling on 32 occasions across eight stations in Erdek Bay (Fig. 1) during four seasonal periods as because of expanded seasonal hydrographical differences occur at a depth of about 40 m in the Sea of Marmara (BeSiktepe *et al.,* 1993; Algan *et al.,* 2004).

Water temperature differs depending on to seasons and depths in the Erdek Bay. There was no correlation between temperature, species numbers, and individual numbers according to Spearman's rank correlation (Table 3). This is because of observation the wide differences in seasonal temperatures, low species numbers, and individual number at the coastal stations. Breman (1975) also could not find a direct relationship between the distribution of Ostracoda species and temperature.

Salinity is an effective factor both the species diversity and the abundance of Ostracoda. (Holmes, 2001; Li *et al.,* 2010). Possitive correlation was observed between species and individual numbers and salinity, according to Spearman's rank correlation ($P < 0.01$) (Table 3) in this study. Similarly Simith and Horne (2002) also noted that salinity has an important effect on the diversity of Ostracoda species, and that there is a positive correlation between Ostracoda populations and salinity.

According to Ellis and Westfall (1946), although oxygen concentrations do have a connection to other factors necessary for survival, because aquatic organ-

Table 1. Dispersion and ecology of the ostracoda species obtained from Erdek Bay. (DO: Dissolved oxygen, SAL: Salinity, TOC: Total organic carbon, TCC: Total calcium carbonate, F: Frequency)

Species	Stations	Depth (m)	DO (mg/l)	Temperature (°C)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Acantocythereis hystrix (Reuss, 1850)	Fall.St- 8 Win. St- 8 Sum. St- 8	30	6.30-7.22	14.7-16.5	34.2-37	91.02	1.21-1.75	12.38-18.54	27	X X X
Aglaiocypris complanata (Brady & Robertson, 1869)	Fall.St-5- Spr. St-5,St-6 Sum. St-5,St-6	5-10	6.29-8.88	13.2-24	22.5-26.7	15.82-37.24	0.70-1.96	59.32-80.08	10	X R R
Aglaiocypris rara (Müller, 1894)	Fall. St-3	0.3	10.35	14.5	26.6	0.29	0.54	0.82	1	X
Argilloecia minor (Müller, 1894)	Win. St-5	5	8.44	9.7	27.6	15.82	018	65.61	3	X
Aurila convexa (Baird, 1850)	Fall. St-7, St-8 Win. St-1,St-5, St-6,St-7, St-8 Spr. St-1,St-5, St-6,St-7 Sum. St-1,St-5, St-6,St-7	0.3-30	6.23-10.14	8.9-27	22.1-37.3	0.56-91.02	0.12-1.96	8.05-82.02	136	R A C C
Aurila prasina Barbeito & Gonzales, 1971	Fall. St-1	0.3	10.93	14.1	26.8	0.56	0.79	8.16	5	X
Bosquetina carinella (Reuss, 1957)	Fall. St-8 Win. St-8 Spr. St-7, St-8 Sum. St-7, St-8	20-30	4.03-7.34	14-17	26.1-37.3	47.07-91.02	0.56-1.93	7.95-74.21	407	X X R R
Buntonia subulata Ruggieri, 1954	Spr. St-7, St-8	20-30	4.03-6.23	14-15.5	26.1-34.2	47.07-91.02	1.22-1.93	7.95-74.21	132	R
Bythocytere minima Bonaduce, Ciampo & Masoli, 1976	Spr. St-8	30	4.03	15.5	34.2	91.02	1.93	7.95	12	X
Bythocythere turgida Sars, 1866	Fall St-8 Win. St-7, St-8 Spr. St-7, St-8 Sum. St-7, St-8	20-30	4.03-7.80	10.9-17	26.1-37.3	47.07-91.02	0.48-1.93	7.95-74.21	498	X R R R
Callistocythere adriatica Masoli, 1968	Fall St-5 Spr.. St-5	5	6.68-8.57	13.2-17.9	22.5-26.7	15.82	0.91-1.02	59.61-66.08	14	X X

Table 1. Continued. Dispersion and ecology of the ostracoda species obtained from Erdek Bay.

