COMU J Mar Sci Fish
2021 4(2): 130-158
DOI: 10.46384/jmsf.985685

Journal Home-Page:
http://jmsf.dergi.comu.edu.tr
Online Submission:
http://dergipark.org.tr/jmsf

COMU JOURNAL OF MARINE SCIENCE AND FISHERIES

RESEARCH ARTICLE e-ISSN 2651-5326 ARAŞTIRMA MAKALESİ

Ecological Gradients of Epimegafaunal Distribution along the Sectors of Gulf of İzmir, Aegean Sea

Erhan Mutlu

Akdeniz University, Fisheries Faculty, Main Campus, Antalya, Turkey
Correspondent: emutlu@akdeniz.edu.tr
Received: 21.08.2021 *Accepted: 25.10.2021*
Erhan Mutlu: Orcid 0000-0002-6825-3587

How to cite this article: Mutlu, E. (2021). Ecological gradients of epimegafaunal distribution along the sectors of Gulf of İzmir, Aegean Sea. COMU J. Mar. Sci. Fish, 4(2): 130-158. DOI: 10.46384/jmsf.985685

Abstract: During 2009-2010 epifaunal materials were collected seasonally with a beam trawl from seven fixed stations in the infralittoral of Gulf of Izmir to study spatiotemporal distribution of megabenthic fauna and their ecology. A total 153 megafaunal species were identified belonging to nine phyla, comprised mostly of 54 molluscans, 43 chordates (mostly fish), 20 arthropods, and 18 echinoderms. Nine alien species were recorded. Four species (two fish species, one gastropod and one Asteroidea species) were constant species and 16 species were common species in the study area. *Lesueurigobius friesii, Buglossidium luteum, Turritellinella tricarinata* and *Astropecten irregularis* were the most frequently occurred, and *Lesueurigobius friesii, Varicorbula gibba, Anomia ephippium, Turritellinella tricarinata* and *Dentalium* sp were the most abundantly occurred species. Excluding the evenness index, faunistic characteristics tended to increase as a factor of depth. Seasonal density (abundance and biomass) was minimal in April and maximal in February, followed by November having 2-fold higher abundance than that inJuly. Faunal assemblages were correlated with regions of the gulf and habitat type. *Buglossidium luteum* overspread the entire gulf excluding the inner gulf. *Varicorbula gibba* and *Fulvia fragilis,* a pollution indicator predominated the inner gulf. Hydrographical parameters and depth were associated to dictate faunal assemblages with difference among the sectors and habitats.

Key words: Megabenthic Fauna, Spatiotemporal Distribution, Ecology, Aegean Sea, İzmir Gulf

İzmir Körfezi'nin (Ege Denizi) Farklı Sektörleri Boyunca Bulunan Epimegafaunanın Dağılımının Ekolojik Yönelimi

Özet: Dağılımlarını ve ekolojilerini çalışmak için 2009-2010 yılları içerisinde İzmir Körfezinin infralittoral zonunda yer alan 7 ayrı ve sabit tutulan derinliklerden epifaunal materyalleri kirişli trol ile mevsimsel toplanmıştır. 9 filuma ait toplam 153 tür bulunmuştur ve bunların bir çoğu 54 tür Mollusca, 43 Chordata (çoğu balık türü), 20 Arthropoda ve 18 to Echinodermata filumlarına ait bulunmuştur. 9 tür yabancı tür olarak tespit edilmiştir. Dört tür (2 balık, 1 gastropod ve 1 Asteroidea türü) bölge için kalıcı ve 16 tür yaygın tür olarak tahmin edilmiştir. *Lesueurigobius friesii, Buglossidium luteum, Turritellinella tricarinata* ve *Astropecten irregularis* bölgede en sık, ve *Lesueurigobius friesii, Varicorbula gibba, Anomia ephippium, Turritellinella tricarinata* and *Dentalium* sp en bol bulunan türlerdir. Düzenlilik indeksi hariç, diğer faunistik karakterler deniz tabani derinliği ile artış eğilimdedir. Mevsimsel bolluk ve biyokütle Nisan ayında minimum ve Şubatta maksimum iken, bunu Temmuz ayındaki değerlerden iki katı değere sahip Kasım ayı takip etmiştir. Fauna topluluğu, körfezin bölgeleri ve habitatları ile ilişkili bulunmuştur. *Buglossidium luteum* iç bölge hariç körfezin her yerine yayılmıştır. Organik kirlilik göstergesi olan *Varicorbula gibba* ve *Fulvia fragilis* iç körfezde oldukça baskındır. Körfezin farklı bölgeleri ve dip yapısı yanında, hidrografik ve dip derinliği farklı faunal topluğun oluşumuna neden olmaktadır.

Anahtar kelimeler: Megabentik Fauna, Mekansal ve Zamansal Dağılım, Ekoloji, Ege Denizi, İzmir Körfezi

Introduction

Megabenthic communities are possible indicators to monitor anthropogenic impacts, or natural long-term alterations in marine ecosystems (Patania and Mutlu, 2021; Garuti and Mutlu, 2021). For instance, bioaccumulation of toxic substances and changes in the flux of energy to the seafloor could be predicted (Bilyard, 1987; Kroncke, 2003; Cartes et al., 2009). Benthic crustaceans of the megafauna are the most sensitive taxa to environmental changes within the complex structure of the marine bottom habitat (Gesteira and Dauvin, 2000; Kramer et al., 2013; Sanchez-Moyano and Garcia-Gomez, 1998). Furthermore, the megafauna is economically important and used as seafood, and is a food source of the scavenging marine organisms. Sessile species such as cnidarians, sponges and tunicates are filter feeders (Fredj and Laubier, 1985) to recycle organic matter through their different diet guilds in the integrated food web descriptions (Ramón et al., 2014; Tecchio et al., 2015).

A semi-enclosed gulf with weak or reduced water currents, Izmir Gulf has not, however, been subjected to vigorous studies on the composition of megafaunal species and their densities under ecological parameters. Most of studies on benthos involved macro-infauna (e.g. Çinar et al., 2006; 2012; 2008; Doğan et al., 2005) and to a lesser degree involved megafaunal species such as sponges in the gulf (Evcen and Çınar 2020). Megafaunal species were mostly subjected to regions of Mediterranean Sea. Particularly, decapod crustaceans are important components of commercial catches in the Mediterranean where they dominate the crustacean megafauna. Of most of the megafauna, 384 species were reported as decapod from the Mediterranean Sea (Coll et al., 2010). Many studies have been carried out in the Mediterranean Sea to describe the spatio-temporal dynamics of Decapoda and megabenthic assemblages (Cartes et al., 2009; DeLaHoz et al., 2018; Koukouras et al., 2010). However, most of these studies have been conducted in the central and western Mediterranean, as well as in Greek waters (Kallianiotis et al., 2020). In contrast, studies on the distribution and ecology of megafaunal assemblages in Turkish coasts of the Aegean Sea are generally lacking.

However, only a few studies were carried out on the megafauna of the Turkish coasts of the Aegean Sea and a lesser extends to the species-environment relation on İzmir Gulf. The present study is scoped to outline the spatio (depth and habitats, and sectors of the Gulf; inner, middle, and outer gulf)-temporal (season) distribution and ecology (hydrographics, physicochemical and sedimentary characteristics) of the megabenthic fauna in the infra-littoral zone of the Izmir Gulf. Regarding to the ecological importance of the megabenthic fauna and the historical lack of comprehensive information on their distribution and ecology in İzmir Gulf, the aim of this study is to provide baseline information on bathymetric and seasonal distribution and biodiversity patterns (i.e. density, wet weight and richness) of the megabenthic faunal assemblages in soft bottoms of the lower continental shelf, between 10 m and 50 m in the sectors having different trophic levels of the waters and sedimentary contents of a semi-closed gulf, Izmir Gulf under anthropogenic influences.

Material and Methods

Epifaunal materials were collected seasonally with a beam trawl and dredge from seven fixed stations in the infralittoral zone of Gulf of Izmir (Figure 1). Seasonal samplings were conducted in April, July, November 2009 and February 2010. Fixed seasonal stations had different seafloor depth; L1 having a seafloor depth of 10-15 m, L2 25 m, L3 35 m, L4 45 m L5 50 m, L6 15 m and L7 15 m isobaths. There were further non-seasonal stations; Gülbahçe cove (LG) at 20 m in November and February, Narlıbahçe (LN) at 10 m in November, Bostanlı (LB) at 10 m in November and Urla Bay (LZ) at 15 m isobaths in November (Fig 1).

The beam trawl was used for sampling the stations whereas the dredge was also used only at station L6 seasonally to compare difference in gear efficiency at catching faunal composition and quantification. Both gears had a 1.20 m opening width and a 4 m long net having 6 mm mesh size. The gears were towed for 15 minutes (R/V "*Koca Piri Reis*") at a speed of 1.5-2.5 knots. During the towing, GPS outputs were recorded every 2 minutes. After towing, the CTD (Seabird of General Oceanography Inc., SBE 911plus CTD) probe with a rosette water sampler was casted from surface to the near-bottom to measure basic physical parameters of water column.

After towing completed, materials in net content were sorted out to flora and fauna. The faunal specimens were then preserved in plastic jars in a solution of 4%-formaldehyde buffered with borax.

At the laboratory, faunal specimens were identified at possible species level based on the nomenclature of WoRMS. Number of individuals and wet-weight measured by an electronic balance having a precision of 0.01 g, were recorded after blotting the specimens on drying paper for 5 minutes.

Data standardization for the quantification of faunal specimens was then performed by converting number of individuals and weight to abundance (ind/km^2) and biomass (kg/km^2), respectively, over swept area of the gears with the dragging distance calculated from the GPS records.

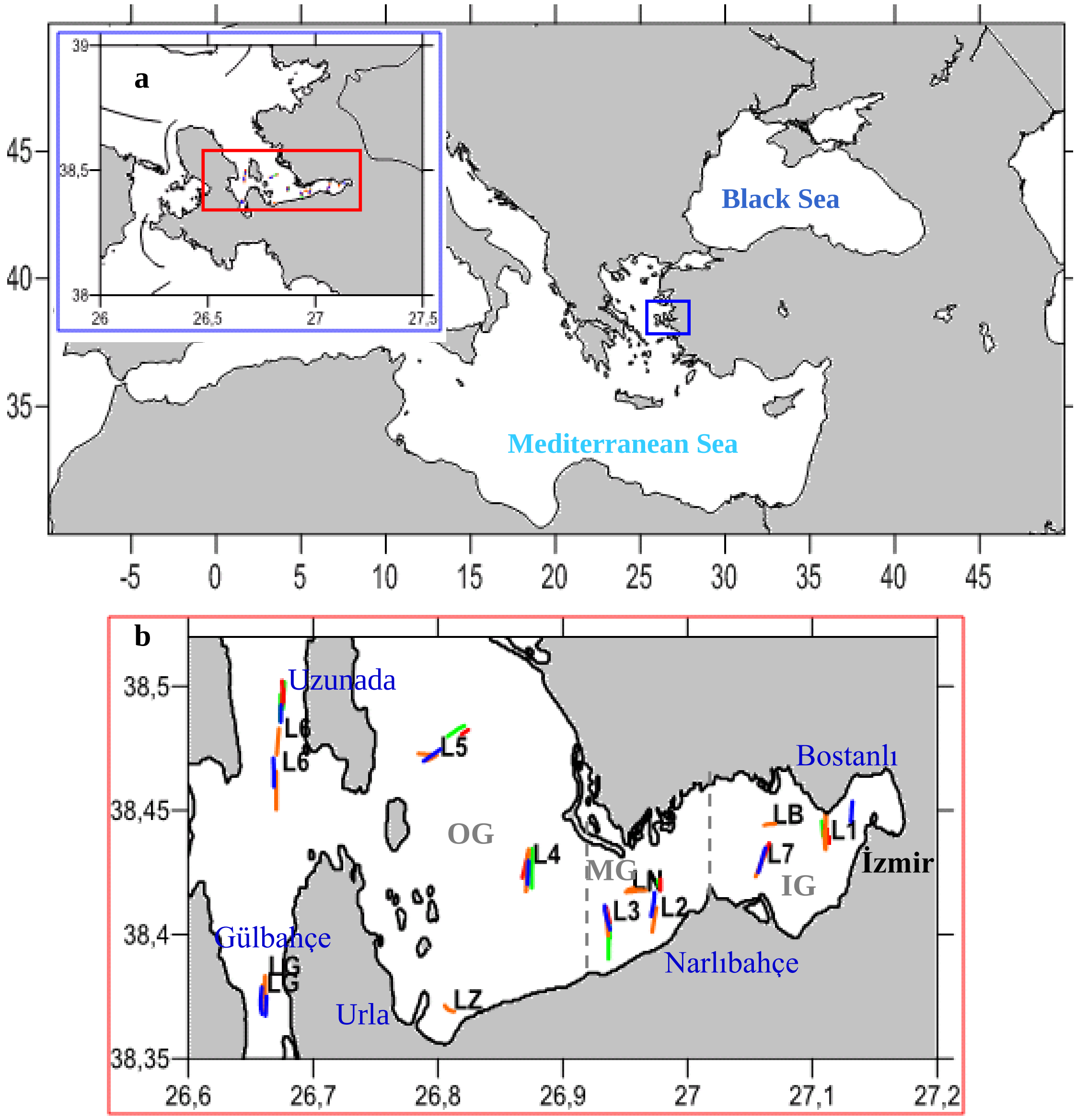

Figure 1. Study area (a; in blue and red frames) and trackline of the sampling gears at seasonal sampling stations (b; green; April 2009, red; July, Orange; November, and blue; February 2010) in the inner gulf (IG), middle gulf (MG) and outer gulf (OG) of İzmir Gulf.

Physical environmental parameters of water columns were formed in a matrix of sea surface and near-bottom water temperature (ºC), salinity (PSU), density (σ_t), dissolved oxygen (ml/l) and pH for determining ecology of the epifaunal assemblages.

