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# Diversity of Marine Ostracoda (Crustacea) on the Northern Coasts of Sea of Marmara (Turkey)

# Marmara Denizi'nin Kuzey Kıyılarındaki Deniz Ostrakodlarının Dağılımı

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## Abstract

In this study the materials collected from the Northern coasts of Sea of Marmara between 1999- 2000 were evaluated and 33 species from 16 genera has been determined. Among these species *Callistocythere diffusa*, *Loxoconcha littoralis* and *Loxoconcha pontica* are new records for the Sea of Marmara. According to the Spermann analysis the primary hydrographical variables did not seem to be very effective in the distribution dynamics of the ostracod species in the Sea of Marmara. However according to the MDS analysis, it has been observed that *Cyprideis torosa* was affected by temperature, *Xesteloberis communis* by salinity, *Loxoconcha rhomboidea* and *Paracytheridea parallia* by dissolved oxygen when compared to other species.

**Keywords:** Ostracoda, Sea of Marmara, Mediterranean Sea, Aegean Sea, diversity

## Introduction

The Sea of Marmara is a small (size ~ 70 x 250 km) intercontinental basin connecting the Black Sea and the Mediterranean Sea. The northern shelf area is narrow (5-10 km in width) compared to the southern shelf (~30 km in width), extends to 90-100 m water depth, widening eastwards and almost disappears in the west, between Mürefte and Dardanelles. It extends parallel to the shoreline, widening to about 12 km at the confluence of Bosphorus and in the vicinity of the Prince Islands, and terminating in Izmit Gulf in the east (Figure 1).

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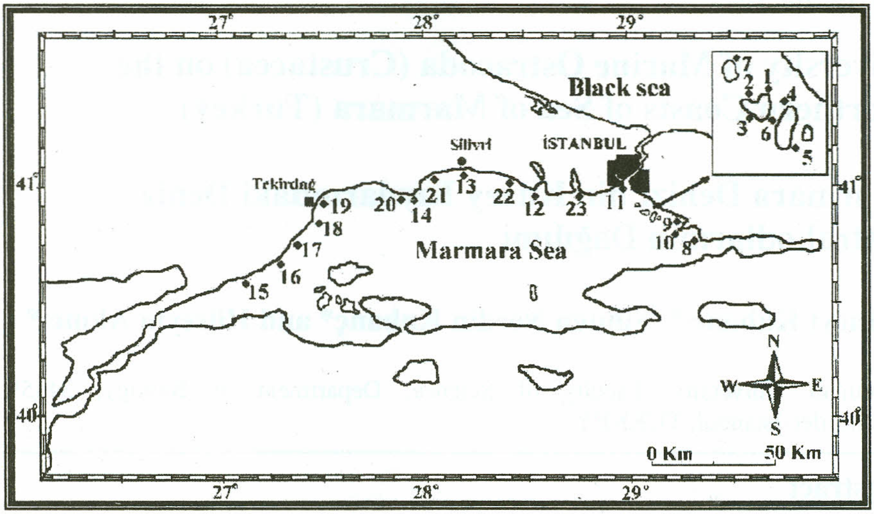
**Figure 1.**Sea of Marmara and the sampling stations.




The oceanographic properties of the Sea of Marmara are influenced by the Black Sea and the Aegean Sea through the Bosphorus Strait and the Dardanelles, having permanent, two-layered, water stratification. Salinity value of the Black Sea at the entrance of the Bosphorus is 17.6 ‰. The same value increases at 22 ‰ towards south. The salinity of the upper layer increases at 26 ‰, affected by strong winds towards Dardanelles. Salinity value of the deep-water layer originated from Mediterranean is as high as 38.5 ‰ (Yüce and Türker 1991). Dissolved oxygen measurements from surface layer of Marmara are similar to the values of Black Sea water from the Bosphorus. It has been observed that the highest value is 11.7 mg/l in April and lower than 7 mg/l in October (Salihoğlu and Mutlu 1999). A dissolved oxygen value of the surface water is near to the satiation degree between 7.5-12.8 mg/l and changing related to temperature (Tuğrul and Salihoğlu 2000). Water temperature values are between 7-22 °C. The Black Sea current with a high dissolved oxygen and low salinity influences surface water of Northern Marmara obviously. During winter, the inflow of Aegean deep water from Dardanelles reaches maximum and as it is denser than the surface water, it sinks on the Western Marmara, which can be distinguished with low temperature, and high salinity (Yüce 1995). Also Northern Marmara Sea is oligotrophic in nature (Balkıs 2003).

