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Research Article

Temporal and spatial changes of crustaceans in mixed eelgrass beds, *Zostera marina* L. and *Z. noltii* Hornem., at the Sinop peninsula coast (the southern Black Sea, Turkey)

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Abstract: This research was carried out to determine the macrobenthic crustacean species associated with mixed eelgrass beds (*Zostera marina* and *Z. noltii*) occurring in the upper-infralittoral zone of the Sinop peninsula coast (the southern Black Sea, Turkey) and their bioecolological features. From June 2004 to April 2005, investigations were seasonally performed at the depths of 2-4 m at 6 different stations chosen on the Sinop peninsula coast. As a result of the study, a total of 7057 individuals belonging to 55 species and 6 orders were identified. Amphipoda was the dominant group in terms of number of species (63% of the total of orders) and number of individuals (83% of the total individuals). Among these, *Ampelisca pseudospinimana* had the highest dominance value with up to 1902 specimens (approximately 27%). However, Isopoda accounted for 47% of the total biomass. The species that have the highest individual biomass was isopod, *Idotea balthica* (35% of total biomass). According to a frequency index, 26 species were designated as constant, 13 species as common and 16 species as rare. The highest number of species (max. 26 species m^{-2}) and number of individuals (2069 ind.m^{-2}) were found at station 4 in fall and summer and the lowest at station 1 in winter (min. 6 species m^{-2}; 8 ind. m^{-2}).

Key words: Temporal changes, Crustacea, diversity, Black Sea, Turkey

Sinop yarımadası kıyıları (Güney Karadeniz, Türkiye) karışık deniz çayırı yataklarının, *Zostera marina* L. and *Z. noltii* Hornem., krustase faunasında görülen zamansal ve alansal değişimler

Özet: Bu araştırma Sinop Yarımadası kıyılarının (Güney Karadeniz, Türkiye) üst infralittoral zonunda yayılış gösteren karışık deniz çayırı yataklarının (*Zostera marina*, *Z. noltii*) makrobentik krustase türlerini ve biyoekolojik özelliklerini tespit etmek amacıyla yürütülmüştür. Araştırmalar Haziran 2004-Nisan 2005 tarihleri arasında Sinop Yarımadası kıyılarından seçilen 6 farklı istasyonda 2-4 m derinliklerde mevsimsel olarak gerçekleştirilmiştir. Sonuç olarak, 6 ordoya ait toplam 55 tür ile bunlara ait 7057 birey tanımlanmıştır. Amphipoda ordosu tür (% 63) ve birey sayısı bakımından (% 83) en baskın grup olup bunlardan 1902 bireyle (% 27) *Ampelisca pseudospinimana* en baskın türleri oluşturmaktadır. Bununla birlikte, Isopoda toplam biyomasın % 47'sini oluşturmaktadır. Tespit edilen türler içerisinde en yüksek biyomas değeri % 35 ile *Idotea balthica*' ya aittir. Frekans indeksine göre 26 tür devamlı, 13 tür yaygın ve 16 tür de seyrek olarak tanımlanmıştır. En yüksek tür (maks. 26 tür. m^{-2}) ve birey sayısı (2069 birey.m^{-2}) 4 nolu istasyonda sonbahar ve yaz mevsiminde, en az tür ve birey sayısı ise 1 nolu istasyonda kış mevsiminde (min. 6 tür.m^{-2}; 8 birey.m^{-2}) tespit edilmiştir.

Anahtar sözcükler: Zamansal değişimler, Crustacea, çeşitlilik, Karadeniz, Türkiye

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Introduction

Seagrass commonly inhabits muddy and sandy bottoms and forms continuous or patchy beds in sheltered areas, shallow inlets and bays, estuaries, and saline lagoons. *Zostera* is considered euryhaline and tolerates salinities from about 32 psu to 5 psu (Mathiesen and Nielsen, 1956). As a result of this habitat flexibility, the species of the genus *Zostera* species are widely but patchily distributed throughout the Black Sea coast. The vertical distribution of *Zostera* beds in the study area is mainly between 0.7 m and 6 m, but low-density patches can go down to 17 m.

Zostera meadows are an important source of food and shelter for the juvenile stages of many fish and crustacean species (Heck and Thoman, 1981). The network of roots and leaves in a *Zostera* bed provides ecological niches for a wide range of fauna and flora, so that the biotopes are important in maintaining coastal biodiversity. These beds exhibit high rates of primary productivity and are an important source of organic matter, fuelling detritus based food chains within the biotope (Boström and Bonsdorff, 1997).

Zostera habitats generally support an invertebrate fauna that has greater species richness, diversity, abundance, and biomass than the adjacent unvegetated habitats (Boström and Bonsdorff, 1997). The main factors that contribute to this improvement in biodiversity are availability of microhabitat, protection from predators, trophic resources, sediment settling, and hydrodynamic force reduction (Pranovi et al., 2000). Under the pressure of human activities, the extent and the number of seagrass meadows are decreasing in many places over the world, leading to a loss of biodiversity.

Different seagrass meadows and their associated faunal assemblages are well described for several coastal regions in the Mediterranean Sea (Atta and Halim, 1990; Scipione et al., 1996; Scipione, 1998; Hily and Bouteille, 1999; Sánchez-Jerez et al., 2000; Pranovi et al., 2000). Despite of detailed literature on the zoobenthic fauna associated with meadows beds along the Aegean coasts of Turkey (Ergen et al., 1988; Çınar et al., 1998; Kırkım, 1998; Katağan et al., 2001; Kocataş et al., 2001; Aslan and Balkıs, 2003; Ateş, 2003; Sezgin, 2003; Ateş et al., 2004; Yurdabak, 2004; Ateş et al., 2005), a few studies were performed in the Turkish Black Sea coasts (Mutlu et al., 1990, Sezgin et al., 2001; Gönlügür, 2003; Kırkım et al., 2006; Bilgin et al., 2007). Moreover, knowledge of composition and diversity of the crustaceans along the Turkish Black Sea coast is rather scarce and fragmented.