Species	Stations	Depth (m)	DO (mg/l)	Temperature (°C)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Callistocythere crispata (Brady, 1868)	Fall. St-6, St-8	10-30	4.03-8.37	10.9-23	22.8-37.3	37.24-91.02	0.48-1.96	7.95-80.08	562	R
	Win. St-7, St-8									R
	Spr. St-6, St-7, St-8									R
	Sum St-6, St-7									R
Callistocythere diffusa (Müller, 1894)	Win. St-8	30	6.40	15.1	37.3	91.02	1.21	12.38	40	X
Callistocythere intricatoides Ruggieri, 1953	Fall. St-5, St-8	5-30	6.40-8.88	10.9-24	23.2-37.3	15.82-91.02	0.18-1.75	12.38-61.36	15	R
	Win. St-7, St-8									R
	Sum St-5, St-7									R
Callistocythere littoralis (G.W. Müller, 1894)	Fall. St-6, St-8	5-30	6.23-8.88	9.7-24	22..5-37.3	15.82-91.02	0.18-1.75	12.38-74.21	58	R
	Win. St-5, St-8									R
	Spr. St-5, St-6, St-7									R
	Sum St-5, St-7									R
Callistocythere pallida (Müller, 1894)	Win. , St-6, St-8	5-30	6.40-8.88	9.6-24	23.2-37	15.82-91.02	0.54-1.21	12.38-82.02	24	R
	Sum St-5									X
Callistocythere vexata Bonaduce, Ciampo & Masoli, 1976	Fall. St-1	0.3	10.93	14.1	26.8	0.56	0.79	8.16	1	X
Carinocythereis antiquata (Baird, 1850)	Fall. St-6	5-30	4.03-8.37	9.6-17.9	22.5-37.3	15.82-91.02	0.54-1.93	12.38-82.02	125	X
	Win. St-6, St-8									R
	Spr. St-5, St-7, St-8									R
	Sum St-7, St-8									R
Carinocythereis carinata (Roemer, 1838)	Fall. St-4, St-5, St-6, St-7, St-8	1-30	4.03-9.59	9.7-24	22.5-37.3	4.96-91.02	0.18-1.96	3.86-82.02	1169	A
	Win. St-5, St-6, St-7, St-8									C
	Spr. St-5, St-6, St-7, St-8									C
	Sum St-5, St-6, St-7, St-8									C
Cariocythereis rhombica Stambolidis, 1982	Fall St-5, St-8	5-30	4.03-8.57	10.9-17.9	22.5-37.3	15.82-91.02	0.48-1.93	7.95-74.21	772	R
	Win. St-7, St-8									R
	Spr. St-5, St-7, St-8									R
	Sum St-7, St-8									R
Caudites sp.	Win. St-7	20	7.80	14.5	29.9	47.07	0.48	61.36	1	X

Table 1. Continued. Dispersion and ecology of the ostracoda species obtained from Erdek Bay.

Species	Stations	Depth (m)	DO (mg/l)	Temperature (℃)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Costa edwardsii (Roemer, 1838)	Fall. St-5, St-7, St-8	5-30	4.03-8.57	10.9-17	26.1-37.3	15.82-91.02	0.48-1.93	7.95-74.21	972	R
	Win. St-7, St-8									R
	Spr. St-7, St-8									R
	Sum. St-7, St-8									R
Costa punctatissima Ruggieri, 1962“	Fall St-4, St-8	0.3-30	4.03-9.59	10.9-25	22.8-37.3	0.29-91.02	0.07-1.93	3.86-74.21	2139	R
	Win. St-7, St-8									R
	Spr. St-7, St-8									R
	Sum St-3, St-7, St-8									R
Cuneocythere semipunctata (Brady, 1868)	Fall St-8	30	7.22	15.1	37	91.02	1.75	17.50	30	X
Cyprideis torosa (Jones, 1850)	Fall St-4, St-7	1-20	6.40-9.59	10.6-24.5	22.5-37.3	4.96-91.02	0.14-1.21	1.47-66.08	21	R
	Win. St-4, St-7 St-8									R
	Spr. St-5									X
	Sum. St-4, St-7									R
Cyprinotus salinus (Brady, 1868)	Fall. St-4	1	9.00-9.59	10.6-14.2	26-27.3	4.96	0.52-0.72	1.47-3.86	3	X
	Win. St-4									X
Cytherella alvearium Bonaduce, Ciampo & Masoli, 1976	Fall St-4, St-8	1-30	4.03-9.59	14.2-16.5	26-37	4.96-91.02	0.72-1.93	3.86-18.54	64	R
	Spr. St-8									X
	Sum. St-8									X
Cytherella vulgata Ruggieri, 1962	Fall St-8	20-30	4.03-7.34	14.7-17	34.7-37.3	47.07-91.02	0.56-1.93	7.95-23.73	220	X
	Win. St-8									X
	Spr. St-8									X
	Sum. St-7, St-8									R
Cytheretta adriatica Ruggieri, 1952	Win. St-7	20	7.80	10.9	29.9	47.07	0.48	61.36	8	X
Cytheretta subradiosa (Roemer, 1836)	Fall St-7	20	7.26-7.34	10.9-17	29.9-34.7	47.07	0.56-0.78	23.73-35.29	12	X
	Sum St-7									X
Cytheridea neapolitana Kollman, 1960	Fall St-4, St-7, St-8	1-30	4.03-9.59	10.9-17	26-37.3	4.96-91.02	0.48-1.93	3.86-74.21	3878	R
	Win. St-7, St-8									R
	Spr. St-7, St-8									R
	Sum. St-7, St-8									R
Cytherois frequens Müller, 1894	Fall , St-8	1-30	7.22-9.00	10.6-15.1	27.3-37	4.96-91.02	0.52-1.75	1.47-17.50	6	X
	Win. St-4									X

Table 1. Continued. Dispersion and ecology of the ostracoda species obtained from Erdek Bay.