The Sea of Marmara is now the recipient of a large amount of wastewater discharging from land-based sources. Pollution loading from Istanbul alone, the biggest city of Turkey in terms of population and industry, make up the major portion (40-65%) of the total anthropogenic discharges (Tuğrul and Polat 1995).

Stratification observed in Marmara Sea with a separating halocline layer affects its faunal diversity in many ways. Ostracoda fauna of the Marmara Sea is affected especially by species from Mediterranean and Aegean Seas (Tunoğlu 1999, Nazik 2001, Kubanç 2002).

The aim of this study is to determinate the Ostracoda fauna of the Northern coasts of the Sea of Marmara which is under the threat of pollution and to report, if any, species that would be new to Turkish waters.

## Material and Methods

The Northern coasts of Marmara Sea were sampled from 23 stations between 1999, 2000 (Figure 1). Samples were obtained with a hand net made of Muller fabric from the mediolittoral zone sweeping the bottom twice in an area of 3 $m^2$ approximately. Primary ecological variables (temperature, salinity and dissolved oxygen) were measured in the field using a WTW Multiline P4 measurement apparatus (Table 1).

Samples were fixed in 4% formaldehyde and later washed under pressurized water to separate the material from mud and detritus. Ostracods were separated from 10 g of material per station under a stereomicroscope. Generic and specific features of carapace and soft parts were examined in order to identify different species.

Spermann rank order correlation was used to correlate the species number of ostracods and hydrographical variables (Siegel 1956). The Sorensen similarity matrix (Sorensen 1948) was calculated in order to determine the similarity between the surrounding seas and the Northern coasts of the Sea of Marmara according to the ostracod species involved. Nonmetric Multi-Dimensional Scaling (MDS) analysis was performed to estimate relationships between the ostracod community and hydrographic data (Clarke and Warwick 2001). Clustering was calculated with the Bray-Curtis Similarity Index, based on Fourthroot transformation, in order to determine the similarity between sampling stations. For the mathematical analysis of the samples the Shannon-Weaver Diversity Index (Zar 1984) and the Evenness Index (Pielou 1969) were calculated.