The primary objective of this study was to analyze both spatial and temporal changes in crustacean species associated with seagrass on Sinop peninsula coast, with special emphasis on the species composition, the dominance relationships, and the abundance pattern.

Materials and method

In order to determine the crustacean species associated with seagrass beds, *Zostera marina* L., *Z. noltii* Hornem, from June 2004 to April 2005, seasonal sampling was (June, October, February, and April) carried out at 6 stations (1. Hamsilos, 2. Akliman, 3. Karakum, 4. Tekel, 5. Emniyet, 6. Mobil) between 2 and 4 m at the upper infralittoral zone of the Sinop peninsula coast (the southern Black Sea) (Figure 1). Due to adverse weather conditions, sampling was not performed during the winter period at station 5. The distribution of *Zostera* spp. meadows at the localities was patchy, forming mosaic patterns with other phytobenthic and zoobenthic species (*Ceramium* spp., *Cladophora* spp., *Ulva* spp., *Polysiphonia* sp., *Potamogeton pectinatus* (only in station 2), *Botryllus schlosseri*, and serpulid polychaets). The total wet weight of *Zostera* roots and leaves within the metal frame was estimated by using a balance of 0.0001 sensitivity. According to stations wet annual biomass ranges of *Zostera* meadows were as follows: station 1: 730-1600 $g.m^{-2}$; station 2: 150-543 $g.m^{-2}$, station 3: 645-1490 $g.m^{-2}$; station 4: 815-2050 $g.m^{-2}$; station 5: 3400-5050 $g.m^{-2}$; and station 6: 1050-1750 $g.m^{-2}$.

Samples were collected based on the methodology proposed by Milchakova (1999), and the area of 625 cm^2 was sampled for mixed *Zostera* beds (*Zostera* spp.). A metal frame (25 × 25 cm) with a bag made from a plankton net (100 μ) was used. The *Zostera* roots and leaves within the metal frame were excavated with a spatula. The samples were washed and sieved with a 0.5 mm mesh and retained fauna

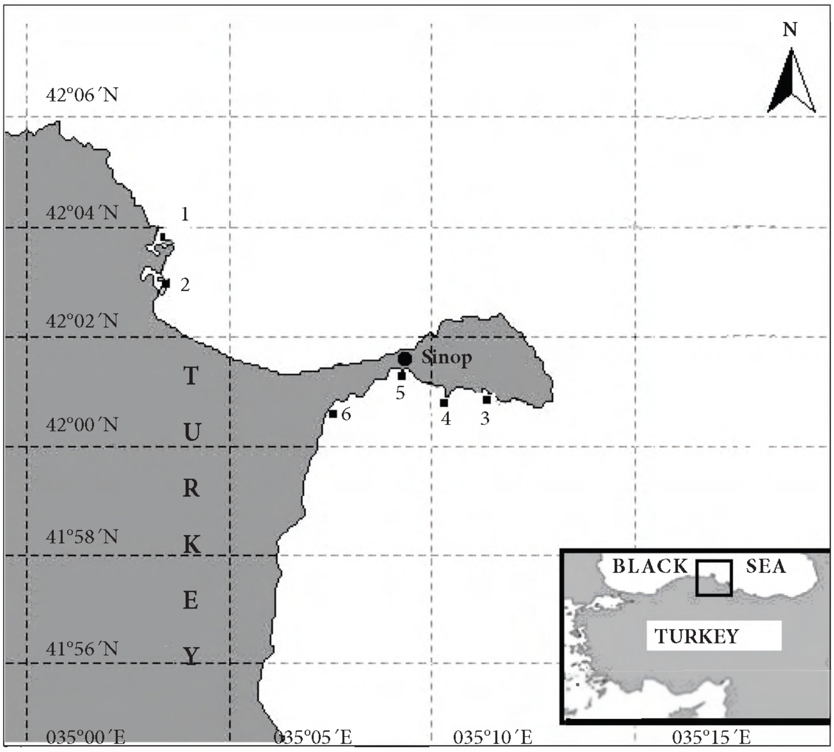

Figure 1. Study area with sampling sites.

were put in jars containing 10% seawater-formaldehyde solution. In the laboratory, the material was sorted according to major taxonomic groups under a stereomicroscope and preserved in 70% alcohol. The crustacean specimens were then identified and counted, and the total wet weight of each specimen was estimated by using a balance of 0.0001 sensitivity. To analyze the benthic crustacean community, a single replicate was taken at each station. The material was deposited at the laboratory of Faculty of Fisheries, Sinop University (SU-FF).

To determine the water quality at each station, temperature, dissolved oxygen concentration, pH, salinity, turbidity, and conductivity of the seawater were measured by using a U2-Horiba (Multi-parameter water quality analyzer) device in the field.

