Cah. Biol. Mar. (2005) 46 : 253-263

Polychaete assemblages on shallow-water benthic habitats along the Sinop Peninsula (Black Sea, Turkey)

Melih Ertan ÇINAR[1] & Gamze GÖNLÜGÜR-DEMIRCI[2]
(1) *Ege University, Faculty of Fisheries, Department of Hydrobiology, 35100 Bornova, Izmir, Turkey.*
Fax: +902323883685, E-mail: cinar@sufak.ege.edu.tr
(2) *Ondokuz Mayis University, Faculty of Fisheries, Department of Hydrobiology, Sinop, Turkey.*

Abstract: The present study describes polychaete assemblages on three shallow-water benthic habitats, *Ulva rigida*, *Cytoseira barbata* and *Mytilus galloprovincialis*, in relation to space and time from the Sinop Peninsula (Turkish Black Sea coast). A total of 55 polychaete species and 21493 individuals belonging to 16 families were identified. Among the species, eight are reported for the first time from the Black Sea and 29 species from the Turkish Black Sea coasts. The polychaete density in the area ranged from 500 ind.m^{-2} to 46775 ind.m^{-2} (both on *M. galloprovincialis*), the polychaete biomass from 3.97 g.m^{-2} (on *U. rigida*) to 72.01 g.m^{-2} (on *M. galloprovincialis*). The highest diversity index values were calculated on *M. galloprovincialis*. Among the biotopes, *C. barbata* had the highest mean polychaete density in all seasons, whereas *M. galloprovincialis* possessed the highest mean biomass value in all seasons except in spring. Analysis of similarity revealed that polychaete community structure significantly differed among biotopes, sites and seasons.

Résumé : *Assemblages de Polychètes des habitats benthiques côtiers le long de la péninsule de Sinop (Mer Noire, Turquie).* La présente étude décrit dans l'espace et le temps les assemblages de polychètes de la péninsule de Sinop (côte turque de la Mer Noire) de trois habitats benthiques peu profonds, *Ulva rigida*, *Cytoseira barbata* et *Mytilus galloprovincialis*. Un total de 55 espèces de polychètes et 21493 individus appartenant à 16 familles ont été identifiés. Parmi les espèces, huit sont signalés pour la première fois en Mer Noire et 29 espèces sur les côtes turques de la Mer Noire. La densité de polychètes dans le secteur varie de 500 ind.m^{-2} à 46775 ind.m^{-2} (tous les deux sur *M. galloprovincialis*), la biomasse de polychète de 3,97 g.m^{-2} (sur *U. rigida*) à 72,01 g.m^{-2} (sur *M. galloprovincialis*). Les valeurs les plus élevées d'indice de diversité ont été calculées sur *M. galloprovincialis*. Parmi les biotopes, *C. barbata* présente la densité moyenne de polychètes la plus élevée à toutes les saisons, tandis que *M. galloprovincialis* présente la biomasse moyenne la plus élevée à toutes les saisons, excepté au printemps. L'analyse de similarité indique que la structure des assemblages de polychètes diffère de manière significative selon les biotopes, les emplacements et les saisons.

Keywords: Polychaetes, Assemblages, Ecological features, Benthic habitats, Black Sea.

Introduction

Polychaetes inhabiting the Turkish Black Sea coast have been poorly studied to date, with available data mainly derived from studies on soft-bottom polychaetes from the entrance of the Bosphorus Strait (Dimitresco, 1960, 1962; Rullier, 1963; Caspers, 1968; Kiseleva, 1981; Uysal et al., 2002), on polychaetes within fouling communities in Amasra Harbour (middle part of the Turkish Black Sea coast) (Pinar, 1974) and on *Melinna palmata* Grube 1870 off Trabzon (eastern part of the Turkish Black Sea coast) (Emig et al., 2003). These studies were mainly focused on

Reçu le 12 janvier 2005 ; accepté après révision le 31 mai 2005.
Received 12 January 2005; accepted in revised form 31 May 2005.

the distribution of polychaetes along the Turkish Black Sea coast and have reported a total of 95 species belonging to 27 families. However, there are a number of papers dealing with faunistic and ecological aspects of polychaetes on the other coasts of the Black Sea, for example Marinov (1959; 1963; 1964; 1968; 1977) and Kiseleva (2004). Polychaetes were also evaluated within general ecological works in the Black Sea such as Arnoldi (1941), Zenkevitch (1963), Bacescu et al. (1965), Abadjieva & Marinov (1977), Bacescu (1977) and Kiseleva (1981).

The present study aims to investigate shallow-water polychaete diversity along the Turkish Black Sea coast and assess their spatio-temporal distribution patterns on the habitats, *Ulva rigida* C. Agardh, *Cystoseira barbata* (Good. & Woodw.) Agardh and *Mytilus galloprovincialis* Lamarck.

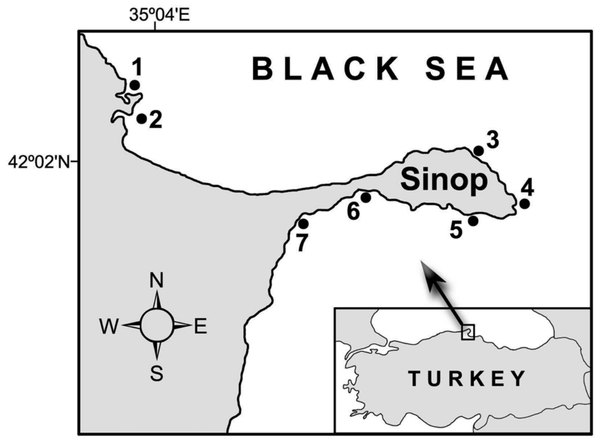

Figure 1. Map of the investigated area with the location of sampling sites.

Figure 1. Carte du secteur étudié et localisation des sites de prélèvement.

Material and Methods

A total of 7 stations was chosen along the Sinop Peninsula (mid-Black Sea region of Turkey) to collect polychaetes associated with the green alga *Ulva rigida* [stations 3 (3 m), 5 (1.5 m) and 7 (1m)], the brown alga *Cystoseira barbata* [stations 1 (3 m), 5 (50 cm) and 7 (50 cm)] and the mussel *Mytilus galloprovincialis* [stations 2 (2 m), 4 (50 cm and 5 m) and 6 (50 cm and 5 m)] (Fig. 1). One sample with an area of 20 x 20 cm (400 cm^2) was taken from each habitat at all stations in each season (July 1999, September 1999, January 2000 and April 2000), except for stations 4 and 6 where the mussel samples were collected at two different depths; 50 cm and 5 m.

Samples were first fixed in 4% formaldehyde, rinsed in freshwater in the laboratory and then sieved through a 0.5-mm mesh. Sorted animals were preserved in 70% ethanol. Polychaetes were separated from the other taxa, identified and counted using dissecting and stereo microscopes. The wet weights of polychaetes from each sample were estimated using a balance of 0.001 g sensitivity.

In order to highlight the structure of polychaete communities in the studied habitats, the following ecological indices were used: Shannon-Weaver's diversity index (log_2 base, H'), Pielou's evenness index (J'), Margalef's species richness index (d) and Soyer's frequency index (F) were applied to the presence and abundance of the species.

