Oceanologic study of an open coastal area in the Ionian sea with emphasis on its benthic fauna and some zoogeographical remarks

Macrobenthos
Zoogeography
Physical oceanography
Sedimentology
Ionian Sea

Macrobenthos
Zoogéographie
Océanologie physique
Sédimentologie
Mer Ionienne

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ABSTRACT

The macrobenthic faunal composition, sedimentology and physical characteristics were investigated in an open coastal area of the Greek Ionian Sea. Hydrographic parameters were recorded at 26 stations using a CTD profiler during nine cruises performed between 1990 and 1991, while benthic samples were collected in November 1990 and April 1991 at 22 stations with the aid of a Ponar grab.

Macrobenthic variety indicated an area of high scientific interest : 351 species in all, 18 of which are new to the Greek fauna. Furthermore, 10 species are previously unrecorded in the Eastern Mediterranean. Of the biological indices estimated, species richness was comparable to that of other open Greek areas, while population density seemed to be a function of a) depth and b) degree of enclosure. Community diversity and evenness of distribution varied within a great range. The minimal values which were noticed at the stations situated in front of the Amvrakikos Gulf opening can be attributed to the outflow of eutrophic waters from the Gulf of Amvrakikos in combination with the area's hydrodynamism and bottom topography.

The absence of fine sediments at the shallow stations is indicative of a high energy regime as opposed to the high percentages of fines dominating at the deeper stations. The area's water masses are mainly of Atlantic origin with some mixing of Levantine Intermediate Water at the deeper layers. Outflow of less saline water from Amvrakikos Gulf was observed during winter and spring.

Classification analysis, based on the faunal composition, produced four groups corresponding to different depth zones. However, due to the heterogeneity of sediment types within each group, the biocoenotic approach showed a muddy biocoenosis only for the deeper group - associated with the biotope of the generally accepted Mediterranean muddy detritus (DE) biocoenosis and that of coastal terrigenous muds (VTC) - while the other groups presented a more complex physiognomy.

RÉSUMÉ

Faune benthique et zoogéographie d'une région côtière ouverte sur la mer Ionienne.

La composition de la faune macrobenthique, la sédimentologie et les caractéristiques physiques ont été étudiées dans une région côtière grecque ouverte sur la mer Ionienne. Les paramètres hydrologiques ont été mesurés en 26 stations à l'aide d'une sonde CTD, au cours de neuf campagnes effectuées entre 1990 et 1991. Les échantillons benthiques ont été prélevés en novembre 1990 et avril 1991 dans 22 stations en utilisant une benne Ponar.

La diversité du macrobenthos révèle une région d'un grand intérêt scientifique : 351 espèces au total, parmi lesquelles 18 sont nouvelles pour la faune grecque. De plus, 10 espèces sont recensées pour la première fois en Méditerranée orientale. L'abondance des espèces est comparable à celle observée dans d'autres mers ouvertes autour de la Grèce, tandis que la densité des populations semble être fonction de la profondeur et du degré de confinement de la région. La diversité et l'équitabilité spécifiques de la communauté présentent une variabilité importante. Les valeurs minimales qui sont observées à l'entrée du golfe Amvrakikos sont probablement dues à l'eutrophisation du golfe combinée avec l'hydrodynamisme de la région et la topographie du fond.
L'absence des sédiments fins aux stations peu profondes indique une région à haute énergie, en opposition à l'abondance des matières fines aux stations profondes. Les masses d'eaux de la région sont principalement d'origine atlantique, mélangées en profondeur avec l'Eau Intermédiaire Levantine. En hiver et au printemps un flux d'eau moins salée est observé en provenance du golfe Amvrakikos. Le groupement des stations, basé sur leur composition spécifique, révèle quatre groupes qui correspondent à la zonation bathymétrique. Pourtant, à cause de l'hétérogénéité du sédiment dans chaque groupe, l'étude bionomique n'a pas révélé de biocénoses distinctes, à l'exception du groupe des stations profondes où le biotope est associé à la biocénose de Détritique Envasé (DE) et à celle de Vase Terrigène Côtière (VTC), les autres groupes présentent un caractère plus complexe.

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INTRODUCTION

The area examined extends along the coasts of western Greece, in the Ionian Sea, between 38° 55' 00" to 39° 02' 58" N and 20° 38' 01" to 20° 43' 00" E.

The Ionian Sea has a short history of oceanographic studies (Lacombe and Tchernia, 1972; Georgopoulos *et al.*, 1986; Theodorou, 1990) in comparison to that of the Adriatic Sea where investigations into physical processes began in the 19th century (reviewed by Orlic *et al.*, 1992), while biological processes have been extensively examined (Gamulin-Brida, 1967; Degobbis *et al.*, 1979; Smodlaka and Relevante, 1984; Marano *et al.*, 1989; Ambrogi *et al.*, 1990, etc.).

The biocoenotic situation of the Ionian Sea is still largely unknown. The literature is limited regarding the Italian part of the Ionian Sea macrobenthic fauna, although the Italians have made a considerable effort in providing an ecotypological classification of the Italian marine environments (Bianchi and Zurlini, 1985; Damiani *et al.*, 1989; Matarrese *et al.*, 1990). On the other hand, several papers have been published on the benthic macroinvertebrate assemblages of the Greek Ionian Sea but are restricted either to the infralittoral zone (Pancucci and Zenetos, 1989; Zenetos, 1993) or to the Ionian Gulfs of Patras and Amvrakikos (Nicolaidou *et al.*, 1983; Bogdanos and Nicolaidou, 1985; Nicolaidou and Karakiri, 1989; Nicolaidou and Papadopoulou, 1989; Zenetos, 1996). Only on a few occasions has the continental shelf been studied (Pérès and Picard, 1958; Bogdanos *et al.*, 1993), while the abyssal and bathyal Ionian zones have been studied by Chardy *et al.* (1973), Pérès (1968) and Picard (1968).

According to a recent oceanologic study of the Amvrakikos Gulf, eutrophication conditions - evidenced by nutrient enrichment and high Chlorophyll *a* biomass - can be attributed to riverine input into the Gulf and effluents from the city of Preveza (Panayotidis *et al.*, 1994). A governmental agreement prior to establishing a central sewage outfall for Preveza effluent, supported several exploration cruises along the western coasts of Preveza city, from October 1990 until July 1991. Although these cruises were not planned for benthic studies, bottom samples collected have permitted a general investigation of the continental shelf benthic communities.

In this study, the prevailing environmental conditions are examined, with reference to the sedimentary characteristics, physical characteristics of the water column and benthic species composition found throughout the study area. Furthermore, possible factors determining the biological parameters are discussed, as well as those responsible for the zonation pattern observed. Finally, some remarks are made regarding the zoogeographical distribution of the macrobenthic fauna.

GENERAL CHARACTERISTICS OF THE STUDY AREA

Topography

The general topography of the area is shown in Figure 1. The only major irregularity is a fault of north-south direction, observed at depths between 65 and 80 metres, which interrupts the uniformity of the low-sloping gradient.

Water masses

Atlantic water entering into the Ionian Sea through the straits of Sicily (Lacombe and Tchernia, 1972) while mixing, occupies the upper layers of the study area (Theodorou, 1990). Levantine Intermediate Water (LIW), characterized by higher salinities, entering the Ionian Sea from the south-east, occupies the subsurface layers (80-150 m). LIW moves northward along the coast of the Greek mainland under the Atlantic Water of the uppermost layers (Georgopoulos *et al.*, 1986).

The main contributor to the water masses of the study area seems to be the Atlantic Water with salinities less than 38.6. All previous studies of the Ionian Sea have pointed to an anticyclonic circulation pattern both during winter and summer season. Consequently, no waters of Adriatic origin appear in the investigation area. The currents and circulation of the adjacent Adriatic Sea were recently reviewed by Orlic *et al.* (1992).

Less saline waters from Amvrakikos Gulf (Panayotidis *et al.*, 1994) enter the study area and spread over the surface during winter and spring as a result of inputs of rain river water. This outflow diminishes during summer.

The oxygen and nutrient pattern of the northeastern Ionian Sea was found to be affected by the presence of mesoscale cyclonic and anticyclonic gyres in the area, the most interesting feature of which is the large anticyclonic flow region southwest of Peloponnesos (Pelops gyre). In the deep layer of the stations near Otranto straits, Souvermezoglou *et al.* (1992) detected newly formed Adriatic Bottom Water.