**Table 1.**Some hydrographical variables, sediment type, coordinate and dates obtained for the stations.

| Stations | Date | Coordinates | Sediment type | Temperature (°C) | Salinity (‰) | Dissolved oxygen (mg/l) | Species number |
|---|---|---|---|---|---|---|---|
| 1 | 30.10.1999 | 40° 53' 00" N - 29° 05' 10" E | Gravel, sand, sea weed | 17 | 22.2 | 9.1 | 7 |
| 2 | 30.10.1999 | 40° 52' 10" N - 29° 04' 55" E | Sand, sea weed | 17 | 22.4 | 9.2 | 10 |
| 3 | 30.10.1999 | 40° 52' 10" N - 29° 05' 10" E | Sand, sea weed | 17 | 22.4 | 9.9 | 8 |
| 4 | 31.10.1999 | 40° 52' 30" N - 29° 07' 30" E | Gravel, sand, sea weed | 18 | 22.5 | 9.7 | 5 |
| 5 | 31.10.1999 | 40° 50' 20" N - 29° 07' 15" E | Sand, sea weed | 17 | 22.3 | 6.7 | 8 |
| 6 | 31.10.1999 | 40° 51' 50" N - 29° 06' 50" E | Sand, sea weed | 17 | 22.5 | 7.3 | 11 |
| 7 | 01.11.1999 | 40° 53' 10" N - 29° 03' 15" E | Gravel, sand, sea weed | 13 | 22.6 | 8.2 | 4 |
| 8 | 02.11.1999 | 40° 45' 30" N - 29° 22' 30" E | Gravel, sand, sea weed | 13 | 22.2 | 8.4 | 6 |
| 9 | 02.11.1999 | 40° 49' 50" N - 29° 16' 30" E | Small gravel, sand | 14 | 22.3 | 7.7 | 13 |
| 10 | 02.11.1999 | 40° 48' 40" N - 29° 15' 30" E | Gravel, sand, sea weed | 14 | 22.5 | 7.9 | 9 |
| 11 | 03.11.1999 | 41° 01' 05" N - 28° 59' 05" E | Big stone, sea weed | 12 | 22.6 | 5.9 | 9 |
| 12 | 03.11.1999 | 41° 00' 25" N - 28° 32' 45" E | Sand, sea weed | 14 | 19.7 | 7.6 | 4 |
| 13 | 04.11.1999 | 41° 03' 55" N - 28° 17' 00" E | Gravel, sand, sea weed | 14 | 22.4 | 7.9 | 9 |
| 14 | 04.11.1999 | 40° 58' 10" N - 27° 55' 10" E | Gravel, sand, sea weed | 14 | 23.3 | 8.2 | 5 |
| 15 | 20.02.2000 | 40° 36' 00" N - 27° 04' 00" E | Gravel, sand, sea weed | 7 | 22.5 | 10.2 | 7 |
| 16 | 20.02.2000 | 40° 39' 20" N - 27° 13' 35" E | Gravel, sand, sea weed | 7 | 22.8 | 9.2 | 9 |
| 17 | 20.02.2000 | 40° 43' 20" N - 27° 19' 20" E | Gravel, sand, sea weed | 7 | 22.8 | 9.8 | 12 |
| 18 | 21.02.2000 | 40° 54' 00" N - 27° 28' 00" E | Gravel, sand, sea weed | 8 | 22.6 | 10.4 | 8 |
| 19 | 21.02.2000 | 40° 58' 30" N - 27° 31' 40" E | Gravel, sand, sea weed | 8 | 22.2 | 8.6 | 9 |
| 20 | 22.02.2000 | 40° 59' 00" N - 27° 51' 15" E | Gravel, sand | 7 | 21.8 | 10.2 | 7 |
| 21 | 22.02.2000 | 41° 02' 20" N - 28° 02' 30" E | Gravel, sand, sea weed | 8 | 22.6 | 9.2 | 14 |
| 22 | 22.02.2000 | 41° 01' 50" N - 28° 27' 00" E | Gravel, sand, sea weed | 8 | 22.6 | 9.4 | 6 |
| 23 | 20.05.2000 | 40° 58' 40" N - 28° 46' 00" E | Gravel, sand, sea weed | 15 | 20.0 | 11.2 | 8 |

## Results

Identified ostracoda species from 23 stations are listed in table 2. Three of them (*Callistocythere diffusa* Muller, *Loxoconcha pontica* Klie and *Loxoconcha littoralis* Muller) were recorded in the Sea of Marmara for the first time. Most of the ostracods belong to genera Loxoconcha. The generalist species that were found throughout the whole of this research were *Costa edwardsi* (f= 69.5%), *Xestoleberis communis* (f= 69.5%), *Loxoconcha rhomboidea* (f=56.5%), *Callistocythere diffusa* (f= 48%), *Urocythereis britannica* (f= 48%) and *Loxoconcha minima* (f= 48%). *Loxoconcha littoralis, Loxoconcha pontica, Xestoleberis aurantia* and *Xestoleberis cornelli* were observed to be the rare species (f= 4%). The highest species numbers were recorded at stations 21 (14 species) and 9 (13 species) followed by stations 17 (12 species) and 6 (11 species). The lowest numbers of species were recorded for stations 7 and 12 (4 species each).

Cluster analysis (Figure 2) made to combine the stations according to the species they involve, showed two distinct groups. The highest similarity among the stations appeared to be between stations 2 and 10 (%78.55) with 8 associated species noticed at both. The lowest similarity among the stations was found between stations 11 and 15 (8.33%) with only 1 associated species. The maximum abundance of ostracods was observed at station 6 (151 individuals) the lowest abundance was at station 12 (13 individuals) (Table 2).

**Figure 2.**Similarity of 23 stations located in the Northern Sea of Marmara according to the occurrence of different species.