Community parameters, such as the number of species, number of specimens, the diversity index (log_2 base) (H') (Shannon-Weaver, 1949), evenness index (J') (Pielou, 1975), frequency index (F%) (Soyer, 1970), quantitative dominance index (DI%) (Bellan-Santini, 1969), and the total biomass value (wet weight) were calculated for each sampling period. To determine better temporal distribution patterns, the abundance data of all stations in each sampling period were analyzed using cluster and multidimensional scaling (MDS) techniques, based on the Bray-Curtis similarity (group average technique), using the PRIMER package. SIMPER analysis was performed to identify the percentage contribution of each species to the overall similarity (dissimilarity) within each of the groups identified from the cluster analysis.

Results

Physico-chemical analyses

Water features are shown in Figure 2. Salinity was usually high in winter (max. 14.6 psu), temperature (max. 25.4 °C), pH (max. 9.4) were usually high in fall, while dissolved oxygen (max. 7.6 $mg.L^{-1}$) was usually high in winter. The turbidity value (40 ntu) was usually high in spring.

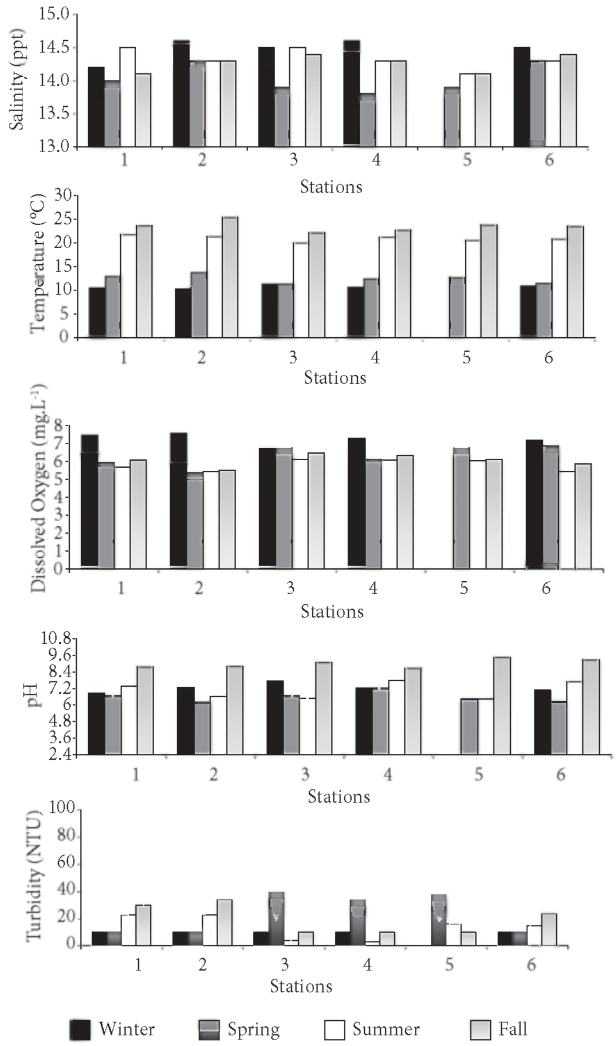

Figure 2. Water characteristics for each station during the various sampling periods.

Faunistic and ecological analysis

A total of 55 benthic crustacean species and 7057 specimens belonging to 6 orders were identified during the study. A list of species and total number of individuals at each station is given in Table 1.

The dominant species in the area were *Ampelisca pseudospinimana* (26.9% of total individuals), *Dexamine spinosa* (16.9%), *A. diadema* (5.7%), *Gammarus insensibilis* (5.6%), and *Leptochelia savignyi* (4.4%), all comprising 59.5% of total specimens.

Among the orders, Amphipoda was the dominant group in terms of number of species with 35 species accounting for 63% of the total, followed by Decapoda with 6 species (16%), Isopoda with 6 species (11%), Cumacea and Tanaidacea with 2 species (4%), and Mysida with 1 species (2%) (Figure 3a). Amphipods accounted for 83% of the total individuals, followed by tanaids (8%) and cumaceans (5%) (Figure 3b). However, isopods accounted for 47% of the total biomass (44.07 g, 0.625 m^{-2}). In addition, amphipods (40%) and decapods (12%) were also other main contributors to the total biomass (Figure 3c).

In respect of Soyer's frequency (F) index, only 26 were continuous ($F \geq 50$), 13 as common (F between 25 and 49) and 16 species as rare ($F \leq 25$) (Table 1). The species with the highest frequency scores within the category continuous were the cumaceans *Cumella limicola* and *Iphinoe tenella*; tanaid *L. savignyi*; isopod *Synisoma capito*; and amphipods, *A. pseudospinimana*, *Apherusa chiereghinii*, *Atylus massiliensis*, *Caprella rapax*, *D. spinosa*, and *Perioculodes longimanus longimanus*. Sixteen species, i.e. *Dynamene torellia*, *Eurydice pulchra*, *A. guttaus*, *Bathyporeia guilliamsoniana*, *C. denilevskii*, *Hyale camptonyx*, *Jassa ocia*, *Megaluropus massiliensis*, *Melita palmata*, *Microdeutopus versiculatus*, *Monoculodes gibbosus*, *Pseudoprotella phasma*, *Brachynotus sexdentatus*, *Callianassa candida*, *Macropodia longirostris*, *Palaemon elegans*, and *Xantho poressa* were only found at 1 station.

The amphipods *A. pseudospinimana* (27% of the total individuals) and *D. spinosa* (17% of the total individuals) were the most abundant species in the *Zostera* beds throughout the year (Table 1, Figure 4a) and these could be considered as the preferential species for *Zostera* facies. *A. pseudospinimana* particularly dominated at station 4 and *D. spinosa* dominated at station 5. The other commonest species were the tanaid *L. savignyi* and amphipods *G. insensibilis* and *A. diadema*.

