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Full Length Research Paper

Seasonal changes of invertebrate fauna associated with *Cystoseira barbata* facies of Southeastern Black Sea coast

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This research was carried out to determine the invertebrate fauna associated with *Cystoseira barbata* facies distributed in the upper-infralittoral zone of the Southeastern Black Sea coasts and their bioecological features. The investigations were seasonally performed at depths of 0 to 3 m in 5 different stations chosen in the Southeastern Black Sea from July 2005 to May 2006. As a result of the study, a total of 6123 specimens belonging to 38 species and 4 taxonomic groups were identified. Arthropoda was the dominant group in terms of number of species (55.3% of the total of phylum) and number of individuals (83.9% of the number total individuals). With regard to frequency index, 14 species were defined as continious, 8 species of common and 16 species as rare. *Idotea metallica* is reported for the first time from the Black Sea coast of Turkey in the present study.

Key words: Seasonal changes, invertebrate fauna, *Cystoseira barbata*, Black Sea, Turkey.

INTRODUCTION

In the coastal ecosystems, macro algae play the key role as the basic primary producers. Also they provide food, oxygen and shelter to organisms living the area (Hemminga and Duarte, 2000). Macroalgae together with associated epiphytes are preferred food resources for many littoral invertebrates such as crustaceans, gastropods, annelids, and insects (Jannson, 1967; Kraufvelin et al., 2006).

Cystoseira barbata is widespread in the Black Sea where the substrate forms a tough perennial pool, very valuable in terms of environment. The fields of *C. barbata* constituted a very important ecological niche for the development of marine life in the rocky infralittoral zone especially for the associated fauna inhabiting that field. In different coastal environments of the Black Sea (Bulgarian, Romanian, Ukranian and Russian shelf area) *Cystoseira* biomass was dramatically declined during last several decades (Minicheva et al., 2008). The previously large belts of *C. barbata*, a perennial brown alga, along the western coast have practically disappeared as have numerous other associated and/or epiphytic algal and animal species (Bologa et al., 1995; Zaitsev, 1997). Currently, the association is very low, on the one hand due to frost in some prior periods and secondly because of pollution, increased water turbidity and substrate clogging (Negreanu-Pirjol et al. 2009). Reduction of *Cystoseira* phytal zone to a narrow inshore strip shallower than 10 m which could only provide enough light for photosynthesis. As *Cystoseira* biomass decreased markedly, macroalgae blooms were dominated by opportunistic species (mainly epiphytic filamentous algae) in basiphytic and epiphytic sinusia. However, current status of *C. barbata* and their associated macroinvertebrate communities along the Turkish Black Sea coast is unknown.

Existing studies concerning the faunal structure of Cystoseira facies were previously carried out on the Black sea by Zavodnik (1965) and Tiganus (1972), the Mediterranean Sea by Bellan-Santini (1969), Boudresque (1969) and Turkish seas by Kocatas (1978), Ergen (1980), Ergen and Çınar (1994) and Kocatas et al. (2004). The benthic macro invertebrate and community structure associated with the *C. barbata* have not been described in the Southeastern Black sea coasts. The present paper aims at estimating the quantitative