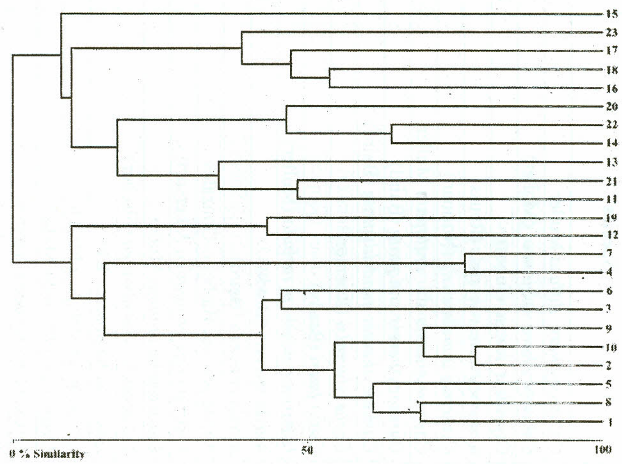


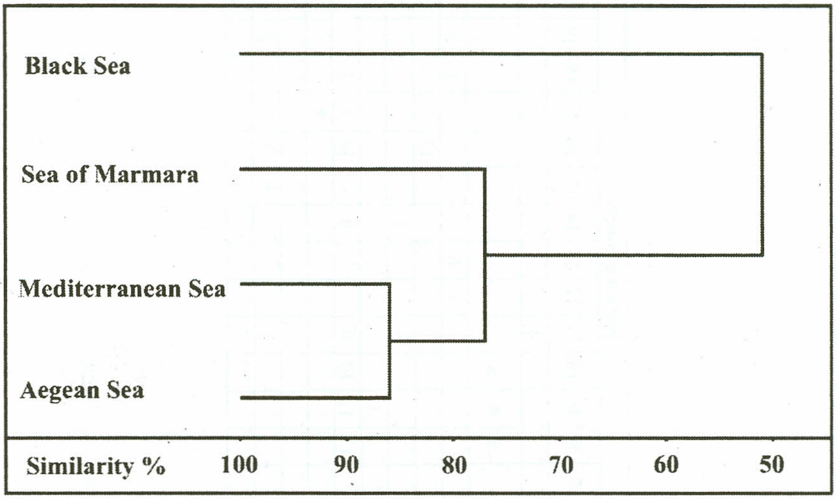
**Table 2.** The abundance and frequency (f) of each identified species in the Northern Sea of Marmara.

| Species | Station numbers | | | | | | | | | | | | | | | | | | | | | | | f (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | |
| *Callistocythere diffusa* Muller | 5 | 9 | | 3 | 6 | 1 | 11 | 7 | 2 | 2 | | | | | | | 3 | 1 | | | | | | 48 |
| *Callistocythere lobiancoi* (Muller) | | 10 | 15 | | | 11 | | | | | 16 | | 7 | | | | | | | | 2 | 5 | | 30 |
| *Cyprideis torosa* (Jones) | 16 | | | 18 | | | 14 | | | | 35 | | 22 | | | | | | | | 8 | | 3 | 30 |
| *Acantocythereis hystrix* (Reuss) | | | | | | 2 | | | 5 | | | | | | | | | | 13 | | | | | 13 |
| *Cythereis dunelmensis* (Norman) | | | | | | | | | | | | | 1 | | | | 3 | | | | | | | 9 |
| *Carinocythereis* aff. *antiquata* Muller | | | 2 | | | | | | | | | | 1 | | | | | | | | 5 | | | 13 |
| *Carinocythereis antiquata* (Baird) | | | | | | 4 | | | | | | | | | | | | | | | 1 | | | 9 |
| *Carinocythereis quadridentata* (Baird) | | | | | | 6 | | | | | | | 7 | | | | | 2 | | | 9 | | | 17 |
| *Costa edwardsi* (Roemer) | 49 | 15 | 21 | | 18 | 22 | | 5 | 12 | 24 | | | 16 | 12 | 10 | 1 | 19 | | 2 | 1 | | 1 | | 69.5 |
| *Costa batei* (Brady) | | 2 | | | | | | 1 | 5 | 3 | | | 6 | 9 | | | | | 1 | 8 | | 6 | | 39 |
| *Hiltermannicythere turbida* (Muller) | | | | | | | | | | | | | | | 3 | 1 | | | | | 1 | | | 13 |
| *Aurila speyeri* (Brady) | 12 | 6 | 18 | 2 | 2 | 1 | 7 | | 16 | 8 | | | | | | | 10 | | | | | | | 43 |
| *Aurila convexa* (Baird) | | | | | 11 | | | | 35 | | 19 | | | | 1 | 5 | 17 | 1 | | | | | 2 | 35 |
| *Aurila prasina* Barbeito-Gonzales | | | | | | | | | | | | | | | 1 | | | | | | 2 | | | 9 |
| *Urocythereis britannica* Athersuch | | 25 | | | | | | | 10 | 9 | 2 | 1 | 5 | | | 2 | 14 | 9 | | | 18 | | 25 | 48 |
| *Loxoconcha minima* Muller | 3 | 8 | 5 | 1 | 1 | | 9 | 5 | 8 | 3 | | 2 | | | | | | | 7 | | | | | 48 |
| *Loxoconcha rhomboidea* (Fischer) | | | | | 5 | 14 | | | 6 | | 2 | | | 1 | | 6 | 11 | 7 | 9 | 13 | 4 | 11 | 34 | 56.5 |
| *Loxoconcha pontica* Klie | | | | | | | | | | | 1 | | | | | | | | | | | | | 4 |
| *Loxoconcha stellifera* Muller | | | | | | | | | | | | | | | 4 | 7 | 1 | 1 | 2 | | | | | 22 |
| *Loxoconcha littoralis* Muller | | | | | | | | | | | | | | | | | 1 | | | | | | | 4 |
| *Loxoconcha tumida* Chapman | | | | | | | | | | | | | | | 5 | | | | | | 3 | | | 9 |
| *Paracytheridea parallia* Barbeito-Gonzales | | | | | | 41 | | | 15 | 4 | | 9 | | | | | | | 7 | | | | 6 | 26 |