Species	Stations	Depth (m)	DO (mg/l)	Temperature (°C)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Cytheroma karadagiensis Dubowsky, 1939	Fall. St-4	1	9.59	14.2	26	4.96	0.72	3.86	1	X
Cytheroma variabilis Müller, 1894	Win. St-4	1	9.00	10.6	27.3	4.96	0.52	1.47	2	X
Cytheropteron alatum Sars, 1866	Fall St-8	30	4.03-7.22	15.1-15.5	34.2-37	91.02	1.75-1.93	7.95-17.50	14	X
	Spr. St-8									X
Cytheropteron ruggierii Pucci, 1955	Win. St-8	30	6.40	14.7	37.3	91.02	1.21	12.38	2	X
Cytheropteron vespertilio (Reuss, 1850)	Win. St-8	30	6.40	14.7	37.3	91.02	1.21	12.38	8	X
Falunia ameciata (Brady, 1867)	Fall St-6	10	8.37	13.4	26.9	37.24	1.57	45.38	5	X
Hemicytherura videns (Müller, 1894)	Fall St-2	0.3	10.79	14.1	26.5	0.32	0.61	0.74	1	X
Heterocythereis albomaculata (Baird, 1838)	Win. St-3	0.3	8.64-9.97	9.9-25	22.8-27.8	0.29	0.07-0.18	0.39-1.11	3	X
	Sum. St-3									X
Hiltermannicythere rubra (Müller, 1894)	Fall St-1, St-5, St-6, St-7, St-8	0.3-30	4.03-10.93	9.6-24	22.5-37.3	0.56-91.02	0.18-1.93	7.95-82.02	1350	A
	Win. St-5, St-6, St-7, St-8									C
	Spr. St-5, St-6, St-7, St-8									C
	Sum. St-5, St-6, St-7, St-8									C
Hiltermannicythere sp.	Win. St-8	30	6.30-6.40	14.7-16.5	35.5-37.3	91.02	1.21-1.26	12.38-18.54	150	X
	Sum. St-8									X
Krithe reniformis (Brady, 1868)	Fall. St-8	30	6.40-7.22	14.7-15.1	37-37.3	91.02	1.21-1.75	12.38-17.50	7	X
	Win. St-8									X
Leptocythere histriana Caraion, 1964	Fall St-7.	5-20	7.26-8.44	9.7-14.5	27.6-29.9	15.82-47.07	0.18-0.78	35.29-65.61	3	X
	Win. St-5									X
Leptocythere macella Ruggieri, 1975	Fall St-7.	20	7.26-7.34	14.5-17	34.7-29.9	47.07	0.56-0.78	23.73-35.29	3	X
	Sum. St-7.									X
Leptocythere multipunctata (Seguenza, 1942)	Fall St-7, St-8	5-30	4.03-8.44	9.7-15.5	26.1-37.3	15.82-91.02	0.18-1.93	7.95-74.21	397	R
	Win. St-5, St-7, St-8									R
	Spr. St-7, St-8									R
Leptocythere rastrifera Ruggieri, 1953	Win. St-6	5-10	7.93-8.88	9.6-24	23.2-27.6	15.82-37.24	0.54-0.70	59.32-82.02	2	X
	Sum. St-5									X

Table 1. Continued. Dispersion and ecology of the ostracoda species obtained from Erdek Bay.

Species	Stations	Depth (m)	DO (mg/l)	Temperature (°C)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Loxoconcha agilis Ruggieri, 1967	Fall St-4, St-5, St-6, St-7, St-8	1-30	4.03-9.59	10.9-17	26-37.3	4.96-91.02	0.48-1.93	3.86-74.21	917	A
	Win. St-7, St-8									R
	Spr. St-7, St-8									R
	Sum. St-7, St-8									R
Loxoconcha alata Brady, 1868	Fall St-6	10	8.37	13.4	26.9	37.24	1.57	45.38	2	X
Loxoconcha bairdi (Müller, 1894)	Fall St-6	10	8.37	13.4	26.9	37.24	1.57	45.38	10	X
Loxoconcha bulgarica Caraion, 1961	Fall St-5	0.3-5	8.57-10.30	13.2-27	21.9-26.7	0.32-15.82	0.21-1.02	1.77-59.61	18	X
	Spr. St-2									X
	Sum. St-1, St-5									R
Loxoconcha exagona Bonaduce, Ciampo & Masoli, 1976	Fall St-4	1	9.59	14.2	26	4.96	0.72	3.86	2	X
Loxoconcha granulata Sars, 1866	Fall St-2, St-3	0.3	10.35-10.79	14.1-14.5	26.5-26.6	0.29-0.32	0.54-0.61	0.74-0.82	10	R
Loxoconcha nea Barbeito Gonzales, 1971	Win. St-3	0.3	8.64-9.97	9.9-25	22.3-27.8	0.29	0.07-0.55	0.46-8.90	8	X
	Spr. St-3									X
	Sum. St-3									X
Loxoconcha pellucida Müller, 1894	Win. St-8	30	4.03-6.40	14.7-16.5	34.2-37.3	91.02	1.21-1.93	7.95-18.54	32	X
	Spr. St-8									X
	Sum. St-8									X
Loxoconcha pontica Klie, 1937	Sum. St-4	1	9.17	24.5	23.2	4.96	0.14	1.48	1	X
Loxoconcha rhomboidea (Fischer, 1855)	Fall St-1, St-3, St-4, St-5, St-6, St-7, St-8	0.3-30	6.23-13.26	9.6-27	22.3-37.3	0.29-91.02	0.07-1.96	0.82-82.02	1177	VA
	Win. St-5, St-6, St-7, St-8									C
	Spr. St-4, St-5, St-6, St-7									C
	Sum. St-2, St-3, St-4, St-5, St-6, St-7									VA
Loxoconcha stellifera Müller, 1894	Fall St-2, St-3, St-4	0.3-5	6.68-10.79	9.7-17.9	22.5-27.8	0.29-15.82	0.18-0.95	0.39-66.08	27	R
	Win. St-2, St-3, St-4									R
	Spr. St-5									X

Table 1. Continued. Dispersion and ecology of the ostracoda species obtained from Erdek Bay.

