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Diversity and Comparison of Ostracoda of South Marmara Sea

Güney Marmara denizi Ostrakodlarının Dağılımı ve Karşılaştırılması

S. Nerdin Kubanç

Istanbul University, Faculty of Science, Department of Biology, 34459, Vezneciler-Istanbul, Turkey

Abstract

The aim of this study was to determine the ostracoda fauna of the South of Marmara Sea. The results were compared with the similar species from the surrounding seas. The Materials were obtained from 27 areas between 11 March-26 July 2000. 35 species were determined of which 12 were dominant. The findings showed that South of Marmara Sea generally contained cosmopolitan species, that were tolerant to salinity. Also total individual number of species in the South of Marmara Sea appeared to be positively correlated to dissolved oxygen (r_s=0,409, p<0,05) rather than other ecological variables and temperature negatively correlated to dissolved oxygen (r_s=-0,771, p<0,05).

Keyword: Ostracoda, South Marmara Sea, Comparison, Diversity

Introduction

The Marmara is located between two seas with different salinity values there is a characteristic stratification of water layers separated with an intermediate salinity layer (halocline). Because of this exchange of water it has a two-layered current regime and an appropriate ecosystem. First 15-20 m from the surface carries the Black Sea water with lower salinity. Mediterranean water with higher salinity flows underneath entering from the Dardanelles. It takes 6 to 7 years for the renewal of the Mediterranean water under the Marmara Sea whereas Black Sea water on the surface renews twice a year. Besides this natural flow of water a high amount of chemical waste is known to be entering the ecosystem as a result of the last 30 years of industrial and residential development in the region. Marmara Sea has been polluted by both regional waste and waste coming from the catchments area of Black Sea (Beşiktepe *et al.*, 2000).

Ostracoda fauna of the Marmara Sea seems to be under pressure by species from Mediterranean and Aegean Seas (Gülen *et al.*, 1995); (Nazik, 1998-2001); (Tunoğlu, 1999); (Kubanç, 2002).

The aim of this study was to determinate the ostracoda fauna of the South of Marmara Sea which was geographically exceptional and under a serious threat of pollution. Also results of data were compared to the similar species from surrounding seas affecting the Marmara Sea.

Material and Methods

South of Marmara Sea was sampled from 27 stations between 11 March-26 July 2000 (Figure 1). Samples were taken with a hand net made of Muller fabric from the mediolittoral zone sweeping the bottom twice in an area of 3 m^2 approximately.

Materials were fixed in 4% formaldehyde and then washed under pressurised water. After the material was dried 10 g of material per station was observed for individuals of ostracoda under a stereomicroscope. Generic and specific features of carapace and soft parts were examined in order to identify different species. Classification of Hartmann and Puri (1974) was followed for the study. Salinity, Dissolved oxygen and temperature were measured in the field using a WTW Multilane P4 measurement apparatus. Results gained from Spearman correlation were used to explain relationships between number of individuals per station and hydrographical parameters. Salinity, temperature and dissolved oxygen intervals of dominant species were evaluated according to ANOVA analysis. This study was supported by Istanbul University Research Fund with project number 1305/050599.