The total biomass of 149.98 $g.m^{-2}$ was seasonally estimated in *Zostera* samples and the isopod *Idotea balthica* accounted for 35% of the total biomass (Figure 4b). The biomass of the isopod *I. balthica* reached its maximum value of 54.91 $g.m^{-2}$ in summer. The other species with high biomass values were the amphipods *G. insensibilis* (19%), *D. spinosa* (7%), the

Table 1. List of species collected by quadrate during the study and their total number of individuals per station, dominance (DI%), frequency (F%) (C: Continuous, Co: Common; R: Rare) and biomass (B).

Species	Stations								
	1	2	3	4	5	6	DI %	F %	B (g)
Mysida									
Siriella jaltensis Czerniavsky, 1868		4		1		1	0.1	C	0.0255
Cumacea									
Cumella limicola Sars, 1879	30	69	23	69	3	64	3.7	C	0.0826
Iphinoe tenella Sars, 1878	12	24	3	25	12	14	1.3	C	0.0854
Tanaidacea									
Apseudes latreillii (Milne-Edwards, 1828)	7	10	1	206		10	3.3	C	0.3510
Leptochelia savignyi (Krøyer, 1842)	51	9	14	22	6	209	4.4	C	0.3732
Isopoda									
Dynamene torellia Holdich, 1968				1			**	R	***
Eurydice pulchra Leach, 1815				1			**	R	***
Gnathia vorax (Lucas, 1849)		1		1			**	Co	0.0036
Idotea balthica (Pallas, 1772)			2	1	93	16	1.6	C	34.9440
Sphaeroma serratum (Fabricius, 1787)			11	1	3		0.2	C	0.0180
Synisoma capito (Rathke, 1837)	14	4	29	34	3	12	1.4	C	9.1008
Amphipoda									
Ampelisca diadema (Costa, 1853)	8	64	11	320			5.7	C	2.9665
Ampelisca pseudospinimana Bellan-Santini & Kaim-Malka, 1977	30	7	12	1822	3	29	26.9	C	2.0922
Amphithoe helleri Karaman, 1975			1	14	1	5	0.3	C	0.0052
Amphithoe ramondi Audouin, 1826			22	80	21	127	3.5	C	0.7410
Apherusa bispinosa (Bate, 1857)	22	2		14	7	164	2.9	C	0.3744
Apherusa chiereghinii Giordani- Soika 1950	2	2	5	40	25	100	2.5	C	0.2668
Atylus guttatus (Costa, 1851)						3	**	R	0.0366
Atylus massiliensis Bellan-Santini, 1975	3	1	11	3	30	40	1.3	C	2.9370
Bathyporeia guilliamsoniana (Bate, 1857)			12				0.2	R	0.0072
Caprella acanthifera Leach, 1814	9	4	18	16		34	1.1	C	0.0405
Caprella denilevskii Czerniavski, 1868						1	0.1	Co	0.0003
Caprella mitis Mayer, 1890	21			2			0.3	Co	0.0046
Caprella rapax Mayer, 1890	8	5	1	88	1	6	1.5	C	0.0381
Dexamine spinosa (Montagu, 1813)	1	4	43	69	833	244	16.9	C	7.2834
Dexamine thea Boeck, 1861			3		2		0.1	Co	0.0008
Echinogammarus olivii (Milne-Edwards, 1830)			14		1		0.2	Co	0.0142
Ericthonius brasiliensis (Dana, 1855)		1	8	36		225	3.8	C	0.0887
Ericthonius punctatus (Bate, 1857)		1		37			0.5	Co	0.0063
Gammarellus angulosus (Rathke, 1843)			3		6		0.1	Co	0.0360

Table 1. (continued).

Species	Stations								
	1	2	3	4	5	6	DI %	F %	B (g)
Gammarus insensibilis Stock 1966	1				238	153	5.6	C	18.8160
Gammarus subtypicus Stock, 1966					42	89	1.9	Co	1.3362
Hyale camptonyx (Heller, 1866)			1				**	R	0.0014
Hyale perieri (Lucas, 1849)	1		1				**	Co	0.0018
Jassa ocia (Bate, 1862)			1				**	R	0.0011
Megaluropus massiliensis Ledoyer, 1976			3				**	R	***
Melita palmata (Montagu, 1804)				5			0.1	R	0.0150
Microdeutopus algicola Della Valle, 1893	30	8	32	56		56	2.6	C	0.0364
Microdeutopus gryllotalpa Costa, 1853		2	3	17	15	20	0.8	C	0.0171
Microdeutopus versiculatus (Bate, 1856)					1		**	Co	0.0007
Monocorophium acherusicum Costa, 1851	3		6	7	26	8	0.7	C	0.0200
Monocorophium insidiosum Crawford, 1937			1		4		0.1	Co	0.0080
Monoculodes gibbosus Chevreux, 1888			12				0.2	R	0.0009
Perioculodes longimanus longimanus (Bate & Westwood, 1868)	33	20	16	43	4	38	2.2	C	0.0128
Pseudoprotella phasma (Montagu, 1804)						7	0.1	R	0.0028
Stenothoe monoculoides (Montagu, 1815)				4		62	0.9	Co	0.0165
Decapoda									
Athanas nitescens (Leach, 1814)		2	2	4		2	0.1	C	0.0440
Brachynotus sexdentatus (Risso, 1827)						2	**	R	0.4320
Callianassa candida (Olivi, 1792)				3			**	R	0.7182
Diogenes pugilator (Roux, 1829)		8	5	16			0.4	C	2.8130
Hippolyte garciarasoi D'Udekem d'Acoz, 1996		1		2			**	Co	0.0243
Macropodia longirostris (Fabricius, 1775)					1		**	R	0.0366
Palaemon elegans Rathke, 1837					1		**	R	0.7980
Upogebia pusilla (Petagna, 1792)	2	2					0.1	Co	6.5768
Xantho poressa (Olivi, 1792)				1			**	R	0.0825