Statistical treatment and interpretation of the faunal and environmental parameters were performed following univariate-multivariate analyses. Environmental parameters were subjected to Principal Component Analysis (PCA) to figure out spatiotemporal characterization of the study area. Dominance of specimens were determined from qualification and quantification data of epifauna with indices of dominance (D%), frequency of occurrence (FO%) and numerical occurrence (NO%) (Holden and Raitt, 1974). To classify the species as constant (DO%>50), common (25≤DO%≤50) and rare species (DO%<25), Soyer Index was used for the study area (Soyer, 1970). Faunistic characteristics of the epifuana were represented by means of number of species (*S*), abundance (*N*), biomass (*B*), Margalef's richness index (*d*), Pielou's evenness index (*J'*) and Shannon-Weiner diversity index (*H'*) using the PRIMER (PRIMER, vers.6+). Abundances of the specimens were subjected to PERMANOVA and Monte Carlo to test the differences among the months and bottom depths and were $\log_{10}$-transformed (X+1) to generate triangle matrix of Bray-Curtis similarity for the application of nMDS, and SIMPER using the PRIMER. Furthermore, difference in gear efficiency to catch epifauna was tested using PERMANOVA. Canonical Correspondence Analyses (CCA) was applied to a matrix set of biomass, and abundance of the epifaunal species with a corresponding matrix of the environmental parameters to cluster the stations and to see relationship of species, and species-ecological parameters and the variation of the CCA axes was tested by Monte Carlo test using the CANOCA (vers. 4.5).

Result and Discussion

Study area

The study area included non-fishing zone for commercial trawls in the Gulf of İzmir, Aegean Sea (Figure 1). The minimum sampling depth was 10 m and maximum depth was 50 m. Bottom of the station L6 was vegetated by Posidonia oceanica and LG with rather larger sized-empty shells referring to actual size of the shell species. The rest of stations had soft sediment bottoms.

The Gulf was divided into three sectors; inner gulf, middle gulf and outer gulf. The study area was restricted up to middle parts of the outer gulf. The seasonal sampling stations were located only in inner (L1, L7), middle gulf (L2-L3), and outer gulf (L4-L6) (Figure 1).

Near-bottom and sea surface water salinity was around 39 PSU throughout the year with an exception of lower salinity than 33 PSU at station L6 in February where sea surface salinity was around 19 PSU (Figure 2a). Sea surface salinity was lower in February than other months. Water temperature varied seasonally between 15 oC in February-April and 27 oC in July. Near-bottom water temperature never exceeded 23 oC throughout the year. Sea surface temperature increased from 14-15 oC in February through 18 oC in April to 27 oC in July and then decreased to 18 oC in November. The temperature had same values in sea surface and near-bottom waters in November (Figure 2a). Inherently, water density varied dependently with water temperature and salinity (Figure 2b). Dissolved oxygen concentration in sea surface and near-bottom water varied between hypoxic in July through around hypoxic in November, particularly in the inner gulf, and oxic conditions in February-April (Figure 2b) as described for the hypoxic condition in general by Hagy et al. (2004).

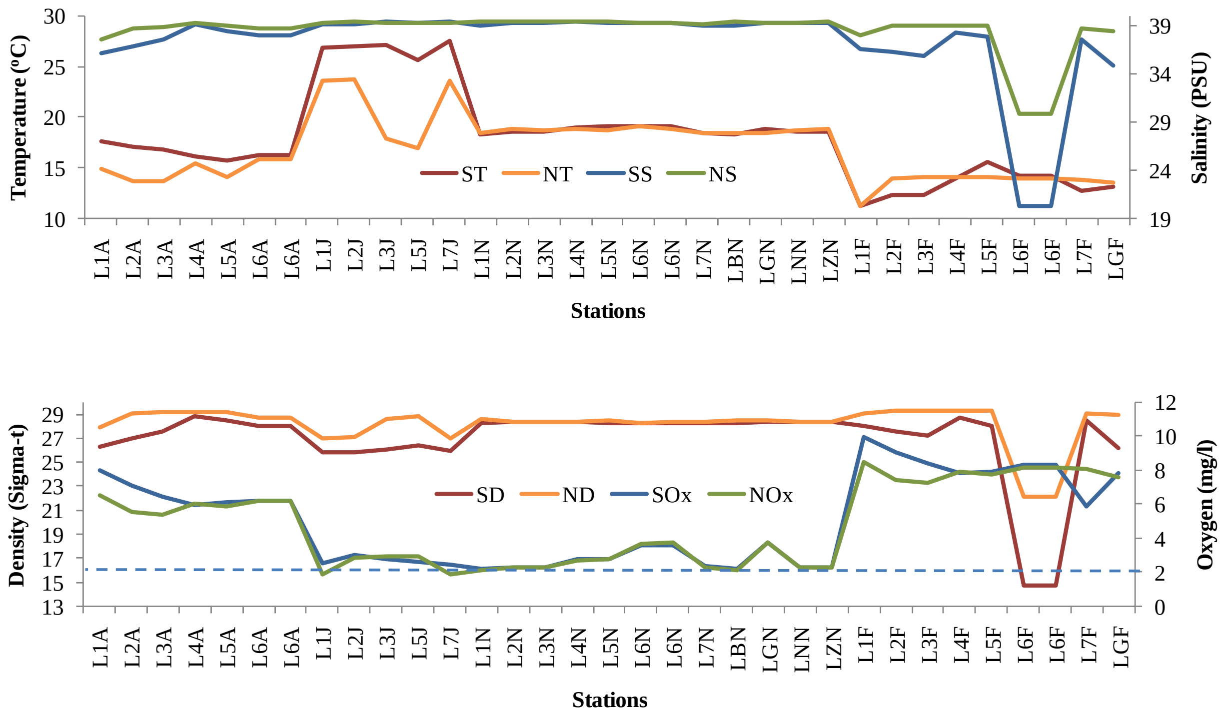

Figure 2. Physical parameters of sea surface (Sx) and near-bottom (Nx) waters of the sampling stations (T; Temperature, S; salinity, D; density and Ox; oxygen). Dashed line is limit of hypoxic threshold for marine benthic organisms (Vaquer-Sunyer and Duarte, 2008).

Physical parameters were coordinated in the PCA ordination according to the seasons on PCA1 axis (Figure3a). Seasonal parameters were water temperature and oxygen content. The first PCA axis was explained with a percent variance of 51.3 (Figure 3). On PCA2 axis, the bottom depth was effective first, followed by pH of the water. The parameters explained the PCA2 axis with a variance of 16.9% (Figure 3). In other words, bottom depth was classified within each season along PCA2 axis. It was hereby noticed that the dissolved oxygen was very low in July, followed by November compared to April and February (Figure 3b).

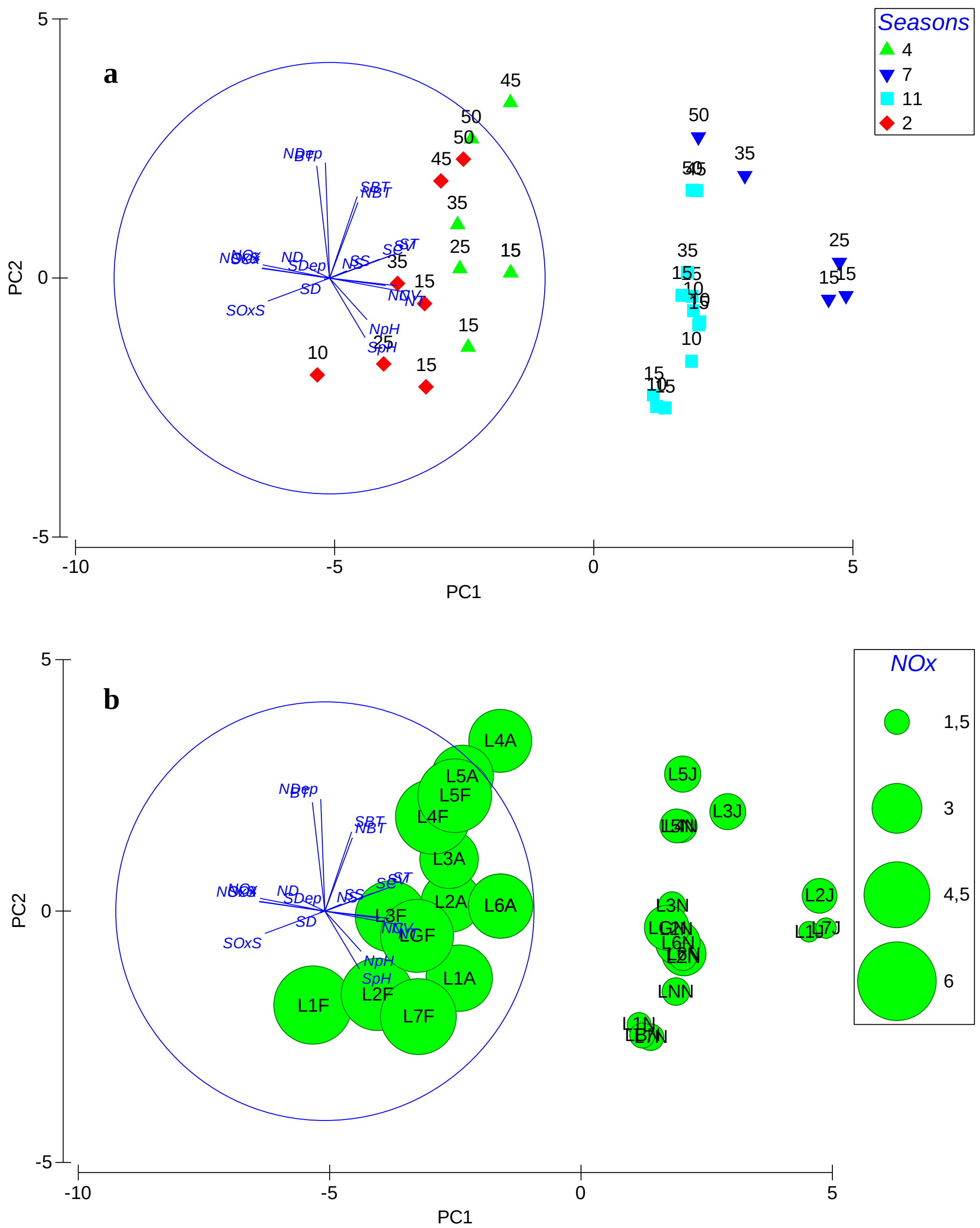

Figure 3. PCA ordination of the physical parameters normalized for the study stations classified by month (4; April, 7; July, 11; November, and 2; February), labeled with the bottom depth (a) and oxygen concentration (ml/l) overlapping on the PCA ordination (b) (sea surface, Sx and near-bottom, Nx waters (T; Temperature, S; salinity, D; density and Ox; oxygen and pH; pH) of the sampling stations (e.g. L1F, station 1 in February. see Figure 1 for station codes and location).

Yelekçi et al. (2021) modeled 3D-hydrodynamic also including the chemical parameters from the data measured during the present study and the results agreed with the measurements. Surface chl-*a* varied between 0.3 mg/m^3 in outer gulf and 3 mg/m^3 in inner gulf (extreme amount of 23.7 mg/m^3) in April 2009, overall between 0 and 0.3 mg/m^3, but was rather high (7 mg/m^3) in inner and middle gulf in July, and November when average chl-*a* measured 4 mg/m^3 in inner and middle gulf with maxima (10 mg/m^3), and between 0 and 2 mg/m^3 in outer gulf, 6 mg/m^3 in inner gulf in February 2010 when the study was influenced by fresh water inputs at station L6 (Figure 2). Nutrients; surface dissolved inorganic nitrogen varied between 0.5 and 0.7 µM, uniformly around 0.5 µM in July and November (extreme 10 µM.), and between 0 and 0.5 µM (8 µM) in February 2010. Surface PO_4 varied between 0 and 0.1 µM in outer gulf all the year, and increased to 2 µM in inner and middle gulfs in April 2009, to maxima (3 µM) in inner gulf in July and November, and in inner and middle gulf in February 2010 (Yelekçi et al., 2021).

Çinar et al., 2012 summarized sedimentary characteristics of the study area as follows: total organic carbon (TOC) content of the sediment varied between 30 - 45 mg/g (3-4.5% denoting organically heavy polluted area at a critical value of 3%, Magni, 2003; Hyland et al., 2005) in the inner gulf. The TOC then decreased sharply through middle gulf to outer gulf (TOC<2.5%; Çinar et al., 2012), which was still higher than that in undisturbed sediments (<1%; Magni, 2003). Sand content was low in the inner and middle gulfs compared to that in the outer gulf whereas there was a moderate content of clay in the inner and middle gulfs where the highest clay content occurred in the outer deep waters (Çinar et al., 2012).

Epifauna

As aforementioned, there were mostly macroinfaunal studies conducted in Izmir Gulf and a few studies on megafauna such as sponges (Çinar et al., 2006; 2012; 2008; Doğan et al., 2005; Evcen and Çınar 2020).

In general, only mega-molluscans (retained in mesh-size of 5 mm of a benthic sledge) had a peak number of species at the shallowest waters as observed in Mersin Bay (Mutlu and Ergev, 2008). This could be attributed to the higher heterogeneity of bottom types on the shallow waters since some molluscan species were related to specific sedimentary habitats (Gofas et al., 2011; Ciércoles et al., 2018). The shallow waters was ascribed “fine, well-sorted sand”, SFBC and the deep zone “the Muddy-Detritic community”, DE (Peres, 1982), being composed mainly of mud, sand and detritus dwelling species at depth greater than 100 m in Cretan shelf (Karakassis and Eleftheriou, 1998). Contrasted to a generalized distribution of sediment grains by the bottom depth, sand content was unusually low in the inner and middle gulfs (shallow waters) compared to outer gulf (the greater depths) (Çinar et al., 2012). However, there was a moderate content of clay in the inner and middle gulfs mostly influenced by anthropogenic activities of city İzmir (Çinar et al., 2012).

Comparison of species composition between two sampling gears

Epifaunal composition and density (abundance and biomass) were not significantly different between two different sampling gears (beam trawl and dredge) conducted seasonally only at station L6 at $p<0.05$ (ANOSIM, R statistic=0.37 and 0.444, p=0.10 and 0.10, respectively, and PERMANOVA) (Table 1).

Epifaunal studies by means of continuous dredging could change ecological characterization of the community.

Table 1. One-way PERMANOVA table of results for difference in the epifaunal densities between dredge and beam trawl (pMC; Monte Carlo test’s p value)

Abundance	df	SS	MS	F	p	pMC
Gears	1	5635.3	5635.3	1.7681	0.111	0.175
Residuals	4	12749	3187.3			
Total	5	18384				
Biomass						
Gear	1	6280.4	6280.4	2.0343	0.081	0.13
Residuals	4	12349	3087.3			
Total	5	18630				

Smith et al. (2000) studied the effect of the trawling on numbers of megabentic species; equal dominance of number of echinoderm, mollusk, and crustacean species in the pre-trawling samples, dominant taxon of molluscans and the smallest taxon of crustaceans after the trawling season. Nevertheless, frequent small-scale disturbances, such as dredging operations, may thus be masked by large-scale environmental perturbations, such as storms, and prevailing hydrodynamic processes (Morello et al., 2006) inducing dominance of small, opportunistic, short-lived species in continuously trawling area, but more fragile and long-living sessile organisms in non-dredged fishing areas (Sarda et al., 2000; Chicharo et al., 2002).

