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RESEARCH ARTICLE **ARAŞTIRMA MAKALESİ**

The community structure of Prosobranchia (Mollusca: Gastropoda) on shallow soft bottoms of the Çanakkale Strait

Çanakkale Boğazı kıyısal sularının yumuşak zeminleri'ndeki Prosobranş (Mollusca: Gastropoda) kommunite yapısı

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Abstract: The goal of this study was to determine the community structure belonging to the Prosobranchia (Gastropoda, Mollusca) in soft bottoms of the Çanakkale Strait coastal waters (0-5 m). Benthos samples were collected seasonally using a 30x30 quadrate operated by a SCUBA diver between July 2008 and April 2009. Samplings were carried out at 3 transect depths of 8 different locations of the Çanakkale Strait. A total of 4472 specimens of Prosobranchs were recorded. *Rissoa splendida* Eichwald, 1830 was the numerically dominant species (Di % = 20.57). Kilitbahir location had the highest number of individuals (1069), while the Lapseki location had the lowest number (157). According to Spearman's rank correlation, the highest positive correlation (rs = 0.75) was between salinity and species number. Conversely, the lowest correlation (rs = 0.51) was found between pH and species number. Bray-Curtis similarity index showed that summer and winter periods were very similar (88.65 %). Çanakkale and the Kilya inlet points had the highest similarity (70.87 %).

Keywords: *Prosobranchia (Gastropoda), community structure, soft bottom, Çanakkale Strait, Turkish Strait System*

Öz: Çalışmanın amacı Çanakkale Boğazı kıyısal sularının (0-5 m) yumuşak zeminlerindeki Prosobranş kommunite yapısını belirlemekti. Bentoz örnekleri Temmuz 2008 ve Nisan 2009 tarihleri arasında bir Scuba dalıcı tarafından 30x30 cm'lik kuadrat kullanılarak mevsimsel olarak toplanmıştır. Örneklemeler Çanakkale Boğazı'nın 8 farklı istasyonun 3 transekt derinliğinde yürütülmüştür. Prosobranşlardan toplam 4472 birey kaydedilmiştir. *Rissoa splendida* Eichwald, 1830 sayısal olarak en baskın türdü (Di % = 20.57). Lapseki istasyonu en düşük birey sayısına (157) sahipken, Kilitbahir en yüksek (1069) birey sayısına sahipti. Spearman korelasyonuna göre en yüksek pozitif ilişki (rs = 0.75) tuzluluk ile tür sayısı arasındadır. Aksine en düşük (rs = 0.51) ilişki ise pH ile tür sayısı arasındadır. Bray-Curtis benzerlik analizi yaz ve kış aylarının (88.65%) çok benzer olduğunu göstermektedir. Çanakkale ve Kilya koyu istasyonları yüksek (70.87 %) benzerliğe sahipti.

Anahtar kelimeler: *Prosobranş (Gastropod), kommunite yapısı, yumuşak zemin, Çanakkale Boğazı, Türk Boğazlar Sistemi*

INTRODUCTION

Sedimentary bottoms are the key elements of the marine ecosystem. Soft bottom macrobenthos plays significant roles in the marine ecosystem processes such as metabolism of pollutants, nutrient cycling, distribution and production (Snelgrove, 1998). Marine communities are determined by the intrinsic characteristics of populations (biomass, abundance, diversity), functioning of communities as food web, functional diversity and community macro-ecological characteristics (Dimitriadis and Koutsoubas, 2008). Benthic molluscs are a fundamental component of macrofauna and play a major role in biodiversity and community structure (Zenetos, 1996; Koutsoubas et al., 2000). Marine gastropods show different diet types, including deposit and suspension feeding, grazing, parasitism, and predation thus could be found through several trophic levels in the community (Taylor, 1980). Specification of the spatial distribution in species is essential to understand the structure of communities (Hoey et al., 2004). Among the parameters controlling the coastal soft-bottom benthic communities, sediment characteristics were regarded as paramount (Grillo et al., 1998) besides several physicochemical and biological factors. Because of the complexity of the environment, it is difficult to determine the exact parameter affecting the invertebrates (Feld and Hering, 2007). The structure of benthic marine communities is highly variable both spatially and temporally (Kelaher and Levinton, 2003). Therefore, establishing which factors control the biodiversity in nature has long been an important theme of research in ecology (Huston, 1994). The purpose of the present study was to describe the seasonal variations in diversity and community structure of benthic prosobranch gastropods found in the

Çanakkale Strait with variations in the characteristics of soft-bottom sediment and environmental variables.

MATERIALS AND METHODS

Study area

Eight locations were sampled in the Çanakkale Strait (Fig.1). Geographic coordinates were as fallows: Gelibolu (loc. 1, 40°40´617˝N 26°66´692˝E), Lapseki (loc. 2, 40°34´661˝N 26°67´985˝E), Çanakkale (loc. 3, 40°15´474˝ N 26°40´879˝ E), Kilya Inlet (loc. 4, 40°20´472˝N 26°36´117˝E), Eceabat (loc. 5, 40°18´253˝N 26°36´046˝E), Kilitbahir (loc. 6, 40°15´048˝N 26°37´878˝E), Kepez Harbour (loc. 7, 40°10´360˝N 26°37´339˝E) and Dardanos (loc. 8, 40°07´493˝N 26°35´806˝E). Three transects with three different depths (0.5, 2, and 4 m) were sampled at each location and one quadrat for each depth in July 2008, November 2008, February 2009, and April 2009 by means of a frame quadrat system of 30×30 cm (the area was 0.09 m-2). Sea water temperature, salinity, pH and dissolved oxygen were measured in situ using a portable multiparametric instrument YSI 556 (Yellow Springs Instruments). Benthos samples were sieved through a 0.5 mm mesh size sieve and then the samples were preserved in formaldehyde-seawater solution of 4%.