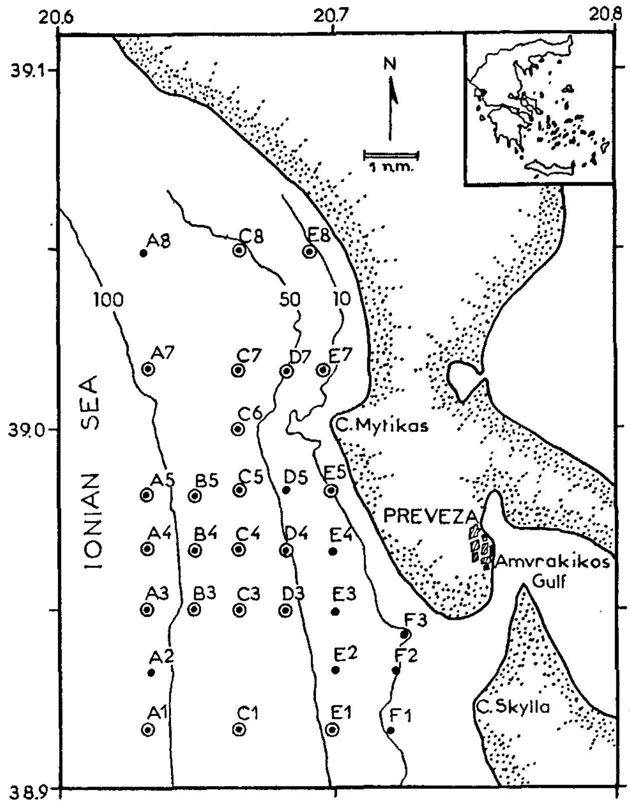

Figure 1

Sampling sites. Open circles denote stations where benthic samples were collected.

MATERIAL AND METHODS

Abiotic parameters

Basic hydrographic parameters (temperature, salinity, depth, *etc.*) were recorded using a SBE-SEACAT CTD profiler at selected stations during nine cruises performed during 1990 and 1991. Measurements were made at all stations marked on Figure 1. Surface as well as vertical profiles of salinity and temperature, along an axis perpendicular to the coast (F3-A3), were drawn using a program package based on the minimum curvature method (SURFER, 1989). In the present study, only the October, January, April and July plots are given as representative of seasonal changes.

Determination of sediment size and distribution was based on quantitative grain size analyses, according to Folk (1974), using a set of 26 surface sediment samples (Fig. 1). The carbonate content ($CaCO_3$) was measured with the carbonate-bomb methodology developed by Muller and Gastner (1968).

Benthic macrofauna

Quantitative benthic samples were taken at 22 stations covering a depth from 10 to 104 m along five transects with a south-north direction (*see* Fig. 1). The survey, conducted in October 1990, included the greater part of the study area. All samples were taken with the aid of a 0.05 m^2 Ponar grab. The limited facilities of the boat used did not permit the operation of a larger sampling device *e.g.* Van Veen 0.1 m^2. Some stations were not sampled because physical conditions (heavy swell) made sampling impossible in those regions or reduced the number of replicates collected. Thus the goal of five replicates per station was not always feasible and in some stations only three replicates were collected. In April 1991, samples were taken in those areas not sampled during November 1990. The material collected was sieved on board through a 1mm mesh and all organisms retained were fixed in 4 % neutralized formalin. Once in the laboratory, organisms were taxonomically sorted, identified to the specific level when possible and preserved in 70 % alcohol. The analysis was based mainly on the groups that were most abundantly represented in the samples, namely Polychaeta, Mollusca and Echinodermata. Crustacea, a relatively abundant group, owing to our insufficient knowledge of the species, were identified down to order level and had therefore to be included in the miscellanea along with other minor phyla *i.e.* Porifera, Bryozoa, Ascidia, Sipuncula, *etc.*

Statistical Treatment

Standard numerical taxonomy techniques such as Bray-Curtis similarity coefficient and group average clustering on $\log_{10}$ transformed data were applied. In addition, the similarity data were ordinated by multidimensional scaling (Field *et al.*, 1982). All analyses were performed by using the PRIMER software package, developed by Plymouth Marine Laboratory, U.K. Community diversity (H) was calculated according to Shannon and Weaver (1963). Evenness (J) was measured using Pielou's (1969) function.

RESULTS AND DISCUSSION

Sediments

The results of the grain size analysis as well as the type and the description of the bottom sediment are shown in Table 1.

In addition to the standard nomenclature adopted by Folk (1974), other *in situ* observations are included, such as shell debris and the presence of *Posidonia.* Generally, mean grain size was related to bottom topography and bathymetry. Thus, sediments in areas deeper than 50 metres contained higher percentages of mud (silt-clay fractions) while in depths shallower than 50 metres sediments became gradually more sandy. The absence of fine material in areas shallower than 20 metres is indicative of a high energy regime.

Hydrological features

Surface temperatures followed the annual climatic cycle, attaining the highest values of about 25 °C during July (Fig. 2*d*). However, the outflow of Amvrakikos Gulf waters, influencing directly the study area, was pronounced mainly during winter and spring. In autumn, surface temperature values reached 21.6 °C (Fig. 2*a*). An homogenous layer (about 21 °C) was observed down to 60 m depth (Fig. 3*a*) which decreased at deeper layers (16 °C). Vertical mixing was apparent and strong during this season (Fig. 3*a*), when surface waters cool and sink. In winter, values lower than 12 °C were observed at the surface in the vicinity of Amvrakikos Gulf (Fig. 2*b*), while higher temperatures were measured with increasing depth (Fig. 3*b*). In spring, a slight increase, due to climatic changes was observed, reaching 16 °C at surface layer (Fig. 2*c*), while the temperature remained at the winter levels, 15 °C, at the bottom (Fig. 3*c*). Summer measurements showed an increase, in the order of 8 °C, at surface layers (Figs 2*c*, 2*d*) and a rapid decrease with depth (14 °C at 45-95 m) (Figs. 3*c*, 3*d*). The thermocline level was not particularly pronounced laying from 10 to 20 metres (Fig. 3*d*).

Regarding salinity, during autumn, winter and spring lower values (even less than 35) (*see* Fig. 4) over the surface layer were the result of outflow from Amvrakikos Gulf. At deeper layers, (*see* Fig. 5) salinity varied between 37.9 to 38.6 indicating the extent of spreading of Atlantic Waters over the area. In autumn, surface values ranged between 37.8 (at the entrance of Amvrakikos Gulf) to 38.4 further offshore (Fig. 4*a*). Values increased with depth up to 38.6 (Fig. 5*a*). In winter, surface salinity values decreased, especially in front of the Amvrakikos Gulf (Fig. 4*b*). An analogous decrease was observed with depth (*see* Figs. 5*a*, 5*b*). In spring, the surface salinity plot presented a somehow anomalous pattern reflecting the influence of Amvrakikos Gulf outflow (Fig. 4*c*). Regarding the salinity distribution with depth, three distinct water masses could be detected (Fig. 5*c*) : a) an uppermost layer down to 5m deep due to the Amvrakikos Gulf, b) an intermediate local layer

Table 1

Depth and sediment characteristics

Station	Depth in m	Sediment type	Sand %	Silt %	Clay %	$CaCO_3$ %
A1	101	Muddy sand	54.3	28.5	17.2	34.0
A3	102	Sandy silt	36.1	42.7	21.2	40.5
A4	104	Sandy silt	33.0	46.5	20.5	-
A5	101	Sandy silt	28.2	48.4	23.4	37.5
A7	91	Sandy silt	20.7	57.1	22.2	40.5
B3	81	Sandy silt	32.6	46.3	21.1	42.5
B4	75	Sandy silt (shell debris)	34.4	44.8	20.8	-
B5	89	Sandy silt	23.7	52.6	23.7	-
C1	64	Muddy sand (shell debris)	80.4	13.0	6.6	45.5
C3	68	Muddy sand (shell debris)	76.9	11.8	11.3	39.5
C4	63	Sand (shell debris)	100	-	-	-
C5	55	Coralligenous sand	92.5	5.7	1.8	40.0
C6	51	Coralligenous sand	100	-	-	-
C7	82	Sandy silt	35.0	46.0	19.0	-
C8	51	Sandy silt	42.1	47.2	10.7	30.0
D3	51	Coralligenous sand	93.5	4.0	2.5	49.0
D4	50	Coralligenous sand	95.9	2.3	1.8	50.5
D7	54	Sandy silt	29.6	54.8	15.6	34.5
E1	46	Coralligenous muddy sand	85.2	5.2	9.6	50.0
E5	10	Sand (shell debris)	100	0.0	0.0	69.5
E7	12	*Posidonia* meadows	-	-	-	-
E8	11	Coarse sand	100	0.0	0.0	20.0

between 5 and 25 m, and c) a typical Atlantic Water layer at depths >25 m. During summer salinity reached 38.6-38.7 (depths over 70 m - Figure *5d*), indicating that the influence of Atlantic waters over the area is rather weak.