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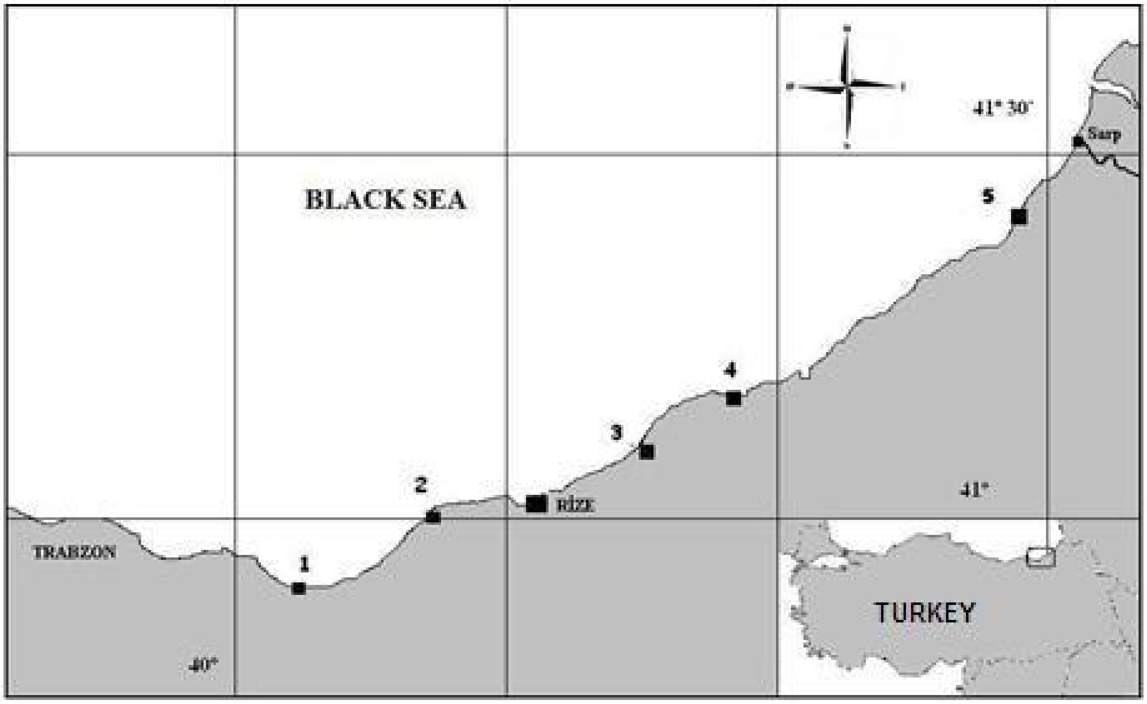

Figure 1. Map of the study area with the location of sampling sites.

distribution of macro fauna associated with *C. barbata* in the infra-littoral zone of the Southeastern Black Sea. The study also intends to compare the taxonomic composition and quantitative characteristics of the macro fauna in the region.

MATERIALS AND METHODS

In order to determine invertebrate fauna assemblages within *C. barbata* facies, samplings were performed at 5 different localities in the upper- infralittoral zone (0 to 3 m) of the Southeastern Black Sea (Figure 1). Sampling areas were chosen from natural rocky habitats where *C. barbata* beds were inhabited together with *Ulva lactuca* and *Jania rubens*. Our observations show that macro algal commu-nities were found intensively between 0 to 3 m, scarcely between 3 to 15 m. After these depths, macro algal communities disappeared, especially station 4 exposure to wave effect; the other stations are relatively more sheltered than this station. At each station, 3 repli-cates were collected every sampling season. Samples were collected according to the methodology proposed by Bellan-Santini (1969), and a 400 cm^2 unit area was sampled for *C. barbata* facies. For this purpose, a metal frame (20 x 20 cm) covered with a bag made up of a plankton net was used. The Cystoseira roots and leaves within the metal frame were excavated using a spatula, and the material collected was preserved in 4% formalin for further analysis back in the laboratory. In the laboratory, the samples were washed through a 0.5 mm sieve and the retained fauna was preserved in 70% ethanol. The extracted fauna were separated into taxonomic groups, identified and counted under a stereomicro-scope. The material was deposited in zoology collection of the Faculty of Fisheries, Rize University, Turkey.

Arthropods were identified according to Chevreux and Fage (1925), Bellan-Santini et al. (1982, 1989 and 1993) and Schultz (1969). The identification of Polychaeta was done with regard to Fauvel (1923), Day (1967) and Campoy (1982). Mollusc and Platyhelminthes were classified following Riedl (1963). Community parameters, such as the number of species, number of specimens, the diversity index (log_2 base) (H') (Shannon and Weaver, 1949), evenness index (J') (Pielou, 1975), frequency index (F %) (Soyer, 1970) and quantitative dominance index (DI %) (Bellan-Santini, 1969), were calculated for each sampling period. To determine better temporal distribution patterns, the abundant data of all stations in each sampling period were analyzed using cluster techniques, based on the Bray-Curtis similarity (group average technique), using the PRIMER package.