The numerical abundance data, obtained per habitat at all stations in each season, were analysed using cluster and multidimensional scaling (MDS) techniques, based on the Bray-Curtis similarity, using the PRIMER package (Clark & Warwick, 2001). Prior to the analysis, the raw data expressed as number of individuals in each sample were transformed using the square root transformation. The cluster analysis and MDS technique were performed on a reduced set of species in order to limit the noise caused by the very rare species (only those found once). SIMPER analysis was performed to identify the percentage contribution of each species to the overall similarity within each of the groups that were assessed from cluster analysis.

Results

Faunistic analysis of polychaetes collected seasonally from three habitats, *Cystoseira barbata*, *Ulva rigida* and *Mytilus galloprovincialis* at 7 stations along the Sinop Peninsula revealed a total of 55 species and 21493 individuals belonging to 16 families (Table 1). Among the species, 8 (*Harmothoe gilchristi*, *Myrianida brachycephala*, *Myrianida edwarsi*, *Proceraea* cf. *picta*, *Syllides fulvus*, *Syllis gerlachi*, *Syllis* cf. *compacta* and *Prionospio multibranchiata*) are being reported for the first time from the Black Sea and 29 species from the Turkish Black Sea coasts (see Table 1).

As shown in Table 1, some of the individuals were only identified to the genus or family level, due to the poor condition of specimens. For example, a high number of *Harmothoe* sp. were found from all habitats examined, but as all elytra were missing (an important characteristic in identification of *Harmothoe)*, identification to species level was not possible. The families represented by a high number of species and individuals at all habitats and stations were the Syllidae and Nereididae, together comprising 51% of the total number of species and 98% of the total polychaete populations. The most dominant species found in the area were *Platynereis dumerilii* (21% of total polychaete specimens), *Salvatoria clavata* (19%), *Nereis zonata* (17%), *Exogone naidina* (14%) and *Salvatoria limbata* (12%).

Table 1. List of polychaete species found and their abundance on the habitats studied at each station.
Tableau 1. Liste des espèces de polychètes échantillonnées et leur abondance d'individus sur les habitats étudiés à chaque station.

Habitats	*Cystoseira barbata*			*Ulva rigida*			*Mytilus galloprovincialis*				
Depths	3 m	50 cm	50 cm	3 m	1.5 m	1 m	5 m	5m	2 m	50 cm	50 cm
Stations	C1	C5	C7	U3	U5	U7	M4	M6	M2	M4	M6
POLYNOIDAE											
***Harmothoe impar* (Johnston, 1839)	1	-	-	5	4	3	14	4	1	-	-
Harmothoe sp.	14	1	3	1	2	-	4	80	1	2	5
**Harmothoe gilchristi* Day, 1960	-	-	-	-	-	-	5	-	-	-	-
PHOLOIDAE											
Pholoe inornata Johnston, 1839	1	-	-	-	1	-	2	7	-	1	-
PHYLLODOCIDAE											
***Eulalia clavigera* (Audouin & M Edwards, 1834)	46	15	2	5	4	-	-	11	13	-	2
Eulalia sp.	-	-	-	-	1	-	-	2	-	-	1
Phyllodoce sp.	1	1	-	1	-	-	2	-	2	1	6
Notophyllum sp.	-	-	-	-	-	-	-	3	1	-	-
Nereiphylla rubiginosa (Saint-Joseph, 1888)	-	-	-	-	-	-	-	1	-	-	-
SYLLIDAE											
**Myrianida brachycephala* (Marenzeller, 1874)	-	-	9	-	-	-	-	-	-	-	-
**Myrianida edwarsi* Saint-Joseph, 1887	-	-	43	-	-	-	-	-	1	-	-
***Myrianida prolifer* (O. F. Muller, 1788)	-	2	3	9	-	-	-	-	1	-	-
Myrianida sp.	-	-	-	1	-	-	-	-	3	-	-
**Proceraea* cf. *picta* Ehlers, 1864	-	-	-	-	-	-	-	-	1	-	-
Exogone (*Exogone*) *naidina* Oersted, 1845	1224	472	74	116	495	17	34	101	362	3	15
Sphaerosyllis sp.	-	-	-	-	1	-	-	-	-	-	-
Salvatoria clavata (Claparède, 1863)	335	1314	539	255	236	65	269	352	206	51	384
***Salvatoria limbata* (Claparède, 1868)	645	370	235	137	455	28	93	85	397	33	128
Parapionosyllis sp.	-	-	-	-	-	1	-	-	-	-	-
***Amblyosyllis formosa* (Claparède, 1863)	1	-	-	-	-	-	-	-	1	-	-
***Pionosyllis pulligera* (Krohn, 1852)	1194	5	3	113	30	3	-	2	531	-	-
***Pionosyllis lamelligera* Saint-Joseph, 1886	-	-	1	-	-	-	-	-	-	-	-
**Syllides fulvus* (Marion & Bobretzky, 1875)	-	-	-	-	1	-	-	-	-	-	-
***Haplosyllis spongicola* (Grube, 1855)	-	-	-	-	-	-	-	-	1	-	-
**Syllis gerlachi* Hartmann-Schröder, 1960	-	-	-	-	-	1	-	-	-	-	-
Syllis gracilis Grube, 1840	2	5	1	1	-	2	9	215	12	21	741
***Syllis krohni* Ehlers, 1864	14	24	8	-	8	3	9	24	11	5	38
**Syllis* cf. *compacta* Gravier, 1900	-	-	-	-	-	-	-	-	-	1	-
Syllis prolifera Krohn, 1852	-	1	4	-	-	-	-	-	7	1	-
Syllis sp.	-	-	-	-	-	2	-	-	-	1	-
Trypanosyllis zebra (Grube, 1840)	-	-	-	-	1	1	1	36	1	-	16
NEREIDIDAE											
***Ceratonereis costae* (Grube, 1840)	3	1	-	-	-	-	-	-	-	-	-
Neanthes succinea (Frey & Leuckart, 1847)	-	-	-	-	-	-	-	15	-	-	34
***Nereis pelagica* Linnaeus, 1758	-	-	-	-	-	-	1	-	-	-	-
***Nereis zonata* Malmgren, 1867	220	174	321	95	72	66	245	1193	700	114	462
Perinereis cultrifera (Grube, 1840)	-	1	-	2	-	-	6	2	-	1	-
Platynereis dumerilii (Audouin & MEdwards 1833)	560	936	1174	192	407	187	201	83	721	96	57
EUNICIDAE											
***Lysidice ninetta (*Audouin & M Edwards 1833)	-	-	-	-	-	-	-	1	1	-	-
DORVILLEIDAE											
***Dorvillea rubrovittata* (Grube, 1855)	-	-	-	-	-	-	-	7	-	-	1
ORBINIIDAE											
***Protoaricia oerstedii* (Claparède, 1863)	-	1	-	-	-	-	-	-	-	-	-
SPIONIDAE											
***Spio decoratus* Bobretzky, 1870	-	-	-	-	1	-	-	-	-	-	-
Polydora ciliata (Johnston, 1838)	-	-	-	-	1	-	-	4	-	-	7
Prionospio cf. *cirrifera* Wiren, 1883	-	-	1	-	-	-	-	-	-	-	-
**Prionospio multibranchiata* Berkeley, 1927	-	-	-	-	1	-	18	14	2	-	-
Prionospio sp.	-	-	-	-	1	-	-	-	-	-	-
OPHELIIDAE											
***Polyophthalmus pictus* (Dujardin, 1839)	11	22	12	-	1	4	5	1	4	1	-