** D < 0.1
*** B < 0.0001 g

isopod *S. capito* (9%) and the decapod *Upogebia pusilla* (7%). *A. pseudospinimana*, the most abundant species, constituted only 2% of the total biomass. *U. pusilla* attained the highest individual wet weight with 2.63 g.m^{-2}, and was followed by the caridean shrimp *Palaemon elegans* with 1.28 g.m^{-2}. The maximum density of Amphipoda was found at station 4 in summer (3051 ind.m^{-2}), of Tanaidacea at station 6 in summer (264 ind.m^{-2}), of Isopoda at station 5 in summer (154 ind.m^{-2}), of Cumacea at station 2 in spring (82 ind.m^{-2}), and that of Decapoda at station 4 in summer (21 ind.m^{-2}).

Temporal variations in number of species and specimens, diversity and evenness values at the stations are presented in Figure 5. The highest number of species was found at station 4 in fall (max. 26 species 0.625 m^{-2}) and the lowest at stations 1 (in winter) and 3 (in fall) (min. 6 species 0.625 m^{-2})

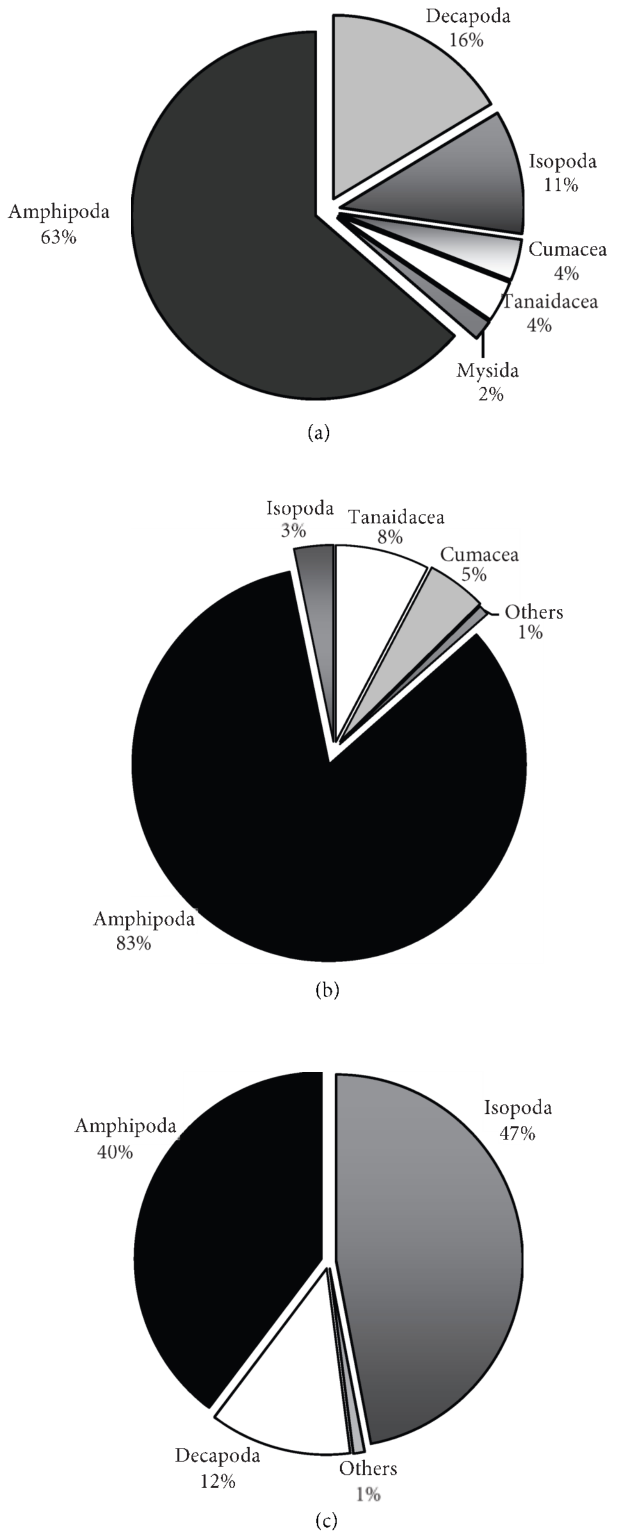

Figure 3. Relative dominance of the groups associated with *Zostera* eelgrass by number of species (a), number of individuals (b) and biomass values (c).