Benthic macrofauna

A total of 351 species were identified. A list of all species, with the exception of those identified down to taxa higher than genus, is given in the Appendix. Comment has already been made on the groups not identified to species level. Examination of the relative importance of the different animal groups shows the following decreasing order : Polychaeta species 213 (61 %), Mollusca 93 (26 %), Echinodermata 19 (5 %) and miscellaneous taxa (Crustacea, Sipuncula, Porifera, Anthozoa, etc.) 26 (7 %). The ten most abundant species in decreasing order are given in Table 2.

Regardless of the numerical differences between stations, Polychaeta accounted for at least 38 % of the fauna (range 250 - 3515 individuals/m^2), occasionally contributing as much as 90 % (station C4), with an average contribution of 61 %. Mollusca were the second most abundant group and occurred in densities ranging from 30-450 individuals/m^2 (average contribution 13 %). Echinodermata occurred in densities of 0 to 285 individuals/m^2 with an average contribution of 3.5 %. Miscellaneous groups contributed with 100 to 1902 individuals/m^2 (average 22 %).

Biotic indices

A list of the biotic indices calculated is given in Table 3. Regarding population density, values varied between 500 ind./m^2 (st E8) and 5787 ind./m^2 (st E7) with the extreme 7830 ind./m^2 at st C4 (due to the high abundances of two polychaetes, namely *Polydora caulleryi* 3130 ind./m^2 and *Potamilla torelli* 2910 ind./m^2. The mean density calculated is 1903 ind./m^2. This value is far higher than those estimated for other Aegean open sea areas *i.e.* Kyklades plateau (mean 240 ind./m^2 - Zenetos *et al.*, 1991); Rodos (mean 629 ind./m^2 - Pancucci (pers. comm.); South Aegean (range 174-586 ind./m^2 - Tselepides and Eleftheriou, 1992), but lower to the mean densities estimated in semi-enclosed areas *i.e.* Geras Gulf (mean 3006 ind./m^2 - Zenetos and Papathanassiou, 1989) ; Saronikos Gulf (mean 2664 ind./m^2 - Zenetos *et al.*, 1990).

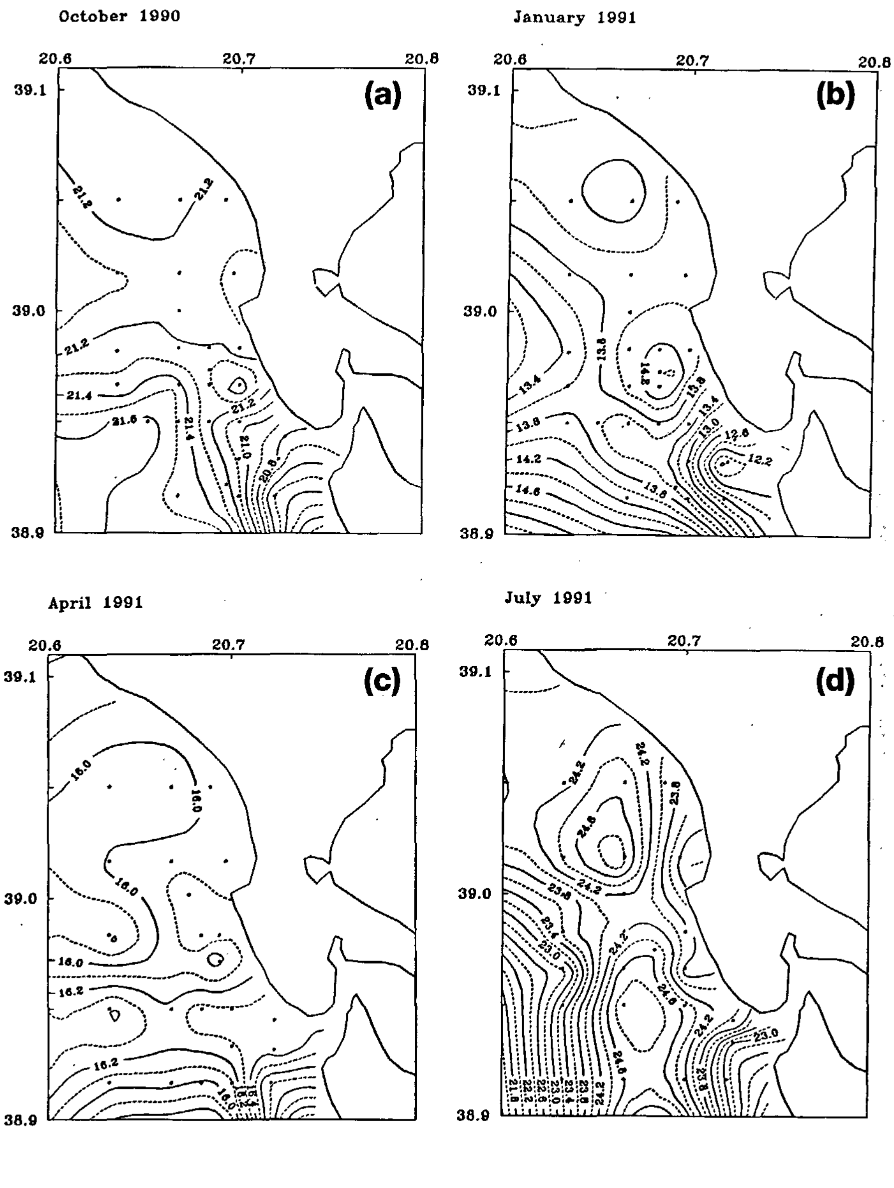

Figure 2

Surface temperature over the year.

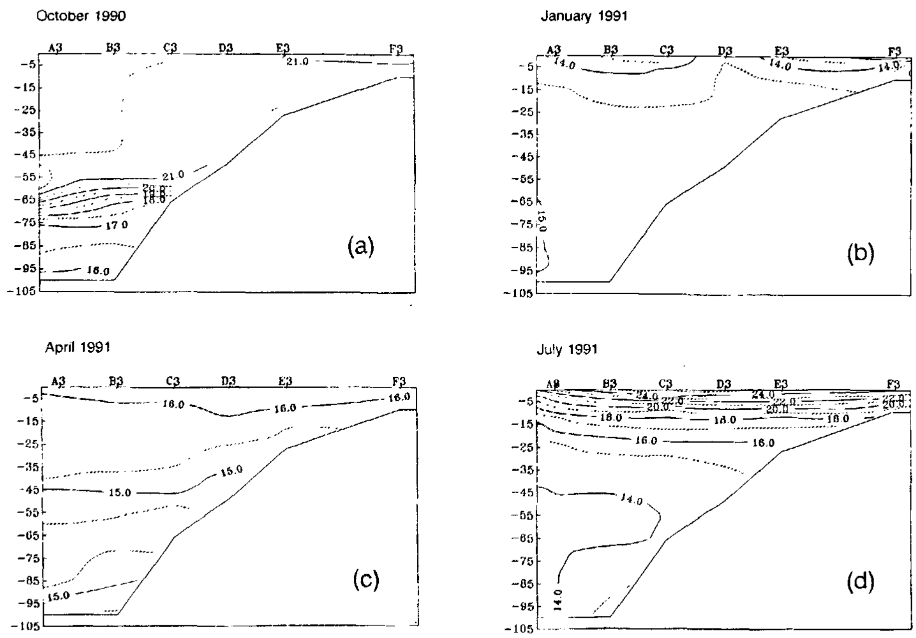

Figure 3 (a-d)

Temperature distribution at cross-section F3-A3.