CAPITELLIDAE											
***Capitella capitata* (Fabricius, 1780)	-	-	-	-	-	-	-	1	-	-	-
CIRRATULIDAE											
Cirriformia sp.	-	-	-	-	-	-	-	1	-	-	-
TEREBELLIDAE											
Polycirrus sp.	1	-	-	-	-	-	-	-	-	-	-
Terebellidae (sp.)	1	-	-	-	-	-	-	-	-	-	-
SABELLIDAE											
Fabricia stellaris adriatica (Banse, 1956)	11	2	-	-	1	-	-	-	14	-	-
SERPULIDAE											
***Vermiliopsis striaticeps* (Grube, 1862)	1	-	-	-	-	-	-	-	-	-	-
Filograna sp.	+	+	+	+	+	+	+	+	+	+	+
SPIORBIDAE											
***Janua pagenstecheri* (Quatrefages, 1865)	+	+	+	+	+	+	+	+	+	+	+
***Pileolaria militaris* (Claparède, 1868)	+	+	+	+	+	+	+	+	+	+	+

* new records for the Black Sea coast, ** new records for the Turkish Black Sea coast, + numerous specimens

According to Soyer's frequency (F) classification, only 10 out of 55 species found can be classified as constant (F ≥ 50), 6 species as common (F between 25 and 49) and 39 species as rare (F < 25). Among the constant species, *Salvatoria clavata* (100%) ranked first, followed by *Platynereis dumerilii* (91%), *Nereis zonata* (89%) and *Syllis krohni* (84%). The species with the highest frequency scores within the common category were *Eulalia clavigera* (48%), *Pionosyllis pulligera* (43%), *Harmothoe* sp. (36%) and *Polyophthalmus pictus* (30%). The rare species occurring in only one sample were *Harmothoe gilchristi*, *Nereiphylla rubiginosa*, *Myrianida brachycephala*, *Proceraea* cf. *picta*, *Sphaerosyllis* sp., *Parapionosyllis* sp., *Pionosyllis lamelligera*, *Syllides fulvus*, *Haplosyllis spongicola*, *Syllis gerlachi*, *Syllis* cf. *compacta*, *Nereis pelagica*, *Protoaricia oerstedi*, *Spio decoratus*, *Prionospio* cf. *cirrifera*, *Prionospio* sp., *Capitella capitata*, *Cirriformia* sp.**,** Terebellidae (sp.), *Polycirrus* sp. and *Vermiliopsis striaticeps*.

When considering the total number of polychaete species in each habitat, the highest number of species (41 species) was found on *Mytilus galloprovincialis,* the lowest on *Cystoseira barbata* (31 species) and a total of 32 species in association with *Ulva rigida*.

The total number of species and individuals, values of biomass, species richness, diversity and evenness indices as well as the dominant species of all samples are presented in Table 2. The dominant polychaete species sampled on *Cystoseira barbata*, *Ulva rigida* and *Mytilus galloprovincialis* differ according to station and season, but all belong to the Syllidae and Nereididae families. The species *Platynereis dumerilii*, *Pionosyllis pulligera*, *Nereis zonata* and *Salvatoria clavata* were dominant components of all habitats examined during this study. However, *Syllis gracilis* was the most important species from the *M. galloprovincialis* samples taken in summer (3850 ind.m^{-2}) and autumn (13150 ind.m^{-2}) at station 6. Whilst *Exogone naidina* was dominant in one sample of *C. barbata* taken from station 1 in spring (15750 ind.m^{-2}) and two samples of *U. rigida* collected at station 5 in spring (2025 ind.m^{-2}) and winter (6025 ind.m^{-2}).

The highest number of species was encountered on *Mytilus galloprovincialis* taken in autumn at station 2 (23 species) and at station 6, 5 m depth (22 species). The lowest number of species was found on *Cystoseira barbata* at station 7 in summer (6 species) (Table 2). Population densities of polychaetes ranged from 500 ind.m^{-2} (on *M. galloprovincialis*; station 4, 50 cm depth, winter) to 46775 ind.m^{-2} (on *M. galloprovincialis*; station 2, autumn); biomass values from 3.97 g.m^{-2} (on *Ulva rigida*; station 7, autumn) to 72.01 g.m^{-2} (on *M. galloprovincialis*; station 6, summer); species richness index from 0.66 (on *C. barbata*; station 7, summer) to 2.83 (on *M. galloprovincialis*; station 6, autumn); diversity index values from 0.69 (on *U. rigida*; station 3, summer) to 2.75 (on *M. galloprovincialis*; station 4, 50 cm depth, summer); and evenness index values from 0.30 (on *U. rigida*; station 3, summer) to 0.89 (on *C. barbata*; station 7, summer).

Maximum polychaete population densities on *Cystoseira barbata* always occurred in autumn (except for station 1 occurring in spring); on *Ulva rigida* always in winter; and *Mytilus galloprovincialis* in autumn (Table 2). As for biomass values, maximum levels always occurred in spring on *C. barbata*, mostly in winter on *U. rigida* and in different seasons on *M. galloprovincialis* (generally high in summer and winter at station 6, always high in spring at station 4 and high in autumn at station 2). As diversity and evenness indices are very sensitive to high abundance levels of a given species in a sample, they were no distinct patterns among stations and seasons, and fluctuated according to the number of species and the dominance levels of species within samples. However, diversity index

Table 2. Number of species (S), density (N), biomass (B), Margalef index (R), evenness index (J') and Shannon diversity index (H') estimated on each habitat and season with their most dominant species (%). D: Depth, St: Station.

Tableau 2. Nombre d'espèces (S), densité (N), biomasse (B), indice de Margalef (R), régularité (J') et indice de diversité de Shannon (H') estimés pour tous les habitats et les saisons avec leurs espèces dominantes (%). D : profondeur, St : Station.