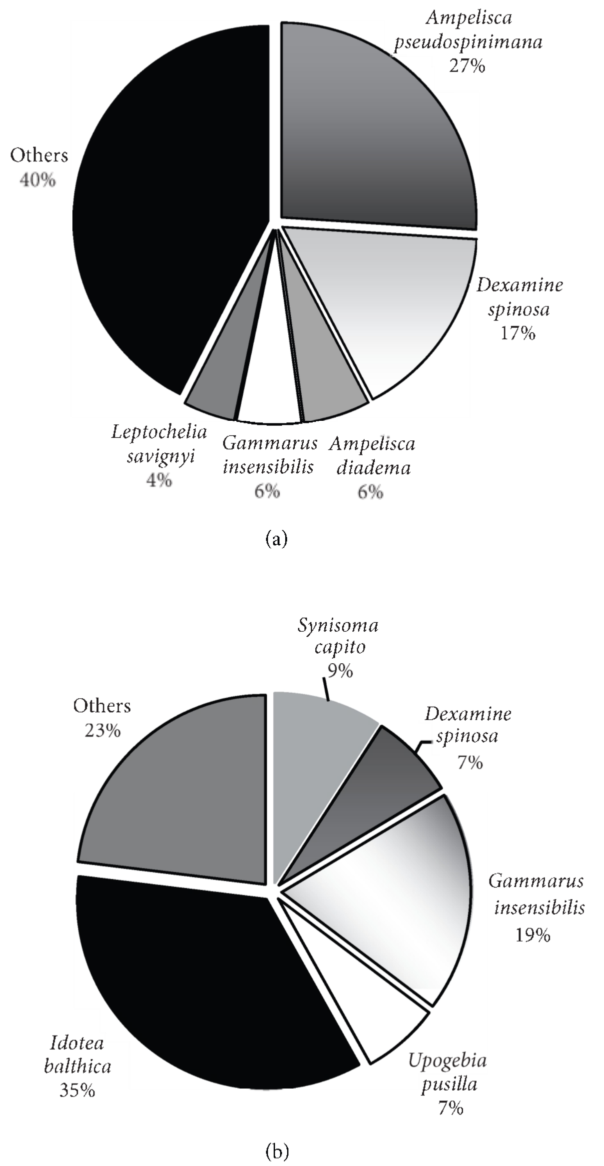

Figure 4. Relative dominance of the species associated with *Zostera* spp. by number of individuals (a) and biomass values (b).

(Figure 5). The number of specimens at each station changed with the season. The highest number of specimens (2069 ind. 0.625 m^{-2}) was encountered at station 4 in the summer period, the lowest (8 ind. 0.625 m^{-2}) at station 1 in winter. The amphipods *A. pseudospinimana* and *A. diadema* and the tanaid *A. latreillii* with the highest number of specimens were the dominant species at station 4. At stations 4, 5, and 6, there was a similar fluctuation in number of

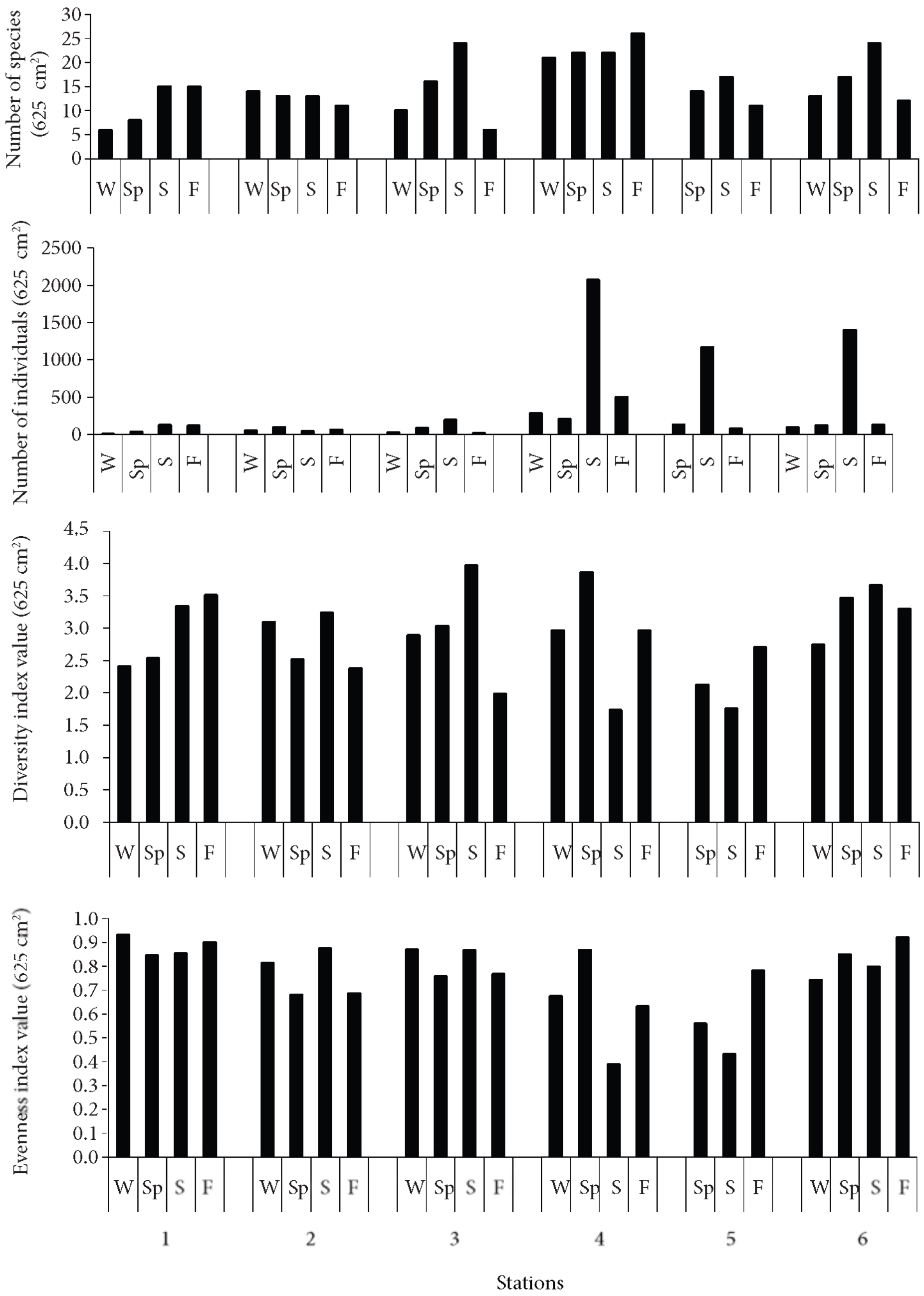

Figure 5. Temporal fluctuations in the mean number of species, faunal densities (number of individuals per 625 cm^2), diversity index and evenness index at each station. (W: Winter, Sp: Spring, S: Summer, F: Fall).