Species composition

A total of 153 megafaunal species were identified belonging to nine phyla (Appendix 1). Of these species, 54 species belonged to phylum Mollusca, 43 species to Chordata, 20 to Arthropoda, and 18 to Echinodermata and rest of the phyla had less than 10 species (spp) (Annelida with 9 spp, Cnidaria with 4 spp, Porifera with 3 spp, and Bryzoa and Sipuncula with 1sp each) (Appendix 1). In Mollusca, 41 bivalve species were dominant, followed by 35 fish species (2 of cartilaginous fish) from Chordata, 17 decapod species from Arthropoda, and 8 Asteriodea species from Echinodermata. Of a total of 417 macrozoobenthic species, infaunal composition was made up mainly of 210 polychaetes, 100 molluscans, and 70 crustaceans in same area and sampling time of the present study (Çinar et al., 2012).

According to Soyer Index, only four species (two fish species, one gastropod and one Asteroidea species) were constant species and 16 species was common species in the present study (Appendix 1). The rest of the species was categorized as rare species. *Lesueurigobius friesii, Buglossidium luteum, Turritellinella tricarinata* and *Astropecten irregularis* were the most frequently occurred, and *Lesueurigobius friesii, Varicorbula gibba, Anomia ephippium, Turritellinella tricarinata* and *Dentalium* sp were the most abundantly occurred species among the all species recorded in the study area (Appendix 1).

A total of 9 alien species was observed in İzmir Gulf (Appendix 1) where a total of 13 alien infaunal species was found during sampling time of the present study (Çinar et al., 2012). In Mersin Bay, eastern Mediterranean Sea, a total number of alien megafaunal species including Lessepsian megafaunal species was 22 and composed of 8 fishes, 4 molluscans, 7 crustaceans and 3 polychaetes (Mutlu and Ergev, 2008), all higher than that in the present study. The number of invertebrate Lessepsian species in Turkish seas is as follows: polychaetes (10), decapods (23), amphipods (2), molluscs (48) (Cinar and Ergen, 2005). The compilation of data on alien species reported from the Turkish coasts yielded a total of 263 species belonging to 11 systematic groups, of which Mollusca had the highest number of species (85 species), followed by Crustacea (51), fishes (43) and phytobenthos (39) with the Levantine Sea represented by 202 species (Cinar et al., 2005). Çinar et al. (2021) updated a total number of alien species as 413 composed mainly of 113 molluscans, 74 fishes, 70 arthropods, 56 polychaetes, 8 each of cnidarians and tunicates, and 6 echinoderms for the Turkish Levantine Sea. However, the number was rather low compared to the Levantine Sea. Patania and Mutlu (2021) found 18 alien arthropod species out of a total of 59 megabenthic arthropods recorded recently in the Antalya Gulf, Levantine Sea.

Faunal characteristics

Overall characteristics

Number of species (S) tended to increase as a factor of depth up to 50 m in all sampling months (Figure 4). Number of species varied between 2 and 45 spp in the present study (Figure 4). At greater depths of the Mediterranean Sea, number of ascidian (tunicates) species and number of megafaunal species decreased by the seafloor depth in the western and central Mediterranean Sea (El Lakhrach et al., 2012).

Average abundance (N) was 900939 ind/km^2, and the abundance varied between 1999 ind/km^2 at station L1 in July and 9714308 ind/km^2 at L2 in November. Abundance of the epifauna showed a similar seasonal distribution in the number of species with respect to depth (Figure 4). Seasonal average abundance was minimal in April and maximal in February, followed by November being 2-fold higher in abundance than that in July. Overall, maximum abundances occurred at 25 m in all seasons except in July having maximum at 35 m. Seasonal density variation in Mediterranean communities was generalized with increases in weight and density of individuals in the spring and summer, and an abrupt decrease in the winter (De Juan et al., 2007) depending mainly on reproduction, recruitment, and migration of larger organism grown by increased temperatures in the summer (Díaz et al., 1990; DeLaHoz et al., 2018). In contrast to the biomass distribution, the highest abundance was found at 100-200 m in the summer and winter, owing to larger number of smaller specimens at 100-200 m, and a smaller number of the larger specimens at 30-100 m (DeLaHoz et al., 2018). The lower diversity of the decapod communities was attributed to the hydrographic heterogeneity and to commercial exploitation (Abello et al., 1988).

An annual average biomass (B) of 1107 kg/km^2 was estimated for the study area. The biomass followed a trend similar to that of the abundance in time and space (Figure 4). The biomass increased slightly from shallower to middle depth waters and then decreased strongly toward the greater depths. Maximum average biomass was measured in February, followed by November and April and biomass was rather low in July when the catch was not obtained at L4, L6 and L7 (Figure 4). In the western Mediterranean Sea, the highest biomass occurred in summer (DeLaHoz et al., 2018). The shallow zone (30-100 m) had the highest biomass, followed by the following greater zone (100-200 m) in the Catalan shelf whereas the lowest biomass was in upper slope, and this trend was more pronounced in summer (DeLaHoz et al., 2018).

Margalef's richness index (d) was very similar to that of the number of species in time and space (Figure 4). In the study area, the richness index (d) varied between 0.13 at station L1 in July and 3.08 at L4 in February per year. Seasonal average species was highest in February, closely followed by April and November and was poorest in July (0.86). The highest richness occurred in the summer in the western Mediterranean Sea (DeLaHoz et al., 2018). Species richness of megabenthic fauna was found to be the highest at the shelf edge (110-180 m), followed by the outer shelf (90-110 m) and the slope (180-350 m) in the Menorca Channel, Western Mediterranean Sea (Grinyo et al., 2018).

Pielou's evenness index (J') was distributed in contrast to the abundance in time and space (Figure 4). Epifauna of the shallow waters were more evenly distributed compared to depths of middle gulf and then the evenness index increased slightly at greater depths (outer gulf). Abundances which were more evenly distributed among the species was recorded in November (J'=0.65) and evenness was closely lower in other seasons (J'=0.53 in February-~0.58 in April-July).

Shannon-Weiner index (H') decreased from shallower to middle depths and then increased toward the greater depths. Seasonal average biodiversity index varied between 0.98 in July and 1.75 in November, followed by April (H'=1.71). There was a moderate index value of H'=1.45 in February (Figure 4). The variety of available substrata resulted in an increased number of microniches, and thus of diversity at the shallow waters, while the homogeneity of the substrate could be responsible for the lower diversity and higher evenness found at the deep waters (Makra and Nicolaidou, 2000).

Dominant taxonomic characteristics

Number (S) of molluscan species was higher at all stations all the year than the other taxa with an exception of sea floors vegetated by *Posidonia oceanica* (L6), followed by fish species. Molluscans was more dominant in the number of species in November and February compared to that in April and July contrasted to the fish species.

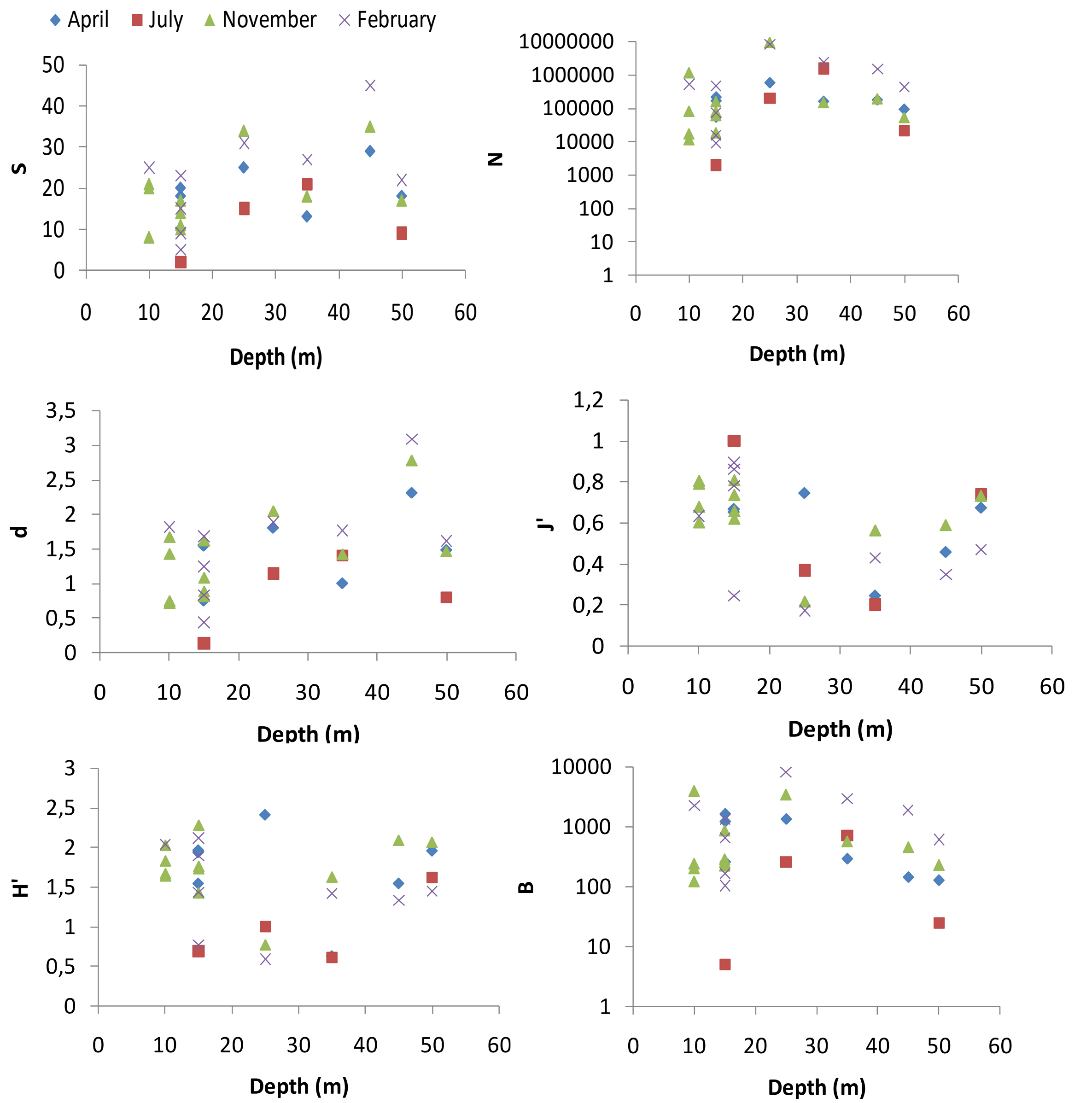

Figure 4. Community characteristics of epifuana in time and space (S; number of species, N; abundance in ind/km^2, d; Margalef's richness index, J'; Pielou's evenness index, H'; Shannon-Weiner diversity index, and B; biomass in kg/km^2).

The minimum number of Arthropoda was in November and maximum in February, and moderate numbers were observed in April and July, and all figures were similar to that for the echinoderms (Table 2 and Figure 5). The highest number of molluscans was at 25 and 35 m while the lowest was at 35 m of the unvegetated bottoms. Similar to the echinoderms, fish had the highest number in a depth range of 25-45 m. The number of arthropods was the highest at 45 m. Only molluscans had a peak number of species at the shallowest waters as observed in Mersin Bay (Mutlu and Ergev, 2008). This could be attributed to the higher heterogeneity of bottom types on the shelf since some mollusc species were related to specific sedimentary habitats (Gofas et al., 2011; Ciércoles et al., 2018).

Abundance of molluscans was estimated to be higher than 1000 ind/km^2 all the year reaching up to 1000000s ind/km^2 at 25 m in November and February (Table 2 and Figure 5). Abundance of the fish species (N≤100000 ind/km^2) was fluctuated with the seasons and seafloor depths in similarity to the molluscans, echinoderms and arthropods (N≤100000 ind/km^2 for each). The molluscs were the second most abundant faunal group in terms of density after the crustaceans, and other less represented faunal groups included echinoderms, annelids, and cnidarians in Alboran Sea (Ciércoles et al., 2018). The echinoderms were predominated abundantly in summer and winter, followed by mollusks and tunicates in the Catalan Sea (DeLaHoz et al., 2018). The echinoderms were the most abundant taxon (38% of the total abundance) in the Gabes Gulf, followed by Tunicata (19%), Mollusca (13%), Porifera (4%), Cnidaria (3%) (El Lakhrach et al., 2012).

The highest biomass (B) was contributed by fish and molluscan species, followed by the resting two taxa (Figure 5). The fish biomass was at maxima at 25 m in April, July and November, but at a depth range of 25 m to 45 m in February (Table 2). In general, arthropods and molluscans followed spatiotemporal distribution of the fish biomass in contrast to the echinoderms (Figure 5). For all taxa, the biomass was relatively high at bottom vegetated by the meadows (L6). In the Catalan Sea, the biomass of Echinodermata comprised of 50% of the total biomass, more pronounced by classes Crinoidea and Echinoidea, followed by Mollusca in winter, but in the summer the solitary tunicates constituted most dominantly 40%, followed by the echinoderms (30%) and molluscs (24%) (DeLaHoz et al., 2018) contrasted to solitary sponges in the present study.

Overall, the molluscs was the richest taxon in this study (Figure 5). Diversity of the molluscans was richer in November and February than in April and July. The fish diversity was contrasted to the molluscs. The poorest season of Arthropoda was November and the richest February, as the echinoderms followed the same (Table 2 and Figure 5). The highest richness depth for molluscans was 25 and 35 m whilst the poorest was 35 m. Similar to the echinoderms, fish had the highest species richness index at a depth range of 25-45 m. Overall, the number of arthropods was the richest at 45 m (Figure 5). The richness of cephalopods increased from 10 m to 200-300 m and then decreased to a depth of 600 m in the central Mediterranean Sea (Colloca et al., 2003).

With Pielou’s evennes index (J’) relatively lower in April compared to the other seasons, fish species were more evenly distributed (J’>0.6) than the other taxa in the study area during the sampling year (Table 2 and Figure 5). This was followed by arthropods and echinoderms along the depth gradient. The molluscans were least evenly distributed among the other taxa in space and time (Figure 5).