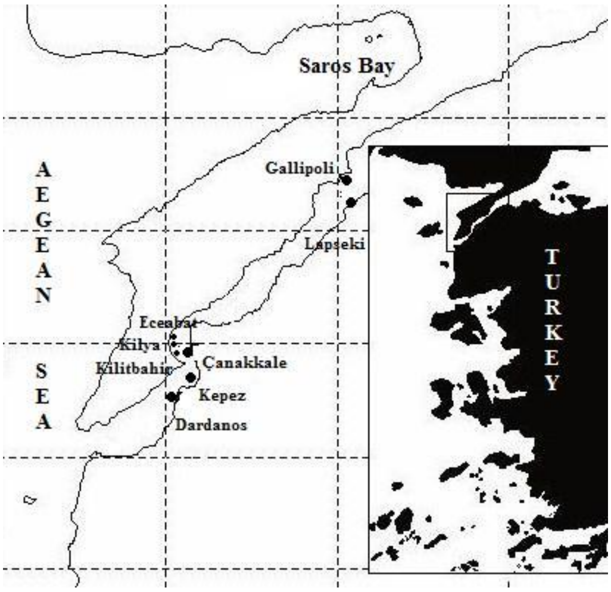

Figure 1. Map showing sampling locations in the Çanakkale Strait

Laboratory analysis

In the laboratory, gastropods were picked under a stereomicroscope and then preserved in 70% ethanol. Determination of specimens was performed using a stereomicroscope and identification followed Graham (1971), Nordsieck (1977), Barash and Danin (1992), Sabelli (1992), Cachia et al. (1996; 2001) and Butakov et al. (1997). The classification of gastropoda to the upper categories was conducted according to Bouchet and Roccroi (2005). Sediment granulometry was made using a series of sieve set ranging from 63 µm to 20 mm and sediment particle size was classified according to Buchanan (1984) (Table 1).

Table 1. Sediment analysis classification

Particle size (mm)	Class of sediment
Q_{50} > 63mm	Boulder
63 > Q_{50} > 4mm	Cobbles
4 > Q_{50} > 2mm	Gravels
2 > Q_{50} > 1mm	Very coarse sand
1 > Q_{50} > 0.5mm	Coarse sand
0,5 > Q_{50} > 0.25mm	Medium sand
0,25 > Q_{50} > 0.125mm	Fine sand
0,125 > Q_{50} > 0.063mm	Very fine sand
Q_{50} < 0.063mm	Silts and clays

Statistical analysis

Number of species (S), total abundance (N), dominance index (Di), frequency index (f), Shannon-Wiener diversity index (H´) (Shannon and Weaver, 1963), and Pielou's evenness index (J´) (Pielou, 1966) were calculated for each sampling point seasonally. Relationships between the abundance and the environmental factors were analysed by non-metric Multi Dimensional Scaling (MDS). Spatial and seasonal biotic similarity was measured according to the Bray-Curtis index values based on the species density. One-way ANOSIM permutation test was used to determine whether there were significant differences between groups of samples or not. SIMPER analysis was used to identify the contribution of each species to the similarity of the groups identified from the cluster analysis. Spearman's correlation coefficient analyses were used to determine relationship between environmental variables and parameters of the gastropod community. Statistical analysis was done by a combination of IBM SPSS Statistic 20, Minitab 16 and PAST Statistical Program.

RESULTS

Abiotic data

Seasonal differences in salinity, temperature and dissolved oxygen were observed during the study. Mean salinity was 25.52 ± 1.30 %o for the whole sampling area. Dardanos had the highest value (28.87 ± 0.95 %o) and the Lapseki had the lowest value (24.55 ± 1.79 %o). Mean temperature value was measured as 16.02 ± 0.28 °C. Kilya Inlet had the highest temperature value (26.77 °C) while the lowest value was at Gelibolu (8.87 °C). The mean value of dissolved oxygen (DO) concentration was 7.13 ± 0.59 mg L-1. Çanakkale site had the highest DO (9.79 mg L-1 in April 2009) while Lapseki was found to have the lowest DO (3.68 mg L-1) in July 2008 (Table 2).

Table 2. Values of the physical and chemical variables measured in each location seasonally

	July 2008				November 2008			Parameters	February 2009				April 2009			
Stations	O_2 mg l^{-1}	T (°C)	S (‰)	pH	O_2 mg l^{-1}	T (°C)	S (‰)	pH	O_2 mg l^{-1}	T (°C)	S (‰)	pH	O_2 mg l^{-1}	T (°C)	S (‰)	pH
Çanakkale	4.19	23.7	23.3	8.21	5	15.25	25.6	8.32	9.63	9.18	27.8	5.3	9.79	14.26	24.4	7.07
Lapseki	3.68	24.57	22.6	8.15	3.34	15.7	24.6	8.25	9.65	9.31	27.4	6.4	8.72	13.68	23.6	6.85
Gelibolu	5.58	25.03	22.8	8.33	5.56	16.17	25.5	8.51	9.61	8.87	27.6	7.48	8.13	13.1	24.3	6.5
Kilya Inlet	8.46	26.77	23.1	8.53	5.9	16.3	25.7	8.55	9.25	9.24	26.5	7.55	7.95	13.5	23.3	6.48
Eceabat	7.4	25.6	22.9	8.39	6.01	16.01	25.5	8.46	9.56	9.24	27.4	8.09	8.9	13.31	24.2	6.52
Kilitbahir	5.16	25.1	23.1	8.31	5.68	16.37	25.6	8.33	9.2	9.12	27.6	8.79	8.9	13.23	24.3	7.05
Kepez Harbour	5.14	24.39	23.5	8.3	5.28	16.22	26.1	8.45	5.68	9.65	28.3	5.44	8.65	14.1	24.8	6.74
Dardanos	6.49	24.36	28.1	8.44	5.83	16.07	30.5	8.7	7.94	9.61	28.3	5.13	8.04	15.75	28.6	6.88

Sediment characteristics

Sediment particle size analysis was carried out for the samples taken from each location. Particle diameter at the Çanakkale Strait, Kepez, Lapseki, Dardanos, Kilitbahir, Eceabat, Kilya Inlet and Gelibolu was 1.027 mm; 1.046 mm; 0.342 mm; 0.235 mm; 0.636 mm; 0.364 mm; 0.465 mm and 0.437 mm, respectively. The Anatolian coast had a mean particle size value of 0.663 mm and the European coast had a mean particle size value of 0.476 mm. Eceabat had the highest value of sand (99.59 %) while the lowest value was recorded at Kepez (73.01 %) (Table 3).