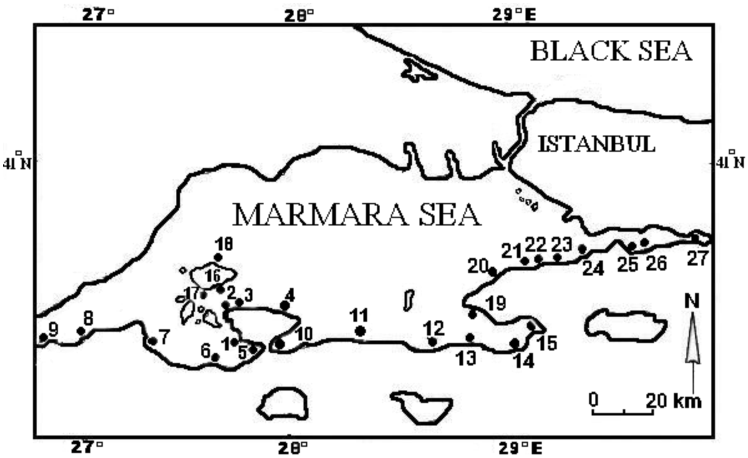


Figure 1. The sampling stations in the Sea of South Marmara

Results and Discussion

35 species belonging to 19 genera were described from the South of Marmara Sea. From 35 species, *Bairdia longevaginata* Muller, *Calistocythere diffusa* Muller, *Callistocythere lobiancoi* (Muller), *Cyprideis torosa* (Jones), *Acanthocythereis hystrix* (Reuss), *Cythereis dunelmensis* (Norman), *Carinocythereis aff. antiquata* Muller, *Carinocythereis antiquata* (Baird), *Carinocythereis quadridentata* (Baird), *Costa edwardsii* (Roemer), *Costa batei* (Brady), *Hiltermannicythere turbida* (Muller), *Echinocythereis laticarina* (Brady) *Aurila speyeri* (Brady), *Aurila convexa* (Baird), *Aurila woodwardi* (Brady), *Aurila prasina* Barbeito-Gonzales, *Quadrocythere prava* (Baird), *Urocythereis britannica* Athersuch, *Loxoconcha minima* Muller, *Loxoconcha rhomboidea* (Fischer), *Loxoconcha stellifera* Muller, *Loxoconcha littoralis* Muller, *Loxoconcha tumida* Chapman, *Paracytheridea parallia* Barbeito-Gonzales, *Pseudocytherura calcarata* (Seguenza), *Semicytherura incongruens* (Muller), *Semicytherura inversa* (Seguenza), *Semicytherura sulcata* Muller, *Cytherepteron punctatum* Hanai, *Cytheropteron alatum* Sars, *Xestoleberis communis* Muller, *Xestoleberis cornelli* Caraion, *Xestoleberis decipiens* Muller, *Paradoxostoma ensiforme* (Brady) encountered from the Northern shelf of Marmara Sea 12 species *Callistocythere lobiancoi* (Muller), *Cyprideis torosa* (Jones),

Acanthocythereis hystrix (Reuss), *Costa edwardsii* (Roemer), *Costa batei* (Brady), *Aurila speyeri* (Brady), *Aurila convexa* (Baird), *Urocythereis britannica* Athersuch, *Loxoconcha rhomboidea* (Fischer), *Loxoconcha stellifera* Muller, *Paracytheridea parallia* Barbeito-Gonzales, *Xestoleberis communis* Muller were dominant (Table 1). Dispersion of the species to different localities was shown in Table 2.

Callistocythere lobiancoi (Muller) was collected from 14 stations and its dominant in 3 stations (8., 17. and 20.) In three of these stations except st. 17 the sediment type is sand, gravel and moss, st. 17 was sampled from gravel and sand. This species generally is found sand type sediments and at depths above 46 m. (Breman, 1975); (Bonaduce *et al.,* 1975). It has been reported before from the South Aegean Sea (Barbeito and Gonzales, 1971); (Stambolidis, 1985). We think that this species could be carried from Aegean Sea with under the sea current.

Table 1. The coordinates, sediment types, major parameters and dominant species of sampling station

Stations	**Date**	**Coordinates**	**Sediment type**	**Dissolved oxygen (mg/l)**	**Temperature (°C)**	**Salinity (‰)**	**Total no. Genera**	**Total no. Species**	**Dominant species**
1	11.3.2000	40° 24’ 30” N 27° 46’ 50” E	Sand, moss	10,8 mg/l	9°C	20,5	11	15	*Xestoleberis communis*
2	11.3.2000	40° 30’ 55” N 27° 41’ 50” E	Gravel, sand, moss	11,6 mg/l	9°C	20,3	5	6	*Acanthocythereis hystrix*
3	11.3.2000	40° 30’ 30” N 27° 47’ 00” E	Gravel, sand, moss	11,6 mg/l	8°C	21,5	6	7	*Urocythereis britannica*
4	11.3.2000	40° 29’ 30” N 27° 58’ 45” E	Gravel, sand, moss	11,2 mg/l	9°C	20,6	4	5	*Costa batei*
5	12.3.2000	40° 22’ 20” N 27° 52’ 50” E	Gravel, sand, moss	10,9 mg/l	8°C	20,2	3	3	*Paracytheridea parallia*
6	12.3.2000	40° 18’ 25” N 27° 40’ 30” E	Gravel, sand, moss	10,8 mg/l	9°C	20,5	4	5	*Xestoleberis communis*
7	12.3.2000	40° 25’ 15” N 27° 19’ 15” E	Gravel, sand, moss	11,9 mg/l	8°C	19,6	8	12	*Urocythereis britannica*
8	12.3.2000	40° 25’ 05” N 27° 03’ 45” E	Gravel, sand, moss	10,7mg/l	8°C	19,7	3	3	*Callistocythere lobiancoi*