RESULTS

A total of 6123 specimens belonging to 38 species (21 Arthropoda, 9 Annelida, 7 Mollusca, 1 Platyhelminthes) were identified (Figure. 2). Among these, Arthropoda was represented by a total of 21 species (55.3 %) and followed by Annelida with 9 species (23.7 %), Mollusca with 7 species (18.4 %) and Platyhelminthes with 1 species (2.6 %) (Table 1). Arthropoda were more diver-sified (21 species) and most abundant in summer (16124 $ind.m^{-2}$). The amphipods *Ampithoe ramondi* (23.4% of the total individuals), *Hyale sp*. (13.7%) and *Ampithoe sp*. (11.2%) were the most abundant species of *C. barbata* facies throughout the year.

According to Soyer's frequency (F) index, only 14 were continuous (F ≥50), 8 as common (F between 25 and 49) and 16 species as rare (F ≤25) (Figure. 3). The species with the highest frequency scores within the category continuous were *Ampithoe ramondi*, *Ampithoe sp.*,

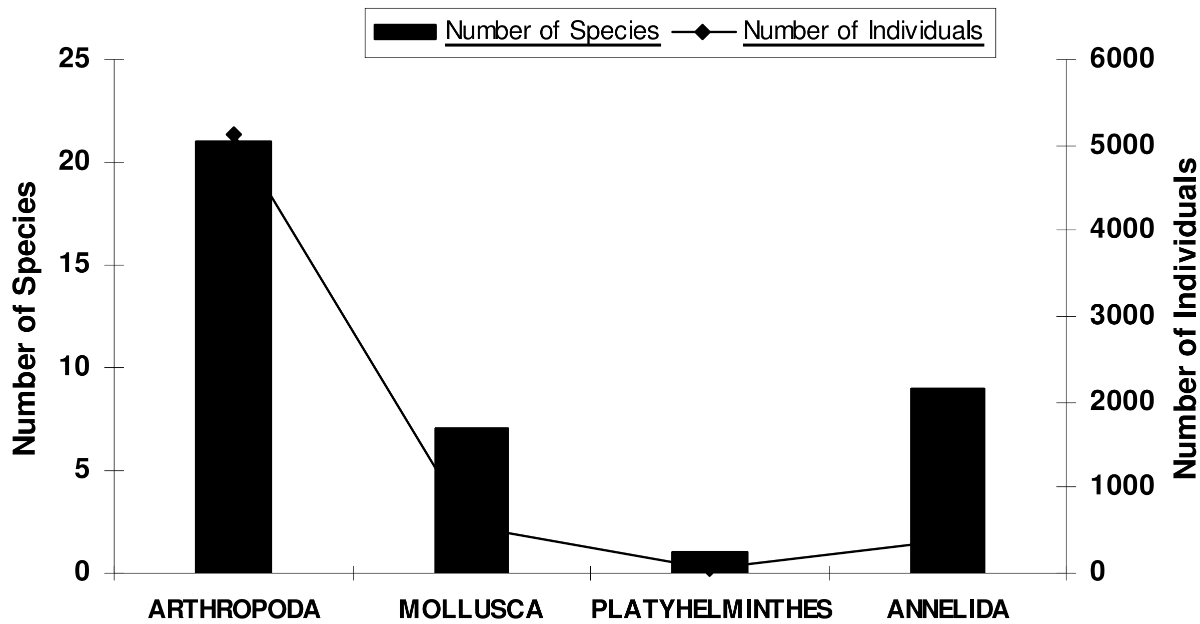

Figure 2. Species and specimen numbers of invertebrate groups.