Species	Stations	Depth (m)	DO (mg/l)	Temperature (°C)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Pontocythere turbida Müller, 1894	Fall , St-2, St-4, St-7, St-8	0.3-30	6.23-10.79	10.9-27	22.1-37.3	0.32-91.02	0.21-1.93	0.74-74.21	33	C
	Win. St-7, St-8									R
	Spr. St-1, St-7									R
	Sum. St-1, St-7									R
Propontocypris dispar (Müller, 1894)	Fall St-4, St-5, St-8	1-30	4.03-9.59	9.7-24	22.5-37.3	4.96-91.02	0.18-1.93	3.86-66.08	348	R
	Win. St-5, St-8									R
	Spr. St-5, St-8									R
	Sum. St-5, St-8									R
Propontocypris pirifera Müller, 1894	Fall St-4, St-5	1-10	6.29-9.59	9.6-24	22.5-27.6	4.96-37.24	0.18-1.96	3.86-82.02	20	R
	Win. St-5, St-6									R
	Spr. St-5, St-6									R
	Sum St-5, St-6									R
Pseudocytherura calcerata (Seguenza, 1880)	Fall St-1	0.3	10.93	14.1	26.8	0.56	0.79	8.16	1	X
Pseudocytherura pontica Dubovsky, 1939	Fall St-7	20	7.26	14.5	29.9	47.07	0.78	35.29	1	X
Pterigocythereis ceratoptera (Bosquet, 1852)	Fall St-8	30	4.03-7.22	14.7-16.5	34.2-37.3	91.02	1.21-1.93	7.95-18.54	117	X
	Win. St-8									X
	Spr. St-8									X
	Sum St-8									X
Pterigocythereis jonesii (Baird, 1850)	Fall St-4, St-5, St-6 St-7, St-8	1-30	4.03-9.59	10.9-17	26-37.3	4.96-91.02	0.48-1.93	3.86-74.21	2243	A
	Win. St-7, St-8									R
	Spr. St-7, St-8									R
	Sum. St-7, St-8									R
Semicytherura acuminata (Müller, 1894)	Fall St-5	5	8.57	13.2	26.7	15.82	1.02	59.61	1	X
Semicytherura acuticostata (Sars, 1866)	Fall St-8	20-30	6.23-7.22	14-15.1	26.1-37	47.07-91.02	1.22-1.75	17.50-74.21	9	X
	Spr. St-7									X
Semicytherura cribriformis (Müller, 1894)	Win. St-3	0.3	8.64	9.9	27.8	0.29	0.18	0.46	1	X
Semicytherura diafora Barbeito-Gonzalez, 1971	Fall St-3, St-5, St-6 St-8	0.3-30	6.23-10.35	9.6-24	23.5-37	0.29-91.02	0.18-1.96	0.82-82.02	19	C
	Win. St-5, St-6									R
	Sum St-6									X

Species	Stations	Depth (m)	DO (mg/l)	Temperature (℃)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Semicytherura inversa (Seguenza, 1880)	Fall St-4, St-5, St-6 St-7	0.3-20	6.23-9.59	9.6-24	22.1-29.9	4.96-47.07	0.18-1.96	3.86-82.02	263	C
	Win. , St-5, St-6									R
	Spr. St-1, St-5, St-6 St-7									C
	Sum St-5, St-6									R
Semicytherura paradoxa (Müller, 1894)	Win. St-6 St-7	5-20	6.23-8.88	9.6-24	22.5-29.9	15.82-47.07	0.70-1.96	59.32-82.02	8	R
	Spr. St-5 St-7									R
	Sum St-5 St-6									R
Semicytherura ruggierii (Pucci, 1956)	Spr. St-6	10	6.29	17.3	22.8	37.24	0.99	77.04	3	X
Semicytherura stilifera Bonaduce, Ciampo & Masoli, 1976	Fall St-6 St-7	5-20	7.26-8.88	13.4-24	23.2-29.9	15.82-47.07	0.70-1.57	35.29-59.32	20	R
	Sum St-5									X
Semicytherura tergestina Masoli, 1968	Fall St-7	5-20	6.68-7.26	14.5-17.9	22.5-29.9	15.82-47.07	0.78-0.91	35.29-65.61	10	X
	Spr St-5.									X
Urocythereis margaritifera (Müller, 1894)	Fall St-1, St-5, St-6	0.3-10	6.29-10.93	8.9-24	21.9-27.8	0.56-37.24	0.12-1.96	1.77-82.02	79	R
	Win. St-1, St-6									R
	Spr. St-2, St-5, St-6									R
	Sum St-5, St-6									R
Urocythereis neapolitana Athersuch, 1977	Fall St-4	1-5	8.44-9.59	9.7-14.2	26-27.6	4.96-15.82	0.18-0.72	3.86-65.61	7	X
	Win. St-5									X
Xestoleberis communis (Müller, 1894)	Fall St-1, St-5, St-6 St-7, St-8	0.3-30	6.23-10.93	9.6-27	22.1-37.3	0.56-91.02	0.18-1.96	8.16-82.02	661	A
	Win. St-5, St-6 St-7, St-8									C
	Spr. St-1, St-5, St-6 St-7									C
	Sum St-5, St-6 St-7									R
Xestoleberis decipiens (Müller, 1894)	Sum St-1	0.3	10.14	27	22.3	0.56	0.21	8.90	4	X
Xestoleberis margaritea (Brady, 1866)	Fall St-2, St-5, St-6 St-7, St-8	0.3-30	6.23-10.79	9.6-27	22.3-37.3	0.29-91.02	0.07-1.96	0.46-82.02	476	A
										A
	Win. St-3, St-4, St-5, St-6 St-7, St-8									C
	Spr. St-4, St-5, St-6 St-7									A
	Sum St-1, St-3, St-5, St-6 St-7, St-8									