9	12.3.2000	40° 24’ 00” N 26° 52’ 00” E	Gravel, sand,	10,9 mg/l	9°C	20,4	3	3	*Aurila convexa*
10	13.3.2000	40° 22’ 30” N 27° 55’ 15” E	Small gravel, sand	10,8 mg/l	8°C	21,4	3	4	*Aurilia prasina*
11	14.3.2000	40° 24’ 05” N 28° 16’ 35” E	Gravel, sand,	11,2 mg/l	8°C	18,3	2	3	*Loxoconcha rhomboidea*
12	14.3.2000	40° 22’ 00” N 28° 38’ 05” E	Gravel, sand, moss	11,4 mg/l	8°C	20,3	6	8	*Costa edwardsii*
13	14.3.2000	40° 23’ 05” N 28° 45’ 30” E	Gravel, sand, moss	11,6 mg/l	8°C	19,9	8	9	*Cyprideis torosa*
14	14.3.2000	40° 21’ 35” N 29° 01’ 30” E	Gravel, sand, moss	11,5 mg/l	7°C	18,8	3	6	*Cyprideis torosa*
15	14.3.2000	40° 26’ 20” N 29° 08’ 30” E	Gravel, sand, moss	9,9 mg/l	7°C	19,5	5	8	*Cyprideis torosa*
16	23.7.2000	40° 35’ 45” N 27° 39’ 50” E	Gravel, sand,	10,1 mg/l	21°C	19,6	4	7	*Costa batei*
17	23.7.2000	40° 34’ 45” N 27° 35’ 10” E	Gravel, sand,	9,8 mg/l	21°C	19,9	6	7	*Callistocythere lobiancoi*
18	23.7.2000	40° 39’ 30” N 27° 39’ 50” E	Gravel, sand, moss	9,5 mg/l	21°C	19,8	4	6	*Loxoconcha rhomboidea*
19	25.7.2000	40° 30’ 30” N 28° 49’ 00” E	Gravel, sand, moss	10,5 mg/l	23°C	19,2	6	8	*Loxoconcha stellifera*
20	25.7.2000	40° 37’ 20” N 28° 57’ 30” E	Gravel, sand, moss	9,2 mg/l	23°C	19,8	3	3	*Callistocythere lobiancoi*
21	25.7.2000	40° 39’ 00” N 29° 07’ 00” E	Gravel, sand, moss	9,6 mg/l	23°C	19,5	3	4	*Loxoconcha stellifera*

22	25.7.2000	40° 39’ 00” N 29° 08’ 00” E	Gravel, sand, moss	9,3 mg/l	23°C	19,8	7	7	*Loxoconcha rhomboidea*
23	26.7.2000	40° 39’ 20” N 29° 10’ 00” E	Gravel, sand,	10,5 mg/l	22°C	19,5	3	3	*Cyprideis torosa*
24	26.7.2000	40° 40’ 15” N 29° 19’ 00” E	Sand, moss	9,7 mg/l	24°C	19,9	2	2	*Aurila convexa*
25	26.7.2000	40° 41’ 45” N 29° 37’ 30” E	Gravel, sand, moss	8,9 mg/l	24°C	20,1	8	11	*Costa edwardsii*
26	26.7.2000	40° 42’ 40” N 29° 41’ 05” E	Gravel, sand, moss	8,9 mg/l	24°C	20,1	7	11	*Urocythereis britannica*
27	26.7.2000	40° 43’ 30” N 29° 50’ 10” E	Gravel, sand, moss	8,2 mg/l	23°C	20,4	5	5	*Loxoconcha rhomboidea*

Table 2. Correlation of ostracoda species from this study with those of other regions