Table 3. Sediment characteristics of the sampling points

Sampling points	Grain size (mm)	Sand content (%)	Mud (silt+clay) content (%)	Gravel (%)
Gelibolu	0.636	93.22	0.44	6.30
Çanakkale	0.364	89.76	0.05	10.19
Eceabat	0.465	99.59	0.26	0.15
Kilya İnlet	0.437	91.64	0.19	8.15
Dardanos	0.342	98.91	0.77	0.32
Lapseki	1.027	97.23	0.09	2.68
Kilitbahir	1.046	83.11	0.13	16.75
Kepez	0.235	73.01	0.04	26.96

Table 4. Total abundance (Σ), dominance (Di%), and frequency of seasonal occurence (f%) of gastropod species in the study area

Species	Abundance (Σ)	%*f*	%Di
Alvania cimex (Linnaeus, 1758)	161	100	3.60
Bela zonata (Locard, 1892)	26	100	0.58
Bela nebula (Montagu, 1803)	19	75	0.42
Bittium latreillii (Payraudeau, 1826)	54	100	1.21
Bittium reticulatum (Da Costa, 1778)	733	100	16.39
Bittium scabrum (Olivi, 1792)	514	100	11.49
Caecum trachea (Montagu, 1803)	16	75	0.36
Cerithium vulgatum Bruguiere, 1792	17	100	0.38
Cerithiopsis minima (Brusina, 1865)	68	100	1.52
Cerithiopsis tubercularis (Montagu, 1803)	1	25	0.02
Calyptera chinensis (Linnaeus, 1758)	3	25	0.07
Conus ventricosus Gmelin, 1791	1	25	0.02
Clanculus cruciatus (Linnaeus, 1758)	13	100	0.29
Cyclope neritea (Linnaeus, 1758)	139	100	3.11
Epitonium clathrus (Linnaeus, 1758)	16	100	0.36
Euspira fusca (Blainville, 1825)	3	50	0.07
Gibbula adansonii adansonii (Payraudeau, 1826)	306	100	6.84

Gibbula albida (Gmelin, 1791)	18	100	0.40
Gibbula divaricata (Linnaeus, 1758)	49	100	1.10
Haminoea hydatis (Linnaeus, 1758)	3	75	0.07
Jujubinus striatus striatus (Linnaeus, 1758)	21	100	0.47
Melarhaphe neritoides (Linnaeus, 1758)	18	100	0.40
Mangelia costata (Donovan, 1804)	4	50	0.09
Mitrella scripta (Linnaeus, 1758)	1	25	0.02
Monophorus perversus (Linnaeus, 1758)	23	100	0.51
Nassarius incrassatus (Stroem, 1768)	9	75	0.20
Nassarius reticulatus (Linnaeus, 1758)	238	100	5.32
Ocenebra erinaceus (Linnaeus, 1758)	75	100	1.68
Rapana venosa (Valenciennes, 1846)	1	25	0.02
Retusa truncatula (Bruguiere, 1792)	18	100	0.40
Rissoa membranacea (J. Adams, 1800)	462	100	10.33
Rissoa splendida Eichwald, 1830	920	100	20.57
Tornus subcarinatus (Montagu, 1803)	84	100	1.88
Tricolia pullus pullus (Linnaeus, 1758)	414	100	9.26
Truncatella subcylindrica (Linnaeus, 1758)	18	100	0.40
Vexillum ebenus (Lamarck, 1811)	6	100	0.13

Faunal Data

A total of 36 species and 4472 prosobranch gastropod specimens were collected on the soft bottoms at the Çanakkale Strait (Table 4). *Rissoa splendida* had the highest dominance value (Di% = 20.57) followed by the cerithiid *Bittium reticulatum* (16.39 %); the lowest dominance value (0.02 %) was shown by *Cerithiopsis tubercularis*, *Conus ventricosus*, *Mitrella scripta* and *Rapana venosa*. The highest number of specimens was found during autumn (n = 1501) and the lowest during spring period (n= 708) (Fig. 2).

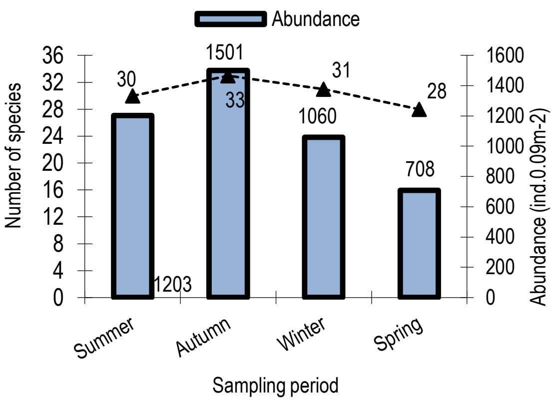

Figure 2. The number of species and individual recorded during the sampling seasons

The highest total number of species and abundance (ind.m-2) was recorded at Kilitbahir site (S = 34; n = 1069 ind.m-2) while Lapseki location had the lowest values (S = 16; n = 157 ind.m-2) (Fig. 3).