specimens, having a peak in the summer, followed by a smaller decrease in fall. Generally, community parameters at all stations varied less or more between sampling periods.

The highest diversity and evenness were found at stations 1 and 6 (Figure 5). The diversity value was always higher than 3 at station 6, but the evenness value was higher at station 1. There were less or more differences in these variables among the sampling periods, with winter having generally lower and summer higher number of species.

The highest diversity and evenness values at the stations were determined in various seasons as below:

At stations 1 (H′ = 3.51, J′ = 0.89) and 5 (H′ = 2.70, J′ = 0.78) in fall, at stations 2 (H′ = 3.23, J′ = 0.87), 3 (H′ = 3.97, J′ = 0.86), and 6 (H′ = 3.66, J′ = 0.86) in the summer, and at the station 4 (H′ = 3.86, J′ = 0.86) in the spring (Figure 5).

Based on Bray–Curtis similarity values, 4 groups of stations (A-D) can be described (Figure 6).

The assemblages identified were also separated in MDS analysis (Figure 7). The stress value for the 2-dimensional MDS plot was 0.17, indicating an appropriate group separation. The samples collected from the same station tended to join to each other, but group A contained samples both from stations 5 and 6. In contrast, group C involved the samples collected from stations 1, 2, 3, and 4.

After SIMPER (Table 2), the density of the tanaid *L. savignyi* was the main factor with a more important contribution in the characterization of samples belonging to the different stations with temporal variation on the similarity and dissimilarity among samples.

SIMPER demonstrated that the cumacean *C. limicola* was the most responsible species for the similarity of the groups B, C, and D, with *I. tenella* for the similarity of groups A, C, and D. Furthermore, the density scores of the isopod *S. capito* and the amphipods *A. diadema*, *Ericthonius brasiliensis*, *G. insensibilis*, and *Monocorophium acherusicum* and the decapod *U. pusilla* affected more or less the association levels in all groups (Table 2).

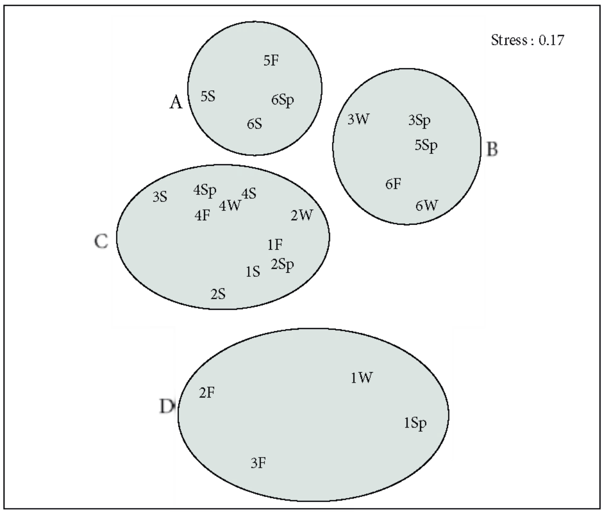

Figure 7. Multidimensional scaling plot and dendrogram showing similarity among seasonal samples. (W: Winter, Sp: Spring, S: Summer, F: Fall).

Discussion and conclusion

The present study revealed that the benthic crustacean fauna inhabiting the shallow-water specimens of *Zostera* is rich and diverse. As a result of the present study carried out at 6 different stations

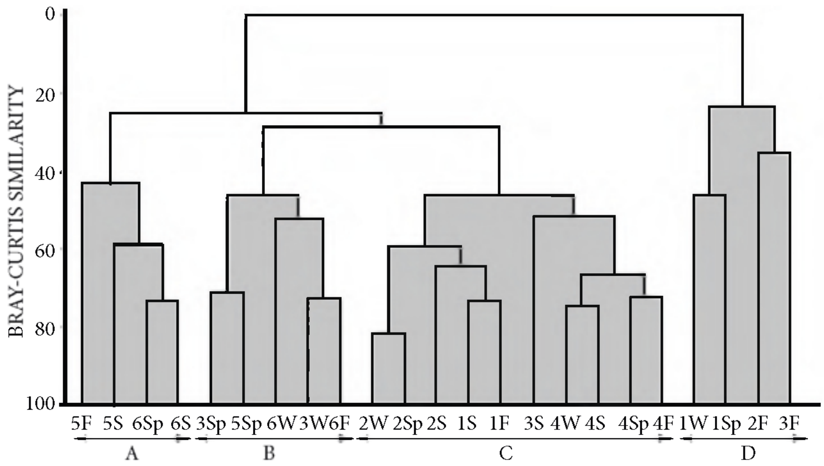

Figure 6. Results of Cluster analysis, based on Bray-Curtis Similarity Index (quadrat samples) (W: Winter, Sp: Spring, S: Summer, F: Fall).

Table 2. Species contributing to similarity within each assemblage of the habitats (as shown in Figure 6), with their average similarity.