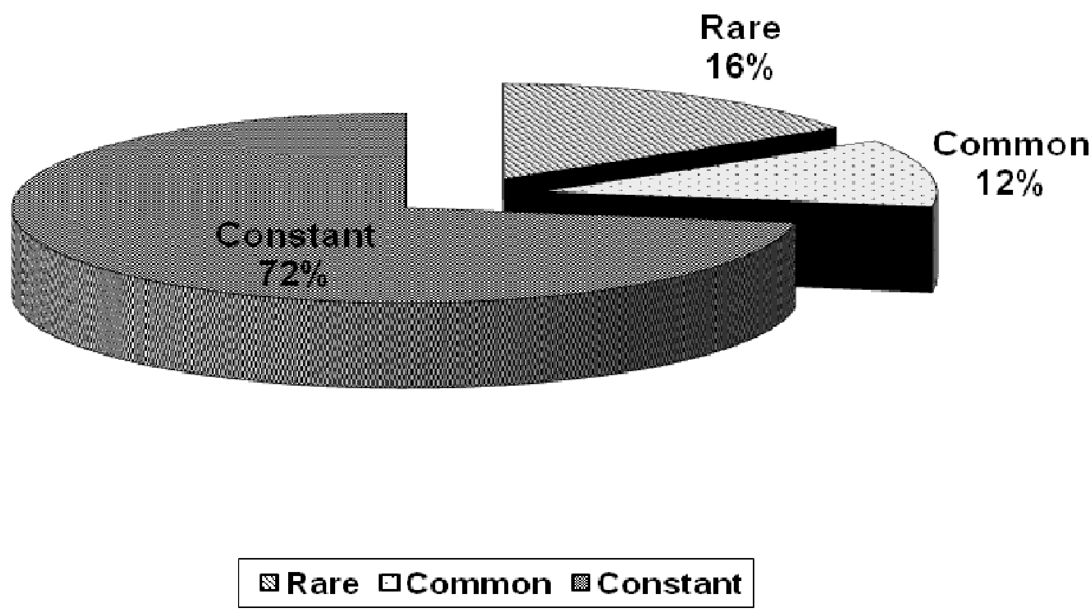

Figure 3. Dispersion of species as a result of 3 frequency index group values.

Ericthonius brasiliensis, *Gammarellus angulosus*, *Hyale sp.*, *Jassa ocia*, *Stenothoe monoculoides*, *Dynamene toralliae*, *Idotea balthica*, *Synisoma capito*, *Rissoa splendida*, *Stylochus sp.*, *Nereis sp.* and unidentified other polychaeta species. 13 Species *Monocorophium insidiosum*, *Melita palmata*, *Idotea metallica*, *Sphaeroma serratum*, *Leptochelia savignyi*, *Acanthochitona fascicularis*, *Cyclope danovani*, *Patella caerulea*, *Rapana thomasiana*, *Nereis pelagica*, *Perinereis cultifera*, *Nereis rava* and *Phyllodocidae sp.*were only found a station.

Temporal variations in number of species and specimens, diversity and evenness values at the stations are presented in Figure 4. The highest number of species was found at station 2 in summer (24 species.m^{-2}) and the lowest at stations 4 in winter (5 species.m^{-2}). The number of specimens at each station changed with the season. The highest number of specimens (24116 ind. m^{2}) was encountered at station 1 in the summer period, the

Table 1. Identified species belonging to *C. barbata* facies at the area (S: Summer; F: Fall; W: Winter; Sp: Spring; 1: Station 1; 2: Station 2; 3: Station 3; 4: Station 4, 5: Station 5; M. A. Mean Abundance; DI: Diversity Index; F: Frequency %, Co: Continuous,C: Common,R: Rare).