	D	St	Season	S	N (ind.m-2)	B (g.m-2)	R	J'	H'	Dominant species (%)
Cytoseira barbata	3 m	1	Spring	16	42150	55.48	1.75	0.63	2.41	*Exogone naidina* (37)
			Summer	14	24450	34.73	1.74	0.62	2.30	*Platynereis dumerilii* (36)
			Autumn	12	18800	11.44	1.51	0.64	2.22	*Pionosyllis pulligera* (37)
			Winter	13	21750	26.79	1.48	0.63	2.18	*P. pulligera* (44)
	50 cm	5	Spring	13	14375	66.76	1.42	0.56	1.87	*Salvatoria clavata* (54)
			Summer	9	30075	26.34	0.71	0.52	1.35	*S. clavata* (68)
			Autumn	15	33275	21.53	1.53	0.59	2.12	*P. dumerilii* (45)
			Winter	13	5950	12.12	1.65	0.69	2.28	*S. clavata* (38)
	50 cm	7	Spring	11	13450	53.20	1.27	0.67	2.11	*P. dumerilii* (46)
			Summer	6	525	7.07	0.66	0.89	1.41	*Nereis zonata* (57)
			Autumn	15	32125	19.84	1.68	0.55	2.02	*P. dumerilii* (53)
			Winter	9	14725	34.44	0.78	0.45	1.15	*S. clavata* (57)
Ulva rigida	3 m	3	Spring	11	3600	9.63	1.41	0.78	2,35	*P. pulligera* (42)
			Summer	8	5375	21.26	0.74	0.30	0.69	*S. clavata* (87)
			Autumn	11	4425	5.21	1.55	0.73	2.31	*N. zonata* (30)
			Winter	13	9925	50.11	1.50	0.75	2.51	*Salvatoria limbata* (28)
	1.5 m	5	Spring	11	4675	9.15	1.34	0.68	2.03	*E. naidina* (43%)
			Summer	12	6025	4.33	1.46	0.39	1.24	*S. limbata* (74%)
			Autumn	19	15550	21.7	2.33	0.52	2.09	*P. dumerilii* (50)
			Winter	13	16850	21.58	1.38	0.66	2.18	*E. naidina* (36)
	1 m	7	Spring	9	1650	8.3	1.19	0.54	1.39	*P. dumerilii* (70)
			Summer	9	1550	6.08	1.21	0.54	1.40	*S. clavata* (53)
			Autumn	9	925	3.97	1.39	0.72	1.87	*P. dumerilii* (54)
			Winter	11	5450	15.93	1.3	0.67	2.02	*P. dumerilii* (44)
Mytilus galloprovincialis	2 m	2	Spring	13	5500	17.13	1.67	0.72	2.39	*N. zonata* (34)
			Summer	17	16800	20.97	2.15	0.63	2.47	*P.dumerilii* (29)
			Autumn	23	46775	36.68	2.52	0.59	2.58	*P. pulligera* (27)
			Winter	9	5800	8.98	0.92	0.55	1.43	*P. dumerilii* (50)
	50 cm	4	Spring	12	2200	31.96	1.79	0.72	2.28	*N. zonata* (40)
			Summer	12	1175	9.63	2.08	0.87	2.75	*S. clavata* (26)
			Autumn	10	4425	11.08	1.16	0.66	1.86	*P. dumerilii* (42)
			Winter	10	500	8	2.00	0.80	2.26	*S. limbata* (45)
	50 cm	6	Spring	11	4425	39.71	1.35	0.65	1.95	*N. zonata* (59)
			Summer	12	6575	47.26	1.62	0,53	1.77	*Syllis gracilis* (59)
			Autumn	13	28250	23.64	1.42	0.60	2.08	*S. gracilis* (47)
			Winter	15	8175	54.3	1.9	0.60	2.15	*N. zonata* (57)
	5 m	4	Spring	13	2725	35.23	1.92	0.69	2.28	*S. clavata* (52)
			Summer	13	3225	7.62	1.85	0.71	2.35	*S. clavata* (42)
			Autumn	13	12375	15	1.45	0.66	2.21	*P. dumerilii* (36)
			Winter	13	4625	7.37	1.72	0.71	2.35	*N. zonata* (37)
	5 m	6	Spring	18	8400	59.11	2.58	0.58	2.32	*N. zonata* (53)
			Summer	16	10450	72.01	2.15	0.61	2.34	*N. zonata* (39)
			Autumn	22	20550	29.89	2.83	0.51	2.20	*N. zonata* (55)
			Winter	19	16725	68.89	2.31	0.52	2.10	*N. zonata* (60)

values were always higher than 2 for *C. barbata* at station 1 and for *M. galloprovincialis* at stations 4 and 6 (5 m depth).

Figure 2 showed mean values of population density, biomass and diversity index on the habitats with respect to seasons. The brown alga *Cystoseira barbata* had the highest

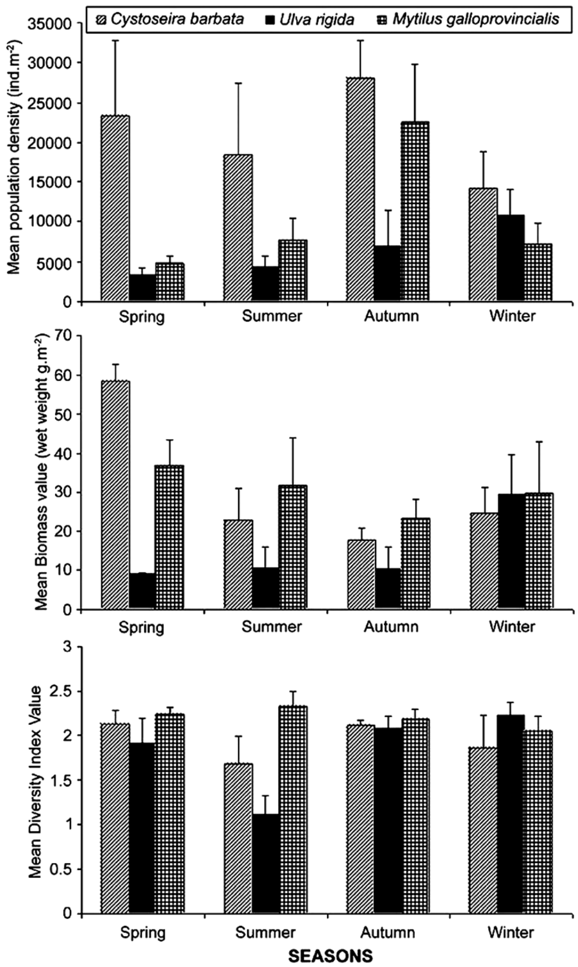

Figure 2. Seasonal fluctuations of mean community density (ind.m^{-2}), biomass (g.m^{-2}) and Shannon diversity index on the three habitats.

Figure 2. Fluctuations saisonnières de la densité moyenne (ind.m^{-2}), de la biomasse (g.m^{-2}) et de l'indice de diversité de Shannon sur les trois habitats étudiés.

mean values for polychaete densities in all seasons, whereas the green alga *Ulva rigida* had the lowest in all seasons, except for winter. *Mytilus galloprovincialis* possessed the highest polychaete biomass values in all seasons, except for spring when *C. barbata* had the highest biomass value. The highest diversity index values were also estimated on *M. galloprovincialis* in all seasons, except for winter when *U. rigida* had the highest score.

The results of MDS analysis based on seasonal species abundance on each habitat (Fig. 3) showed three assemblages on *Ulva rigida* and *Cystoseira barbata*, and four on *Mytilus galloprovincialis*. SIMPER analysis detected a total of 11 species that are responsible for 90% of similarity in all associations (Table 3). The species that contributed greatly to the similarity of the groups detected on *U. rigida* are *Platynereis dumerilii*, *Salvatoria clavata*, *S. limbata* and *Exogone naidina* and were represented by different population densities in each assemblage (i.e. *P. dumerilii* had average densities of 750 ind.m^{-2}, 3200 ind.m^{-2} and 275 ind.m^{-2} in the groups A, B and C, respectively). A similar result was also found on *C. barbata*; the sample grouping again mainly constructed by the above-mentioned species. However, *Syllis krohni* (to a lesser extent) and *Pionosyllis pulligera* (to a greater extent) played an important role in the assemblages A and B on *C. barbata*. There were four distinct species assemblages on *Mytilus galloprovincialis*, differing in their population densities of the species *Nereis zonata*, *P. dumerilii*, *S. clavata* and *S. limbata*. Unlike *U. rigida* and *C. barbata*, two syllid species (*Syllis gracilis* and *Trypanosyllis zebra*) and one nereidid species (*Neanthes succinea*) were also among the species responsible for constructing assemblages on *M. galloprovincialis*. When all abundance data were pooled by station and habitat, it could be seen that there were three assemblages with an average similarity higher than 73% (Fig. 3). Except for *Eulalia clavigera*, which was one of the main components of group A, the species that contributed most to the similarity and dissimilarity among associations on the three habitats were also responsible for the groups determined on the pooled data. The samples of *C. barbata* and *U. rigida* were similar to each other, except for samples taken from station 7 on *U. rigida*, which had similarity with the sample of *M. galloprovincialis* collected at station 4. This was due to the fact that these samples were mainly characterized by low densities of *E. naidina* and *S. limbata*. The relatively high densities of the species *Syllis gracilis*, *S. krohni*, *T. zebra* and *N. zonata* contributed to the dissimilarity between samples taken from station 6 on *M. galloprovincialis* (association B) and the others (Fig. 3D).