| Species | Station numbers | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | f (%) |
| *Pseudocytherura calcarata* (Seguenza) | | | | | | | | | | | 4 | | | | | | 1 | | | | 5 | | 3 | 12 |
| *Semicytherura rarecostata* Bonaduce,Ciampo,Masoli | 10 | 8 | | | 2 | 4 | | 5 | 6 | 8 | | | | | | | | | | | | | | 30 |
| *Semicytherura incongruens* (Muller) | | | | | | | | | | | | 1 | 6 | | | | | 1 | 3 | | | 1 | 1 | 26 |
| *Semicytherura inversa* (Seguenza) | | | | | | | | | | | | | | | | 13 | | | | 3 | | | 7 | 13 |
| *Cytheropteron punctatum* Hanai | | | 1 | | | | | | | | | | | 1 | | | | | | 5 | 2 | | | 17 |
| *Cytheropteron alatum* Sars | | 1 | 3 | | | | | | 1 | | | | | | | | | | | | 1 | | | 17 |
| *Xestoleberis communis* Muller | 26 | 37 | 31 | 5 | 1 | 45 | | 15 | 11 | 10 | 6 | | | 8 | | 14 | 1 | 3 | | | 9 | 21 | | 69.5 |
| *Xestoleberis aurantia* (Baird) | | | | | | | | | | | | | | | | | 8 | | | | | | | 4 |
| *Xestoleberis cornelli* Caraion | | | | | | | | | | | | | | | | | | | | 5 | | | | 4 |
| *Xestoleberis decipiens* Muller | | | | | | | | | | | | | | | 5 | 1 | | | 2 | | | | | 13 |
| *Paradoxostoma ensiforme* (Brady) | | | | | | | | | | | 7 | | | | | | | | | 1 | | | | 9 |

Cluster analysis (Figure 3), made to combine the seas according to species they involve, showed that the Mediterranean and the Aegean Sea had the highest similarity (86%) the similarity of the Sea of Marmara to these two seas is 77%. The similarity of the Black Sea to the others is only 51%.

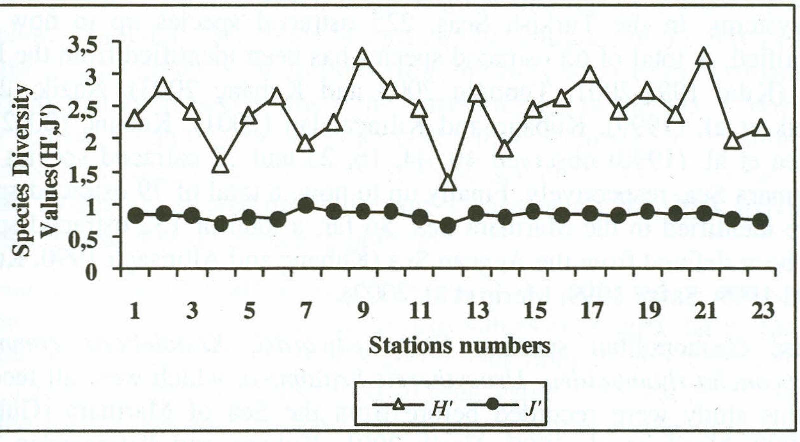
**Figure 3.** Dendrogram constructed from Sorensen similarity matrix between the seas according to the species involved.