Systematic groups	S1	S2	S3	S4	S5	F1	F2	F3	F4	F5	W1	W2	W3	W4	W5	Sp1	Sp2	Sp3	Sp4	Sp5	M.A	DI%	F%
Arthropoda																							
Amphıpoda																							
Amphithoe ramondi Audouin, 1826	9700	4492	5517	4969	667	1467	628	567	400	175	42	33	-	-	-	-	42	-	-	-	1435	23.44	Co
Ampithoe sp.	4900	1233	2225	3617	500	575	150	175	358	5	2	-	-	-	-	8	17	-	-	-	688	11.24	Co
Caprella spp.	500	8	1992	658	925	33	-	150	92	-	-	-	-	-	-	-	-	-	-	-	218	3.56	C
Monocorophium insidiosum Crawford, 1937	-	-	-	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8	1	0.02	R
Dexamine spinosa (Montagu, 1813).	125	125	-	1192	-	-	-	-	150	-	-	-	-	17	-	-	17	-	-	-	81	1.33	C
Ericthonius brasiliensis (Dana, 1855)	3617	1850	2875	550	-	358	150	400	67	-	25	33	67	-	-	-	8	-	-	-	500	8.17	Co
Gammarellus angulosus (Rathke, 1843)	225	33	250	-	-	33	8	42	-	-	8	-	8	-	-	108	67	17	-	-	40	0.65	Co
Hyale sp.	300	1233	4167	-	4275	150	375	833	17	1712	33	75	258	-	317	92	217	1192	33	1467	837	13.67	Co
Jassa ocia (Bate, 1862)	2717	558	2042	825	125	17	-	25	33	17	83	8	17	-	-	-	42	-	-	-	325	5.31	Co
Melita palmata (Montagu, 1804)	-	-	-	-	792	-	-	-	-	1059	-	-	-	-	17	-	-	-	-	108	99	1.61	R
Microdeutopus gryllotalpa Costa, 1853		17	-	8	642	-	-	-	-	125	-	-	-	-	17	-	8	-	17	275	55	0.91	C
Stenothoe monoculoides (Montagu, 1815)	58	200	833	817	317	-	42	375	283	92	-	8	175	150	8	8	33	1467	1192	117	309	5.04	Co
Isopoda																							
Dynamene toralliae holdich, 1968	258	117	542	33	8	58	8	25	8	-	8	-	8	-	-	25	-	17	8	-	56	0.92	Co
Idotea balthica (Pallas, 1772)	1467	4900	67	33	-	358	1233	8	-	-	175	400	17	-	-	-	283	-	-	-	447	7.30	Co
Idotea metallica Bosc, 1802	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0.01	R
Synisoma capito (Rathke, 1837)	225	67	33	58	0	33	-	-	25	-	8	17	8	-	-	-	92	-	-	-	28	0.46	Co
Sphaeroma serratum (Fabricius, 1787)	8	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	R
Tanaidacea																							
Leptochelia savignyi (Krøyer, 1842)	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0,4	0.01	R
Decapoda																							
Athanas nitescens (Leach, 1814)	8	8	-	-	-	15	20	13	25	-	-	-	-	-	-	-	-	-	-	-	4	0.07	C
Cumacea																							
Cumella limicola (Sars, 1879)	8	8	-	8	8	32	-	8	-	-	-	-	-	-	-	-	-	-	-	-	4	0.06	C
Acarina																							
Acar sp.	17	8	-	18	8	50	-	10	-	-	-	-	-	-	-	-	-	-	-	-	6	0.09	C
Mollusca																							
Gastropoda																							
Acanthochitona fascicularis (Linnaeus, 1767)	-	-	-	-	33	-	-	-	-	25	-	-	-	-	8	-	-	-	-	-	3	0.05	R
Cyclope donovani (Risso,1826)	-	-	-	8	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	1	0.01	R
Patella caeurelea Linnaeus, 1758	-	-	-	-	25	-	-	-	-	25	-	-	-	-	25	-	-	-	-	75	8	0.12	R
Rapana thomasiana Crosse, 1861	-	8	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.01	R
Rissoa splendida (Eichwald, 1830)	-	-	308	117	175	83	400	8	1233	150	-	8	-	25	100	-	-	-	-	225	142	2.31	Co
Tricolia pullus pullus (Linnaeus, 1758)	-	-	375	100	358	142	2200	292	2042	325	142	58	-	108	225	-	383	25	150	275	360	5.88	R

Table 1. Continued.