Discussion

The present paper enhances our knowledge about the shallow-water polychaete fauna of the Black Sea, adding 8 previously unrecorded species to the species inventory of the Black Sea fauna and 29 species to the Turkish Black Sea fauna. Of all species reported here for the first time in the Black Sea, six are syllids, which are known to occur in the other basins of the Mediterranean Sea. The syllids (*Myrianida brachycephala*, *M. edwarsi*, *Proceraea* cf *picta*, *Syllides fulvus*, *Syllis gerlachi*, *Syllis* cf *compacta*) were reported to be among dominant species of the shallow waters of the Aegean Sea (Çinar, 2003).

Eulalia viridis (Linnaeus, 1767) was frequently reported on hard substrates from the Black Sea (Marinov, 1964; 1977; Kiseleva, 2004). However, a morphologic and biochemical study performed by Bonse et al. (1996) on speci-

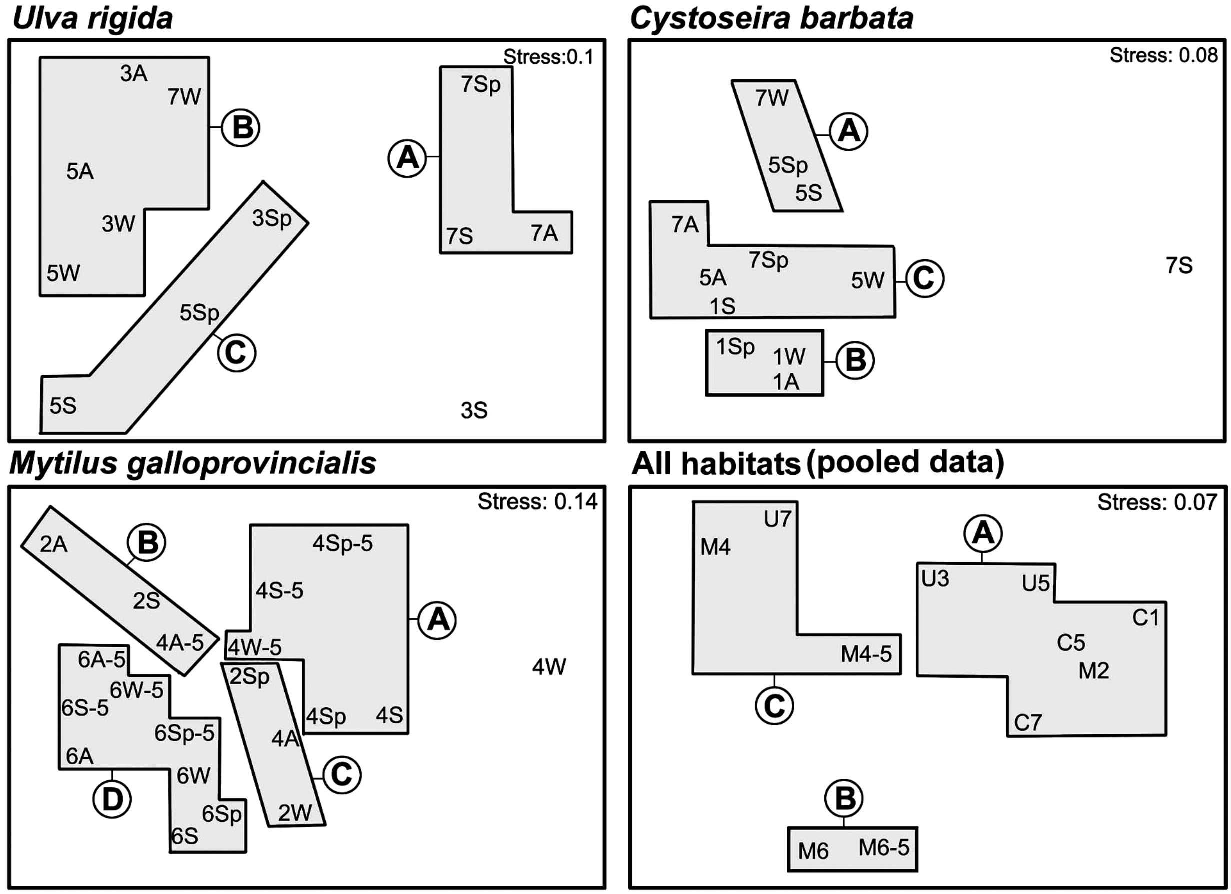

Figure 3. nMDS plot showing similarity among samples of *Ulva rigida*, *Cystoseira barbata*, *Mytilus galloprovincialis* and pooled data of all habitats. Associations in all samples were determined according to the results of Bray-Curtis similarity analysis (each association has a similarity higher than 45%). Number indicates stations and depth after hyphen. Sp: Spring, S: Summer, A: Autumn and W: Winter.

Figure 3. Analyse nMDS montrant la similarité entre échantillons récoltés sur *Ulva rigida*, *Cystoseira barbata* et *Mytilus galloprovincialis* et les données regroupées. Les associations entre échantillons ont été déterminées selon les résultats de l'analyse de similitude de Bray-Curtis (chaque association a une similarité supérieure à 45%). Le nombre indique la station, celui après le tiret la profondeur. Sp : Printemps, S : Été, A : Automne et W : Hiver.

mens of *Eulalia* along the eastern Atlantic coasts revealed that *E. viridis* is in fact a complex of two species, *E. viridis* and *E. clavigera*, which morphologically differ from each other in the length of anterior dorsal cirri; being about twice as long as broad in *E.viridis*, and $1^1/_2$ times as long as broad in *E. clavigera*. Examination of the type specimens of *E. clavigera* deposited at the Zoological Museum of Copenhagen and comparison with the Black Sea material indicated that our specimens and most probably the previous reports of *E. viridis* in the Black Sea appeared to be *E. clavigera*.