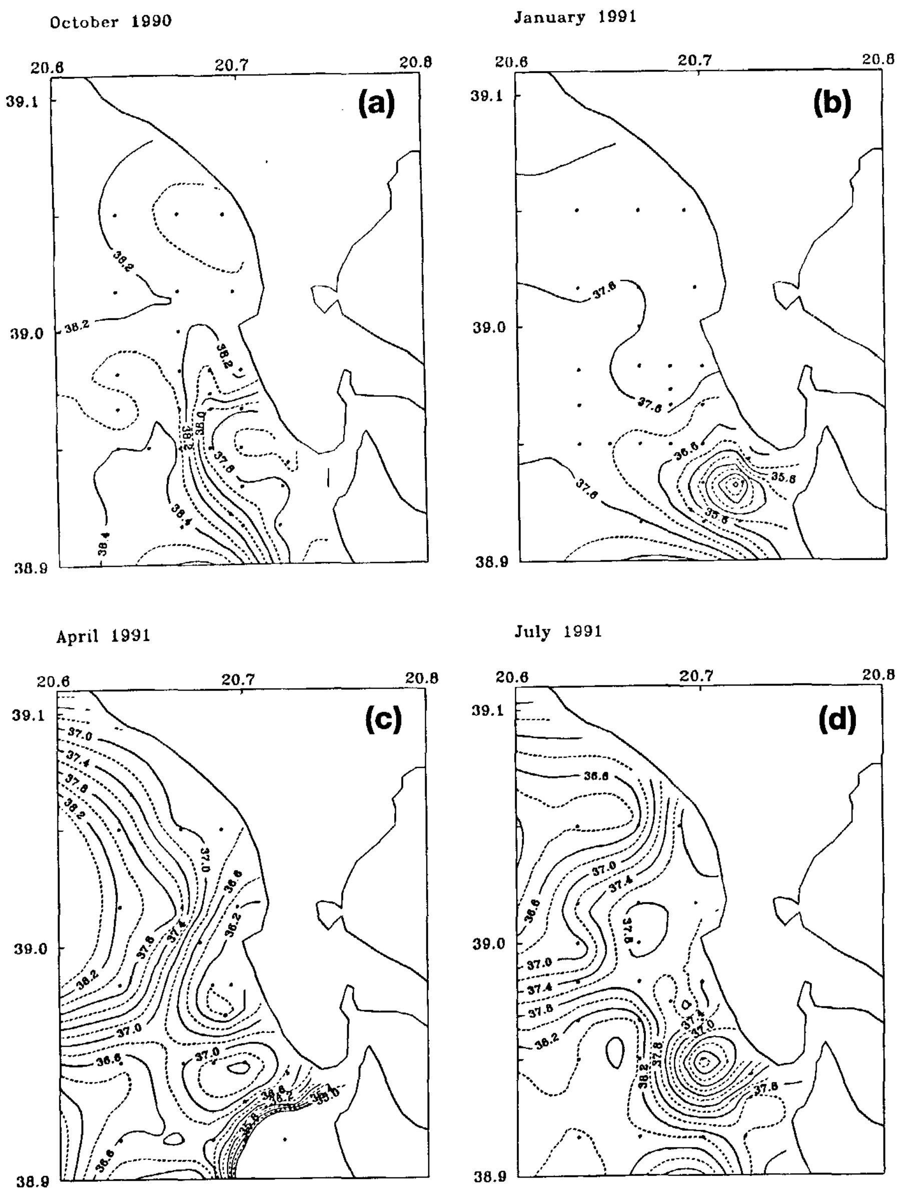

Figure 4

Surface salinity over the year.

Figure 5

Salinity distribution at cross-section F3-A3.

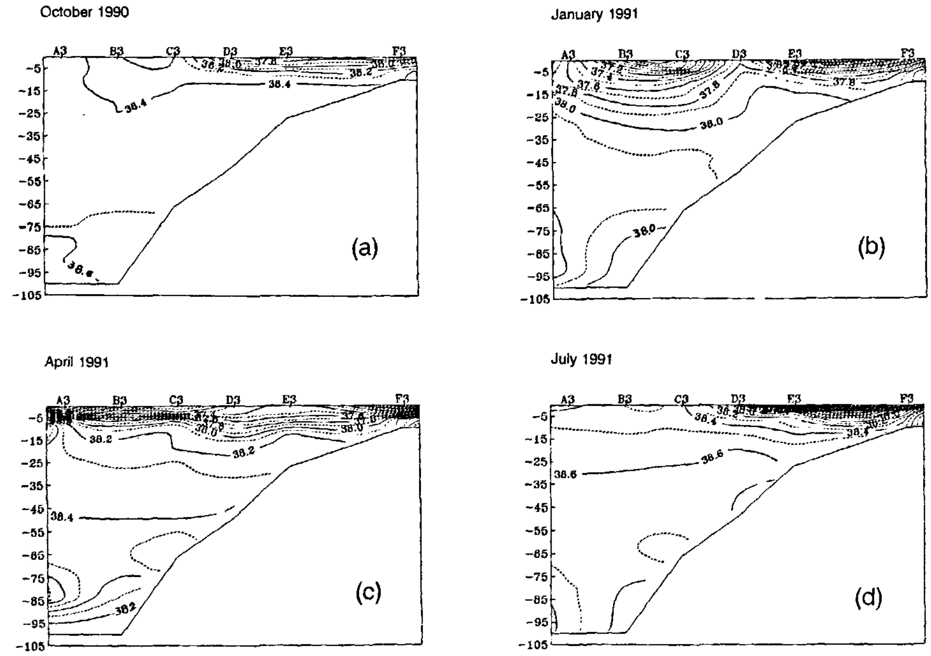

Table 2

The ten most abundant species in decreasing order. Numbers in parentheses are mean density values per square metre at all stations.

Polydora caulleryi (142)	*Monticellina dorsobranchialis* (46)
Potamilla torelli (132)	*Timoclea ovata* (38)
Levinsenia gracilis (64)	*Lumbrineris latreilli* (29)
Syllis hyalina (53)	*Chone filicaudata* (27)
Prionospio fallax (52)	*Aphelochaeta marioni* (22).

Table 3

Biological indices at all sampling stations (N/m^2 : number of indiv./m^2, S: number of species, H: community diversity, J: evenness of distribution).

Station	N/m^2	S	H	J
A1	1130	51	5.19	0.91
A3	930	40	4.91	0.92
A4	850	58	5.03	0.86
A5	635	68	5.61	0.92
A7	860	75	5.67	0.91
B3	1712	75	5.74	0.92
B4	1030	49	5.22	0.93
B5	580	32	4.68	0.94
C1	1010	53	4.81	0.84
C3	1000	24	4.31	0.94
C4	7830	75	2.83	0.45
C5	1310	68	5.26	0.86
C6	1170	98	6.20	0.94
C7	1620	53	4.81	0.84
C8	2945	73	5.12	0.83
D3	2030	114	5.91	0.86
D4	1730	81	5.51	0.87
D7	3820	95	5.75	0.88
E1	900	50	5.16	0.91
E5	2500	74	4.67	0.75
E7	5758	100	5.18	0.78
E8	500	22	3.74	0.84

Species richness (S) ranged between 22 (st E8) and 114 (st D3). The total number of species (351) is comparable to the total estimated for the Kyklades plateau (329 species), offshore Rodos area (383 species) and Pagassitikos Gulf (353 species - Bogdanos and Satsmadjis, 1983). In the adjacent Ionian coasts of Italy, a faunal affinity can be speculated based on information from similar data. In fact, the closest data set available is from the Apulian continental shelf, where a survey was conducted in both soft and hard bottoms, between 7 and 125 m depth, with a Van Veen grab as well as by scuba-diving and the material considered was >1mm (Bedulli *et al.*, 1986). From a total of 500 species reported there, about 100 were Crustacea. Keeping in mind that Crustacea were not identified in detail in this study and that Bedulli *et al.* (1986) also covered hard substrata, the similarity, in species richness at least, is obvious. Other studies conducted with trawls, at depths of 16-600 m, revealed only 164 macrobenthic species (Matarrese *et al.*, 1990), while reviews concerning separate taxonomic groups have shown a far greater number *i.e.* for polychaetes 250 taxa from the Ionian and lower Adriatic (Gherardi *et al.*, 1993).