Table 1. Continued. Dispersion and ecology of the ostracoda species obtained from Erdek Bay.

Species	Stations	Depth (m)	DO (mg/l)	Temperature (ºC)	SAL (‰)	Mud Percentage	TOC	TCC	Total İndividual Number	F (%)
Xestoleberis margaritopsis Rome, 1942	Fall St-4	1-30	4.03-9.59	14.2-24	23.2-37.3	4.96-91.02	0.70-1.93	3.86-59.32	143	X
	Win. St-8									X
	Spr. St-8									X
	Sum St-5									X
Xestoleberis pellucida (Müller, 1894)	Fall St-2	0.3-30	6.30-10.79	14.1-16.5	26.5-37.3	0.32-91.02	0.61-1.26	0.74-18.54	53	X
	Win. St-8									X
	Sum St-8									X

Fall: Fall, Win: Winter, Spr: Spring, Sum :Summer; VA: Very Abundant species (81-100%);, A: Abundant species (61-80%);C: Common species (41-60%), R: Rare species (21-40%), X: Present sporadically (1-20%)

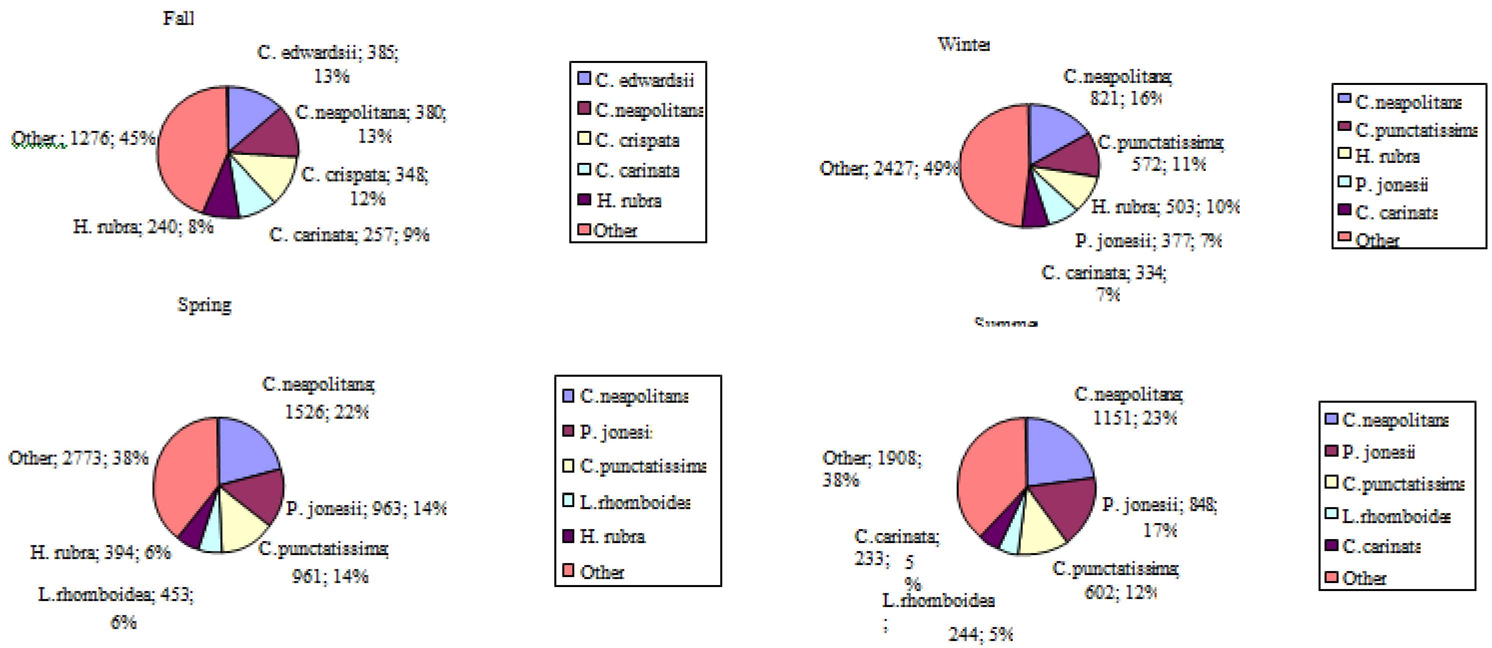

Fig.2. Percentage of the individual numbers of Ostracoda species according to seasons