Systematic groups	S1	S2	S3	S4	S5	F1	F2	F3	F4	F5	W1	W2	W3	W4	W5	Sp1	Sp2	Sp3	Sp4	Sp5	M.A	DI%	F%
Bivalve																							
Mytilus galloprivancialis (Lamarck, 1819)	-	8	17	-	8	-	-	8	375	-	-	-	-	-	-	-	100	-	-	-	26	0.42	R
Platyhelminthes																							
Stylochus sp.	-	75	42	42	150	33	433	108	-	75	-	-	-	-	25	-	-	-	-	125	55	0.90	Co
Annelida																							
Polychaeta																							
Nereis zonata Malmgren (1867)*	-	1712	209	1550	575	-	-	-	-	450	-	-	-	-	225	-	-	-	-	325	252	4.12	C
Perinereis cultifera Grube (1840)	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	R
Platynereis dumerilii (Audouin and Edwards, 1833)*	8	275	184	575	17	-	-	-	-	8	-	-	-	-	8	-	-	-	-	17	55	0.89	C
*Nereis sp.**	42	50	42	17	8	-	-	-	-	-	50	108	33	-	-	32	113	160	107	-	38	0.62	Co
Nereis pelagica (Linné, 1758)*	-	8	-	-	-	-	50	-	-	-	-	-	-	-	-	-	17	-	-	-	4	0.06	R
Nereis rava Ehlers (1868)*	-	-	8	-	-	-	-	-	-	-	-	-	17	-	-	-	-	-	-	-	1	0.02	R
Phyllodoce sp.	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	R
Syllis sp.	-	-	-	25	17	-	-	-	-	8	-	-	-	-	8	-	-	-	-	17	4	0.06	R
Others	-	33	-	25	125	17	67	25	17	100	25	-	8	33	75	43	-	-	-	150	37	0.61	Co
Total number of individiulas	24116	16937	21676	15175	9742	2808	5619	2883	4775	4346	600	749	616	333	1058	308	1421	2878	1507	3184	6123	-	-

*Data obtained from Gözler et al. (2009) (except for station 5).

lowest (303 ind.m^{-2}) at station 1 in spring. The amphipods *Ampithoe ramondi*, *Ampithoe sp*, and *Ericthonius brasiliensis* with the highest number of specimens were the dominant species at station 1. At each station, there was a similar fluctuation in number of specimens having a peak 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 values at the stations were determined in various seasons as below: At stations 3 (H′ = 3.11, J′ = 0.71) in summer, and (H′= 3.06 J′ = 0.73) in fall; at stations 2 (H′ = 3.13, J′ = 0.86) in the summer, and at the station 4 (H′ = 3.86, J′ = 0.86) in the spring (Figure 4). Based on Bray–Curtis similarity values, 4 groups of stations can be described (Figure 5). In these groups, station 5 was separated from other stations in all seasons. In the winter sampling period we found only four species in station 4.

DISCUSSION

A total of 6123 individuals belonging to 38 invertebrate species were recorded from *C. barbata* facies along the Southeastern Black Sea coast. Among the identified species, *Idotea metallica* is the first record of the Black Sea coast of Turkey. In previous studies performed on Aegean Sea and its vicinity, concerning inverte-brate diversity associated with Cystoseira facies, Kocatas (1978) reported 191 invertebrate species, Calis (1984) 55 species, Gulpercin (1990) 115 species, Ergen and Cınar (1994) 153 species, and Kansu (1995) 145 species. According to a study carried out at the Sinop Peninsula coast (Turkish Black Sea), Demirci (2003) determined 128 invertebrate species (59 Artropod, 34 Annelid, 24 Mollusc and 11 species relating to other groups) from *C.barbata* facies. Gozler et al. (2009) reported 5 polychaeta species associated with *C. barbata* from Eastern Black Sea coast. All previous studies mentioned above compared the faunal and floral structure of facies; therefore, our study is comparable to those only in terms of number of species. Moreover, the number of species determined in our study is remarkably lower than in other previous studies. The relation-ship between algal complexity and faunal distri-bution is not simple, as other factors such as food distribution, competition, plant defense and parasite may also play important roles in structuring faunal communities (Russo, 1990). This fact can be