Community diversity ranged between 3.74 bits per unit (st E8) and 6.20 bits per unit (st C6) with the exception of st C4 (H = 2.83) where evenness of distribution was also the lowest (J = 0.45). The latter values, being rather low, usually indicate degradation of the biotope to a great degree. This however was not true in our case. The abrupt decrease of community diversity was due to extremely high densities of the two polychaete species mentioned above. They were found in the form of bands of tubes intermingled with each other and forming calcareous encrustments on the surface and in crevices of small stones. Their robust presence is therefore associated with the type of substratum rather than with any disturbance factor. Discrepancies in biological parameters (from the mean values in a given area) have been reported by Damiani *et al.* (1989) from the coasts and Seas of SE Italy, where marine ecosystems exhibit a considerable natural integrity. Low biological indices observed there were related to geomorphological parameters rather than anthropogenic intervention in the area.

Statistical treatment

Faunal affinity between stations, calculated as indicated in the methods [log(x+1), Bray-Curtis, Group Average clustering], gave the results presented as a dendrogram in Figure 6. It is clear from the dendrogram that the shallow stations E5, E7 and E8 (Group I), were easily distinguished from the rest. A further separation was evident between the stations with depth range 46-55 m (Group II) and those with depth range from 63-81 m (Group III). Finally, a distinct group was formed by stations with depths over 80 m (Group IV). A graphic presentation of the groups I-IV is shown in Figure 7, where it is obvious that they occupy different depth zones.

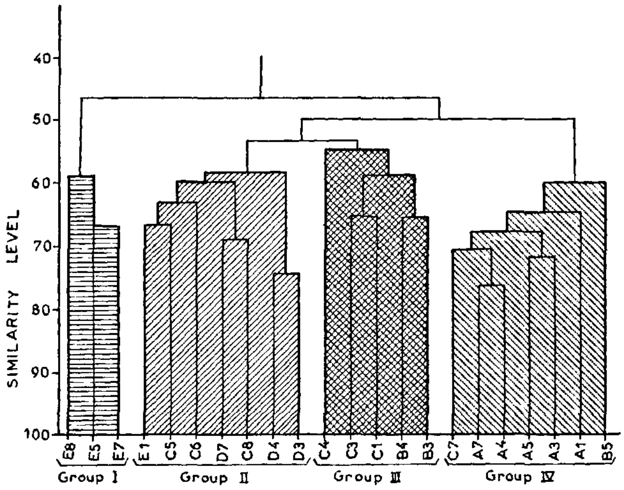

Figure 6

Grouping of stations derived by Bray-Curtis/Group Average.

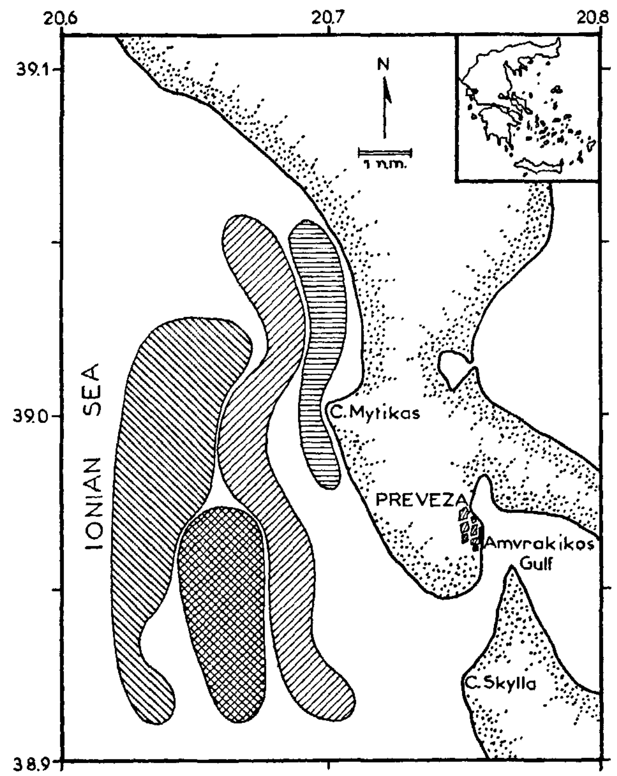

Figure 7

Areal presentation of the groups derived by dendrogram of Fig. 6.

In an effort to determine the biocoenotic character of the four groups, which ideally correspond to the biotopes of different biocoenoses, the ten most dominant species from each group and their mean densities over the stations of each group were tabulated (Tab. 4) and their ecological significance was examined.

Group I consisted of three stations at depths 10-12 m presenting a variety of 20-100 species, with a total of 155 species. The common feature of the Group I stations was the high energy environment (0 % mud) which is evidenced by the presence of extended *Posidonia* meadows (st E7), or the Cephalochordata *Branchiostoma lanceolatum* (st E8). According to the biocoenotic character of the 10 dominant species at the stations of Group I (Tab. 4), established from the literature, it is clear that most of them, being characteristic of infralittoral conditions, have strong affinities for hard substrata and sciaphilic or photophilic algal communities *i.e. Syllis hyalina* (Abbiati *et al.*, 1987), *Kefersteinia cirrata* (Pérès,

Table 4

Mean density value over the stations of each group. In bold italics the 10 dominant species of each group.

	Group I	Group II	Group III	Group IV
Syllis hyalina	***252***	11		
Kefersteinia cirrata	***66***	16		
Diplodonta apicalis	***62***			
Polyophthalmus pictus	***59***			
Nematonereis unicornis	***55***	7	3	4
Branchiostoma lanceolatum	***42***	5	2	
Syllis prolifera	***37***			
Praegeria remota	***33***	12		
Syllis cornuta	***33***	13	3	
Paleonotus debile	***31***	8		
Levinsenia gracilis		***101***	15	***90***
Monticellina dorsobranchialis		***77***	11	***61***
Sarsonuphis quadricuspis			2	***45***
Chaetozone sp.		20	2	***32***
Aphelochaeta marioni		14	***36***	***29***
Prionospio fallax	9	***84***	***66***	***25***
Amphiura filiformis			17	***25***
Leptaxinus ferruginosus			15	***22***
Aricidea fauveli		22		***21***
Falcidens gutturosus			***26***	***17***
Lumbrinereis latreilli	9	***61***	15	14
Timoclea ovata		***58***	***68***	
Chone filicaudata	6	***55***	***31***	4
Cossura coasta		***50***		
Sphaerosyllis hystrix	17	***44***	14	1
Amphipholis squamata	2	***34***	6	
Euchone rosea		***28***	5	
Polydora caulleryi			***626***	
Potamilla torelli			***582***	
Parvicardium minimum	3	5	***44***	6
Myriochele oculata		10	***33***	
Owenia fusiformis		25	***27***	

1954), *Polyophthalmus pictus* (Colognola *et al.*, 1984), *Syllis cornuta* (Sarda, 1986), or coarse sands under the influence of bottom currents *i.e. Branchiostoma lanceolatum* (Augier, 1982), *Praegeria remota* (Duineveld *et al.*, 1991), *Echinocardium fenauxi* (Augier, 1982), thus reflecting a high energy environment.

Groups II and III included the majority of stations located in the circalittoral zone at depths between 46 and 81 m. Although the bottoms of stations at both groups were very heterogenous (sediment type ranging from coralligenous sand with 0 % mud to sandy silt with 70.4 % mud), the benthic fauna present seem to divide it clearly into two groups which occupied different depth zones. Thus, we have :

Group II, with seven stations at depths 46-55 m, had a total of 138 species evenly distributed among stations ($50 \leq S \leq 114$) leading to high community diversity values ($5.16 \leq H' \leq 6.20$). The biocoenotic character of the ten most abundant species (Tab. 3) was very variable. Species found were typical of sandy mud substrata of the circalittoral and bathyal zone such as *Cossura coasta* (Intes and Le Loeuff, 1986) as well as species typical of coralligenous bottoms such as *Euchone rosea* (Giangrande, 1990). The presence of *Branchiostoma lanceolatum* (st. D3 and D4) at low densities was indicative of a high energy environment, a fact also clear from the sediment analysis (0 % mud). Among other species favoured by mixed substrata in high energy environments was the echinoderm *Amphipholis squamata* found here in abundance (34 ind./m^2).