The distribution of Shannon-Weiner index (H’) of the fish increased from 15 m to 45 m and then decreased at 50 m. The index was always high at L6, which was vegetated with the meadows. Arthropods followed fish by inhabiting location deeper than that of the fish in space, which was followed by echinoderms by shifting further isobaths. The diversity index of molluscans was highest at the shallowest and deepest bottom of the study area (Figure 5). The ascidians were responded to the same depth gradient in term of diversity index in the Balearic Sea (Arroyo et al., 2019). Soft bottom sponges had lower diversity in the southern ($H' < 1$) under influence of oligotrophic Levantine Sea than the northern Aegean Sea under influence of the eutropic Black Sea ($H' > 2$; Kefalas et al., 2003a, b).

In Levantine Basin of the Mediterranean Sea, these cycles were consistent with the temporal variation in several key species, especially molluscan species: *Conomurex persicus* could however be most reasonable species for the seasonal fluctuations of the epifaunal density (Mutlu and Ergev 2008) depending on bottom depth (Tselepides et al., 2000) and trawling (Smith et al., 2000).

Faunal community and ecology

Faunal assemblages were oriented with sectors of the gulf and habitat type (Figure 6). Inner gulf and bottoms vegetated with the meadows were the distinguished faunal assemblage zones from the middle and outer gulfs, being close to each other. The bottoms predominated with larger sized-shells than the current forms of the shells were centered around the outer and middle gulf depending on the seasons (Figure 6).

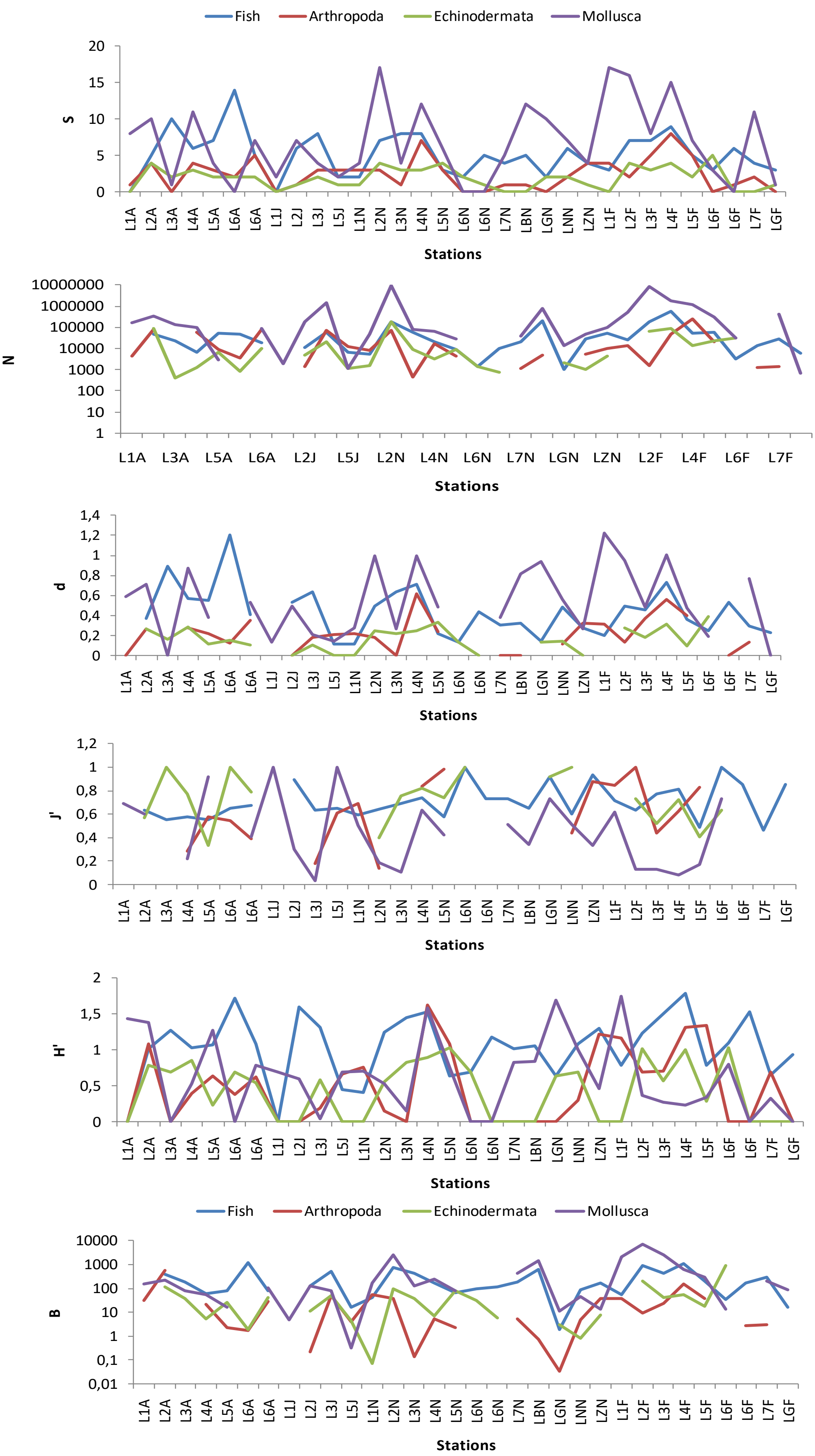

Figure 5. Community characteristics of dominant taxa of the epifuana at the stations (e.g. L1F, station 1 in February. see Figure 1 for station codes and location) in time (S; number of species, N; abundance in ind/km^2, d; Margalef's richness index, J'; Pielou's evenness index, H'; Shannon-Weiner diversity index, and B; biomass in kg/km^2).

Table 2. Temporal distribution of average faunistic characteristics in *X±SD* (S; number of species, N; abundance in ind/km^2, d; Margalef's richness index, J'; Pielou's evenness index, H'; Shannon-Weiner diversity index, and B; biomass in kg/km^2) of the dominant taxa in the study area.

Taxa	N	d	J'	H'	B
Fishes					
April 2009	28179±21403	0.67±0.32	0.61±0.05	1.03±0.52	289±437
July	19062±26670	0.43±0.28	0.72±0.15	0.84±0.74	165±244
November	49272±69831	0.36±0.20	0.73±0.14	1.02±0.35	226±240
February 2010	105045±182365	0.39±0.18	0.73±0.18	1.15±0.40	347±380
Molluscans					
April 2009	115900±112421	0.51±0.30	0.57±0.27	0.77±0.62	91±79
July	399999±680618	0.25±0.17	0.58±0.49	0.51±0.31	54±62
November	872236±2656714	0.60±0.31	0.43±0.19	0.71±0.54	420±774
February 2010	1340138±2543498	0.64±0.42	0.29±0.27	0.45±0.54	1439±2323
Arthropods					
April 2009	33309±37093	0.21±0.13	0.51±0.19	0.44±0.38	92±206
July	21722±34679	0.13±0.11	0.39±0.31	0.22±0.32	14±25
November	10106±19837	0.19±0.20	0.66±0.32	0.43±0.59	12±19
February 2010	38738±84422	0.27±0.19	0.79±0.22	0.66±0.55	30±49
Echinoderms					
April 2009	15055±31682	0.18±0.07	0.74±0.26	0.54±0.31	32±40
July	6866±9942	0.03±0.06	0.21±0.42	0.15±0.29	17±23
November	17303±49574	0.15±0.12	0.80±0.21	0.44±0.41	22±33
February 2010	24252±30708	0.21±0.14	0.60±0.14	0.43±0.48	136±298

Faunal communities were overall significantly different among the sectors (regions) of the gulf (Table 3). Pairwise test of one-way PERMANOVA showed that all sectors were significantly different in faunal communities from each other of the sectors, and the faunal communities were not between the sector and the shelly bottoms at $p<0.05$ (Table 4). Depth, substrate and ecological status of seafloors under disturbance were important factors influencing the structure of the megaepibenthic fauna. Cosentino and Giacobbe (2006) concluded that in the shallower zone (<20 m), a wide typology of trophic-ethological guilds was related to community patchiness, in contrast to a greater functional uniformity of the deeper assemblage (25-50m), dominated by sessile, semi-infaunal suspension feeders. The variety of available substrata results in an increased number of microniches, and thus of diversity at the shallow waters, while the homogeneity of the substrate could be responsible for the lower diversity and higher evenness found at deep waters (Makra and Nicolaidou, 2000), followed by the hydrodynamic process (Karakassis and Eleftheriou, 1998). The organic content complements the sediment type and status to reinforce this differentiation (Kroncke et al., 2003). The number of species changed depending on the sediment structure (sandy, sandy muddy and muddy bottoms) in the Turkish shelf of the Aegean Sea (Ateş and Katagan, 2008), and in the Çanakkale Strait (Aslan Cihangir and Pancucci-Papadopoulou, 2011, 2012).

Table 5 showed that there were contributor species at each regions of the gulf. Average similarities increased from inner through middle to outer gulfs, which implied that inner gulf was more affected with the seasonal environmental parameters than the middle and outer gulfs (Table 5). Contributor species composition was totally different in the inner gulf than other two gulfs where there were common contributor species. Species composition was also different in meadows from all other regions. *Buglossidium luteum* overspread the gulfs excluding the inner gulf. *Varicorbula gibba* and *Fulvia fragilis*, a pollution indicator, which had tolerance to organic pollution in İzmir Gulf (Öztürk and Poutiers, 2005) predominated the inner gulf (Table 5). Çinar et al. (2012) classified the inner gulf as moderate and bad with respect to ecological status and the middle (moderate only in summer) and outer gulfs as good based on the benthic indices applied to infauna in İzmir Gulf in the sampling time of the present study. Rex (1981) explained briefly causes of depth gradient of the megafauna associated with nutrient input and trophic relationships, biological interactions and species-area relationships.

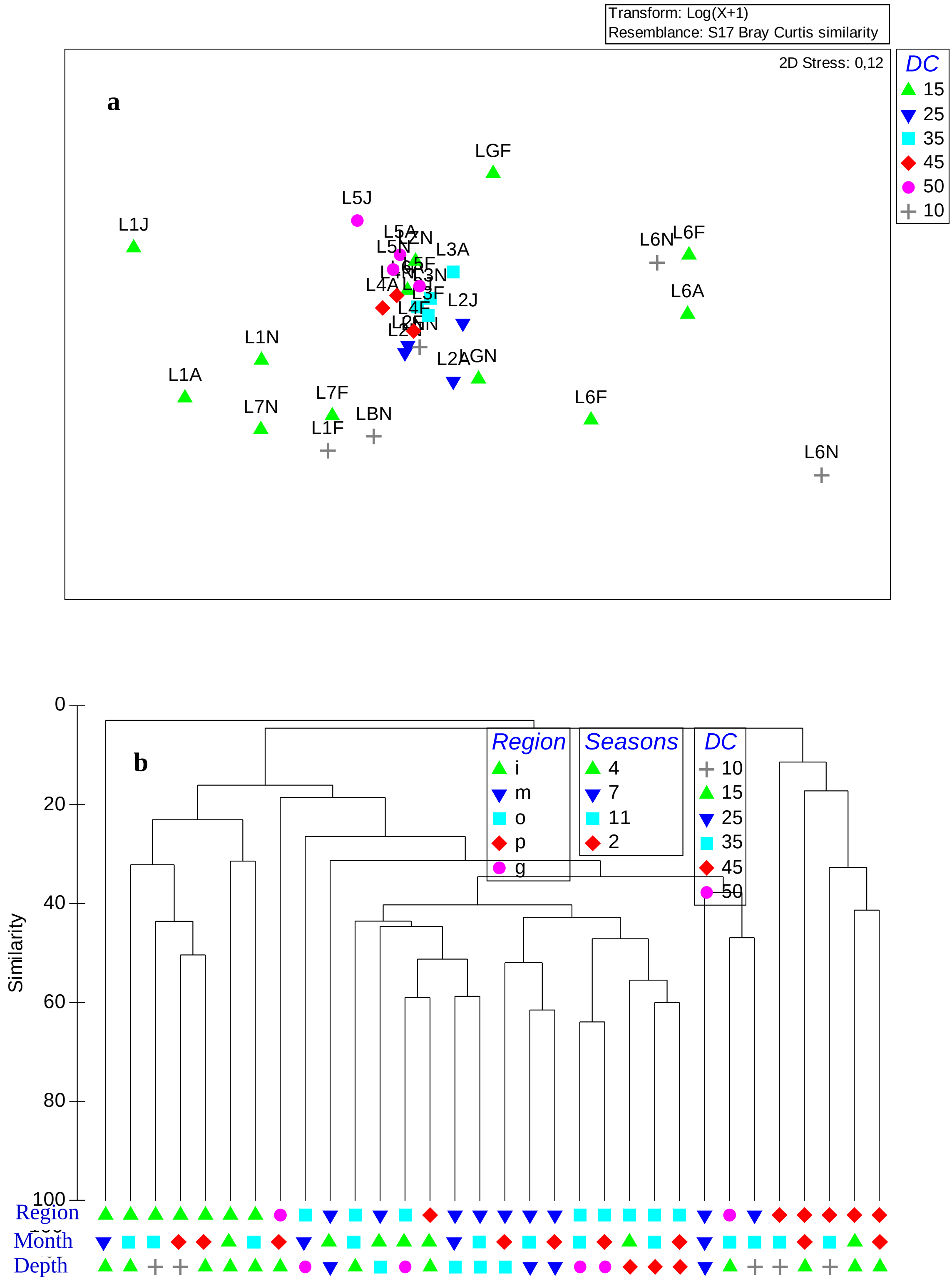

Figure 6. nMDS (a) and cluster (b) ordination of the stations, classified with regions (sectors; i; inner gulf, m; middle gulf, o; outer gulf, g; shelly bottom, and p; vegetative bottom with *Posidonia oceanica*) of the gulf, sampling months (4; April, 7; July, 11; November, and 2; February) and bottom depths (DC), based on Bray-Curtis similarity indices calculated from $\log_{10}$-transformed abundances of the megafauna.

Table 3. One-way PERMANOVA table of results for the difference in the epifaunal abundance among the regions (sectors) (pMC; Monte Carlo test's p value). Bold P value was significantly different at P<0.05.