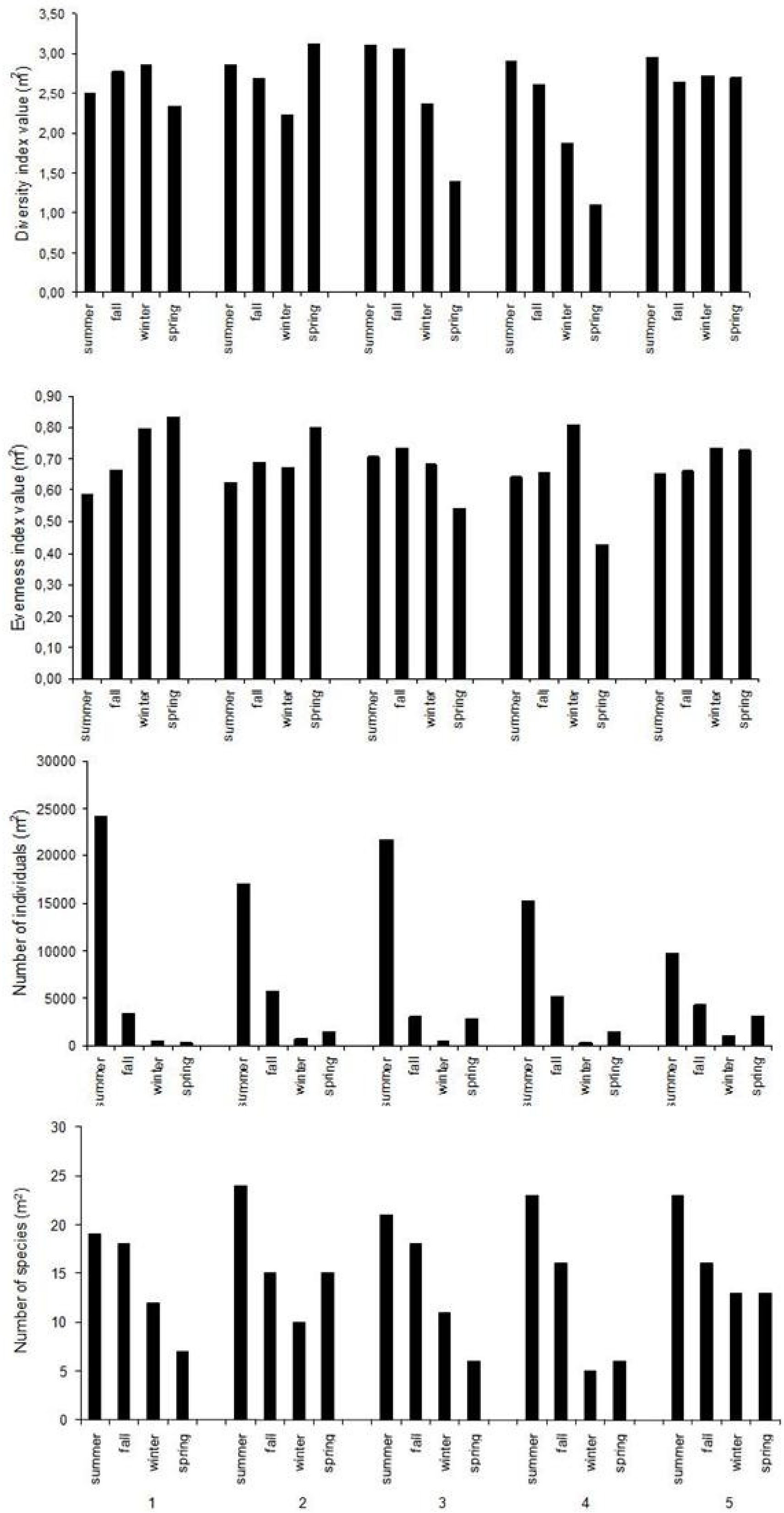

Figure 4. Temporal fluctuations in the mean number of species, faunal densities (number of individuals.m^{-2}), diversity index and evenness index at each station (W: Winter, Sp: Spring, S: Summer, F: Fall).