Among the habitats investigated, *Cystoseira barbata* had the highest polychaete densities in all seasons, followed by *Mytilus galloprovincialis* and *Ulva rigida*, respectively. Regarding the polychaete biomass, *M. galloprovincialis* generally ranked first, followed by *C. barbata* and *U. rigida*. However, in winter, *U. rigida* was ranked the second habitat in terms of population density and biomass, mainly due to high population densities of *Exogone naidina*, *Salvatoria limbata* and *Nereis zonata*. A similar trend was also encountered in the value of diversity index; *M. galloprovincialis* had the highest mean scores in all seasons (except for winter). These results showed that the habitats investigated support different microhabitats for polychaete settlement according to their complexity. Russo (1997) also compared epifaunal assemblages of shallow water algae around Cyprus and found that *C. barbata* supported fewer animals g^{-1} of plant. He suggested that *C. barbata* could produce allelochemicals which act as a defence against colonization by epibiota. Differences in epifaunal assem-

Table 3. Species contributing to similarity within each assemblage (as shown in Fig. 3), with their average similarity. Bold numbers indicate the highest score of species contribution in each assemblage.

Tableau 3. Espèces contribuant à la similarité dans chaque assemblage (tel que présenté Fig. 3), avec leurs similarités moyennes. Les nombres en gras indiquent les plus fortes contributions d'espèces dans chaque assemblage.

	Ulva rigida			*Cystoseira barbata*			*Mytilus galloprovincialis*				Total		
Associations	A	B	C	A	B	C	A	B	C	D	A	B	C
Average similarity	69	73	57	73	87	76	65	73	83	68	74	73	78
Eulalia clavigera	-	-	-	-	-	-	-	-	-	-	2	-	-
Exogone naidina	9	21	19	7	**26**	12	5	13	-	-	15	4	6
Salvatoria clavata	34	11	**32**	**53**	8	15	**32**	14	10	19	17	19	19
Salvatoria limbata	-	17	24	-	13	23	20	13	-	3	17	9	14
Pionosyllis pulligera	-	-	6	-	25	-	-	-	-	-	6	-	-
Syllis gracilis	-	-	-	-	-	-	-	-	10	18	-	15	4
Syllis krohni	-	-	-	3	-	-	5	-	-	5	-	5	4
Trypanosyllis zebra	-	-	-	-	-	-	-	-	-	5	-	4	-
Neanthes succinea	-	-	-	-	-	-	-	-	-	4	-	4	-
Nereis zonata	-	16	5	-	10	14	23	**25**	37	**32**	12	**23**	21
Platynereis dumerilii	**50**	**27**	6	29	11	**31**	5	24	**39**	6	**22**	8	**23**

blages on shallow water habitats such as algae, mussel and phanerogames depend on the structure of the habitat itself (Sardá, 1991; Çinar, 2003); habitats with large branched thalli and basal structures provide suitable shelter and food for species, and support high species diversity and abundance.

Studies on polychaete fauna associated with *Ulva rigida* are absent in the Black Sea and scarce in the Mediterranean Sea (Balduzzi et al. 2001; Sfriso et al. 2001). Sfriso et al. (2001) found a total of 8 polychaete species on *U. rigida* from Venice Lagoon and outlined the high dominance levels of the opportunistic species, *Capitella capitata* and *Neanthes caudata* (Chiaje, 1828) They also pointed out that benthic fauna living in *Ulva* stations were strongly affected by frequent anoxic conditions in spring-summer, whilst high species abundance occurred in winter when the water was relatively well oxygenated. Balduzzi et al. (2001) also found similar results that the abundance and biomass of macrofaunal components inhabiting *U. rigida* were strongly dependant on environmental parameters such as temperature, light availability and the oxidation state of the environment. The *Ulva rigida* polychaete community in the Black Sea is more diverse than that reported from Venice lagoon. As the environment from which samples of *U. rigida* were collected in the Black Sea was clean (transparent), the habitat was dominated by the species typical of undisturbed shallow water habitats. Kocatas (1978) studied epifaunal components of *Ulva lactuca* Linnaeus in Izmir Bay (Aegean Sea) and reported 31 polychaete species, of which *Platynereis dumerilii*, *Terebella lapidaria* Linnaeus (1767) and *Hydroides elegans* (Haswell, 1883) were the most important ones. In our collection, *P. dumerilii* was also the most important species on *U. rigida*, but no specimens of *T. lapidaria* and *H. elegans* were found on *U. rigida* from the Black Sea. The other striking difference between the study performed in Izmir Bay and the present study is that the minute syllid species such as *Exogone naidina*, *Salvatoria clavata* and *S. limbata* that characterized the *U. rigida* community in the Black Sea were absent among the material collected from Izmir Bay.

In the present study, the highest polychaete densities were encountered on the brown alga *Cystoseira barbata*, mainly due to the high densities of the key taxa such as *Exogone naidina* (max. 15875 ind.m^{-2}), *Salvatoria clavata* (max. 20550 ind.m^{-2}), *Pionosyllis pulligera* (max. 10625 ind.m^{-2}) and *Platynereis dumerilii* (max. 17000 ind.m^{-2}). Brown algae, which dominate the upper infralittoral zone of the Mediterranean Sea, are known to harbour a variety of epifaunal components (Bellan, 1964; Katzmann, 1971; Alós, 1990; Ergen & Çinar, 1994; Tena et al. 2000; Fraschetti et al., 2002). In the Black Sea, the fauna associated with *Cystoseira* spp. were studied in the following papers; Milovidova (1966), Tiganus (1972), Abadjieva & Marinov (1977) and Andriescu (1977). Milovidova (1966) reported 14 polychaete species on *C. barbata* collected from Novorosisk Bay and outlined the relative importance of the species *Nereis zonata*, *Platynereis dumerilii* and *Pomatoceros triqueter* (Linnaeus, 1767) within the community. Tiganus (1972) stated that the different *Cystoseira* species had different benthic assemblages. Abadjieva & Marinov (1977) found the highest species density and biomass on *Cystoseira barbata* in spring when juveniles were recruited. This finding was also evident in our study that the highest polychaete biomass was determined in spring. Like the present study, Andriescu (1977) reported a high abundance of *P. dumerilii* on *Cystoseira* species. Studies on polychaetes associated with *Cystoseira* spp. from the Mediterranean Sea outlined high polychaete diversity. For example, Çinar (2003) reported a total of 53 syllid species on *Cystoseira* spp. from the Aegean Sea, whereas 12 syllid species were found in this study. He also pointed out differences in syllid diversity among the *Cystoseira* species; 50 species were found on *C. crinita* (Desf.) Bory, whereas only 6 species were encountered on *C. compressa* (Esper) Ferloff & Nizamuddin. Alós (1990) identified a total of 86 polychaete species on *Cystoseira mediterranea* (Feldmann) from the western Mediterranean. The dominant polychaete species on *Cystoseira* spp. from the Mediterranean Sea seem to be almost constant. They are *P. dumerilii*, *S. clavata* and *Syllis prolifera*. Although *P. dumerilii* and *S. clavata* were also dominant on *C. barbata* in the Black Sea, *S. prolifera* was represented by only a few individuals. In contrast to the studies performed in the Mediterranean Sea, the Black Sea material had a dense population of *Pionosyllis pulligera*.