Source	df	SS	MS	F	P	P(MC)
Regions	4	36672	9168.1	3.7693	**0.001**	**0.001**
Residual	27	65672	2432.3			
Total	31	102345				

Table 4. Pairwise test of one-way PERMANOVA table of results for difference in the epifaunal abundance among the regions (sectors; i; inner gulf, m; middle gulf, o; outer gulf, g; shelly bottom, and p; vegetative bottom with *Posidonia oceanica*) (pMC; Monte Carlo test's p value). Bold P value was significantly different at P<0.05.

Regions	t	P	P(MC)
i vs m	2.3215	**0.001**	**0.001**
i vs o	2.3899	**0.002**	**0.001**
i vs p	1.9258	**0.001**	**0.004**
i vs g	1.4033	**0.025**	0.112
m vs o	1.6948	**0.002**	**0.005**
m vs p	2.1896	**0.001**	**0.002**
m vs g	1.4479	**0.034**	0.06
o vs p	2.1977	**0.002**	**0.005**
o vs g	1.5845	**0.024**	**0.049**
p vs g	1.1592	0.178	0.268

Referring to the contribution of the species as key species of the taxa, Quetglas et al. (2000) studied depth gradient of the cephalopod distribution from coastal waters through the transition zone to the slope. The temporal trends showed a remarkable change in contrast to no regular seasonal pattern in the faunistic characters in very shallow waters of the NE Aegean Sea (Kourelea et al., 2004) and in Mersin Bay (Mutlu and Ergev, 2008) where *Conomurex persicus* was present.

The cephalopods were dominant in the circalittoral and in the slope but a crinoid species and *Illex coindetti* dominated the intermediate zone, the upper shelf in the Catalan Sea (DeLaHoz et al., 2018). Cephalopod assemblages were differentiated in the three depth strata of the shelf (50, 100, 200 m) and the shelf-break (500 m), 10-50 m and 50-100 m strata in the Adriatic Sea (Sifner et al., 2011). Furthermore, *Astropecten irregularis* were responsible for the main differences between seasons in German Bight (Hinz et al., 2004). Conides et al. (1999) found a similar pattern where winter was the key-divisor season in the south of Nisyros Island. Serrano et al. (2006) showed a pattern of two gradients on epibenthic communities of the Cantabrian shelf, Spain: depth/water temperature and sediment characteristics; *Diogenes pugilator* typified the poor sands of inner shelf; fishes *Arnoglosus laterna*, *Callyonimus maculatuts* and *Anapagusus laevis* characterized the assemblage of inner and middle shelf sediments with higher organic content. Abundance and biomass of megafauna,however, were not significantly affected by sampling seasons and bottom depth (p<0.05; Table 6). Average similarities increased by the bottom depth (Table 7). Particularly the first two shallow depths located mostly in the inner gulf had very low average similarities compared to the greater depths.

Table 5. Similarity table and contributor species, + within the regions (sectors; i; inner gulf, m; middle gulf, o; outer gulf, g; shelly bottom, and p; vegetative bottom with *Posidonia oceanica*), determined from an analysis of a similarity of percentages, SIMPER. (Avg. Sim.: Average similarity at each bottom depth, Avg. Abn: $\log_{10}$-transformed average abundance, Avg. Sim; average similarity, Sim/SD; correction term; Con.%: percent contribution and Cum.%; percent cumulative contribution of the similarities, and SD; standard deviation of the similarity).

i, Avg sim: 23.71	**Avg Abn**	**Av.Sim**	**Sim/SD**	**Con.%**	**Cum.%**
Varicorbula gibba+	6.99	4.86	0.86	20.51	20.51
Fulvia fragilis+	6.01	2.71	0.87	11.42	31.93
Anomia ephippium+	6.95	2.51	0.91	10.59	42.52
Metapenaeus affinis	4.50	1.91	0.59	8.04	50.56
Gobius niger jozo	5.07	1.65	0.57	6.97	57.54
m, Avg sim: 41.69					
Turritellinella tricarinata+	13.10	6.49	4.05	15.57	15.57
Lesueurigobius friesii+	10.07	5.00	4.30	11.98	27.55
Buglossidium luteum+	9.33	4.52	4.20	10.84	38.39
Astropecten irregularis+	8.67	4.03	4.56	9.68	48.07
Serranus hepatus	6.96	2.88	1.68	6.92	54.99
o, Avg sim: 42.20					
Lesueurigobius friesii+	9.33	5.44	3.05	12.89	12.89
Goneplax rhomboides+	8.10	4.68	2.60	11.10	23.99
Alpheus glaber+	7.98	4.31	3.26	10.21	34.20
Astropecten irregularis+	7.51	4.22	2.77	10.01	44.21
Turritellinella tricarinata	8.71	2.96	0.99	7.02	51.23
Buglossidium luteum+	6.86	2.92	1.51	6.92	58.15
Sternaspis scutata	7.57	2.51	1.01	5.94	64.09
p, Avg sim: 15.09					
Symphodus roissali+	5.05	3.18	0.71	21.04	21.04
Scorpaena porcus+	4.83	3.17	0.76	21.03	42.08
Serranus scriba	3.77	1.71	0.47	11.34	53.42
g, Avg sim: 17.68					
Buglossidium luteum+	7.09	8.84	high	50.00	50.00
Astropecten irregularis+	7.09	8.84	high	50.00	100.00

Number of contributor species increased with respect to depth up to 50 m. Excluding *Turritellinella tricarinata* and *Buglossidium luteum* both of which were common along gradient of the bottom depths, the composition and their density were not significantly different at the greater depths (Table 7). Seasonal diversity depended on the dominance of key species linked to different water masses prevailing in time (Maria and Pires, 1992). However, the decapods did not respond with a specific assemblage and aggregation to the meadow beds (Sánchez-Jerez *et al.*, 2000). In shallow waters of Mersin Bay, the community composition was largely affected by the considerable number of species represented by *Conomurex persicus*, *Murex trunculus* and *Murex brandaris* at the shallower waters (Mutlu and Ergev, 2008), and also in the NE Aegean Sea (Kourelea et al., 2004). An invasive species, *Conomurex persicus* was alone highly effective on the formation of the community along the Turkish Mediterranean coasts (Mersin Bay; Mutlu and Ergev, 2008, and Antalya Gulf; Garuti and Mutlu, 2021).

Table 6. Two-way PERMANOVA results for differences in the epifaunal abundance and biomass among seasons and bottom depths (pMC; Monte Carlo test's p value).

Abundance	**df**	**SS**	**MS**	**F**	**P**	**P(MC)**
Season	3	7519.3	2506.4	0.59287	0.989	0.974
Depth	5	26425	5285	1.2501	0.126	0.147
Season x Depth	12	22142	1845.2	0.43646	1	1
Residuals	11	46504	4227.6			
Total	31	102345				
Biomass						
Season	3	8419.6	2806.5	0.62625	0.983	0.962
Depth	5	27807	5561.5	1.241	0.133	0.17
Season x Depth	12	24492	2041	0.45542	1	1
Residuals	11	49297	4481.5			
Total	31	110525				

Table 7. Similarity table and contributing species, + within the bottom depth, determined from an analysis of a similarity of percentages, SIMPER. (Avg. Sim.: Average similarity at each bottom depth, Avg. Abn: log_{10}-transformed average abundance, Avg. Sim; average similarity, Sim/SD; correction term; Con.%: percent contribution and Cum.%; percent cumulative contribution of the similarities, and SD; standard deviation of the similarity).

10 m, Avg sim: 12.59	**Avg Abn**	**Av.Sim**	**Sim/SD**	**Con.%**	**Cum.%**
Lesueurigobius friesii+	6.12	1.51	0.62	11.98	11.98
Acanthocardia paucicostata+	5.85	1.44	0.62	11.40	23.38
Callionymus reticulatus+	5.45	1.29	0.62	10.22	33.60
Phallusia mammillata+	5.47	1.25	0.62	9.93	43.54
Scorpaena porcus	2.77	1.15	0.32	9.16	52.70
Moerella pulchella+	4.36	1.13	0.62	8.94	61.64
Fulvia fragilis+	4.69	1.08	0.62	8.58	70.22
Astropecten irregularis	2.57	0.61	0.32	4.83	75.05
15 m, Avg sim: 11.14					
Varicorbula gibba+	4.08	1.55	0.40	13.89	13.89
Buglossidium luteum+	3.75	1.47	0.51	13.22	27.10
Turritellinella tricarinata	3.44	0.68	0.31	6.14	33.25
Astropecten irregularis	2.63	0.65	0.30	5.83	39.08
25 m, Avg sim: 39.04					
Turritellinella tricarinata+	13.97	5.52	6.39	14.15	14.15
Dentalium sp+	11.21	4.31	7.56	11.05	25.20
Moerella pulchella+	10.00	4.25	5.18	10.87	36.07
Astropecten irregularis	9.51	3.92	6.16	10.03	46.10
Lesueurigobius friesii+	9.97	3.78	13.15	9.69	55.80
Buglossidium luteum+	9.81	3.77	10.96	9.66	65.46

Table 7 continued

35 m, Avg sim: 48.75	Avg Abn	Av.Sim	Sim/SD	Con.%	Cum.%
Turritellinella tricarinata+	12.89	7.57	4.76	15.52	15.52
Lesueurigobius friesii+	10.23	5.95	4.43	12.21	27.73
Buglossidium luteum+	9.46	5.41	4.49	11.09	38.83
Serranus hepatus+	7.94	4.33	5.92	8.87	47.70
Astropecten irregularis+	8.44	4.29	5.51	8.81	56.51
Diplodus annularis+	7.60	3.68	5.61	7.55	64.06
45 m, Avg sim: 56.92					
Turritellinella tricarinata+	11.91	4.02	6.31	7.06	7.06
Sternaspis scutata+	10.70	3.72	9.27	6.53	13.59
Processa edulis+	10.39	3.51	5.62	6.17	19.76
Lesueurigobius friesii+	9.05	3.24	7.59	5.70	25.45
Alpheus glaber+	9.32	3.11	6.06	5.46	30.92
Dosinia sp+	7.70	2.78	5.74	4.88	35.79
Serranus hepatus+	8.03	2.60	9.56	4.56	40.35
Acanthocardia paucicostata+	7.40	2.59	6.30	4.54	44.90
Buglossidium luteum+	7.54	2.58	7.76	4.54	49.44
Goneplax rhomboides+	7.61	2.54	8.32	4.46	53.89
Astropecten irregularis+	7.28	2.33	6.27	4.10	57.99
Squilla mantis+	6.65	2.31	6.31	4.06	62.05
Nephtys sp+	6.71	2.26	9.78	3.97	66.02
Ophiozonella alba+	6.71	2.22	9.29	3.90	69.92
Amphiura chiajei +	6.65	2.11	6.98	3.70	73.62
Magallana gigas+	6.57	2.03	9.08	3.57	77.19
Solea solea	6.11	1.96	9.57	3.44	80.63
Sipunculidae gen sp+	6.11	1.96	9.57	3.44	84.08
50 m, Avg sim: 43.08					
Lesueurigobius friesii+	9.62	7.29	5.73	16.92	16.92
Goneplax rhomboides+	8.39	6.46	4.05	15.00	31.93
Astropecten irregularis+	7.45	5.62	4.97	13.03	44.96
Alpheus glaber+	7.21	5.38	4.35	12.50	57.46

However, the megafaunal communities or assemblages oriented primarily with the seafloor depths on the CCA plot (Table 8 and Figure 7). On CCA1 axis, near-bottom salinity was then correlated with the megafaunal abundance and biomass. Temperature, sea surface salinity and pH were slightly correlated with faunal assemblages formed on the CCA1 axis (Table 8 and Figure 7). This discrimination was explained with a percent variance of 6.5% and 16.5% and 7.8% and 17.6% for species data and species-environment relation based on abundance and biomass, respectively on CCA1 axis, but was not significantly approved by Monte Carlo test (F = 1.258, P = 0.7060 and F=1.516, P=0.4880, respectively) at p<0.05. On CCA2 axis, near-bottom water density shaped the megafaunal communities (Table 8 and Figure 7) which were not significantly explained (Table 8). Therefore, the CCA2 of all four CCA axes was not significantly proofed by Monte Carlo test (F = 1.071, P = 0.3420 and F=1.297, P=0.0660, respectively).

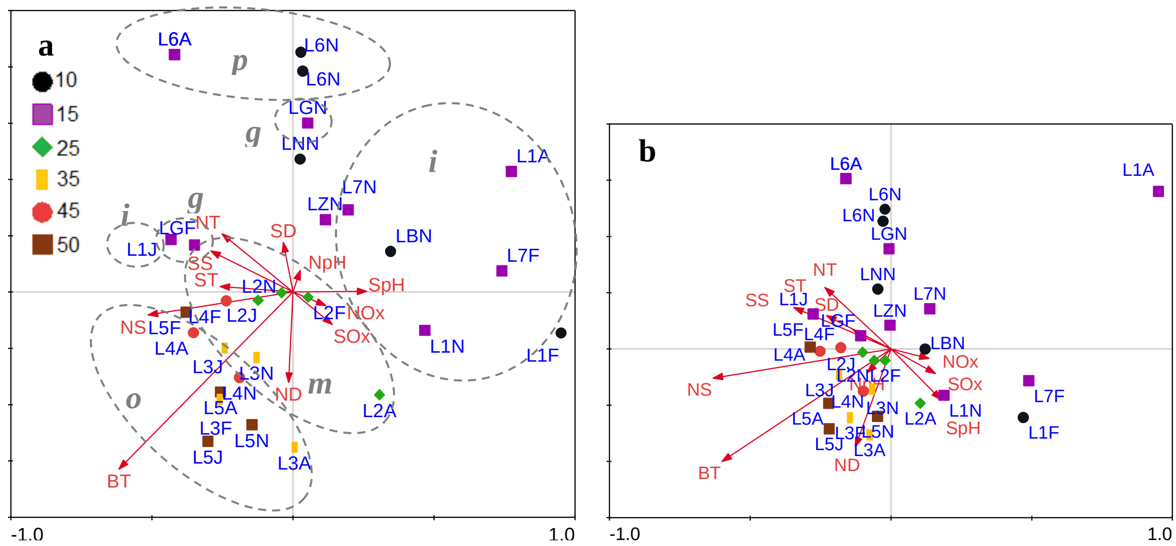

Figure 7. Biplot of CCA of the sampling stations (e.g. L1F, station 1 in February, see Figure 1 for station codes and location) classified by bottom depths, and environmental parameters (Prefixes for the abbreviations: S, sea surface, and N; Near-bottom water: T; Temperature, S; salinity, D; density and Ox; oxygen, pH; pH, and BT: Bottom depth) based on $\log_{10}(X+1)$-transformed abundances (a) (sectors; *i*; inner gulf, *m*; middle gulf, *o*; outer gulf, *g*; shelly bottom, and *p*; vegetative bottom with *Posidonia oceanica*) and biomass (b) of the megafauna.