Group III included five stations occupying the deepest part of the circalittoral zone (depth range 63-81 m). The biotic parameters $29 \leq S \leq 75$, $1030 \leq N/m^2 \leq 7830$, $2.83 \leq H' \leq 5.74$ and $0.45 \leq J \leq 0.94$ in combination with the macrobenthic fauna indicated an unstable environment. As seen in Table 4, five of the ten most abundant species are also among the dominant species in Group II and Group IV. The polychaetes *Polydora caulleryi* and *Potamilla torelli* were found exclusively in Group III. The high abundance of the polychaetes *Myriochele oculata* and *Owenia fusiformis* was somewhat anomalous as both are known to prefer fine infralittoral sands (Picard, 1965; Desbruyères *et al.*, 1972-73). Among other species dominating in the Group III stations were the molluscs *Falcidens gutturosus* and *Parvicardium minimum*, species with no special ecological significance, referred to as tolerant in mixed sediments (Picard, 1965). The bivalve *Timoclea ovata*, third in rank among the species of Group III, has an obscure biocoenotic identity. It has been found abundantly in coastal detritic bottoms (DC biocoenosis) of the gulf of Cassis (Bourcier, 1976-78), but was also among the dominant ones on muddy detritus bottoms (DE biocoenosis) on the continental shelf of the Spanish Catalanian coast (Desbruyères *et al.*, 1972-73). Based on the species composition, it is assumed that besides the depth gradient and the type of substratum a combination of more complicated factors such as the local hydrodynamism, water outflow from Amvrakikos Gulf and the bottom topography affect the species distribution.

Group IV included the seven deeper stations (depth range 82-104 m) with muddy substrata (46-80 % mud). A total of 155 macrobenthic species were present ($32 \leq S \leq 68$) at densities of 580-1620 ind./m^2, with a high level of community diversity ($4.68 \leq H' \leq 5.67$ bits per unit). The biocoenotic character of the ten most abundant species (given in Tab. 4) indicated that species were characterizing benthic communities from muddy bottoms of open sea areas; in terms of biocoenoses the VTC (Vase Terrigène Côtière) and DE (Détritic Envasé) *i.e.* the polychaetes *Levinsenia gracilis*, *Aphelochaeta marioni Sarsonuphis quadricuspis* and the echinoderm *Amphiura filiformis* (Desbruyères *et al.*, 1972-73). *Sarsonuphis quadricuspis* has also been reported as typical of a deep mud biocoenosis VP (Vase Profonde) (Carpine, 1970; Intes and Le Loeuff, 1986).

Due to the complex physiognomy of the stations comprising each of the above groups, no clear classification into the widely accepted marine benthic biocoenoses of the Mediterranean (Pérès, 1982; Augier, 1982) could be detected for groups II and III. The same holds true in the adjacent Italian Ionian coasts where Matarrese *et al.* (1990) has tried to identify the most important biotic communities. The homogeneity of sediment types and the dominance of species characterizing deep muddy bottoms from open sea areas, however, leads us to assume a deep mud biocoenosis, closely resembling the VTC and DE, occupying the zone over 80 m deep.

Zoogeographical observations

The faunal composition of the study area was generally similar to that of the coastal areas in the Eastern and Western Mediterranean, Adriatic Sea and Italian Ionian Sea, while it had low affinity with the benthic fauna of deeper waters *e.g.* Adriatic (Marano *et al.*, 1989). A number of species reported here are recorded for the first time in the Eastern Mediterranean basin, while some are new recordings for the Greek fauna. More analytically:

Seventeen polychaete species namely: *Auchenoplax crinita* Ehlers, 1887; *Brania arminii* (Langerhans, 1881); *Chone longiseta* Giangrande, 1991; *Hesiospina similis* (Hessle, 1925); *Hydroides nigra* Zibrowius, 1971; *Lumbrinerides amoureuxi* Miura, 1980; *Myriochele oculata* (Zaks, 1922); *Ophelia roscoffensis* Augener, 1910; *Opisthodonta pterochaeta* Southern, 1914; *Pettiboneia urciensis* Campoy and San Martin, 1980; *Polydora caulleryi* Mesnil, 1897; *Polydora guillei* Laubier and Ramos, 1974; *Prionospio* cf. *multibranchiata* Berkeley, 1927 sensu Mackie, 1984; *Scalibregma celticum* Mackie, 1991; *Sphaerosyllis brevicirra* Hartmann-Shroeder, 1960; *Sphaerosyllis taylori* Perkins, 1980 and *Syllis torquata* Marion and Bobretzky, 1875, were found here for the first time in Greek waters (Simboura, 1996).

Among the above, the following nine: *Auchenoplax crinita, Myriochele oculata, Opisthodonta pterochaeta, Syllis torquata, Pettiboneia urciensis, Polydora guillei, Prionospio* cf. *multibranchiata, Scalibregma celticum* and *Ophelia roscoffensis* are reported here for the first time in the Eastern Mediterranean. It is noteworthy that *Sphaerosyllis taylori*, a cosmopolitan species, was found at a far greater depth (91 m) than its previously known bathymetric distribution (0-25 m, Perkins, 1980; Besteiro *et al.*, 1987; Gambi *et al.*, 1989). *Polydora guillei*, a species previously only recorded at 44 m depth from the Western Mediterranean (Laubier and Ramos, 1974), was found here at 99 m depth. Of zoogeographical interest is also the finding of *Syllis torquata,* an extremely rare species, found here in silty sandy bottom in accordance with its known biotope: in *Posidonia* or *Caulerpa* meadows and in sciaphilic infralittoral communities in sandy sediments (Sarda, 1991; Martin-Sintes and San Martin, 1988).

The molluscan fauna of the study area was typical of the Mediterranean. A total of ninety-three species were found, most of which are widely distributed in the Mediterranean Sea. A number of species could be considered to be rare in Greek waters, but this is probably due to the fact that only few studies have been undertaken on the continental shelf : they include: *Bathyarca grenophia, Kelliella abyssicola, Cardiomya striolata, Cuspidaria rostrata* and *Leptaxinus ferruginosus,* all well established Mediterranean forms with narrow bathymetric distribution range. The occurrence of *Diplodonta apicalis* Philippi, 1836 in relatively high numbers was unexpected as this is an otherwise rare bivalve. It reached densities of 480 ind./m^2 and 104 ind./m^2 in spring and autumn respectively, while vast numbers of empty shells were encountered among the shell debris that constituted the station's substratum. *Diplodonta apicalis* has only been mentioned before from Rodos island and Aegean Sea by Jeffreys (1881) as *Diplodonta trigonula* Bronn, 1831.

Most of the echinoderms are very common in Greek waters. The echinoid *Echinocardium fenauxi,* characteristic of the infralittoral (biocoenosis of coarse sands and fine gravels under the influence of bottom currents) in the Western Mediterranean Sea, was found here for the first time in the Eastern Mediterranean (Pancucci, 1993). Also, characteristic of the same zone is the ophiuroid *Ophiopsila annulosa* (Augier, 1982), whose distribution is known to extend as far as the Ionian Sea but which is missing from the Adriatic (Zavodnik, 1981). The species *Amphiura brachiata,* previously mentioned from the west coasts of Greece (Pancucci and Zenetos, 1989), having a restricted distribution in the whole Mediterranean, is here further reported in western Greece.

Among the Miscellanea, worth mentioning is the species *Branchiostoma lanceolatum,* characteristic of the biocoenosis of coarse sands and fine gravels under the influence of bottom currents. This species, independent of vertical zoning, is closely associated with the bottom currents; it colonises both infralittoral and circalittoral zones (to a depth of about 80 m) along the paths of the bottom currents (Augier, 1982). Indeed at the stations where *Branchiostoma lanceolatum* occurred, irrespective of depth (ranging 10 to 64 m), the sea bottom was characterized as coarse sand or coralligenous sand, substrata indicative of a high energy environment.

SUMMARY AND CONCLUSIONS

The water masses of the study area originate mainly from Atlantic Water entering the Ionian Sea through the Sicily Channel. Mixing with deeper masses of Levantine Intermediate Water origin occurs during the summer period. This mixing, during autumn, transfers the summer thermocline, situated between 10-20 metres, to deeper layers (60-75 metres – *see* Fig. 4). The existence of Atlantic Water was more pronounced in winter.

Noticeable differences were observed at the surface layer, mainly at the stations situated in front of the Amvrakikos Gulf opening, as a result of outflow from the Gulf, while homogeneity characterized the deeper layers. Vertical mixing was apparent and strong during autumn, while colder but less saline water masses from Amvrakikos Gulf spread over the surface, to some extent prohibiting vertical mixing during winter.

Most of the surface sediments were characterized by substantial amounts of biogenic material. Deeper and more tranquil areas were dominated by finer sediments (sandy silt). The sedimentation is controlled mainly by littoral drift due to wave action, as well as the hydrodynamic conditions in the continental shelf.