Species	Black Sea	Bosphorus	Marmara Sea	Dardanelles	North Aegean Sea	South Aegean Sea	Adriatic Sea	İskenderun Bay	Italy Sea	Mediterranean Sea
B. longevaginata						3	7			
C. diffusa	1,2,24				10	3	7			
C. lobiancoi			28		10	3	6,7			
C. torosa	2,14, 24	12, 19	17,22, 25,28		10,13,21,29	3,4,16	6	31	18	11
A. hystrix		19	,28,22		10,16,21,23	3	6,7	15	20	
C. dunelmensis			28							
C aff. *antiquata*			28			3				
C. antiquata	27	12,19	17,22,25,28	26	16,21,23	3,4,16	5,6,7	15	20	9
C. quadridentata		19	25,28	26	23	3,4		15,31		
C. edwardsii	2,24,27	12,19	17,22,25,28		10,16,21, 23	3,4,16	5,6,7	15,31	20	9
C. batei			17,25,28		23,29	3,4		15	20	
H. turbida					10,16,21	16	6			
E. laticarina					21		7			11
A. speyeri	14				10,13,16, 23	3,4,16	5,6,7			9
A. convexa	2,14,24,27	19	22,25,28	26	10,13,21, 23, 29	3,4	6,7	15,31	20	9,11
A. woodwardi	24				10	3	7			
A. prasina	14,30				13,21	3	7			
Q. prava					10,16,23	3	7			
U. britannica	14,30	12	17,28	26	13,16	4,8				8

L. minima	30						7	31		
L. rhomboidea	2,24,30	19	22,25,28,17	26	10,16,21,29	3,4,16	5,7	15,31	20	9,11
L. stellifera	30				10,13,21	3	6,7	31	18	9
L. littoralis	30					3	7			
L. tumida	27	19			16,21	16	6,7	31		9
P. parallia	30	19	17,25,28	26	10,16,21	3,16	5	31		
P. calcarata	27,30		17,2528		16	3,4	6		20	9
S. incongruens			17,28	26		3	6			9
S. inversa			22		10,16,21	3,4,16	6,7			9
S. sulcata					23		7			
C. punctatum			28		21		6			11
C. alatum			28		10,16,21		6			9,11
X. communis	30	19	22,25		10,16,21,29	3,16	6,7	15,31	1820	9
X. cornelli	1,2,24									
X. decipiens	1,2, 14,30				10,16	3,16		31		9
P. ensiforme			17,28							

[1]Caraion (1967); [2]Schornikov (1969); [3]Barbeito-Gonzales (1971); [4]Sissingh (1972); [5]Uffenode (1972); [6]Breman (1975); [7]Bonaduce et al. (1975); [8]Athersuch (1977); [9]Bonaduce et al (1983); [10]Stambolidis (1985); [11]Oertli (1985); [12]Gülen et al (1990); [13]Kubanç C., Altınsaçlı (1990); [14]Kılıç (1992); [15]Nazik (1994); [16]Kubanç C. (1995); [17]Gülen et al (1995); [18]Montenegro (1995); [19]Nazik (1998); [20]Montenegro et al., (1998); [21]Kubanç N. (1999); [22]Tunoğlu (1999); [23]Şafak (1999); [24]Kılıç (2001); [25]Nazik (2001); [26]Kubanç N., Kılınçarslan (2001); [27]Tunoğlu (2002); [28]Kubanç C. (2002); [29] Meriç at. al (2002); [30]Kubanç C. (2003); [31]Perçin (2004).

Cyprideis torosa (Jones) was encountered in 8 stations and is dominant in 4 (stations 13, 14, 15 and 23). In four of these stations except st. 23 the sediment type is gravel, sand, moss, st. 23 was sampled from gravel, sand. This species was encountered between dissolved oxygen values of 8,2-11,6 mg/l, between 7-24ºC, salinity interval of 19,5-20,4‰ (Figure 2a, 2b, 2c). This species has an affinity for brackish water, sand and infralittoral zone (Keyser, 1976); (Breman, 1975) and showing congruity with our observations. Surface currents in Northern Marmara and the Bosphorus entrance usually affect its distribution (Beşiktepe *et al.,* 2000). As a cosmopolitan species it was recorded before from the Marmara Sea and surrounding seas, which were compared in this study, except from Dardanelles. It is found within its general distribution area.