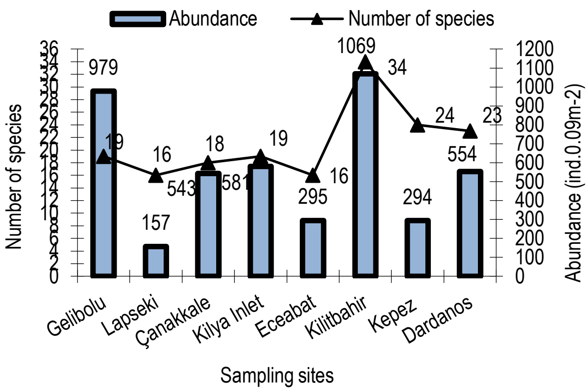

Figure 3. The number of species and specimens found at the sampling points

Shannon-wiener diversity index (H') ranged from 1.16 to 1.48. The highest diversity values were in autumn (H' = 1.46) and the lowest values were calculated in spring (H' = 1.38). Regarding locations, the highest values were observed at Kilitbahir location (H' = 1.48) while the lowest values were calculated at Lapseki and Eceabat locations (H' = 1.16). The evenness index ranged from 0.94 to 0.98. Kepez location had the highest evenness value (J' = 0.97) and the lowest value was at Kilya Inlet (J' = 0.94) (Table 5).

Table 5. Diversity index values for the sampling periods

Sampling periods	H'	J'
Summer	1.436	0.972
Autumn	1.469	0.967
Winter	1.449	0.972
Spring	1.389	0.97

In Bray-Curtis similarity analysis based on the seasons, winter and summer showed the same similarity groups (88.65 %) (Figure 4).

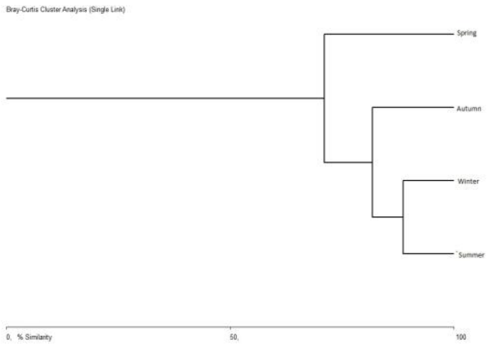

Figure 4. Results of Cluster Analysis based on the Bray-Curtis similarity index for the sampling periods

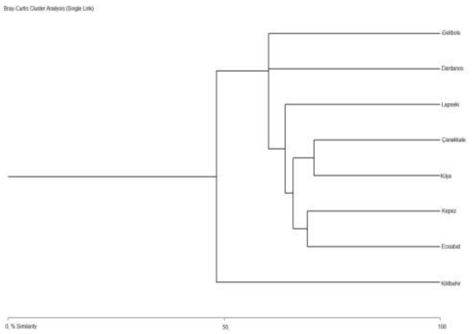

Figure 5. Results of Bray-Curtis Cluster Analysis for the sampling points

Çanakkale and Kilya İnlet sites were the most similar with a similarity value of 70.87 % (Figure 5).

According to the sampling depths (0.5 – 4 m) the highest number of individuals was recorded at 2 m in autumn (Figure 6).

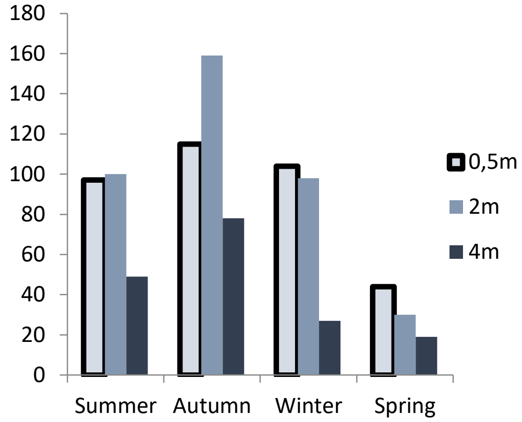

Figure 6. Total abundance at each sampling depth

According to the results of SIMPER Analysis, a total of six species (*Bittium reticulatum*, *Alvania cimex*, *Gibbula* adansonii *adansonii*, *Rissoa membranacea*, *Rissoa splendida*, *Tricolia* pullus *pullus*) had an important degree in terms of the sampling location similarity (Table 6).

Correlation with environmental variables

The relationship between faunal data and environmental variables based on Spearman's rank correlation coefficient was given in Table 7.

Table 6. Results of SIMPER and ANOSIM analysis

Groups	SIMPER			One-Way ANOSIM	
	Average Dissimilarity (%)	Discriminating species	Contribution (%)	R value	P value
Kepez- Gelibolu	67.5	*Rissoa membranacea* *Tricolia pullus pullus*	23.87 14.16	1	0.030
Çanakkale-Lapseki	66.21	*Rissoa splendida* *Gibbula adansonii adansonii*	19.84 13.88	0.427	0.057
Lapseki-Kilitbahir	77.83	*Bittium reticulatum* *Alvania cimex*	12.87 10.25	0.895	0.028
Gelibolu-Lapseki	76.28	*Rissoa membranacea* *Tricolia pullus pullus*	27.02 16.31	0.833	0.029
Kilya-Lapseki	63.85	*Rissoa splendida* *Bittium reticulatum*	24.45 10.98	0.354	0.082
Eceabat-Kilitbahir	68.38	*Bittium reticulatum* *Alvania cimex*	9.76 9.25	0.833	0.024
Dardanos-Lapseki	68.86	*Tricolia pullus pullus* *Rissoa splendida*	20.05 12.44	0.760	0.025

Table 7. The results of Spearman's rank correlation coefficient

	oxygen	abundance	species	pH	particle size	temperature	salinity
oxygen	1	0.524	-0.193	-0.095	.786*	-0.595	-0.548
abundance	0.524	1	0.542	0.095	0.503	-0.214	0.095
species	-0.193	0.542	1	0.41	0	-0.024	.747*
pH	.786*	0.503	0	-0.086	1	-0.589	-0.54
particle size	-0.095	0.095	0.41	1	-0.086	-0.286	0.238
temperature	-0.595	-0.214	-0.024	-0.286	-0.589	1	0.095
salinity	-0.548	0.095	.747*	0.238	-0.54	0.095	1

*. Correlation is significant at the 0.05 level . **. Correlation is significant at the 0.01 level

The correlation between number of species versus salinity was positive and significantly important (r_s = 0.78; P < 0.05). A positive correlation between number of species and pH (r_s = 0.041; P < 0.05) was found. However, the correlation between temperature and number of species was negative (r_s = -0.02; P < 0.05). According to the Spearman's correlation coefficient, the correlation between the particle size (µm) and abundance was positive and relatively high (r_s = 0.52; P < 0.05) (Fig. 7), but the correlation between particle size (µm) and the species number was very low (r_s = 0.09; P < 0.05).