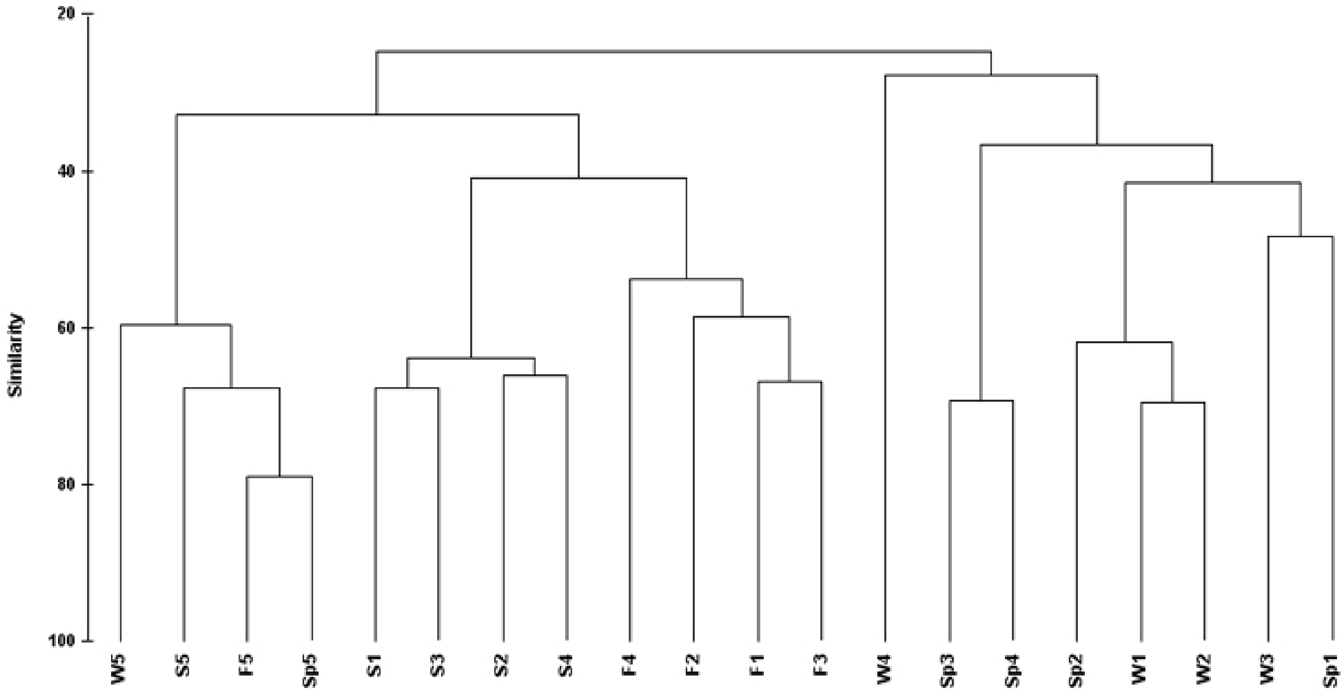

Figure 5. Results of Cluster analysis, based on Bray-Curtis Similarity Index (W: Winter, Sp: Spring, S: Summer, F: Fall).

explained that the samplings from *C. barbata* facies exposed to different hydrographical conditions differ locally in the Black Sea, and this impacts on the distribution of marine organisms. Because of intensive freshwater input, Eastern part of Turkish Black Sea coast differ from central part of Turkish Black Sea coast.

areas investigated (Edgar, 1983). Seasonal changes of invertebrate species are considered, highest number of individuals and species were found at summer. Animal numbers rise during the summer months in response to the considerable habitat heterogeneity and production epiphytes, but, as these resources are removed by grazers in autumn, predation and lack of recruitment reduce the number of invertebrates to comparatively low winter and spring levels (Edgar, 1983).

Many researchers have reported that, increasing eutrophication and other man-made activities have considerably changed the structure and functioning of the Black Sea ecosystems, mainly in its NW corner, affecting both the qualitative and the quantitative state of the benthic and planktonic communities during the last four decades. The increasing anthropogenic affects along the Eastern coast of Turkish Black Sea, particularly threat *C.barbata*, which is intolerant eutrophication, and fauna associated with this macrophyte. This study has information for ecological valuation of macrophyte ecosystems habitat protection, and fisheries management. This present study show that further investigations need to be carried out on Cystoseira and other macrophytes, in order to monitor changes of biodiversity.

In this study, Arthropoda was the dominant group (especially order Amphipoda) in the *C. barbata* throughout the year. Water depth had the greatest influence on the distribution of the phytal fauna. Amphipods peaked in abundance in shallow water (<2 m depth), while isopods and molluscs were most common in the deepest (>5 m)

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