Table 8. Summary of statistical measures of the characteristics of megafaunal species abundance and biomass in relation to the environmental variables for CCA. Environmental parameters with the abbreviations used in statistical analyses (Prefixes for the abbreviations: S, sea surface, and N; Near-bottom water: T; Temperature, S; salinity, D; density and Ox; oxygen, pH; pH, and BT: Bottom depth).

Variables	Abundance		Biomass	
	CCA1	CCA2	CCA1	CCA2
ST	**-0.2482**	0.0159	**-0.2226**	0.0968
SS	**-0.2797**	0.1133	**-0.3350**	0.1202
SD	-0.0325	0.1368	-0.1309	0.0555
SpH	**0.2508**	0.0020	0.1722	-0.1470
SOx	0.1332	-0.0896	0.1530	-0.0715
NT	**-0.2412**	0.1609	-0.2281	0.1781
NS	**-0.4929**	-0.0634	**-0.6134**	-0.0847
ND	-0.0152	**-0.2496**	-0.1229	**-0.2849**
NpH	0.0244	0.0601	-0.0820	-0.0691
NOx	0.1118	-0.0372	0.1312	-0.0282
BT	**-0.5919**	**-0.4893**	**-0.5829**	**-0.3266**
Eigenvalues	0.451	0.390	0.557	0.495
Species-environment correlations	0.959	0.778	0.971	0.816
Cumulative percentage variance				
of species data	6.5	12.2	7.8	14.7
of species-environment relation	16.5	30.8	17.6	33.2

Çinar et al. (2012) correlated infauna of the inner gulf positively with total organic carbon contents of the sediment, water nutrients and chl-*a* in İzmir Gulf. The outer gulf was correlated with the sedimentary characters; positively with sand, negatively with silt and clay contents. Infaunal community of the middle gulf was located around the centre of the CCA in Izmir Gulf (Çinar et al., 2012) as occurred in the present study implying that there was no correlation with the environmental parameters but the seasonality compensated faunal community. Infaunal community was found to be significant among the seasons (Çinar et al., 2012). Colloca et al. (2003) found a similar fauna distribution pattern in the central Mediterranean Sea, where Peres and Picard (1964) observed that the demersal fauna assemblage exhibited a strong relationship with depth-related sedimentary texture from sandy detritic bottom to muddy detritic bottoms. Hyland et al. (2005) found that the species richness decreased as a factor of total organic carbon after a critical concentration of 5% for the benthic communities as occurred in the present study.

Acknowledgement

The present study was carried out to estimate qualification and quantification of the benthic macrophytes conducted by me as task manager within framework of a project (grant no: SINHA 107G067) funded by TUBITAK. I thank Barış Akçalı for his help onboard sampling, and Erdem Sayın for providing the study with water physical parameters obtained with the CTD.

Conflict of Interest

The author declares no conflict of interest.

References

Abello, P., Valladares, F.J. & Castellon, A. (1988). Analysis of the structure of decapod crustacean assemblages off the Catalan coast (North-West Mediterranean). *Marine Biology* 98, 39-49.

Arroyo, E, Urbano E.M., Garcia-Ruiz, C, Esteban, A. & Ramos-Esplá, A.A., (2019). Ascidians (Chordata: Tunicata) from circalittoral and upper-bathyal soft bottoms of the Iberian Mediterranean. Bottom trawling impact. Front. Mar. Sci. Conference Abstract: XX Iberian Symposium on Marine Biology Studies (SIEBM XX). https://doi.org/10.3389/conf.fmars.2019.08.00075

Aslan Cihangir, H. & Pancucci-Papadopoulou, M.A. (2012). Spatial and temporal variation of echinoderm assemblages from soft bottoms of the Çanakkale Strait (Turkish Strait System) with a taxonomic key of the genus *Amphiura* (Echinodermata: Ophiuroidea). *Turkish Journal of Zoology* 36, 147-161. https://doi.org/10.3906/zoo-1008-20

Aslan-Cihangir, H. & Pancucci-Papadopoulou, M.A. (2011). Aspects of decapod crustacean assemblages from soft bottoms submitted to strong hydrodynamic conditions: an example from Canakkale Strait (Turkish Strait System). *Fresenius Environmental Bulletin* 20, 2400-2411.

Ateş, A.S. & Katağan, T. (2008). Decapod crustaceans of soft-sediments on the Aegean Sea coast of Turkey (the eastern Aegean Sea). *Oceanol. Hydrobiol. St.* XXXVII(1), 17-30. https://doi.org/10.2478/v10009-007-0040-32008

Bilyard, G.R. (1987). The value of benthic infauna in marine pollution monitoring studies. *Marine Pollution Bulletin* 18(11), 581-585. https://doi.org/10.1016/0025-326X(87)90277-3

Cartes, I.E., Maynoua, F., Fanelli, E., Romano, Ch., Mamouridis, V. & Papiol, V. (2009). The distribution of megabenthic, invertebrate epifauna in the Balearic Basin (western Mediterranean) between 400 and 2300 m: Environmental gradients influencing assemblages composition and biomass trends. *Journal of Sea Research* 61, 244–257. https://doi.org/10.1016/j.seares.2009.01.005

Chicharo, L.,.Chicharo A, Gaspar M., Alves F. & Regala J. (2002). Ecological characterization of dredged and non-dredged bivalve fishing areas off south Portugal. *Journal of the Marine Biological Association of the United Kingdom* 82, 41-50.

Ciércoles, C., García-Ruiz, C., González Aguilar, M., Ortiz De Urbina Gutierrez, J., Lópezgonzález, N., Urra Recuero, J. & Rueda Ruiz, J. (2018). Molluscs collected with otter trawl in the northern Alboran Sea: main assemblages, spatial distribution and environmental linkage. *Mediterranean Marine Science* 19(1), 209-222. https://doi.org/10.12681/mms.2124

Çinar M.E., Katağan T., Koçak F., Öztürk B., Ergen Z., Kocatas A., Önen M., Kirkim F., Bakir K., Kurt G., Dağli E., Açik S., Doğan A. & Özcan T. (2008). Faunal assemblages of the mussel *Mytilus galloprovincialis* in and around Alsancak Harbour (Izmir Bay, eastern Mediterranean) with special emphasis on alien species. *Journal of Marine Systems* 71(1–2), 1-17. https://doi.org/10.1016/j.jmarsys.2007.05.004.

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

Çinar ME, Bilecenoğlu M, Yokeş MB, Ozturk B, Taşkin E, Bakir K, Doğan, A. & Açik, Ş. (2021). Current status (as of end of 2020) of marine alien species in Turkey. *PLoS ONE* 16(5), e0251086. https://doi.org/10.1371/journal.pone.0251086

Cinar, M.E. & Z. Ergen. 2005. Lessepsian migrants expanding their distributional ranges; *Pseudonereis anomala* (Polychaeta: Nereididae) in Izmir Bay (Aegean Sea). *Journal of the Marine Biological Association of the United Kingdom* 85, 313-321.

Çinar, M.E., Katagan, T., Öztürk, B., Egemen, Ö., Ergen, Z., Kocatas, A., Önen, M., Kirkim, F., Bakir, K., Kurt, G., Dagli, E., Kaymakçi, A., Açik, S., Dogan, A. & Özcan, T. (2006), Temporal changes of soft-bottom zoobenthic communities in and around Alsancak Harbor (Izmir Bay, Aegean Sea), with special attention to the autecology of exotic species. *Marine Ecology*, 27, 229-246. https://doi.org/10.1111/j.1439-0485.2006.00102.x

Çinar, M.E., M. Bilecenoglu, B. Ozturk, T.Katagan & V. Aysel. (2005). Alien species on the coasts of Turkey. *Mediterranean Marine Science* 6, 119-146.

Coll, M., Piroddi, C., Steenbeek, J., Kaschner, K., Ben Rais Lasram, F., Nike Bianchi, C., Corbera, J., Dailianis, T., Danovaro, R., Estrada, M., Froglia, C., Galil, B.S., Gasol, J.M., Gertwagen, R., Gil, J., Guilhaumon, F., Kesner-Reyes, K., Kitsos, M.S., Koukouras, A., Lampadariou, N., Laxamana, E., Lopez-Fe de la Cuadra, C.M., Lotze, H.K., Martin, D., Mouillot, D., Oro, D., Raicevich, S., Rius-Barile, J., Saiz-Salinas, J.I., San Vicente, C., Somot, S., Templado, J., Turon, X., Vafidis, D., Villanueva, R. & Voultsiadou, E. (2010). The biodiversity of the Mediterranean sea: Estimates, patterns, and threats. *PLoS One* 5(8), e11842. https://doi.org/10.1371/journal.pone.0011842

Colloca, F., Cardinale, M., Belluscio, A. & Ardizzone, G. (2003). Pattern of distribution and diversity of demersal assemblages in the central Mediterranean Sea. *Estuarine Coastal and Shelf Science* 56, 469–480. https://doi.org/10.1016/S0272-7714(02)00196-8

Conides, A., Bogdanos, C. & Diapoulis, A. (1999). Seasonal ecological variations of phyto- and zoobenthic communities in the south of Nisyros Island, Greece. *The Environmentalist* 19, 109-127.

Cosentino, A. & Giacobbe, S. (2006). A case study of mollusc and polychaete soft-bottom assemblages submitted to sedimentary instability in the Mediterranean Sea. *Marine Ecology* 27, 170–183. https://doi.org/10.1111/j.1439-0485.2006.00088.x

De Juan, S., Thrush, S.F. & Demestre, M. (2007). Functional changes as indicators of trawling disturbance on a benthic community located in a fishing ground (NW Mediterranean Sea). *Marine Ecology Progress Series* 334, 117–129. https://doi.org/10.3354/meps334117

DeLaHoz M.V., Sardà, F., Coll, M., Sáez, R., Mechó, A., Oliva, F., Ballesteros, M. & Palomera, I. (2018). Biodiversity patterns of megabenthic non-crustacean invertebrates from an exploited ecosystem of the Northwestern Mediterranean Sea. *Regional Studies in Marine Science* 19, 47–68. https://doi.org/10.1016/j.rsma.2018.03.002

Díaz, J.I., Nelson, C.H., Barber jr, J.H. & Giró, S. (1990). Late Pleistocene and Holocene sedimentary facies on the Ebro continental shelf. *Marine Geology* 95, 333–352. https://doi.org/10.1016/0025-3227(90)90123-2

Doğan A., Çinar M.E., Önen M., Ergen Z. & Katağan T.(2005). Seasonal dynamics of soft bottom zoobenthic communities in polluted and unpolluted areas of Izmir Bay (Aegean Sea). *Senckenbergiana Maritima* 35, 133–145. https://doi.org/10.1007/BF03043182

El Lakhrach, H., Hattour, A., Jarboui, O., Elhasni, K. & Ramos-Espla, A. (2012). Spatial distribution and abundance of the megabenthic fauna community in Gabes gulf (Tunisia, eastern Mediterranean Sea). *Mediterranean Marine Science* 13(1), 12-29. https://doi.org/10.12681/mms.19

Evcen A. & Çinar M.E. (2020). Sponge species from ports of the inner and middle parts of İzmir Bay (Aegean Sea, Eastern Mediterranean) İzmir iç ve orta körfezi limanlarından sünger türleri (Ege Denizi, Doğu Akdeniz). *Ege Journal of Fisheries and Aquatic Sciences* 37(2), 149-155. DOI: 10.12714/egejfas.37.2.05

Fredj, G. & Laubier, L. (1985). The deep Mediterranean benthos. In: Moraitou-Apostolopoulou, M., Kiortis, V., (Eds.), Mediterranean Marine Ecosystems. Plenum Press, New York, pp. 109–145.

Garuti A. & Mutlu E. (2021). Spatiotemporal and ecological distribution of megabentic non-crustacean invertebrates in an ultra-oligotrophic gulf, the eastern Mediterranean Sea. *Journal of Marine Systems*, 103644. https://doi.org/10.1016/j.jmarsys.2021.103644

Gesteira, J.G. & Dauvin, J.C. (2000). Amphipods are good bioindicators of the impact of oil spills on soft-bottom macrobenthic communities. *Marine Pollution Bulletin*, 40(11), 1017-1027.

Gofas, S., Moreno, D. & Salas, C. (2011). Moluscos marinos de Andalucía. Volumen I y II. Servicio de Publicaciones e Intercambio Científico, Universidad de Málaga, Málaga.

Grinyó, J., Gorib, A., Greenacre, M., Requena, S., Canepa, A., Iacono C.Lo, Ambroso, S., Purroy, A. & Gili, J.-M. (2018). Megabenthic assemblages in the continental shelf edge and upper slope of the Menorca Channel, Western Mediterranean Sea. *Progress in Oceanography* 162, 40–51. https://doi.org/10.1016/j.pocean.2018.02.002

Hagy, J.D., Boynton, W.R., Wood, C.W. & Wood, K.V. (2004): Hypoxia in Chesapeake Bay, 1950–2001: long-term changes in relation to nutrient loading and river flow. *Estuaries*, 27, 634–658.

Hinz, H., Kroncke I. & Ehrich, S. (2004). Seasonal and annual variability in an epifaunal community in the German Bight. *Marine Biology* 144, 735-745.

Holden, M.J. & Raitt, D.F.S. (1974). *Manual of fisheries science. Part 2-Methods of resource investigation and their application*. Documents Techniques FAO sur les Peches (FAO)-Documentos Tecnicos de la FAO sobre la Pesca (FAO).

Hyland J., Balthis L.W., Karakassis I., Magni P., Petrov A., Shine J.R.,Vestergaard O. & Warwick R. (2005) Organic carbon content of sediments as an indicator of benthic stress. *Marine Ecology Progress Series* 295, 91–103.

Kallianiotis, A., Sophronidis, K., Vidoris, P. & Tselepides, A. (2000). Demersal fish and megafaunal assemblages on the Cretan continental shelf and slope (NE Mediterranean): seasonal variation in species density, biomass and diversity. *Progress in Oceanography* 46(2-4), 429-455.