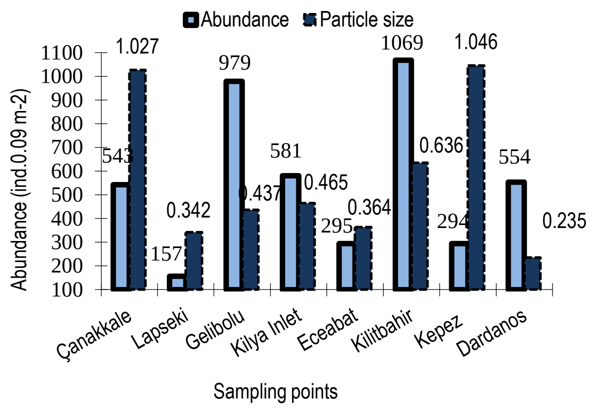

Figure. 7. Particle size and abundance for the sampling points

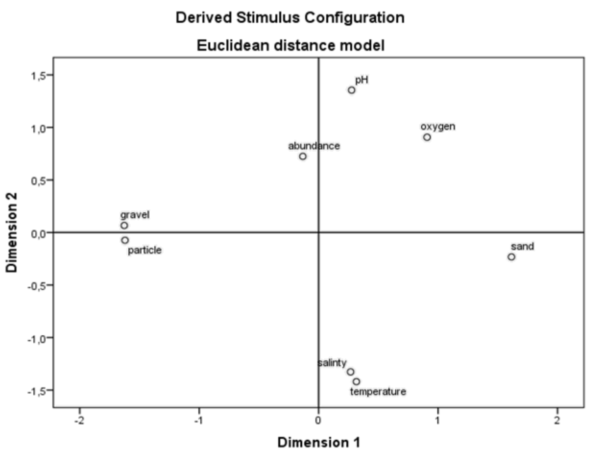

Figure 8. Multidimensional scaling plot showing the similarity among the biological factors

The correlation between the sand content (%) and total abundance was positive (r_s = 0.45; P < 0.05), whereas the gravel content and abundance was negative (r_s = -0.44; P < 0.05). Chi-square test results showed that the depth was important on the abundance of the species occurrence (P = 0.00, P < 0.05). According to the results of the MDS analysis, abundance had a positive correlation with temperature and salinity. DO and pH were related among themselves. Particle size was negatively correlated with abundance (Fig. 8-9).

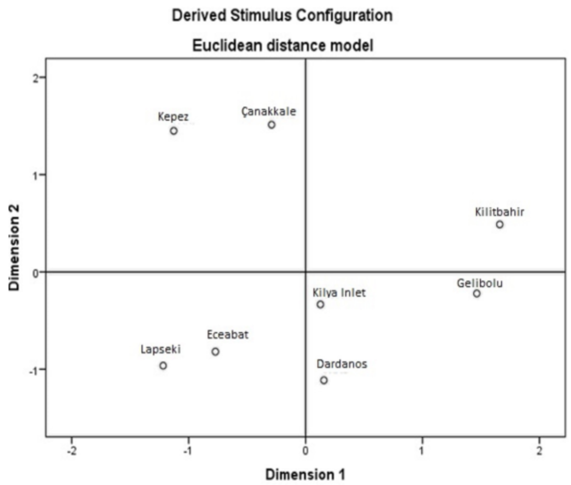

Figure 9. Multidimensional scaling plot showing the similarity among the sampling points

DISCUSSION

Ecological studies are difficult to carry out in marine areas because of the complexity of factors, environmental and anthropogenic, that dominate the ecosystem. These factors cause pressure on benthic communities in severeal functions, for example, some species can be disturbed and cannot develop naturally, impose an opportinistic behavior and become less competitive (Glemarec, 1993). The distribution of populations in marine ecosystems is dependent on the environmental factors such as temperature, salinity, and sediment characteristics (Afli et al., 2008). Molluscs are used as indicators to compare the differences between ecosystems and they play important roles on the benthic biota (Zenetos, 1996). Soft bottom benthic habitats can be classified based on the community diversity index as bad (0 < H' ≤ 1.5), poor (1.5 < H' ≤3), moderate (3< H' ≤4), good (4 < H' ≤5) and high (H' > 5) (Simboura and Zenetos, 2002). In a study, Koutsoubas et al. (2000) found that the diversity index (H') values in Giolova Lagoon (southwestern Greece) changed between 0.75 and 2.35. In their study, they have reported 18 gastropoda species inwhich *Gibbula adansonii*, *Gibbula divaricata*, *Cerithium vulgatum*, *Bittium reticulatum*, *Cyclope neritea* and *Nassarius incrassatus* also showed distribution in our study. Dimitriadis and Koutsoubas (2008) recorded a diversity index (H') of 1.50 in Gera Gulf of Lesvos and they have reported 45 gastropod species. Albayrak et al., (2007) reported H' values as 2.5-5 in Edremit Bay. In the present study, unlike the ones mentioned above the diversity index was low (H' = 1.35 - 1.50). Therefore, according to the above classification our sampling locations can be considered as "poor".

Relationship between the distribution of benthic communities on/in soft bottoms and sediment characteristics has been studied for decades (Lu, 2005). Physical unrest and chemical contamination in sediment may have higher effects on macrobenthic community structure than sediment characteristics at coastal waters (Gray, 1997; Snelgrove et al., 1997). The distribution of macrobenthic communities in marine ecosystems is highly correlated with the type of sediment, which is related to a wider set of environmental conditions (Hoey, 2004). In the present study, particle size distribution of the sediment and the species number showed low correlation (rs= 0.52; P < 0.05). On the contrary, Albayrak et al., (2007) determined a positive correlalation between particle size and number of individuals as well as number of species from Edremit Bay (the northeastern Aegean Sea). This could be attributed to the substrate characteristics and hydrodinamic forces leading to the benthic community structure in the shallow waters of the Aegean Sea (Albayrak et al., 2007).