During the course of this study, values of temperature, salinity and dissolved oxygen were 12-18 °C, 19.7-23.3 ‰ and 5.9-11.2 $mgl^{-1}$, respectively. (Table 1) The values of temperatures recorded in the studied area are consistent with the seasonal changes (Balkıs 2003). The lowest salinity value was recorded for station 12 (19.7 ‰) and all other stations were recorded around 22‰ because of being affected by the Black Sea current.

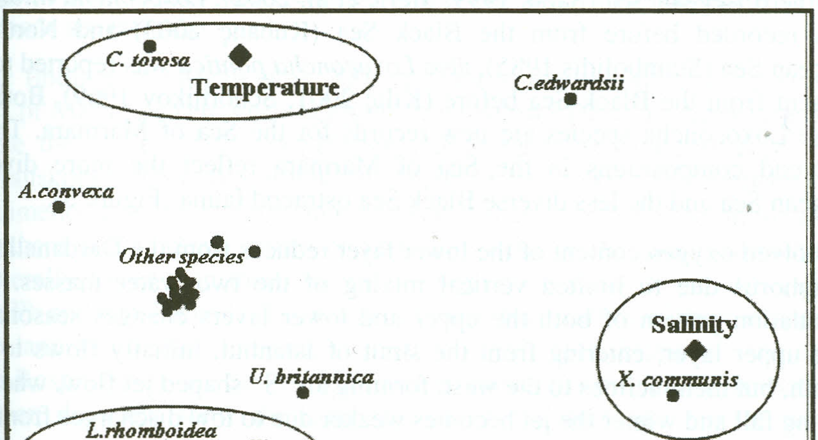
The result of the diversity index of Shannon-Weaver showed that the highest diversity index (*H'*) was obtained at station 9 (*H'*=3.28) and 21 (*H'*=3.29), and the lowest at station 12 (*H'*=1.35). The result of Evenness Index showed that the highest Evenness Index (*J'*) was obtained at station 7 (*J'*= 0.97), and the lowest at station 12 (*J'*= 0.67) (Figure 4).

**Figure 4.**Annual variations of the Shannon-Weaver Index (*H'*) and Evenness Index (*J'*) according to stations.




The Spermann analysis was performed in order to determine the relationship between the species of Ostracoda species and the primary hydrographical variables, however no significant relationship was observed. MDS analysis revealed that, *Cyprideis torosa* was affected by temperature, *Xesteloberis communis* by salinity, *Loxoconcha rhomboidea* and *Paracytheridea parallia* by dissolved oxygen when compared to other species (Figure 5).

**Figure 5.**Multi-Dimensional Scaling (MDS) plot in two dimensions for the ostracod community in the Northern Coasts of Marmara Sea with relation to temperature, salinity and oxygen.



## Discussion

Ostracods are of great importance in benthic populations of Turkish marine ecosystems. In the Turkish Seas, 225 ostracod species up to now were identified. A total of 65 ostracod species has been identified from the Black Sea (Kılıç 1992-2001, Tunoğlu 2002 and Kubanç 2003). Nazik (2001), Nazik et al. (1999), Kubanç and Kılınçarslan (2001), Kubanç (2002) and Gülen et al. (1990) observed 46, 44, 16, 25 and 22 ostracod species from Marmara Sea, respectively. Finally up to now, a total of 79 ostracod species were identified in the Marmara Sea. So far, a total of 132 ostracod species has been defined from the Aegean Sea (Kubanç and Altınsaçlı 1990, Kubanç 1995-1999, Şafak 1999, Meriç et al. 2002).