Table 2 .Seasonal and ecological parameters of the stations with total species and individual numbers

	Depths (m)	*Temperature (°C)*	*Salinity (‰)*	*DO (ml/l)*	*TOC (%)*	*TCC (%)*	*Mud Percentage (%)*	*Visibility (m)*	*Species Numbers*	*Individual Numbers*
St 1										
Nov. 2006		14.1	26.8	10.93	0.79	8.16		Visible	8	35
Feb. 2007	0.30	8.9	27.8	8.61	0.12	8.05	0.56	Visible	3	30
May 2007		21.9	22.1	9.44	0.30	12.37		Visible	5	10
Aug. 2007		27	22.3	10.14	0.21	8.90		Visible	6	31
St 2										
Nov. 2006		14.1	26.5	10.79	0.61	0.74		Visible	7	40
Feb. 2007		9.7	27	9.08	0.45	0.39	0.32	Visible	1	3
May 2007	0.30	21.8	21.9	10.30	0.34	1.77		Visible	3	3
Aug. 2007		27	23.6	13.26	0.07	1.11		Visible	2	5
St 3										
Nov. 2006		14.5	26.6	10.35	0.54	0.82		Visible	5	10
Feb. 2007		9.9	27.8	8.64	0.18	0.46	0.29	Visible	5	13
May 2007	0.30	18.3	22.3	9.02	0.55	6.27		Visible	2	3
Aug. 2007		25	22.8	9.97	0.07	8.90		Visible	5	16
St 4										
Nov. 2006		14.2	26	9.59	0.72	3.86		Visible	22	72
Feb. 2007	1	10.6	27.3	9.00	0.52	1.47	4.96	Visible	5	8
May 2007		18.3	22.3	7.82	0.48	3.53		Visible	2	2
Aug. 2007		24.5	23.2	9.17	0.14	1.48		Visible	3	5
St 5										
Nov. 2006		13.2	26.7	8.57	1.02	59.61		Visible	20	150
Feb. 2007	5	9.7	27.6	8.44	0.18	65.61	15.82	Visible	17	116
May 2007		17.9	22.5	6.68	0.91	66.08		Visible	21	228
Aug. 2007		24	23.2	8.88	0.70	59.32		Visible	22	278
St 6										
Nov. 2006		13.4	26.9	8.37	1.57	45.38		Visible	20	278
Feb. 2007	10	9.6	27.6	7.93	0.54	82.02	37.24	Visible	16	125
May 2007		17.3	22.8	6.29	0.99	77.04		8	15	235
Aug. 2007		23	23.5	7..75	1.96	80.08		9	15	228
St 7										
Nov. 2006		14.5	29.9	7.26	0.78	35.29		10	21	144
Feb. 2007	20	10.9	29.9	7.80	0.48	61.36	47.07	13	23	1529
May 2007		14	26.1	6.23	1.22	74.21		8	26	1261
Aug. 2007		17	34.7	7.34	0.56	23.73		10	26	503
St 8										
Nov. 2006		15.1	37	7.22	1.75	17.50		13	33	2157
Feb. 2007	30	14.7	37.3	6.40	1.21	12.38	91.02	13	34	3210
May 2007		15.5	34.2	4.03	1.93	7.95		8	22	5328
Aug. 2007		16.5	35.5	6.30	1.26	18.54		9	20	3920

Table 3. Spearman's rank correlation matrix (rs) correlating Ostracoda assemblages and environmental variables in the study area
(TOC: Total Organic Carbon; TCC: Total Calcium Carbonate)

	Temperature	Salinity	Dissolved oxygen	Depth	Mud percentage	TOC	TCC	Species num.	Individual num.
Temperature	1								
Salinity	-0,599**	1							
Dissolved oxygen	ns	-0,458**	1						
Depth	ns	0,585**	-0,878**	1					
Mud percentage	ns	0,565**	-0,849**	0,976**	1				
TOC	ns	ns	-0,624**	0,704**	0,691**	1			
TCC	ns	ns	-0,630**	0,642**	0,666**	0,472**	1		
Species number	ns	0,546**	-0,649**	0,836**	0,832**	0,682**	0,619**	1	
Individual number	ns	0,579**	-0,734**	0,862**	0,863**	0,730**	0,663**	0,924**	1

** *P<0,01*, **P<0,05*, ns= not significant isms can survive with low dissolved oxygen concentrations, dissolved oxygen alone does not have an impact on live creatures in an aquatic ecosystem. Also Delorme (1991) pointed out high number of Ostracod species can tolerate low dissolved oxygen concentrations. Negative correlation was observed between dissolved oxygen with species number and individual number according to Spearman's rank correlation in our study ($P < 0.01$) (Table 3). Species numbers and individual numbers were high even in the lowest dissolved oxygen concentration levels at the deeper stations, not because of dissolved oxygen concentration but because of high detritus deposits.