Polychaetes inhabiting *Mytilus galloprovincialis* beds were studied in the Black Sea by Bacescu et al. (1965), Kiseleva & Slavina (1966), Milovidova (1966), Bacescu (1977) and Kiseleva (1981). The community structure of polychaetes on *M. galloprovincialis* differed from one area to another and seemed to be greatly influenced by the environmental conditions prevailing in the area. For example, the following polychaetes which were reported to be dominant on *M. galloprovincialis* beds collected between 28 m and 41 m from Romania by Bacescu et al. (1965) were not found in the present study; *Nepthys hombergii* Savigny 1818 (500 ind.m^{-2}) and *Heteromastus filiformis* (Claparède, 1864) (150 ind.m^{-2}). Kiseleva (1981) reported a total of 40 polychaete species on *M. galloprovincialis* beds along the coasts of Crimea and Caucas, and pointed out the high frequency values of *Aricidea claudiae* Laubier 1967, *Sphaerosyllis bulbosa* Southern, 1914, *Prionospio fallax* Söderstrom, 1920 (cited as *P. malmgreni* Claparède, 1868) and *Terebellides stroemi* Sars 1835, which were also absent in our collection. There is only one species common (*Exogone naidina*) between the study by Kiseleva & Slavina (1966) and the present study. *Syllis gracilis*, which dominated the *M. galloprovincialis* beds along the Sinop Peninsula (max. density 13150 ind.m^{-2}), has not been previously reported on the mussel assemblages in the Black Sea. In contrast to the results from the Black Sea, the polychaete diversity on *M. galloprovincialis* in the Mediterranean was reported to have a stable structure and showed a certain similarity (Damianidis & Chintiroglou, 2000). We identified a total of 40 polychaete species on the *M. galloprovincialis* community in the Black Sea, but Kocatas (1978) listed 35 species in Izmir Bay; Bellan-Santini (1969) reported 14 species in clear water and 13 species in polluted waters from Marseille; Saldanha (1974) identified 33 species on mussels in various sites off Portugal coastline; Tsuchiya & Bellan-Santini (1989) reported 33 species on mussels in the region of Marseille; Topaloglu & Kihara (1993) mentioned only 10 species on mussel beds in the Bosphorus Strait; Damianidis & Chintiroglou (2000) encountered 48 species in the Bay of Thessaloniki; and more recently Chintiroglou et al. (2004) listed 45 species in Thermaikos Gulf. As it can be seen from the data indicated above, polychaete diversity of the mussel assemblages in the Black Sea are more diverse than many reports from the Mediterranean Sea, except for reports along the Greek coasts. As the Black Sea is brackish water (mean salinity value ca. 18‰), it can be expected that the mussel assemblages in the Black Sea contain a lesser number of polychaete species than those in the Mediterranean Sea. However, it seems that the water quality of sites where mussel samples are collected has a decisive effect in structuring the assemblages; the mussel beds from polluted environments provide lower numbers of species but high abundances of opportunistic species. Damianidis & Chintiroglou (2000) also pointed out the importance of the structure of mussel populations in the diversity of the polychaete fauna. When the mean polychaete densities on the mussel beds from the Aegean Sea are compared to that on the mussel beds from the Black Sea, it can be seen that the density ranged from 1000 to 62575 ind.m^{-2} in Thermaikos Gulf vs. and from 500 to 46775 ind.m^{-2} around the Sinop Peninsula.

The seasonal analysis of polychaete data indicated that polychaete density and biomass showed different seasonal patterns on each habitat. For example, polychaete density and biomass on *Cystoseira barbata* and *Mytilus galloprovincialis* reached their highest scores in autumn or spring, whereas those on *Ulva rigida* reached their maximum scores in winter. The density and biomass values on each habitat did not change synchronously among seasons. For example, both the highest density and lowest biomass scores on *C. barbata* were estimated in the same season (autumn). The value of biomass depends on the availability and number of specimens of large-sized polychaetes in the samples. The tiny syllids such as *Exogone naidina*, *Salvatoria clavata* and *S. limbata* dominated the samples of *C. barbata* in autumn and increased the total density scores of samples in this season. On the contrary, a lack or a small number of specimens of relatively large-sized polychaetes such as *Harmothoe* sp., *Pionosyllis pulligera* and Terebellidae (sp.) on *C. barbata* samples taken in autumn diminished the total biomass value of polychaetes in this season. The MDS analysis showed that there was no distinct seasonal pattern in the polychaete community structures associated with the habitats investigated. It was clearly evident in the mussel assemblages that samples collected from the same station in each season grouped together. This showed that understanding life cycles of each species on each habitat and their relationships with the prevailing environmental condition and biota is necessary to give a reasonable interpretation about the reason behind seasonal fluctuations in species number and biomass. Sardá et al. (1999) reported that seasonal patterns of reproductive events of species were the main factors which explain markedly repeated cycles in the abundance and biomass of macroinfaunal assemblages along the coast of the Bay of Blanes.

The present paper elucidates the faunistic and ecological features of polychaetes associated with the shallow water benthic habitats from the Turkish Black Sea coast where such studies have not been previously carried out. Future studies to be undertaken along the Black Sea coast would enable us to understand the real polychaete diversity of the Black Sea and their functional roles on biotopes.

Acknowledgements

We are much indebted to two anonymous referees for their constructive comments on the manuscript and to Dr. Kate Mortimer (National Museums and Galleries of Wales, U.K.) for correcting the English of the text.

References

Abadjieva V.K. & Marinov T. 1977. Zoobenthos in the *Cystoseira* biocenosis. *Bulgarian Academy of Sciences, Hydrobiology*, **6:** 76-88.

Alós C. 1990. Anélidos poliquetos del Cabo de Creus (NE de España). Facies de *Corallina eleongata* Ellis & Solander y de *Cystoseira mediterranea* (J. Feldmann). *Miscellania Zoologica*, **14:** 17-28.

Andriescu I. 1977. Le zoobenthos de l'ecosysteme des fonds rocheux de la côte Roumaine de la Mer Noire. *Biologie des eaux saumatres de la Mer Noire, 1ère Partie*: 117-127.

Arnoldi L. 1941. Quantitative characteristics of the zoobenthos of the Black Sea. *Travaux de l'Institut Zoologique de l'Académie des Sciences de l'URSS*: 94-113.

Bacescu M. 1977. Les biocenoses benthiques de la Mer Noire. *Biologie des eaux saumatres de la Mer Noire, Premiere partie*: 128-134.

Bacescu M., Müller G., Skolka H., Petran A., Elian V., Gomoiu M.T., Bodeanu N. & Stanescu S. 1965. Cercetari de ecologie Marina în sectorul predeltaic în conditiile Anilor 1960-1961. Ecologie Marina. *Editura Academiei Republicii Populare Romane, Bucuresti*: 185-344.

Balduzzi C., Sfriso A. & Pavoni B. 2001. Macrofauna impact on *Ulva rigida* C. Ag. production and relationship with environmental variables in the lagoon of Venice. *Marine Environmental Research*, **52:** 27-49.

Bellan G. 1964. Contribution à l'étude systématique, bionomique et écologique des Annélides Polychètes de la Méditerranée. *Recueil des Travaux de la Station Marine d'Endoume*, **49:** 1-371.

Bellan-Santini D. 1969. Contribution à l'étude des peuplements infralittoraux sur substrat rocheux (Etude qualitative et quantitative de la frange supérieure). *Recueil des Travaux de la Station Marine d'Endoume*, **47:** 5-294.

Bonse S., Schmidt H., Eibye-Jacobsen D. & Westheide W. 1996. *Eulalia viridis* (Polychaeta: Phyllodocidae) is a complex of two species in northern Europe: results from biochemical and morphological analyses. *Cahiers de Biologie Marine*, **37:** 33-48.