Acanthocythereis hystrix (Reuss) was collected from 5 stations and its dominant in st.2. Sediment type for this station is gravel, sand and moss. A preference for sandy type of sediment is observed for these species, likewise the observation made by in Adriatic by Bonaduce *et al.* (1975). Being one of the Pleistocene ostracoda it is encountered from Mediterranean and Adriatic Seas. It is also encountered in central Europe and Mediterranean in Miocene and Pliocene (Breman, 1975). Known as a euhaline species *Acanthocythereis hystrix* is encountered in littoral regions (Stambolidis, 1985). It is likely that this species penetrated through Marmara using the high salinity bottom currents from the Aegean Sea later adapting to less saline surface water and reproducing here. As this species has been recorded from Marmara, it is proven that this species is probably becoming polyhaline (Nazik, 1998); (Tunoğlu, 1999); (Kubanç, 2002).

Costa edwardsii (Roemer) was recorded in 10 stations and dominant in st.12 and st.25. This species is associated with a mud or mixed sand-mud substrate (Breman, 1975). But in this study, these 10 stations' sediment type was gravel, sand and moss. Although a typical marine species from North Aegean sea it is considered to be a polyhaline species as it is reported from Black Sea and the most general species both in this study and the other studies from surrounding seas (Stambolidis, 1985); (Schornikov, 1969); (Kılıç, 2001).

Costa batei (Brady) was encountered in 10 stations and is dominant in 2 (stations 4, 16). st. 4 the sediment type is gravel, sand, moss, st. 16 was sampled from gravel, sand. This species is very common in the Adriatic Sea (Bonaduce *et al.,* 1975). It was recorded before from Marmara sea (Gülen *et al.,* 1995); (Nazik, 2001); (Kubanç, 2002) and Aegean sea (Sissingh, 1972); (Şafak, 1999); (Meriç *at. al.,* 2002). But we think that it wasn't shown in Bosphorus and Black sea. Because of this it could be possible to come from Aegean Sea.

Aurila convexa (Baird) was seen to be present in 13 stations and its dominant in 2 (9, 24). This species shows a tendency towards sandy and phytal sediment type (Breman, 1975). In this study, st. 9 the sediment type is gravel, sand and st. 24 is sand, moss. This species known as a cosmopolitan Mediterranean species (Bonaduce *et al.,* 1975) also recorded from the North Aegean Sea (Stambolidis, 1985). It has been encountered in brackish water systems as a polyhaline species, which has been proven by reports from Black Sea in a number of studies. (Schornikov, 1969); (Kılıç, 1992-2001); (Tunoğlu, 2002).

Aurila prasina Barbeito-Gonzales was collected from 5 stations and its dominant in st. 10 This species is typical near-shore form (Bonaduce *et al.,* 1975). Aurila species are associated with sand and possibly with vegetation (Breman, 1975). In this station the sediment type is small gravel and sand. It has been reported from the Black Sea (Kılıç, 1992); Aegean Sea (Barbeito and Gonzales, 1971); (Kubanç and Altınsaçlı, 1990); (Kubanç, 1999) and Adriatic (Bonaduce *et al.,* 1975). Also it is possible that this species could be found in these regions.

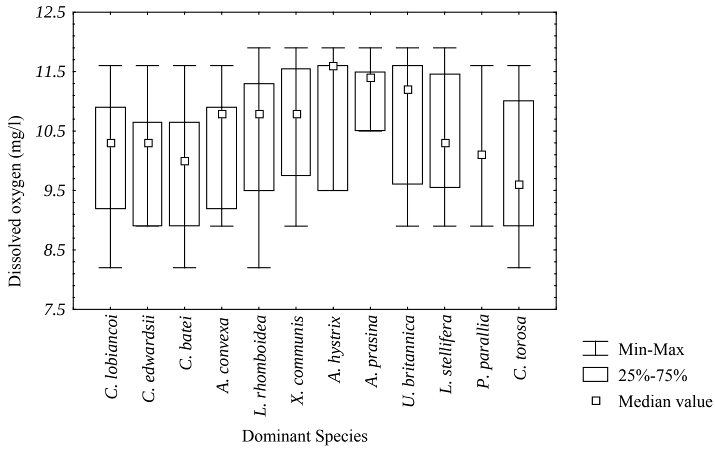
Urocythereis britannica Athersuch was collected from 7 stations and dominant in 3 (stations 3, 7, 26). Sediment types of these stations are gravel, sand and moss. This species reached to Marmara and Bay of İzmit at the end of late Pleistocene (Gülen *et al.,* 1995). It was first reported by Kubanç (2002) from Marmara Sea. Later reports from Black Sea, Dardanelles, Bosphorus, Marmara, North and South Mediterranean were added. This shows us *Urocythereis britannica* spread to Black Sea by the straits as a Tethys relict and is a polyhaline species. In this study the salinity interval of this species is considerably large.