In this study, mud percentage has a positive correlation to species numbers and individual numbers according to Spearman's rank correlation ($P < 0.01$) (Table 3).Benson and Maddocks (1964), Puri (1966), Breman (1975), Montenegro *et al.,* (1998), and Coimbra *et al.,* (1999) had observed a positive correlation between mud percentage with species and individual numbers also pointed out that the grade of the sediment was one of the important factors in population intensity and distribution of Ostracoda.

The relationship between total organic carbon and total calcium carbonate with species and individual numbers is positive, according to Spearman's rank correlation ($P < 0.01$) (Table 3). Elakkiya, (2012) determined a positive relation between organic matter content with ostracod fauna and also with fines of the substrate.The abundance of ostracod fauna is directly proportional to depth and inversely proportional to grain size. Ostracoda abundance was high in the depth station with high mud percentages in Erdek bay St 7 (20m) and St 8 (30m). The individual number and species number of Oscracoda species are positively correlated with depth and mud percentage (Table 3 $P< 0.01$). The textural characteristics of the bottom sediment are important factors controlling the distribution and density of ostracods (Machado, et al. 2005). Similarly Elakkiya (2012) had observed positive correlation between Ostracoda fauna with fine sediments and depth. According to Whatley et al. (1995) and Ramos et al. (1999) the absence and lowest number of species in shallower samples, closer to the coast as the because of the instability of the bottom substrates due to wave action.

CONCLUSIONS

In conclusion we observed the diversity of Ostracoda species were mostly affected by the depth, salinity and mud percentage in Erdek Bay. Because the highest number of Ostracoda species and individual numbers were observed between 10-30m deep stations (St-6, St-7, St-8) with high salinity and muddy sediment. At the same time we determined the distributional patterns of the Ostracoda species in relation to seasonal environmental and ecological factors. This study has an importance in that it is the first to research the effect of seasonal ecological parameters on Ostracoda species and their statistical considerations in Erdek Bay. Consequently, this study will be able to be used as a reference for following studies concerning the identification of future ecological problems and differences in Ostracoda fauna in the Sea of Marmara, which suffers from a high level of pollution.

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REFERENCES

Algan, O., Balkis, N., Cagatay, M.N. and Sari, E. (2004). The sources of metal contents in the shelf sediments from the Marmara Sea, Turkey. Environmental Geology, **46,** 932-950.

Aliyev, S.A. and Sari, A. (2005). Element and Organic Carbon Distribution in the Core Sediments of the Sea of Marmara, Geochemistry International, **43,** 784-796.

Athersuch, J. (1977). The genus Urocythereis (Crustacea; Ostracoda) in Europe, with particular reference to Recent Mediterranean species. Bulletin of the British Museum of Natural History, **32(7),** 247-283.

Balkıs, N. (2009). Seasonal variations of microphytoplankton assemblages and environmental variables in the coastal zone of Bozcaada Island in the Aegean Sea (NE Mediterranean Sea). Aquatic Ecology, **43(2),** 249-270.

Balkis, N. and Cagatay, M.N. (2001). Factors controlling metal distributions in the surface sediments of the Erdek Bay, Sea of Marmara, Turkey. Environment International, **27(1),** 1-13.

Barbeito-Gonzales, J.P. (1971). Die ostracoden des künstenbereiches von Naxos (Griechenland) und ihre lebensbereiche. Mitteilungen aus dem Zoologischen Staatsinstitut und Zoologischem Museum in Hamburg, **67,** 255-326.

Benson, R.H. and Maddocks, R.L. (1964). Recent Ostracodes of Knysna Estuary, Cape Province, Union of South Africa. University of Kansas paleontological contributions. (Arthropoda) **5,** 1-39.

Besiktepe, S.T., Ozsoy, E. and -nlüata, -. (1993). Filling of the Marmara Sea by the Dardanelles lower layer inflow. Deep Sea Research Part I. Oceanographic research papers, 40, 1815-1838.

Bonaduce, G., Ciampo, G. and Masoli, M. (1975). Distribution of Ostracoda in the Adriatic Sea. Publicazioni Della Stazione Zoologica di Napoli, **40,** 1-154.

Breman, B. (1975). The distribution of ostracodes in the bottom sediments of the Adriatic Sea. Krips Repro, Meppel, 50-165.

Coimbra, J.C., Pinto, I.D., Würding, N.L. and Carmo, D.A. (1999). Zoogeography of Holocene Podocopina Ostracoda from the Brazilian equatorial continental shelf. Marine Micropaleontology, **37,** 365-379.

Delorme, L.D. (1991). Ostracoda. (In: Thorpe J.H. and Covich AP (eds.) Ecology and Classification of North American Invertebrates, Academic press Inc., California 691-722.

Elakkia, P. (2012). Environmental and ecological parameters of recent Ostracods in Cauvery River Estuary, Poombuhar, Tamil Nadu, India. International journal of environmental sciences, **2,** 2104-2109.

Ellis, M.M. and Westfall, B.A. (1946). Determination of Water Quality. U.S. Fish and Wildlife Service Rep. No.**9,** 117p.

Folk, L.R. (1974). Petrology of Sedimentary Rocks, Hemphill, Tusa, Oklahama. - ISBN 0914696033.