A total of 351 macroinvertebrate species were recorded in the study area distributed among the main benthic groups as follows : Polychaeta 61 %, Mollusca 26 %, Echinodermata 5 % and miscellanea groups 7 %. The mean population density estimated was higher than that measured in the open seas (Kyklades isl., Rodos) but lower than that of Greek gulfs. This matches the pattern where population density seems to be a function of : a) depth - the greater the depth the lower the values; b) stress upon anthropogenic impact - higher degree of dominance in degraded environments; and c) degree of enclosure and wave action - lower values at more exposed areas.

On the basis of the species composition, the area can be divided into four groups : Group I - corresponding to shallow zones with depths around 10 m; Group II - occupying intermediate depths 46-55 m; Group III - occupying the 63-81 m zone; and Group IV - corresponding to the deeper parts of the study area. Besides depth, substratum seemed to be the major separating feature between these groups. Additional factors determining the observed pattern are: the bottom topography; the hydrodynamism of the area; and the water outflow from Amvrakikos Gulf. Distinct marine benthic biocoenoses, analogous to those defined for the whole Mediterranean Sea, could not be assigned to the biotopes of Groups I-III. However, Group IV closely matched the biotopes of coastal detritic muds (VTC) and the muddy detritus (DE) biocoenoses. The richness of species found, a number of them new to the Greek benthic fauna, can be attributed to the fact that the study area was so far unexplored. Indeed, seventeen polychaetes and one echinoderm species are first records for the Greek Seas. Among them nine polychaetes, namely *Auchenoplax crinita, Myriochele oculata, Opisthodonta pterochaeta, Syllis torquata, Pettiboneia urciensis, Polydora guillei, Prionospio* cf. *multibranchiata, Scalibregma celticum* and *Ophelia roscoffensis* and the echinoid *Echinocardium fenauxi* are recorded for the first time in the Eastern Mediterranean.

The marine ecosystems of the study area are of great naturalistic and scientific interest. Their variety is directly associated with the prevailing environmental characteristics, primarily depth, and any anthropogenic impact is negligible.

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APPENDIX : List of species in phylogenetic order within major phyla

MOLLUSCA

CAUDOFOVEATA
Falcidens gutturosus (Kowalevsky, 1901)

POLYPLACOPHORA
Acanthochitona fascicularis (Linne, 1767)
Chiton sp.

GASTROPODA
Scissurella costata D'Orbigny, 1824
Haliotis tuberculata lamellosa Lamarck, 1822
Gibbula sp.
Tricolia pullus (Linne, 1758)
Bittium sp.
Rissoa variabilis (Von Muehlfeldt, 1824)
Alvania aspera (Philippi, 1844)
Alvania settepassii Amati and Nofroni, 1985
Peringiella elegans (Locard, 1892)
Rissoina bruguieri (Payraudeau, 1826)
Calyptraea chinensis (Linne, 1758)
Euspira nitida (Donovan, 1804)
Neverita josephinia Risso, 1826
Monophorus pervesus (Linne, 1758)
Vitreolina antiflexa Monterosato, 1884
Hadriania oretea (De Gregorio, 1885)
Ocinebrina aciculata (Lamarck, 1822)
Pollia dorbignyi (Payraudeau, 1826)
Cyclope neritea (Linne, 1758)
Columbella rustica (Linne, 1758)
Mangelia attenuata (Montagu, 1803)
Mangelia paciniana (Calcara, 1839)
Mangiliella multilineolata (Deshayes, 1835)
Raphitoma laviae (Philippi, 1844)
Retusa mammillata (Philippi, 1836)
Philine aperta (Linne, 1767)
Philine catena (Montagu, 1803)
Cylichna cylindracea (Pennant, 1777)

BIVALVIA
Nucula sulcata Bronn, 1831
Nucula nitidosa Winckworth, 1930
Nuculana commutata (Philippi, 1844)
Nuculana pella (Linne, 1767)
Nuculana sp. juv.
Arca noae Linne, 1758
Bathyarca grenophia (Risso, 1826)
Striarca lactea (Linne, 1758)

Glycymeris insubrica (Brocchi, 1814)
Crenella decussata (Montagu, 1803)
Musculus discors (Linne, 1767)
Modiolarca subpicta (Cantraine, 1835)
Modiolula phaseolina (Philippi, 1844)
Dacrydium hyalinum Monterosato, 1875
Aequipecten opercularis (Linne, 1758)
Hyalopecten similis (Laskey, 1811)
Chlamys varia (Linne, 1758)
Chlamys sp.
Anomia ephippium Linne, 1758
Pododesmus squamula (Linne, 1758)
Limea loscombi (Sowerby G.B. I., 1823)
Limatula sp.
Anodontia fragilis (Philippi, 1836)
Myrtea spinifera (Montagu, 1803)
Thyasira flexuosa (Montagu, 1803)
Leptaxinus ferruginosus (Forbes, 1844)
Diplodonta apicalis Philippi, 1836
Diplodonta rotundata (Montagu, 1803)
Montacuta substriata (Montagu, 1808)
Tellimya ferruginosa (Montagu, 1808)
Mysella bidentata (Montagu, 1803)
Neolepton obliquatum Chaster, 1897
Sportella recondita (Fischer P., 1872)
Cardita calyculata (Linne, 1758)
Glans trapezia (Linne, 1767)
Parvicardium exiguum (Gmelin, 1791)
Parvicardium minimum (Philippi, 1836)
Parvicardium scabrum (Philippi, 1844)
Plagiocardium papillosum (Poli, 1795)
Mactra stultorum (Linne, 1758)
Phaxas adriaticus (Coen, 1933)
Tellina donacina Linne, 1758
Tellina nitida Poli, 1791
Tellina pulchella Lamarck, 1818
Tellina pygmaea Loven, 1846
Tellina serrata Brocchi, 1814
Donax variegatus Gmelin, 1791
Psammobia costulata Turton, 1822
Abra alba (Wood W., 1802)
Abra nitida (Mueller O.F., 1776)
Kelliella abyssicola (Forbes, 1844)
Timoclea ovata (Pennant, 1777)
Gouldia minima (Montagu, 1803)
Pitar rudis (Poli, 1795)
Corbula gibba (Olivi, 1792)
Hiatella arctica (Linne, 1767)a
Thracia sp.
Cuspidaria cuspidata (Olivi, 1792)
Cuspidaria rostrata (Spengler, 1793)
Cardiomya striolata (Locard, 1898)

SCAPHOPODA

Dentalium sp.
Fustiaria rubescens (Deshayes, 1826)

ECHINODERMATA

Holothurioidea sp.
Labidoplax digitata (Montagu, 1815)
Ocnus planci (Brandt, 1835)
Astropecten juv.
Amphipholis squamata (Delle Chiaje, 1828)
Amphiura brachiata (Montagu, 1804)
Amphiura chiajei Forbes, 1843
Amphiura filiformis (O.F. Mueller, 1776)
Ophiacantha setosa (Retzius, 1805)
Ophiopsila annulosa (M. Sars, 1857)
Ophiomyxa pentagona (Lamarck, 1816)
Ophiothrix fragilis (Abildgaard, 1789)
Ophiura albida Forbes, 1839
Ophiura grubei Heller, 1863
Genocidaris maculata A. Agassiz, 1869
Echinocyamus pusillus (O.F. Mueller, 1776)
Brissopsis sp. juv.
Echinocardium fenauxi (Pequignat, 1963)
Spatangus purpureus (O.F. Mueller, 1776)

POLYCHAETA

Orbiniidae sp.
Protoaricia oerstedii (Claparede, 1864)
Scoloplos armiger (O.F. Mueller, 1776)
Aricidea capensis Day, 1961
Aricidea fragilis mediterranea Laubier and Ramos, 1974
Aricidea cerrutii Laubier, 1966
Aricidea hartmani (Strelzov, 1968)
Aricidea minima Strelzov, 1973
Aricidea fauveli Hartman, 1957
Aricidea simplex (Day, 1963)
Aricidea claudiae Laubier, 1967
Aricidea catherinae Laubier, 1967
Aricidea monicae Laubier, 1967
Cirrophorus branchiatus Ehlers, 1908
Cirrophorus harpagoneus (Storch, 1967)
Levinsenia gracilis (Tauber, 1879)
Paradoneis lyra (Southern, 1914)
Paraonidae sp.
Cossura coasta Kitamori, 1960
Aquilaspio sp.
Laonice cirrata (Sars, 1851)
Polydora sp.
Polydora caulleryi Mesnil, 1897
Prionospio sp.
Prionospio cf. multibranchiata Berkeley, 1927 Sensu Mackie, 1984
Prionospio fallax Soderstrom, 1920
Prionospio dubia Maciolec, 1985
Pseudopolydora sp.
Scolelepis tridentata (Southern, 1914)
Spio decoratus Bobretzky, 1870
Spiophanes kroyeri Grube, 1860
Magelona sp.
Poecilochaetous serpens Allen, 1904
Chaetopteridae
Spiochaetopterus costarum (Claparede, 1868)
Aphelochaeta marioni (Saint-Joseph, 1894)
Caulleriella caput-esocis (Saint-Joseph, 1894)
Caulleriella bioculata (Keferstein, 1862)
Caulleriella zetlandica (McIntosh, 1911)
Chaetozone sp.