These cosmopolitan species, *Costa edwardsi, Xestoleberis communis, Loxoconcha rhomboidea, Urocythereis britannica,* which were all recorded in this study were recorded before from the Sea of Marmara (Gülen et al.1990; Nazik et al. 1999, Nazik 2001, Kubanç and Kılınçarslan 2001, Kubanç 2002), the Aegean Sea (Kubanç 1995, Şafak 1999, Kubanç 1999, Meriç et al. 2002), and the Black Sea (Kılıç 1992, 2001, Tunoğlu 2002 and Kubanç 2003). It is possible that these species are euryhaline species as they were recorded from different areas with wide ranges of salinity. Also one of the generalist species in this study, *Callistocythere diffusa* was recorded before from the Black Sea (Kılıç 2001) and Northern Aegean Sea (Stambolidis 1985) and this species was recorded for the first time with this study from the Sea of Marmara. Most rarely observed species, *Xestoleberis aurantia* and *Xestoleberis cornelli* were recorded before from the Black Sea (Kılıç 2001), the Sea of Marmara (Nazik et al. 1999, Nazik 2001) and Northern Aegean Sea (Şafak 1999, Meriç et al. 2002). *Loxoconcha littoralis* was recorded before from the Black Sea (Kubanç 2003) and Northern Aegean Sea (Stambolidis 1985), also *Loxoconcha pontica* was reported to be present from the Black Sea before (Kılıç 2001, Schornikov 1969). Both of these Loxoconcha species are new records for the Sea of Marmara. These ostracod compositions in the Sea of Marmara reflect the more diverse Aegean Sea and the less diverse Black Sea ostracod fauna (Figure 3).

Dissolved oxygen content of the lower layer reduces from the Dardanelles to Bosphorus due to limited vertical mixing of the two water masses. The circulation pattern of both the upper and lower layers changes seasonally. The upper layer, entering from the strait of Istanbul, initially flows to the South, but then inclines to the west, forming an "S" shaped jet flow, whereas during fall and winter the jet becomes weaker due to low discharges from the Black Sea, and has a tendency flow over the northern shelf from the exit of the Istanbul Strait (Beşiktepe et al. 1994) Cluster analysis (Figure 2) made to combine the stations according to the species they involve, showed two distinct groups. The first group is the stations starting from the exit of the Bosphorus including the Prince Islands and the entrance of the Bay of Izmit and the second group is the stations from the Bosphorus to the Dardanelles. We think that the reason of this is the current regime of the Sea of Marmara. Only stations 12 and 19 are not congruent with this clustering. We think that the reason of this is the locations of these stations which are near ports, station 19 directly located inside the port. Consequently the ships arriving to docks are creating a difference in pollution.

The surface water of Northern Sea of Marmara, is in affected by atmospheric conditions, consequently dissolved oxygen values are higher during the cold seasons than warm seasons (Balkıs 2003). Our findings are congruent with this. The lowest recorded dissolved oxygen value is in station 11 as it is located on the entrance of the Golden Horn, which is the most densely polluted region. An extensive study about the Golden Horn reveals that, this region is heavily polluted especially by domestic waste (Yüce 1972).

The Diversity index of Shannon-Weaver value is the highest for the stations 9 and 21, which have the highest number of species. The lowest number of species is observed for station 12 with the lowest value of Shannon-Weaver Diversity index. Also the lowest Evenness value is observed in station 12. However the highest Evenness value is for station 7 the reason for this probably is evenly distributed individual number of species that are not as low as general individual numbers. This situation is probably showing the signs of ecological degeneration. One can assume that the origin of this degeneration is from different sources as the species compositions of these stations are different.

The findings of (Algan et al. 2004) related to the pollution of the Northern Sea of Marmara were given with the table below (Table 3). According to the table the values of Cr and Pb are higher than the Shale average values (Krauskopf 1979). According to Algan et al. (2004) the northern shelf sediments contain slightly lower metal values compared to those of the southern shelf. Mean values of metals in both of the shelf sediments are generally lower than those for the average crust (Krauskopf 1979), except for Pb and Cr (Table 3). The reason of these high values of these elements is the land based anthropogenic (industrial) discharges. Especially the exit of the Bosphorus to the Sea of Marmara is under this influence. However the region does not show the same degree of pollution like similar regions, because of the strong currents specific for the region. Also when compared to the sediments from adjacent seas of the Sea of Marmara, the ranges of Mn, Co, Fe, Cu and Zn in the northern shelf are comparable to the sediments from the southern shelf of the Black Sea (Algan et al. 2004). Besides, the impact of Istanbul's urban and industrial effluent is also apparent in the total organic carbon according to Albayrak et al. (2006) Total organic carbon content of sediments varied from 2.1 mg/g to 22 mg/g in the four area (Büyükçekmece, Silivri, Tekirdağ and Hoşköy) of the Northern Sea of Marmara. Highest average total organic carbon content value was detected at Büyükçekmece transect (near Istanbul). Average values of total organic carbon were decreased as the distance from Istanbul increased. It was 11.7mg/g at Silivri transect, 8mg/g at Tekirdağ transect and 5.3 mg/g at Hoşköy transect (Albayrak et al. 2006). While all of these results are not measured in our study they are able to show the general pollution level of the Sea of Marmara. The high values of Pb and Cr measured in the study of Algan et al. (2004) from the vicinity of the Bosphorus exit to the Sea of Marmara corresponds to the station 11 in our study. However these values are probably not very effective on the number of species due to the currents in this region. Also the high values of organic Carbon measured in the study of Albayrak et al. (2006) corresponds to station 12 in this study. As it is stated before station 12 has the lowest number of species and the lowest value oh H'. Although not certainly the reason of this might be the pollution. Also the vicinity of Silivri in the study of Albayrak et al. (2006) corresponds to our station 22 with a low value of *H'* (*H'*=1.99). Although this station yielded only 6 species the individual number of *Xestoleberis communis* is higher than other species.