Rueda et al. (2008) found high number of species of *Jujubinus striatus* (N= 173) at a sampling point with a mud content of 13.4 %. Argyrou et al. (1999) recorded 11 gastropoda species in a 95 % sandy bottom. *Cerithium vulgatum*, *Conus ventricosus* and *Bela nebula* were also found in this study. Lourido et al. (2006) studied the molluscan assemblages of soft bottom in the Ria de Aldan (the northwestern Spain) and recorded the mean sand content as 86.5 % for a depth of 4 m. Moreover, same authors reported the mean species number as 29. Similar to their study, *Caecum trachea, Nassarius reticulatus, Bittium reticulatumalso* showed distribution according to the sediment characteristics in the present study. In a study, Koutsoubas et al. (2000) found a total number of 60 gastropoda species at 40 m depth in the Cretan Sea (the eastern Mediterranean) and they stated that *Bittium reticulatum, Calyptera chinensis, Euspira fusca* and *Retusa truncatula* occurred in dense abundances at 40 m depth. In the present study these species were also recorded from the coastal waters of Çanakkale Strait.

Dimitriadis and Koutsoubas (2008) performed a study on the molluscans of Gera Bay (Lesvos, the northeast Aegean Sea) and recorded a total of 45 gastropod species. Albayrak et al. (2007) reported a total of 13 species of molluscs in Edremit Bay (the norteastern Aegean Sea). Çınar et al. (2008) carried out a study on macrobenthos of Alsancak Harbour, İzmir Bay (the eastern Aegean Sea) and found totally 62 species of molluscs from the area. Recently, Bitlis et al. (2010) reported 62 species belonging to gastropods in the Sea of Marmara coast. *Bittium scabrum* was the dominant species (Di % = 27) in the study (Bitlis et al., 2010). Dogan et al. (2005) found a total of 6 gastropod species on the soft bottoms of İzmir Bay (the eastern Aegean Sea). We found *Calyptera chinensis*, *Monophorus perversus* and *Cyclope neritea* in our study and these species were also reported by Dogan et al., (2005). Çınar et al., (2012) conducted a seasonal study between the depths of 19 m and 67 m in İzmir Bay and they recorded 68 gastropoda species. Palaz and Colakoglu (2009) studied macrozoobenthic diversity in the Çanakkale Strait and reported only *B. reticulatum* and *C. neritea* in their study. Aslan-Cihangir and Ovalis (2013) conducted a study in the Çanakkale Strait between the depths of 10m and 83 m and recorded 191 gastropoda species. Additionally, *Bittium reticulatum* had the highest number of individuals in the same study. During this study, a total of 36 species and 4472 individulas belonging to gastropoda were found from the Çanakkale Strait coastal waters.

The community structure of molluscs can be influenced by biological and physicochemical factors. The factors such as sediment particle size, salinity, pH, depth, nutrients, food sources, and pollution affect the community structure (Rumisha et al., 2012).

In this study *Rissoa splendida* was found to be the most abundant species and it was followed by *Bittium reticulatum* (Di % = 16.39). Dense population of *R. splendida* and *B. reticulatum* were presented in previous works (Öztürk, 2001; Albayrak et al., 2007; Çulha et al., 2007; Mutlu and Ergev, 2008; Bitlis et al., 2010; Çulha et al., 2010; Aslan-Cihangir and Ovalis 2013) carried out on the Turkish coasts.

Rueda and Salas (2003) indicated that *Jujubinus striatus* (Di % = 30.15), *Tricolia pullus* (Di % = 14.41) and *Nassarius incrassatus* (Di % = 0.72) were dense in *Caulerpa prolifera* meadows. Yet, we noted that this species created a dense population on the soft bottoms as well. *Jujubinus striatus* generally prefers *Zostera marina* meadows (Rueda et al., 2001). Arrayo et al., (2006) found dense populations (Di % = 71.8) of *Jujubinus striatus* in *Z. marina* beds at the depth of 14-16 m Alboran Sea (the southern Spain). In the present study, we recorded a 0.47% dominance value of *J. striatus*. Recently, Moreira et al., (2010) reported 4 species of Rissoidae and Trochidae in subtidal sandy sediments of Iberian Peninsula. In this study, we recorded 5 species from Trochidae and 4 species from Rissoidae.

Studies showed that changes in salinity and temperature may affect the community structure as well as species diversity.

According to Albayrak et al., (2007) the salinity values were between 37.7 ppt and 37.9 ppt at the depths of 1-20 m in Edremit Bay. In the same study temperature values were measured between 18.8 and 1.6 °C. Dogan et al., (2005) noted that salinity and temperature values were between 32.1 and 39.8 ppt and between 12 and 25.1 °C, respectively for İzmir Bay (the eastern Aegean Sea). Recently, Albayrak et al., (2010) found salinity levels as 22-25 ppt at 1-10 m depths of the Sea of Marmara. In our study area, we determined quite similar measurement values regarding salinity and temperature to Albayrak et al., (2010).

The Çanakkale Strait plays an important role in the water mass exchange through the Aegean –Black Sea System. The dynamics of the Çanakkale Strait depend on the turbulent friction (Kanarska and Maderich, 2008) and the area is swept by currents, the soft bottoms may contain some small aggregates of stones, or pebbles, which function as a substrate for the species found in the sampling area.

Our data was very scarce in terms of gastropod fauna of the area since the sampling depths were quite shallow. However, this study has made a contribution in terms of community structure and species composition on soft-bottoms of the shallow waters of the Çanakkale Strait which has not been studied previously. Moreover, in this study the relationships between the community structure and the environmental variables were also presented which in turn may have significant effects on species diversity.