Caspers H. 1968. Le macrofaune benthique du Bosphore et les problemes de l'infiltration des elements Méditerranées dans le Mer Noire. *Rapport de la Commission Internationale Exploration de la Mer Méditerranée*, **19:** 107-115.

Chintiroglou C.C., Damianidis P., Antoniadou C., Lantzouni M. & Vafidis D. 2004. Macrofauna biodiversity of mussel bed assemblages in Thermaikos Gulf (northern Aegean Sea). *Helgolander Marine Research*, **58:** 62-70.

Çinar M.E. 2003. Ecological features of Syllidae (Polychaeta) from shallow-water benthic environments of the Aegean Sea, eastern Mediterranean. *Journal of the Marine Biological Association of the United Kingdom*, **83:** 737-745.

Clarke K.R. & Warwick R.M. 2001. *Change in marine communities: an approach to statistical analysis and interpretation, 2nd edition*. PRIMER-E: Plymouth.

Damianidis P. & Chintiroglou C.C. 2000. Structure and functions of Polychaetofauna living in *Mytilus galloprovincialis* assemblages in Thermaikos Gulf (north Aegean Sea). *Oceanologica Acta*, **23:** 323-337.

Dimitresco H. 1960. Contributions à la connaissance des polychètes de la Mer Noire, specialement des eaux prébosphoriques. *Travaux du Muséum d'Histoire Naturelle "Gregor Antipa"*, **2:** 69-85.

Dimitresco H. 1962. Nouvelle contribution á l'étude des polychètes de la Mer Noire. *Travaux du Muséum d'Histoire Naturelle "Gregor Antipa"*, **3:** 61-68.

Emig C.C., Çinar M.E. & Ergen Z. 2003. Phoronida from the eastern Mediterranean and Black Sea. *Cahiers de Biologie Marine,* **44:** 185-191.

Ergen Z. & Çinar M.E. 1994. Qualitative and quantitative investigations on the *Cystoseira* facies of the Aegean Sea. *XIIth National Biology Congress*, Edirne: 138-149 (in Turkish).

Fraschetti S., Giangrande A., Terlizzi A., Miglietta M.P., Della Tommasa L. & Boero F. 2002. Spatio-temporal variation of hydroids and polychaetes associated with *Cystoseira amentacea* (Fucales: Phaeophyceae). *Marine Biology*, **140:** 949-957.

Katzmann W. 1971. Polychaeten (Errantier, Sedentarier) aus nordadriatischen *Cystoseira*-Beständen und deren Epiphyten. *Oecologia*, **8:** 31-51.

Kiseleva M.I. 1981. Benthos of soft substratum of the Black Sea. *Naukova Dumka, Kiev*: 1-164 (in Russian).

Kiseleva M.I. 2004. Polychaetes (Polychaeta) of the Azov and Black Seas. *Presidium of the Kola Science Centre, Russian Academy of Science*: 1-409.

Kiseleva M.I. & Slavina O.Y. 1966. Quantitative distribution of macrobenthos along the coast of Caucas. *Naukovaya dumka, Kiev*: 55-74.

Kocatas A. 1978. Contribution à l'étude des peuplements des horizons supérieurs de substrat rocheux du golfe d'Izmir (Turquie). *Scientific monographs of the Faculty of Science Ege University*, **12:** 1-93 (in Turkish).

Marinov T. 1959. Sur lá faune de polychètes des amas de moules de lá Mer Noire. *Comptes rendus de l'Académie bulgare des Sciences*, **12:** 443-446.

Marinov T. 1963. Über die polychätenfauna der sandbiozönose vor der Bulgarischen Schwarzmeerküste. *Bulletin de l'Institut central de Recherche Scientifique de Pisciculture et de Pêcherie, Varna*, **3:** 61-78.

Marinov T. 1964. Composition and features of the polychaetous fauna off the Bulgarian Black Sea coast. *Bulletin de l'Institut de Zoologie et Musée*, **17:** 79-107.

Marinov T. 1968. Au sujet de la distribution per région de la faune des Polychètes dans la mer Noire. *Rapport de la Commission Internationale Exploration de la Mer Méditerranée*, **19:** 197-199.

Marinov T. 1977. Fauna Bulgarica. Polychaeta. *Academia Scientiarum Bulgarica*, 1-258.

Milovidova H. O. 1966. Deep biocenoses in the Novorosisk Gulf. *Naukovaya Dumka, Kiev*: 75-89.

Pinar E. 1974. Fouling and boring organisms in some Turkish harbours and the affectivity of antifouling and antiboring paints against these organisms. *Scientific Reports of Faculty of Science, Ege University*, **170**: 1-67 (in Turkish).

Rullier F. 1963. Les Annélides polychètes du Bosphore, de la Mer de Marmara et de la Mer Noire, en relation avec celles de la Méditerranée. *Extrait des Rapports et Procès-verbaux des réunions de la C.I.E.S.M.M.*, **17:** 161-260.

Russo A.R. 1997. Epifauna living on sublittoral seaweeds around Cyprus. *Hydrobiologia*, **344:** 169-179.

Saldanha L. 1974. Estudo do povoamento dos horizontes superiores da rocha litoral da costa da Arrábida (Portugal). *Publicação do Museu e Laboratório Zoológico e Antropólógico. Faculdade de Ciências de Lisboa*, **5:** 1-382.

Sardá R. 1991. Polychaete communities related to plant covering in the Mediolittoral and Infralittoral zones of the Balearic Islands (Western Mediterranean). *Marine Ecology-Pubblicazioni della Stazione Zoologica di Napoli*, **12:** 341–360.

Sardá R., Pinedo S. & Martin D. 1999. Seasonal dynamics of macroinfaunal key species inhabiting shallow soft-bottoms in the Bay of Blanes (NW Mediterranean). *Acta Oecologica*, **20:** 315-326.

Sfriso A., Birkemeyer T. & Ghetti P.F. 2001. Benthic macrofauna changes in areas of Venice lagoon populated by seagrasses or seaweeds. *Marine Environmental Research*, **52:** 323-349.

Tena J., Capaccioni-Azzati R., Torres-Gavila F.J. & García-Carrascosa A.M. 2000. Polychaetes associated with facies of photophilic algal community in the Chafarinas Archipelago (SW Mediterranean). *Bulletin of Marine Sciences*, **67:** 55-72.

Tiganus V. 1972. Ecological observations on the fauna associated to the *Cystoseira* belt along the Romanian Black Sea coast. *Cercetari Marine*, **4:** 153-167.

Topaloglu B. & Kihara K. 1993. Community of mediterranean mussel *Mytilus galloprovincialis* Lamarck, 1819 in the Bosphorus Strait. *Journal of Tokyo University of Fisheries,* **80:** 113-120.

Tsuchiya M. & Bellan-Santini D. 1989. Vertical distribution of shallow rocky shore organisms and community structure of mussel beds (*Mytilus galloprovincialis*) along the coast of Marseille, France. *Mésogée*, **49:** 91-110.

Uysal, A., Yüksek A., Okus E. & Yilmaz N. 2002. Benthic community structure of the Bosphorus and surrounding area. *Water science and technology*, **46:** 37-44.

Zenkevitch L. 1963. *Biology of the Seas of the U.S.S.R.* George Allen & Unwin Limited, London, 955 pp.