Karakassis, I. & Eleftheriou, A. (1998). The continental shelf of Crete: The benthic environment. *Marine Ecology-P S Z N I.* 19, 263-277. https://doi.org/10.1111/j.1439-0485.1998.tb00467.x

Kefalas, E., Castritsi-Catharios J. & Miliou, H. (2003b). The impacts of scallop dredging on sponge assemblages in the Gulf of Kalloni (Aegean Sea, northeastern Mediterranean). *ICES Journal of Marine Sciences* 60, 402–410. 2003, https://doi.org/10.1016/S1054–3139(03)00012-2

Kefalas, E., Tsirtsis, G. & Castritsi-Catharios, J. (2003a). Distribution and ecology of Demospongiae from the circalittoral of the islands of the Aegean Sea (Eastern Mediterranean*)*. *Hydrobiologia* 499, 125–134. https://doi.org/10.1023/A:1026343113345

Koukouras, A., Kitsos, M.S., Tzomos, Th. & Tselepides, A. (2010). Evolution of the entrance rate and of the spatio-temporal distribution of lessepsian crustacean Decapoda in the Mediterranean Sea. *Crustaceana*, 83, 1409-1430.

Kourelea, E., Dimitrios, V., Chariton-Charles, C., Georgios T. & Louis, C. (2004). Temporal variations in fine sand assemblages in the North Aegean Sea (Eastern Mediterranean). Int. Rev. *Hydrobiologia* 89, 175-187. https://doi.org/10.1002/iroh.200310672

Kramer, M.J., Bellwood, O. & Bellwood, D.R. (2013). The trophic importance of algal turfs for coral reef fishes: the crustacean link. *Coral Reefs* 32(2), 575-583.

Kroncke, I., Türkay, M. & Fiege, D. (2003). Macrofauna communities in the Eastern Mediterranean deep sea. *Marine Ecology* 24(3), 193-216. https://doi.org/10.1046/j.0173-9565.2003.00825.x

Magni P. (2003). Biological Benthic Monitoring. 4th MAMA Meeting, Rome 3-6 June 2003

Makra, A. & Nicolaidou A. (2000). Benthic communities of the inner Argolikos Bay. *Belgium Journal of Zoology* 130, 61-67.

Maria, A. & Pires, S. (1992). Structure and dynamics of benthic megafauna on the continental shelf offshore of Ubatuba, southeastern Brazil. *Marine Ecology Progress Series* 86, 63-76. https://doi.org/10.3354/meps086063

Morello, E.B., Froglia C., James R., Atkinson A. & Moore P.G. (2006). Medium-term impacts of hydraulic clam dredgers on a macrobenthic community of the Adriatic Sea (Italy). *Marine Biology* 149, 401-413.

Mutlu, E. & Ergev, M.B. (2008). Spatio-temporal distribution of soft-bottom epibenthic fauna on the Cilician shelf (Turkey), Mediterranean Sea. *Revista de Biología Tropical* 56(4), 1919-1946.

Öztürk, B. & Poutiers, J.M. (2005). *Fulvia fragilis* (Bivalvia: Cardiidae): A lessepsian mollusc species from Izmir bay (Aegean Sea). *Journal of the Marine Biological Association of the United Kingdom*, 85(2), 351-356.

Patania, A. & Mutlu, E. (2021). Spatiotemporal and ecological distribution of megabenthic crustaceans on the shelf-shelf break of Antalya Gulf, the eastern Mediterranean Sea. *Mediterranean Marine Science*, 22(3), 446-465. https://doi.org/10.12681/mms.26142

Peres, J.M. & Picard, J. (1964). Nouveau manuel de bionomie bentique de la mer Mediterranee. Recueil des Travaux de la Station Marine d' Endoume 31, 1–137.

Peres, J.M. (1982). Zonation. General features of organismic assemblages in pelagial and benthal. Structure and dynamics of assemblages. Major benthic assemblages. Specific benthic assemblages. In Kinne, O., (Ed), Marine ecology. John Wiley, Chichester V-1, pp. 9-66, 119-186, 373-581.

Quetglas, A., Carbonell, A. & Sanchez, P. (2000). Demersal continental shelf and upper slope cephalopod assemblages from the Balearic Sea (North-Western Mediterranean). Biological aspects of some deep-sea species. *Estuar. Coast. Shelf Sci.* 50, 739–749. https://doi.org/10.1006/ecss.1999.0603.

Ramón, M., Abelló, P., Ordines, F. & Massutí, E. (2014). Deep epibenthic communities in two contrasting areas of the Balearic Islands (western Mediterranean). *Jornal of Marine Systems.* 132, 54–65. https://doi.org/10.1016/j.jmarsys.2014.01.002

Rex, M.A. (1981). Community structure in the deep-sea benthos. *The Annual Review of Ecology, Evolution, and Systematics* 12, 331-53.

Sánchez-Jerez, P., Cebrian, C.C. & Ramos-Esplá, A.A. (2000). Influence of the structure of *Posidonia oceanica* meadows modified by bottom trawling on crustacean assemblages: comparison of amphipods and decapods. *Scientia Marina* 64(3), 319-32

Sanchez-Moyano, J.E. & Garcia-Gomez, J.C. (1998). The arthropod community, especially Crustacea, as a bioindicator in Algeciras Bay (southern Spain) based on a spatial distribution. *Journal of Coastal Research* 14, 1119-1133.

Sarda, R., Pinedo, S., Gremare A.& Taboada S. (2000). Changes in the dynamics of shallow sandy-bottom assemblages due to sand extraction in the Catalan Western Mediterranean Sea. *ICES Journal of Marine Sciences* 57, 1446-1453.

Serrano, A., Sanchez F. & Garcia-Castrillo G. (2006). Epibenthic communities of trawlable grounds of the Cantabrian Sea. *Scientia Marina* 70, 149-159.

Šifner, S.K., Peharda, M., Vrgoč, N., Isajlović, I., Dadić, V. & Petrić, M. (2011). Biodiversity and distribution of cephalopods caught by trawling along the Northern and Central Adriatic Sea. *Cahiers de Biologia Marina* 52, 291-302.

Smith, C.J., Papadopoulou, K.N. & Diliberto, S. (2000). Impact of otter trawling on an eastern Mediterranean commercial trawl fishing ground. *ICES Journal of Marine Sciences* 57, 1340-1351. https://doi.org/10.1006/jmsc.2000.0927

Soyer, J. (1970). Bionomie benthique du plateau continental de la côte catalane française Volume III - Les peuplements de Copepodes harpacticoides (Crustacea). *Vie et Milieu* 21(2B), 337-551

Tecchio, S., Coll, M. & Sardà, F. (2015). Structure, functioning, and cumulative stressors of Mediterranean deep-sea ecosystems. *Progress in Oceanography* 135, 156–167. https://doi.org/10.1016/j.pocean.2015.05.018

Tselepides, A., Papadopoulou K.N., Podaras D., Plaiti W. & Kousoubas D. (2000). Macrobenthic community structure over the continental margin of Crete (South Aegean Sea, NE Mediterranean). *Progress in Oceanography* 46, 401-428.

Vaquer-Sunyer, R. & Duarte, C.M. (2008): Thresholds of hypoxia for marine biodiversity. *Proceedings of the National Academy of Sciences of the United States of America* 105, 15452–15457

Yelekci, O., Ibello, V., Fach, B., Kucuksezgin, F., Yumruktepe, C., Sayin, E., Salihoglu, B., & Tugrul, S. (2021). Assessing the impact of nutrient loads on eutrophication in the semi-enclosed Izmir Bay combining observations and coupled hydrodynamic-ecosystem modelling. *Mediterranean Marine Science, 0*. https://doi.org/10.12681/mms.23294

Appendix 1. Epifaunal species with their annual dominance (constant and common species), *D* (%), frequency of occurrence (most frequently occurred species), *FO* (%) and numerical occurrence (most abundantly occurred species), *NO* (%), and ranges of abundance, *A* (in a format of minimum-maximum abundance/minimum-maximum corresponding bottom depth, bottom depth where the maximum abundance ocurred), and biomass, *B* (minimum-maximum biomass/bottom depth where the maximum biomass ocurred) and *: Alien species. + one species in branch.

Species	DO%	FO%	NO%	Abundance (ind/km^2)	Biomass (kg/km^2)
CHORDATA	**43**				
Gnathostomata	**37**				
Osteichthyes	**35**				
Arnoglossus laterna (Walbaum, 1792)	39.39	2.18	0.545	681-33216/10-50,26	2.90-141.74/26
Blennius ocellaris Linnaeus, 1758	3.03	0.17	0.003	722-722/26-26,26	2.23-2.23/26
Buglossidium luteum (Risso, 1810)	63.64	3.53	1.011	697-86651/10-50,26	0.49-267.96/26
Callionymus filamentosus Valenciennes, 1837*	3.03	0.17	0.003	880-880/36-36,36	0.83-0.83/36
Callionymus maculatus Rafinesque, 1810	3.03	0.17	0.001	415-415/35-35,35	0.71-0.71/35
Callionymus reticulatus Valenciennes, 1837	39.39	2.18	0.260	138-29149/9-48,9	0.09-10.48/12
Cepola macrophthalma (Linnaeus, 1758)	6.06	0.34	0.003	207-794/35-40,40	0.47-0.47/35
Chromis chromis (Linnaeus, 1758)	3.03	0.17	0.004	1272-1272/15-15,15	17.07-17.07/15
Citharus linguatula (Linnaeus, 1758)	6.06	0.34	0.008	815-1612/45-48,48	26.04-26.04/48
Coris julis (Linnaeus, 1758)	3.03	0.17	0.019	5512-5512/15-15,15	23.60-23.60/15
Diplodus annularis (Linnaeus, 1758)	33.33	1.85	0.713	207-177297/9-48,40	6.58-472.51/48
Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)	9.09	0.50	0.018	740-3266/13-15,15	6.81-54.28/15
Gobius geniporus Valenciennes, 1837	6.06	0.34	0.019	1959-3407/15-18,18	3.95-5.74/15
Gobius niger jozo Linnaeus, 1758	33.33	1.85	0.378	207-62900/9-45,9	2.55-144.30/36
Gobius paganellus Linnaeus, 1758	3.03	0.17	0.001	424-424/15-15,15	11.95-11.95/15
Gobius sp.	3.03	0.17	0.001	351-351/19-19,19	0.21-0.21/19
Gobius vittatus Vinciguerra, 1883	3.03	0.17	0.003	848-848/15-15,15	9.32-9.32/15

Species	DO%	FO%	NO%	Abundance (ind/km^2)	Biomass (kg/km^2)
Lesueurigobius friesii (Malm, 1874)	66.67	3.70	2.592	1415-212437/9-50,40	4.66-399.65/9
Merluccius merluccius (Linnaeus, 1758)	3.03	0.17	0.003	974-974/38-38,38	35.85-35.85/38
Mullus barbatus Linnaeus, 1758	3.03	0.17	0.001	407-407/45-45,45	3.83-3.83/45
Pegusa lascaris (Risso, 1810)	3.03	0.17	0.002	707-707/24-24,24	9.41-9.4102/24
Scorpaena maderensis Valenciennes, 1833	6.06	0.34	0.004	424-653/15-15,15	ND
Scorpaena porcus Linnaeus, 1758	12.12	0.67	0.023	708-3392 /11-15,15	17.96-359.58/15
Scorpaena scrofa Linnaeus, 1758	6.06	0.34	0.004	424-653/15-15,15	78.90-505.45/15
Serranus cabrilla (Linnaeus, 1758)	3.03	0.17	0.006	1612-1612/48-48,48	167.55-167.55/48
Serranus hepatus (Linnaeus, 1758)	42.42	2.35	0.209	415-22071/10-50,40	1.45-220.69/48
Serranus scriba (Linnaeus, 1758)	9.09	0.50	0.031	740-6784/13-15,15	8.36-173.01/15
Solea solea (Linnaeus, 1758)	27.27	1.51	0.234	138-59316/9-48,40	1.45-106.29/38
Sparus aurata Linnaeus, 1758	3.03	0.17	0.003	722-722/26-26,26	45.34-45.34/26
Symphodus cinereus (Bonnaterre, 1788)	3.03	0.17	0.003	740-740/13-13,13	2.44-2.44/13
Symphodus mediterraneus (Linnaeus, 1758)	3.03	0.17	0.006	1696-1696 /15-15,15	19.90-19.90/15
Symphodus ocellatus (Linnaeus, 1758)	3.03	0.17	0.087	25018-25018/15-15,15	70.57-70.57/15
Symphodus roissali (Risso, 1810)	12.12	0.67	0.044	424-5924/13-15,13	2.53-17.80/15
Symphodus rostratus (Bloch, 1791)	3.03	0.17	0.004	1272-1272/15-15,15	15.01-15.01/15
Symphodus sp	3.03	0.17	0.002	708-708/11-11,11	2.69-2.69/11
Chondrichthyes	**2**				
Dasyatis pastinaca (Linnaeus, 1758)	3.03	0.17	0.002	710-710/15-15,15	157.32-157.32/15
Torpedo marmorata Risso, 1810	18.18	1.01	0.017	207-1121/13-50,25	25.22-224.39/25
Ascidiacea	**6**				
Ciona intestinalis (Linnaeus, 1767)	9.09	0.50	0.010	710-1444/13-26,26	4.76-4.76/26