Loxoconcha rhomboidea (Fischer) was collected from 14 (11, 18, 22, 27) stations and dominant in 4 of them. It's dissolved oxygen, salinity and temperature intervals are 8,2-11,9 mg/l, 18,3-21,5‰ and 7-23ºC (Figure 2a, 2b, 2c). Mostly seen on sandy and phytal type of sediment, this species is encountered from a very wide salinity interval (7-36‰) from Eulitoral and Sublitoral zones (Stambolidis, 1985). Sediment type of st. 11 is gravel and sand, other stations are gravel, sand and moss. It has been reported from the Black, Aegean Sea and Adriatic. Also it is normal that this species can be found in these regions. It also spread to Black Sea (Schornikov, 1969); (Kılıç, 2001); (Kubanç, 2003) as it is a polyhaline and cosmopolitan species. Other members of the Loxoconchidae family have been reported from different types of environments (Bonaduce, 1975); (Breman, 1985).

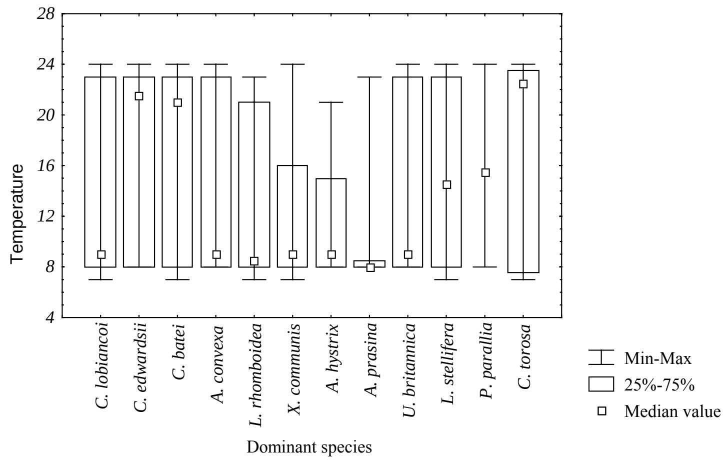
Loxoconcha stellifera Muller was collected from 12 stations and dominant in 2 (19, 21) of them. Species' dissolved oxygen; salinity and temperature ranges are 8,9-11,9 mg/l, 18,3-21,5‰ and 7-24ºC respectively (Figure 2a, 2b, 2c). It can find sand and very sandy sediments (Bonaduce *et al.,* 1975). In this study it was found gravel sand and moss. It has been encountered from the North Aegean Sea between 25-40‰ of salinity (Stambolidis, 1985). In this study it has been reported from the Black (Kubanç, 2003); Aegean (Barbeito and Gonzales, 1971); (Stambolidis, 1985); (Kubanç and Altınsaçlı, 1990); (Kubanç, 1999) and Adriatic Sea (Breman, 1975); (Bonaduce *et al.,* 1975).

Paracytheridea parallia Barbeito-Gonzales is seen to be present in 4 stations being dominant in st. 5. It shows a tendency towards mud and sandy sediment type in North Aegean Sea (Stambolidis, 1985). The sediment type of this station is gravel, sand and moss. Ranges of dissolved oxygen, salinity and temperature are between 8,9-11,6mg/l, 19,8-20,2‰, 8-24ºC (Figure 2a, 2b, 2c). Although this species is euhaline in North Aegean Sea (Stambolidis, 1985) this species seems to be polyhaline as it is found in brackish water environments in Marmara (Gülen *et al.,* 1995); (Nazik, 2001); (Kubanç, 2002) with a high number of individuals also supported by its presence in Black Sea (Kubanç, 2003).