Associations in Figure 7	**A**		**B**		**C**		**D**	
Average similarity	19	MD	29	MD	27	MD	13	MD
Cumella limicola	-	-	9	12	26	16	13	1
Iphinoe tenella	8	6	-	-	7	5	7	2
Leptochelia savignyi	4	43	9	9	5	8	43	4
Synisoma capito	-	-	-	-		-	12	2
Ampelisca diadema	-	-	-	-	16	34	-	-
Ampelisca pseudospinimana	-	-	-	-	11	170	13	1
Apherusa chiereghinii	5	28	7	3	-	-	-	-
Dexamine spinosa	44	248	32	25	-	-	-	-
Ericthonius brasiliensis	-	-	16	7	-	-	-	-
Gammarus insensibilis	11	99	-	-	-	-	-	-
Monocorophium acherusicum	7	11	-	-	-	-	-	-
Perioculodes longimanus longimanus	-	-	11	6	10	8	-	-
Upogebia pusilla	-	-	-	-		-	7	1

MD: Mean density (individuals 625 cm^2).

of the Sinop peninsula coasts (Turkish Black Sea), a total of 55 species and 7057 individuals belonging to 6 orders were identified (Table 1). In previous studies performed on *Zostera* beds, Çınar et al. (1998) reported 19 crustacean species, Kırkım (1998) 2 species, Yurdabak (2004) 8 species, and Bilgin et al. (2007) 9 species. When all the previous studies cited above are considered, our study includes the richest numbers of crustacean species.

Makkaveeva (1976) stated that *Zostera* meadows provides shelter to as many as 70 macrobenthic invertebrates, 34 species of fish, and 19 fish larvae, such as rockfish, horsemackarel, anchovy and surmullet, which spawn there also.

By comparing the community structure of crustacean fauna of *Zostera* and *Posidonia* meadows, it is evident that the *Posidonia* system was characterized by higher species richness. When the previous studies on the subject are considered, Kırkım (1998) reported 24 isopod species, Sánchez-Jerez et al. (2000) reported 68 crustacean species, i.e. 34 decapod and 32 amphipod, Katağan et al. (2001) reported 40 amphipod species, Kocataş et al. (2001) reported 6 amphipod species, Ateş (2003) reported 75 decapod species, Sezgin (2003) reported 83 amphipod species, Ateş et al. (2004) reported 69 decapod species, and Ateş et al. (2005) reported 40 decapod species.

The present study has shown that spatial variations are important for crustacean communities in 2 seagrass habitats: patchy dominated by either *Z. marina* or *Z. noltii*. Regarding the number of specimens and biomass of isopod, *I. balthica* was higher at station 5 mainly dominated by *Z. marina* than in the sites composed of mainly *Z. noltii*. Differences observed in 2 seagrass communities can be explained by habitat preferences. As stated in the relevant literature presented by Heck and Thoman (1981), the main reasons for spatial heterogeneity of crustaceans in *Zostera* meadows may be differences in plant morphology and structural complexity. Moreover, this study shows that the spatial distributions of crustaceans in seagrass meadows are variable, but indicates an interaction between assemblages structure and seagrass community.

In the present study, the abundance of some species correlated with seagrass density, while the abundance of some species did not. This condition may be explained by the vertical distribution of the crustacean species in the *Zostera* beds. For instance, the amphipods *C. rapax, D. spinosa*, and *G.*

insensibilis, and the tanaid *L. savignyi* are distributed on both leaves and sediment; the amphipod *C. acanthifera* live only on leaves while the other amphipods *A. pseudospinimana, A. chiereghinii*, and *P. longimanus longimanus* can be found within sediments, among sand grains. *C. acanthifera* seems to live in sediment regardless of the local seagrass biomass, i.e. even in plain sediments.

During the study period, the species did not frequently show an exclusive association with the stations. Differences in densities, if small, have the disadvantage of being difficult to interpret and should always be carefully analyzed. A small difference that is statistically not significant in density can occasionally indicate a local phenomenon, which cannot be generalized. Densities are often directly dependent on surface availability and directly on the quantity of substrate present per unit of bottom surface (e.g. *Zostera* per unit area of bottom). *Zostera* meadows occurred in patches in our study area, and therefore in many places the density of *Zostera* was lower. According to Bowden et al. (2001), seagrass patch size appears to be less significant than 'regional' factors, which relate to relatively small variation in environmental parameters, for the structuring of faunal macro-invertebrate assemblages.

Crustaceans occurring in ecosystems of shallow water are considered to be one of the most important prey items for fishes, especially for those less then 10 cm in body length (Takeuchi and Hino, 1997). Furthermore, the amphipod grazers are very important in controlling periphyton and ephiphytes of seagrass (Jernakoff and Nielsen, 1997). For instance, Caine (1980) reported that, in the absence of some caprellids, periphyton biomass increased by 411% in *Z. marina* beds.

Seagrass constitutes an important part of the Black Sea coastal zone. They have received much less attention than other systems in terms of research and management. In Turkey, as in other Black Sea countries, the negative impact on the seagrass ecosystems is increasing due to a growing coastal population, pollution, and over-exploitation of natural resources. The Sinop region is an example of an area strongly influenced by over-fishing and illegal bottom trawling, verified by local fisherman complaining of diminishing catch rates.

Consequently, it is important to increase the present scientific knowledge on ecological interactions between fish and invertebrate assemblages and seagrass environments of the region. This study has put forward information for ecological valuation of seagrass ecosystems habitat protection, and fisheries management.

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