Species	DO%	FO%	NO%	Abundance (ind/km^2)	Biomass (kg/km^2)
Microcosmus polymorphus Heller, 1877	6.06	0.34	0.035	2204-7853/15-25,25	46.22-160.37/15
Microcosmus vulgaris Heller, 1877	12.12	0.67	0.337	1506-87447/9-30,9	36.55-1193.42/9
Phallusia mammillata (Cuvier, 1815)	18.18	1.01	0.274	138-65969/9-45,9	2.92-120.73/9
Styela canopus (Savigny, 1816)	3.03	0.17	0.011	3306-3306/15-15,15	45.63-45.63/15
Styela plicata (Lesueur, 1823)*	3.03	0.17	0.001	407-407/45-45,45	12.6804-12.6804/45
MOLLUSCA	**54**				
Bivalvia	**41**				
Abra alba (W. Wood, 1802)	15.15	0.84	0.470	351-58280/15-45,15	0.17-29.40/30
Abra prismatica (Montagu, 1808)	18.18	1.01	0.098	707-17424/15-50,40	0.13-7.55/40
Abra sp	3.03	0.17	0.004	1144-1144/15-15,15	0.11-0.11/15
Acanthocardia echinata (Linnaeus, 1758)	6.06	0.34	0.039	806-10304/15-48,15	1.45-4.12/15
Acanthocardia paucicostata (G. B. Sowerby II, 1834)	42.42	2.35	0.985	703-117932/9-48,30	0.14-132.09/30
Acanthocardia tuberculata (Linnaeus, 1758)	24.24	1.34	0.158	710-25995/10-48,26	0.45-45.41/26
Anadara sp	9.09	0.50	0.142	2130-31258/12-15,13	23.01-405.39/13
Arca noae Linnaeus, 1758	6.06	0.34	0.406	5682-111380/12-15,12	33.16-1278.27/12
Arca sp	12.12	0.67	0.123	722-29149/9-26,9	0.57-179.34/9
Barbatia barbata (Linnaeus, 1758)	3.03	0.17	0.011	3068-3068/9-9,9	5.06-5.06/9
Bivalvia	18.18	1.01	0.062	397-12636/14-40,26	0.39-6.18/15
Cardium sp	3.03	0.17	0.023	6497-6497/12-12,12	45.57-45.57/12
Cerastoderma edule (Linnaeus, 1758)	6.06	0.34	0.091	1223-24977/15-45,15	1.71-25.20/15
Chlamys sp	9.09	0.50	0.014	806-1856/12-48,12	5.48-17.07/12
Crassostrea sp	3.03	0.17	0.000	138-138/45-45,45	0.94-0.94/45
Dosinia sp	21.21	1.18	0.035	539-3669/12-48,45	0.0007-13.86/48

Species	**DO%**	**FO%**	**NO%**	**Abundance (ind/km^2)**	**Biomass (kg/km^2)**
Dosinia exoleta (Linnaeus, 1758)	12.12	0.67	0.136	707-20328/24-48,40	1.46-6.09/40
Ensis sp	3.03	0.17	0.127	36758-36758/30-30,30	9.80-9.80/30
Fulvia fragilis (Forsskål in Niebuhr, 1775)*	30.30	1.68	0.115	502-10739/9-48,9	0.05-78.68/15
Limecola balthica (Linnaeus, 1758)	3.03	0.17	0.019	5569-5569/12-12,12	24.03-24.03/12
Limopsis multistriata (Forsskål in Niebuhr, 1775)	6.06	0.34	0.097	351-27615/9-19,9	267.55-267.55/9
Magallana gigas (Thunberg, 1793)*	9.09	0.50	0.015	138-3261/45-48,45	4.93-35.10/45
Mimachlamys varia (Linnaeus, 1758)	3.03	0.17	0.002	595-595/15-15,15	0.23-0.23/15
Moerella pulchella (Lamarck, 1818)	39.39	2.18	0.436	539-38631/9-48,26	0.18-10.61/26
Mytilus galloprovincialis Lamarck, 1819	3.03	0.17	0.005	1534-1534/9-9,9	20.40-20.40/9
Nucula nucleus (Linnaeus, 1758)	12.12	0.67	0.241	1664-25273/26-45,26	0.49-17.13/40
Ostrea edulis Linnaeus, 1758	24.24	1.34	0.079	416-9205/9-50,9	2.18-50.01/9
Palliolum striatum (O. F. Müller, 1776)	6.06	0.34	0.004	416-815/45-45,45	1.9-2.77/45
Peronaea planata (Linnaeus, 1758)	12.12	0.67	0.078	710-19491/9-26,12	0.50-29.23/12
Pinctada imbricata Röding, 1798*	6.06	0.34	0.006	648-1192/40-50,40	4.60-8.22/40
Polititapes aureus (Gmelin, 1791)	9.09	0.50	0.032	710-6497/12-15,12	4.82-26.08/12
Pteria hirundo (Linnaeus, 1758)	15.15	0.84	0.071	722-9077/26-50,50	10.61-134.95/45
Ruditapes decussatus (Linnaeus, 1758)	3.03	0.17	0.002	595-595/15-15,15	4.76-4.76/15
Spisula sp	3.03	0.17	0.034	9839-9839/15-15,15	4.54-4.54/15
Talochlamys multistriata (Poli, 1795)	3.03	0.17	0.005	1531-1531/30-30,30	8.73-8.73/30
Tapes sp	6.06	0.34	0.050	1534-12994/9-12,12	1.53-1.53/9
Tellina purpurata Gmelin, 1791	3.03	0.17	0.054	15707-15707/25-25,25	11.21-11.21/25
Thyasira flexuosa (Montagu, 1803)	3.03	0.17	0.004	1046-1046/49-49,49	1.36-1.36/49
Thyasira sp	6.06	0.34	0.047	880-12636/26-36,26	0.52-6.31/26

Species	**DO%**	**FO%**	**NO%**	**Abundance (ind/km^2)**	**Biomass (kg/km^2)**
Varicorbula gibba (Olivi, 1792)	21.21	1.18	2.826	407-404843/13-45,15	0.08-48.72/15
Venus sp	3.03	0.17	0.005	1458-1458/50-50,50	0.43-0.43/50
Gastropoda	**10**				
Anomia ephippium Linnaeus, 1758	24.24	1.34	2.813	351-610598/9-45,9	0.07-576.53/9
Aporrhais pespelecani (Linnaeus, 1758)	18.18	1.01	0.128	138-16847/12-48,30	1.45-112.80/30
Bolinus brandaris (Linnaeus, 1758)	15.15	0.84	0.018	348-2243/19-49,25	3.30-38.93/25
Calyptraea sp.	12.12	0.67	0.075	1664-12636/15-45,26	0.72-1.30/15
Hexaplex trunculus (Linnaeus, 1758)	6.06	0.34	0.008	806-1506/10-48,10	25.96-36.80/10
Ocenebra sp	3.03	0.17	0.003	765-765/30-30,30	3.52-3.52/30
Philine aperta (Linnaeus, 1767)	9.09	0.50	0.012	397-2122/24-40,24	0.95-2.92/38
Phorcus articulatus (Lamarck, 1822)	3.03	0.17	0.148	42635-42635/25-25,25	20.86-20.86/25
Tritia reticulata (Linnaeus, 1758)	9.09	0.50	0.387	2130-103954/12-25,12	1.06-137.92/12
Turritellinella tricarinata (Brocchi, 1814)	54.55	3.03	72.575	7037-8187083/10-50,26	1.82-6676.48/30
Scaphopoda	**1**				
Dentalium sp	33.33	1.85	3.167	440-575868/10-50,26	0.03-100.01/26
Cephalopoda	**2**				
Sepia officinalis Linnaeus, 1758	15.15	0.84	0.017	681-1534/9-36,9	64.24-218.46/9
Sepiola robusta Naef, 1912	3.03	0.17	0.003	765-765/30-30,30	1.37-1.37/30
ARTHROPODA	**20**				
Crustacea	**20**				
Cirripedia	**1**				
Chthamalus sp	3.03	0.17	0.239	68959-68959/26-26,26	32.45-32.45/26
Decapoda	**17**				

Species	DO%	FO%	NO%	Abundance (ind/km^2)	Biomass (kg/km^2)
Alpheus glaber (Olivi, 1792)	27.27	1.51	0.390	397-82246/15-50,48	0.11-50.87/48
Alpheus macrocheles (Hailstone, 1835)	6.06	0.34	0.004	424-815/15-45,45	0.04-0.38/45
Carcinus aestuarii Nardo, 1847	3.03	0.17	0.086	24683-24683/25-25,25	246.05-246.05/25
Eriphia verrucosa (Forskål, 1775)	27.27	1.51	0.188	595-38147/10-48,25	0.29-280.27/25
Galathea sp	0.00	0.00	0.000	ND/19-45,19	0.01-0.03/19
Goneplax rhomboides (Linnaeus, 1758)	39.39	2.18	0.162	693-9706/9-50,45	0.35-36.04/48
Leucisca sp	6.06	0.34	0.014	928-3225. /12-48,48	0.74-7.17/48
Liocarcinus depurator (Linnaeus, 1758)	6.06	0.34	0.019	710-4640/12-15,12	1.85-2.62/15
Liocarcinus vernalis (Risso, 1827)	3.03	0.17	0.047	13463-13463/25-25,25	26.81-26.81/25
Metapenaeus affinis (H. Milne Edwards, 1837)*	15.15	0.84	0.051	1077-6497/12-25,12	2.87-31.24/15
Metapenaeus monoceros (Fabricius, 1798)*	3.03	0.17	0.020	5896-5896/15-15,15	31.77-31.77/15
Pagurus sp	6.06	0.34	0.014	502-3434/10-15,15	0.75-34.34/15
Penaeus kerathurus (Forskål, 1775)	15.15	0.84	0.157	737-40657/12-50,40	1.45-26.97/50
Pisa sp	3.03	0.17	0.006	1612-1612/48-48,48	0.40-0.40/48
Processa edulis (Risso, 1816)	24.24	1.34	0.641	722-110467/26-50,48	0.14-21.20/48
Processa sp	27.27	1.51	0.673	440-70149/15-48,38	0.07-17.42/40
Sphaerifer sp	3.03	0.17	0.004	1223-1223/45-45,45	0.12-0.12/45
Stomatopoda	**2**				
Erugosquilla massavensis (Kossmann, 1880)*	3.03	0.17	0.007	1948-1948/38-38,38	34.48-34.48/38
Squilla mantis (Linnaeus, 1758)	15.15	0.84	0.018	407-1612/15-50,48	0.44-25.31/48
ECHINODERMATA	**18**				
Asteroidea	**8**				
Amphiura chiajei Forbes, 1843	42.42	2.35	0.758	138-146945/10-50,26	0.01-18.70/26

Species	**DO%**	**FO%**	**NO%**	**Abundance (ind/km^2)**	**Biomass (kg/km^2)**
Asterias rubens Linnaeus, 1758*	3.03	0.17	0.218	62831-62831/25-25,25	22.43-22.43/25
Astropecten bispinosus (Otto, 1823)	3.03	0.17	0.024	6897-6897/40-40,40	0.72-0.72/40
Astropecten irregularis (Pennant, 1777)	63.64	3.53	0.659	207-70933/10-50,40	0.80-151.93/30
Astropecten jonstoni (Delle Chiaje, 1827)	3.03	0.17	0.003	806-806/48-48,48	8.30-8.30/48
Astropecten spinulosus (Philippi, 1837)	3.03	0.17	0.001	207-207/35-35,35	7.06-7.06/35
Echinaster (Echinaster) sepositus (Retzius, 1783)	6.06	0.34	0.005	424-1102/15-15,15	0.81-6.39/15
Marthasterias glacialis (Linnaeus, 1758)	3.03	0.17	0.002	708-708/11-11,11	0.28-0.28/11
Ophiuroidea	**2**				
Amphiodia (Amphispina) obtecta Mortensen, 1940*	3.03	0.17	0.001	397-397/40-40,40	0.79-0.79/40
Ophiozonella alba (Lütken & Mortensen, 1899)	18.18	1.01	0.028	277-3828/30-49,30	0.37-1.69/48
Echinoidea	**4**				
Echinocardium cordatum (Pennant, 1777)	12.12	0.67	0.121	3488-16608/25-49,26	20.75-76.19/49
Gracilechinus acutus (Lamarck, 1816)	3.03	0.17	0.004	1121-1121/25-25,25	7.85-7.85/25
Psammechinus microtuberculatus (Blainville, 1825)	3.03	0.17	0.001	424-424/15-15,15	1.14-1.14/15
Sphaerechinus granularis (Lamarck, 1816)	3.03	0.17	0.011	3306-3306/15-15,15	118.38-118.38/15
Holothuroidea	**4**				
Holothuria (Holothuria) tubulosa Gmelin, 1791	6.06	0.34	0.079	722-22045/15-26,15	1.37-653.41/15
Holothuria (Panningothuria) forskali Delle Chiaje, 1823	3.03	0.17	0.008	2204-2204/15-15,15	33.39-33.39/15
Holothuria (Platyperona) sanctori Delle Chiaje, 1823	3.03	0.17	0.011	3306-3306/15-15,15	102.61-102.61/15
Holothuria (Roweothuria) poli Delle Chiaje, 1824	3.03	0.17	0.002	708-708/11-11,11	30.25-30.25/11
ANNELIDA	**9**				
Polycheata	**9**				
Eunice sp	9.09	0.50	0.006	351-806/15-48,48	0.07-8.06/48

Species	DO%	FO%	NO%	Abundance (ind/km^2)	Biomass (kg/km^2)
Glycerina sp	18.18	1.01	0.030	416-3897/15-48,38	0.07-1.55/38
Lumbrineridae sp	3.03	0.17	0.003	806-806/48-48,48	0.64-0.64/48
Magelona rosea Moore, 1907	3.03	0.17	0.002	708-708/11-11,11	6.44-6.44/11
Nephtys hombergii Savigny in Lamarck, 1818	12.12	0.67	0.038	440 -7794/36-45,38	0.26-4.28/38
Nephtys sp	9.09	0.50	0.011	277-1612/45-48,48	0.16-0.97/45
Serpulidae sp	3.03	0.17	0.003	974-974/38-38,38	0.09-0.09/38
Sternaspis scutata (Ranzani, 1817)	36.36	2.02	1.239	722-94593/15-50,45	0.35-32.81/40
Syllis incisa (O. Fabricius, 1780)	3.03	0.17	0.002	539-539/45-45,45	0.10-0.10/45
PORIFERA	**3**				
Axinella cannabina (Esper, 1794)	9.09	0.50	0.028	653-6377/11-19,11	0.52-271.08/19
Chondrosia reniformis Nardo, 1847	6.06	0.34	0.020	2204-3543/11-15,11	45.98-103.50/15
Sarcotragus foetidus Schmidt, 1862	3.03	0.17	0.003	756 9-756/15-15,15	1491.22-1491.22/15
SIPUNCULA	**1**				
Sipunculidae gen sp	9.09	0.50	0.007	138-1612/45-48,48	0.02-1.45/48
CNIDARIA	**4**				
Anthozoa	**4**				
Actinia sp	6.06	0.34	0.090	1144-24683/15-25,25	2.86-36.35/25
Anemonia sulcata (Pennant, 1777)	6.06	0.34	0.029	806. -7695/40-48,40	1.45-6.61/48
Anthozoa sp	18.18	1.01	0.023	648-2204/13-50,15	1.61-62.60/15
Pennatula phosphorea Linnaeus, 1758	18.18	1.01	0.320	502-65969/9-50,9	8.83-587.43/,9
BRYOZOA+	3.03	0.17	0.015	4251-4251/11-11,11	55.48-55.48/11