Gaudette, H., Flight, W., Tanner, L. and Folger, D. (1974). An expensive titration method for the determination of organic carbon in recent sediments. Journal of Sedimentary Petrolegy, **44(1),** 249- 253.

Griffiths, H.I. and Evans, J.G. (1991). Some Freshwater ostracods (Crustacea:Ostracoda) From South Wales. Freshwater Forum, **1(1),**64-72.

Hartmann, G. and Puri, S.H. (1974). Summary of neontological and paleontotogical classification of Ostracoda. Mitteilungen aus dem Zoologischen Staatsinstitut und Zoologischem Museum in Hamburg, Band **70,** 7-73.

Holmes, J.A. (2001). Ostracoda. (In Smol JP, Birks HJB Last WM (Eds). Tracking Environmental Change Using Lake Sediments Zoological Indicators. Dordrecht: Kluwer Academic Publishers, **4,**125-152.

Ivanoff, A. (1972). Introduction al'oceanographie, Tome I. Librairie Vuibert, Paris.

KocataS, A. (1996), Ekoloji ve çevre biyolojisi.(Ecology and environmental biology) -çüncü baskı. Ege -niversitesi, Su -rünleri Fakültesi Yayınları, No: 51. Ege University Press, Bornova, ›zmir.

Külkylüoglu, O., Sarı, N. and Akdemir, D. (2012). Distribution and ecological requirements of ostracods (Crustacea) at high altitudinal ranges in Northeastern Van (Turkey). Journal of Limnology **48(1),** 39-51.

Li, X., Lui, W., Zhang L. and Sun, Z. (2010). Distribution of recent ostracod species in the Lake Qinghai area in Northwestern China and its ecological significance. Ecological indicators **10(4),** 880-890.

Loring D.H. and Rantala, R.T.T. (1992). Manuel for the Geochemical Analyses of Marine Sediments and Suspended Paticulate Matter. Earth Science Reviews, **32,** 235-283.

Machado, C.P., Coimbra, J.C. and Carreno, A.L. (2005). The ecological and zoogeographical significance of the sub-Recent Ostracoda off Cabo Frio, Rio de Janeiro State, Brazil. Marine Micropaleontology, **55,** 235-253.

Meriç, E. and Algan, O. (2007). Paleoenvironments of the Marmara Sea (Turkey) coasts from paleontological and sedimentological data. Quaternary International **67,** 128-148.

Montenegro, M.E., Pugliese, N. and Bonaduce, G. (1998). Shelf Ostracods distribution in the Italian Seas, What about Ostracoda! Bulletin de Centre de Recherche, Exploration Production, Elf-Aquatine, Memoire **20,** 91-101.

Mordukhai-Boltovskoi, D.D. (ed) (1969). Ostracoda of the Black Sea from determination of the fauna of the Black and Azov Seas (in Russian). Kiev, Kievskaya Kni/linaya Fabrika 1-82.

Perçin- Paçal, F. and Balkıs, H. (2012). Seasonal Distribution of Ostracoda in Band?rma Bay and Erdek Bay, Sea of Marmara, Turkey. Crustaceana **85(7),** 847-875.

Puri, H.S. (1966). Ecological distribution of Recent Ostracoda. Proceeding in the Symposium of Crustacea, 457-495.

Ramos, M.I.F., Coimbra, J.C., Whatley, R.C. and Moguılevsky, A. (1999). Taxonomy and ecology of the family Cytheruridae (Ostracoda) in Recent sediments from the Northern Rio de Janeiro Coast, Brazil. Journal of Micropaleontology, **18,** 1-16.

Siegel, S. (1956). Non-parametric statistics for the behavioral sciences. McGraw-Hill, New York.

Smith, A.J. and Horne, D.J. (2002). Ecology of Marine, Marginal Marine and Nonmarine Ostracodes. In: The Ostracoda: Applications in Quaternary Research Geophysical Monograph 131.

Stambolidis, A.E. (1985). Zur kenntnis Der Ostracodes des Evros-Delta (North-Agaisches Meer) Griechland. Mitteilungen aus dem Zoologischen Staatsinstitut und Zoologischem Museum in Hamburg, **82,** 155-254.

-nlüata, -., Oguz, T., Latif, M.A. and ضzsoy, M. (1990). On the physical oceanography of the Turkish straits. In: Pratt LJ (ed) The physical oceanography of sea straits. Kluwer, Dordrecht, 25-60.

Whatley, R.C., Toy, N., Moguilevsky, A. and Coxill, D. (1995). Ostracoda from the South West Atlantic: part I. The Falkland Islands Revista Espanola de Micropaleontologia. **27(1),** 17-38.

Winkler, L.W. (1888). The determination of dissolved oxygen in water, Berlin Deutsche Deutsche Chemische Gesellschaft, **(21),** 2843-2855.

Yassini, I. (1979). The littoral system ostracodes from the Bay of Bou-Ismail, Algiers, Algeria. Revista Espanola De Micropaleontologia, **11(3),** 353-416.

Zarikian, C.A.A., Blackwelder, P.L., Hood, T., Nelsen, T.A. and Featherstone, C. (2000). Ostracods as indicators of natural and anthropogenically-induced changes in coastal marine environments. Coasts at the Millennium, Proceedings of the 17th International Conference of The Coastal Society, Portland, OR USA, July 9-12, 986-905.