Xestoleberis communis Muller was encountered in 12 stations and dominant in only st. 1 and st. 6. As a species of Mediterranean origin it is usually encountered in sandy type of sediment (Breman, 1975) (Stambolidis, 1985). In this study, the sediment type of stations 1 is sand and moss, stations 6 is gravel, sand and moss. Species' dissolved oxygen, salinity and temperature ranges are 8,9-11,9mg/l, 18,8-21,5‰ and 7-24ºC respectively (Figure 2a, 2b, 2c). It has been encountered from the North Aegean Sea between 25-40‰ of salinity (Stambolidis, 1985). It is a polyhaline species showing a distribution up to Marmara (Tunoğlu, 1999); (Nazik, 2001) and Black Sea (Kubanç, 2003). It is normal that this species has been observed as dominant in the Marmara Sea.



(a)



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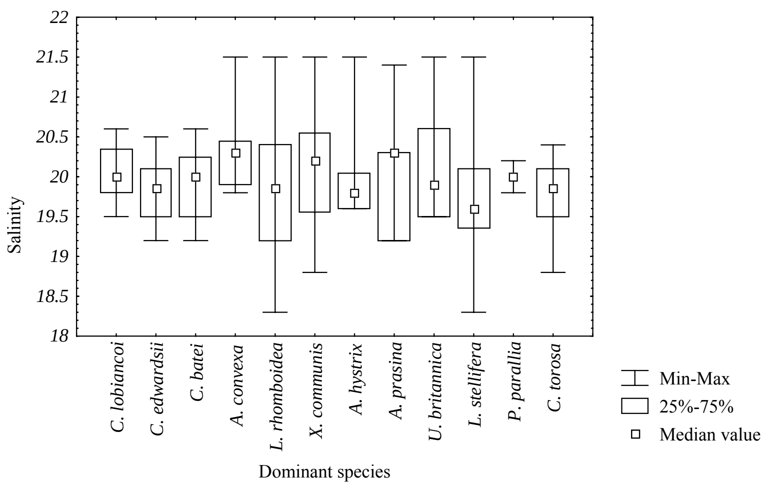

(c)

Figure 2 (a-b-c): Intervals of dissolved oxygen, temperature and salinity of dominant species

The results of Spearman correlation employed to explain the relationships between the species number and total individual number of species and hydrographical parameters and among the hydrographical parameters themselves are given (Table 3). Total individual number of species and dissolved oxygen appear to be positively correlated (r_s=0,409, p<0,05) and temperature and dissolved oxygen appear to be negatively correlated (r_s=-0,771, p<0,05) according to the results of Spearman correlation. Other parameters did not seem to be affecting the distribution of ostracoda for the South of Marmara Sea.

Table 3: The results of statistical analyses between the species number and individual number of dominant species of ostracoda and hydrographical parameters and among the hydrographical parameters themselves.

Axis X	Axis Y	Spearman R	t(N-2)	p-level
Salinity	Species number	0,051	0,259	0,797
Temperature	Species number	-0,035	-0,178	0,859
Dissolved oxygen	Species number	0,072	0,362	0,720
Salinity	Total individual number	-0,240	-1,237	0,227
Temperature	Total individual number	-0,319	-1,688	0,103
Dissolved oxygen	Total individual number	0,409	2,247	0,033
Temperature	Salinity	-0,010	-0,053	0,958
Temperature	Dissolved oxygen	-0,771	-6,068	0,000
Salinity	Dissolved oxygen	0,141	0,713	0,482

Conclusion

This study proceeded in South of Marmara Sea is generally included cosmopolitan species which are tolerant to salinity. The species number is very low whereas individual number is high. Moreover in some stations, some dominant species formed more than 90 % of the total abundancy. Also individual number of the species was affected by dissolved oxygen.

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Özet

Bu çalışmadaki amacımız Güney Marmara Denizi'indeki ostrakod türlerini tayin etmekti. Sonuçlar çevre denizlerdeki benzer türler ile karşılaştırıldı. Material 27 bölgeden 11 Mart-26 Temmuz 2000 tarihleri arasında elde edildi. 12 tanesi baskın olan 35 tür tayin edildi. Bulgular gösterdiki, Güney Marmara Denizi genel olarak cosmopolitan ve tuzluluğa toleranslı türler içermekteydi. Aynı zamanda, Güney Marmara Denizindeki türlerin toplam birey sayısı ile çözünmüş oksijen miktarı arasında diğer ekolojik faklılıklardan ziyade pozitif bir ilişki (r_s=0,409, p<0,05) olduğu ve çözünmüş oksijen ile sıcaklık arasında da negatif bir ilişki (r_s=-0,771, p<0,05) olduğu görüldü.

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