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REFERENCES

Afli, A., Ayarı, R. & Zaabi, S. (2008). Ecological quality of some Tunisian coast and lagoon locations, by using benthic community parameters and biotic indices. *Estuarine, Coastal and Shelf Science*, 80, pp: 269-280 doi: 10.1016/j.ecss.2008.08.010

Albayrak, S., Balkıs, H., Zenetos, A., Kurun, A. & Kubanç, C. (2006). Ecological quality status of coastal benthic ecosystems in the Sea of Marmara. *Marine Pollution Bulletin*, 52:790-799 doi: 10.1016/j.marpolbul.2005.11.022

Albayrak, S., Balkıs, H. & Çınar, M.E. (2007). Shallow-water soft bottom macrozoobenthic communities from Edremit Bay (NE Aegean Sea). *Belgian Journal of Zoology*, 137(2): 127-132.

Albayrak, S. & Çağlar, S. (2010). Three Bivalve Species New To The Turkish Levantine Sea, *IUFS Journal of Biology*, 69: 107-110.

Argyrou, M., Demetropoulos, A. & Hadjichristophorou, M. (1999). Expansion of the Macroalga Caulerpa racemosa and Changes in Softbottom Macrofaunal Assemblages in Moni Bay, Cyprus. *Oceanologica Acta*. 22(5): 517-528. doi: 10.1016/S0399-1784(00)87684-7

Arrayo, M.C., Salas, C., Rueda, J.L. & Gofas, S. (2006). Temporal changes of mollusc populations from a Zostera marina bed in Southern Spain (Alboran Sea), with Biogeographic Considerations. *Marine Ecology*, 27: 417-430 doi: 10.1111/j.1439-0485.2006.00117.x

Aslan-Cihangir, H. & Ovalis, P. (2013). Seasonal variations and structure of the molluscan assemblage in the Çanakkale Strait (Turkey). *Acta zoologica Bulgarica*, 65 (2): 233-250.

Barash, A. & Danin, Z. (1992). Fauna Palestina, Mollusca I, Annotated list of Mediterranean Molluscs of Israel and Sinai, The Israel Academy of Sciences and Humanities, Jerusalem, 405p.

Bitlis, B., Öztürk, B., Doğan, A. & Önen, M. (2010). Marmara Denizi kıyılarında dağılım gösteren bazı mollusca türlerinin sistematik ve ekolojik özellikleri. Marmara Denizi Sempozyumu, 253-265 p.

Bouchet, P. & Rocroi, J.P. (2005). Classification and Nomenclature of Gastropod Families. *Malacologia* 47(1-2): 1-397.

Buchanan, J.B. (1984). Sediment analysis. In: (eds. N.A. Holme & A.D. McIntyre) methods for the study of marine benthos 2nd ed. Blackwell, Oxford, 41-65.

Butakov, E. A., Chuchin, V. D., Cherkasova, M. B. & Lelekov, S.G. (1997). Determinator of Gastropoda of the Black Sea. IBSS, NASU, Sevastopol, 127 p.

Cachia, C., Misfud, C. & Sammut, P.M. (1996). The Marine Mollusca of the Maltase Islands, Part. 2, Neotaenioglossa, Backhuys Publishers, Leiden, Netherlands, 1-228 p.

Cachia, C., Misfud, C. & Sammut, P.M. (2001). The Marine Mollusca of the Maltase Islands, Part. 3, Sub-class Prosobranchia to sub-class Pulmonata, order Basommatophora, Backhuys Publishers, Leiden, Netherlands, 266 p.

Çınar, M.E., Katagan, T., Öztürk, B., Egemen, Ö., Ergen, Z., Önen, M., Kirkim, F., Bakir, K., Kurt, G. & Dagli, E. (2006). Temporal Changes of Soft-bottom Zoobenthic Communities in and Around Alsancak Harbor (İzmir Bay, Aegean Sea), With Special Attention to the Autecology of Exotic Species. *Marine Ecology*, 27(3): 229-246 doi: 10.1111/j.1439-0485.2006.00102.x

Çınar. M.E., Katagan, T., Öztürk, B., Bakır, K., Daglı, E., Açık, S., Dogan, A. & Bitlis, B. (2012). Spatio-temporal distributions of zoobenthos in soft substratum of İzmir Bay (Aegean Sea, eastern Mediterranean), with special emphasis on alien species and ecological quality status. *Journal of the Marine Biological Association of the United Kingdom*, 92(7): 1457-1477 doi: 10.1017/S0025315412000264.

Çulha, M., Bat, L. & Türk Çulha, S. (2007). On The Presence of Melarhaphe neritoides (Linnaeus, 1758) (Prosobranchia, Gastropoda, Mollusca) In the Sinop Peninsula (Central Black Sea, Turkey). *Journal of Applied Biological Sciences*, 1(2): 41-43.

Dimitriadis, C. & Koutsoubas, D. (2008). Community properties of benthic molluscs as indicators of enviromental stres induced by organic enrichment. *Journal of Natural History* 42(5-8): 559-574 doi: 10.1080/00222930701835530

Doğan, A., Çınar, M.E., Önen, M., Ergen, Z. & Katağan, T. (2005). Seasonal Dynamic of Soft Bottom Zoobenthic Communities in Polluted and Unpolluted Areas of İzmir Bay (Aegean Sea). *Senckenbergiana maritima*, 35(1): 133-145.

Feld, C. K. & Hering, D. (2007). Community structure or function: effects of environmental stress on benthic macroinvertebrates at different spatial scales. Freshwater Biol 52: 1380-1399 doi: 10.1111/j.1365-2427.2007.01749.x

Glamarec, M. (1973). The benthic communities of European North Atlantic continental shelf. *Oceanography and Marine Biology: An Annual Review* 11, 263-289.

Graham, A. (1971). British Prosobranch and other Operculate Gastropod Molluscs, Academic Press, 112 p.