**Table 3.** Heavy metal values between the years 1996-2000 for the Northern Sea of Marmara.

| Heavy Metals | Mean | Range | Shale Average |
|---|---|---|---|
| **Al** (%) | 5.7 | 2.4-8.8 | 9.2 |
| **Fe** (%) | 2.9 | 0.6-5.2 | 4.7 |
| **Mn** (ppm) | 300 | 100-616 | 850 |
| **Cr** (ppm) | 130 | 31-654 | 100 |
| **Ni** (ppm) | 56 | 11-116 | 80 |
| **Co** (ppm) | 11 | 3-21 | 20 |
| **Cu** (ppm) | 28 | 7-80 | 50 |
| **Pb** (ppm) | 29 | 11-68 | 20 |
| **Zn** (ppm) | 84 | 38-162 | 90 |
| **$Hg^+$** (ppm) | 0.2 | 0.04-0.7 | 0.3 |

According to Algan et al. (2004)

This study has shown that the ostracod species present in the region and their distribution in the Northern Sea of Marmara. In this distribution it has been determined that some ostracod species are affected more by temperature, salinity and dissolved oxygen than other species. According to the cluster analysis, studied stations were separated in two main groups: stations between 1-10 and stations between 11-23 (excluding 19 and 23). The most important difference between stations 11 and 23 and the others is apparent when the distributions of Xestoleberis and Loxoconcha taken in account (Table 2). The species of both genera are starting to occur (excluding *X. communis* and *L. rhomboidea*) in these stations where the pollution levels are higher than normal. The studies about the heavy metal and Carbon levels in this region (Algan et al. 2004), (Albayrak et al. 2006) and another study about the positive relation with the populations of the species of Loxoconcha with the increase in pollution levels (Alvarez Zarikian et al. 2000) are supporting this situation. Excluding the cosmopolitan species of *L. rhomboidea* and *X. communis* in our study the distribution of all other species of Loxoconcha and Xestoleberis between the stations 11 and 23 makes us think that this region is more polluted than the region corresponding to the area between the stations 1 and 10. If these findings could be supported with future studies that include analysis about pollution detection the detailed determination of indicator ostracoda species for pollution may be possible.

**Özet**

Çalışma materyali 1999 sonbaharı ile 2000 yazı arasında Marmara Denizi'nin kuzey kıyılarında bulunan 23 istasyondan sağlanmıştır. Temel hidrografik veriler her örnekleme bölgesinden ayrı ayrı alınmıştır. Çalışmanın sonucunda Marmara Denizi'nin kuzey kıyılarında üçü Türkiye için yeni kayıt 33 tür tayin edilmiştir. Ayrıca, bu ostrakot türlerinin geniş bir tuzluluk aralığında bulunduğu görülmüştür.

Hidrografik değişkenlerin bu bölgedeki ostrakot türleri üzerine herhangi önemli bir etkisi olmadığı görülse de, özellikle *Cyprideis torosa* sıcaklıktan, *Xesteloberis communis* tuzluluktan ve Loxoconcha *rhomboidea* ve *Paracytheridea parallia* türleride ise çözünmüş oksijenden diğer türlere göre daha çok etkilenmişlerdir. Bu çalışmanın sonucunda söylenebilirki Loxoconcha, Paracytheridea, Xestoleberis genusları diğer genuslara göre daha iyi bir kirlilik indikatörüdürler.

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