Gray, J.S. (1981). The ecology of marine sediments. Cambridge University Press. Cambridge.

Grillo, M.C.G., Ventura, C.R., DA & Silva S.G.H. (1998). Spatial distribution of bivalvia (Mollusca) in the soft-bottoms of Ilha Grande Bay, Rio de Jenerio, *Brazil Revista Brasileira de Oceanografia*, 46: 19-31.

Hoey, G. V., Degraer, S. & Vincks, M. (2004). Macrobenthic community structure of soft bottom sediments at the Belgian Continental Shelf. Estuarine, Coastal and Shelf Science 59: 599-613. doi:10.1016/j.ecss.2003.11.005

Huston, M.A. (1994). Biological diversity. The coexistence of species on changing landscapes. Cambridge University Press, Cambridge.

Kanarska, Y. & Maderich, M. (2008). Modelling of seasonal exchange flows through the Çanakkale Strait Strait. Estuarine, *Coastal and Shelf Science*, 79: 449–458 doi:10.1016/j.ecss.2008.04.019

Kelaher, B.P. & Levinton, J.S. (2003). Variation in detrial enrichment causes spatio-temporal variation in soft sediment assemblages. *Marine Ecology Progress Series*, 261: 85-97.

Koutsoubas, D., Arvanitidis, C., Dounas, C. & Drummond, L. (2000). Community structure and dynamics of the Molluscan Fauna in a Mediterranean lagoon (Giolova lagoon, SW Greece). *Belgian Journal of Zoology*, 130 (1): 131-138.

Koutsoubas, D., Tselepides, A. & Eleftheriou, A. (2000). Deep Sea Molluscan Fauna of the Cretan Sea (Eastern Mediterranean): Faunal, Ecological and Zoogeographical Remarks. *Senckenbergiana maritima*, 30(3/6): 85-98.

Lourido, A., Gestoso, L. & Troncoso, J.S. (2006). Assemblages of the Molluscan Fauna in Subtidal Soft Bottoms of the Ria de Aldán (North-western Spain). *Journal of the Marine Biological Association of the United Kingdom* 86: 129-140.

Lu, L. (2005). The relationship between soft-bottom macrobenthic communities and environmental variables in Singaporean waters. Marine Pollution Bulletin 51(8-12): 1034-1040. doi: 10.1016/j.marpolbul.2005.02.013

Moreira, J., Aldea, C. & Troncoso, J.S. (2010). Temporal Dynamics of Gastropod Fauna on Subtidal Sandy Sediments of the Ensenada de Baiona (NW Iberian Peninsula). *Helgol Mar Res* 64: 311-320 doi: 10.1007/s10152-009-0186-3

Mutlu, E. & Ergev, M.B., (2008). Spatio-temporal Distribution of Soft-bottom Epibenthic Fauna on the Cilician Shelf (Turkey), Mediterranean Sea. *Revista de Biología Tropical* 56 (4): 1919-1946.

Nordsieck, F. (1977). The genus Bittium LEACH, 1847, in the European Seas, pp: 6-9.

Öztürk, B. (2001). Turridae Swainson, 1840 Species (Gastropoda-Mollusca) of İzmir Bay (Aegean Sea). *Turkish Journal of Zoology*, 25: 53-56.

Palaz, M. & Colakoglu, S. (2009). Macrozoobenthic diversity of the Çanakkale Strait. *Journal of Animal and Veterinary Advances* 8 (11): 2341-2344.

Pielou, E.C. (1975). Ecological diversity. A Wiley-Inter Science Publication, London.

Rueda, J.L., Fernández-Casado, M., Salas, C. & Gofas, S. (2001). Seasonality in a Taxocoenosis of Molluscs From Soft Bottoms in the Bay of Cádiz (Southern Spain). *Journal of the Marine Biological Association of the United Kingdom*, 81(6): 903-912.

Rueda, J.L. & Salas, C. (2003). Seasonal Variation of a Molluscan Assemblage Living in a Caulerpa prolifera Meadow within the Inner Bay of Cádiz (SW Spain). *Estuarine Coastal Shelf Science*, 57 (5): 909-918.

Rueda, J.L., Marina, P., Salas, C., Urra, J. (2008). Jujubinus striatus striatus (Linneaus, 1758) (Gastropoda: Trochidae) From a Deep Zostera marina Bed in Southern Spain (Alboran Sea): Aspects of Ecology and Biology. *Journal of Molluscan Studies*, 74 (4): 345-354.

Rumisha, C., Elskens, M., Leemakers, M. & Kochzius, M. (2012). Trace metal pollution and its influence on the community structure of soft bottom molluscs in interdial areas of the Dar es Salaam coast, Tanzania. *Marine Pollution Bulletin*, 64: 521- 531. doi:10.1016/j.marpolbul.2011.12.025

Sabelli, B., Giannuzzi-Savelli, R. & Bedulli, D. (1992). Catalogo Annotato dei Molluschi Marini del Mediterraneo, Vol 2. *Libreria Naturalistica Bolognese, Bologna*, 150 p.

Shannon, C. E. & Weaver, W. (1963). The Mathematical Theory of Communications. University of Illinois Press, Urbana, Illinois, 117 p.

Simboura, N. & Zenetos, A. (2002). Benthic indicators to use in ecological quality classification of Mediterranean soft bottoms marine ecosystems, including a new biotic index. *Mediterranean Marine Science* 3(2): 77-111. doi: 10.12681/mms.249

Snelgrove, P.V.R. (1998). The biodiversity of macrofaunal organisms in marine sediments. *Biodiversity Conservation*. 7(9): 1123–1132. doi:10.1023/A:1008867313340

Taylor, J. D., Noel, J., Morris & Taylor, C.N. (1980). Food specialization and the evolution of predatory prosobranch gastropods. Palaentology, Vol. 23(2): 375-409.

Zenetos, A. (1996). FAUNA GRAECIAE VII. The marine Bivalvia (Mollusca) of Greece.*Hellenic Zoological Society and NCMR*, Athens: NCMR.