Cirratulus filiformis Keferstein, 1862
Cirriformia filigera (Delle Chiaje, 1841)
Dodecaceria capensis Oersted, 1843
Macrochaeta clavicornis (Sars, 1835)
Monticellina dorsobranchialis (Kirkegaard, 1959)
Tharyx killariensis (Southern, 1914)
Capitellides giardi Mensil, 1897
Dasybranchus caducus (Grube, 1846)
Notomastus latericeus Sars, 1851
Chirimia biceps (Sars, 1861)
Clymenura clypeata (Saint-Joseph, 1894)
Euclymene santanderensis (Rioja, 1917)
Euclymene palermitana (Grube, 1840)
Euclymene oesterdii (Claparede, 1863)
Euclymene lumbricoides (Quatrefages, 1865)
Lubriclymene sp.
Maldane sarsi Malmgren, 1865
Maldanidae sp.
Metasychis gotoi (Izuka, 1902)
Praxillella lophoseta (Orlandi, 1898)
Praxillella gracilis (Sars, 1861)
Armandia cirrosa Philippi, 1861
Armandia sp.
Armandia polyophthalma Kukenthal, 1887
Ophelia roscoffensis Augener, 1910
Opheliidae sp.
Polyophthalmus pictus (Dujardin, 1893)
Tachytrypane jeffreysii McIntosh, 1878
Scalibregma celticum Mackie, 1991
Mysta siphonodonta (Delle Chiaje, 1822)
Mysta picta (Quatrefages, 1865)
Lacydonia miranda Marion and Bobretzky, 1875)
Notophylum foliosum Sars
Paralacydonia paradoxa Fauvel, 1913
Paranaitis lineata (Claparede, 1870)
Phyllodoce macrophthalma Schmarda, 1861
Protomystides bidentata (Langerhans, 1880)
Pseudomystides limbata (Saint-Joseph, 1888)
Pseudomystides elongata (Southern, 1914)
Sige macroceros (Grube, 1860)
Adyte pellucida (Ehlers, 1864)
Harmothoe spinifera (Ehlers, 1864)
Harmothoe lunulata (Delle Chiaje, 1841)
Harmothoe Ljungmanni (Malmgren, 1867)
Harmothoe johnstoni (McIntosh, 1900)
Harmothoe fraserthomsoni McIntosh, 1897
Lepidonotus clava (Montagu, 1808)
Eupanthalis kinbergi McIntosh, 1976
Grubeulepis katzmanni juv. Pettibone, 1986
Pholoe synophthalmica Claparede, 1868
Sthenolepis yhleni (Malmgren, 1867)
Bhawania reyssi
Katzmann, Laubier and Ramos, 1974
Paleanotus debilis (Grube, 1855)
Pisione remota (Southern, 1914)
Hesiospina similis (Hessle, 1925)
Kefersteinia cirrata (Keferstein, 1863)
Podarke pallida (Claparede, 1864)
Pilargis verrucosa Saint-Joseph, 1899
Autolytinae sp. (stolon)
Autolytus sp.
Brania arminii (Langerhans, 1881)
Eurysyllis tuberculata Ehlers, 1864
Exogone gemmifera (Pagenstecher, 1862)
Exogone dispar (Webster, 1879)
Exogone verugera (Claparede, 1868)
Haplosyllis spongicola (Grube, 1855)
Opisthodonta pterochaeta Southern, 1914
Parapionosyllis minuta (Pierantoni, 1903)
Pionosyllis divaricata (Keferstein, 1862)
Pseudobrania limbata (Claparede, 1868)
Streptosyllis websteri Southern, 1914
Syllidia armata (Marion and Bobretzky, 1875)
Syllis cornuta (Rathke, 1843)
Syllis torquata Marion and Bobretzky, 1875
Syllis variegata Grube,1860
Syllis prolifera Krohn, 1852
Syllis krohnii Ehlers, 1864
Syllis hyalina (Grube, 1863)
Syllis brevipennis Grube, 1863
Syllis armillaris (Mueller, 1776)
Syllis gracilis Grube, 1840
Syllis ferrugina (Langerhans, 1881)
Sphaerosyllis taylori Perkins, 1980
Sphaerosyllis ovigera Langerhans, 1879
Sphaerosyllis bulbosa Southern, 1914
Sphaerosyllis brevicirra
Hartmann-Schroeder, 1960
Nereis sp
Glycera unicornis Savigny, 1818
Glycera tesselata Grube, 1863
Glycera Rouxi
Audouin and Milne-Edwards, 1833
Glycera tridactyla Schmarda, 1861
Glycera capitata Oersted, 1843
Goniada maculata Oersted, 1843
Goniada emerita
Audouin and Milne-Edwards, 1833
Lacydonia miranda Marion and Bobretzky, 1875)
Paralacydonia paradoxa Fauvel, 1913
Inermonephtys inermis (Ehlers, 1887)
Micronephthys sphaerocirrata
(Wesenberg-Lund, 1949)
Nephtys hombergi (Savignyi, 1820)
Chloeia venusta (Quatrefages, 1865)
Hyalinoecia tubicola (Mueller, 1788)
Hyalinoecia brementi Fauvel, 1916
Onuphis eremita Audouin and M.Edwards, 1834
Sarsonuphis sp.
Eunice vittata (Delle Chiaje, 1825)
Eunice Oerstedii Stimpson, 1854
Marphysa bellii
(Audouin and Milne-Edwards, 1833)
Lycidice ninetta
Audouin and Milne-Edwards, 1834
Nematonereis unicornis Schmarda, 1861
Lumbrinerides amoureuxi Miura, 1980
Lumbrineris sp.juv.
Lumbrineris latreilli
Audouin and Milne-Edwards, 1834
Lumbrineris impatiens (Claparede, 1868)
Lumbrineris gracilis (Ehlers, 1868)
Lumbrineris emandibulata mabiti Ramos, 1976
Lumbrineris coccinea (Renieri, 1804)

Ninoe armoricana Glemarec, 1968
Drilonereis filum (Claparede, 1868)
Dorvillea rubrovittata (Grube, 1855)
Meiodorvillea sp.
Pettiboneia urciensis Campoy and San Martin, 1980
Protodorvillea kefersteini (McIntosh, 1869)
Schistomeringos Rudolphii (Delle Chiaje, 1828)
Schistomeringos neglectus (Fauvel, 1923)
Sternaspis scutata (Renier, 1807)
Myriochele oculata (Zaks, 1922)
Owenia fusiformis Delle Chiaje, 1844
Brada villosa (Rathke, 1843)
Chloremidae sp
Diplocirrus glaucus Haase, 1914
Pherusa plumosa (O.F. Mueller, 1776)
Piromis eruca (Claparede, 1868)
Amphictene auricoma (Mueller)
Pectinaria capensis (Pallas, 1776)
Ampharete acutifrons (Grube, 1860)
Amphicteis gunneri (Sars, 1835)
Anobothrus gracilis (Malmgren, 1865)
Auchenoplax crinita Ehlers, 1887
Melinna palmata Grube, 1870
Neosabellides oceanica (Fauvel, 1909)
Amaena trilobata (Sars, 1863)
Lanice conchilega (Pallas, 1778)
Nicolea zostericola (Oersted, 1844)
Pista cristata (Mueller, 1776)
Polycirrus aurantiacus Grube, 1860
Terebellides stroemi Sars, 1835
Chone duneri Malmgren, 1867
Chone collaris Langerhans, 1880
Chone filicaudata Southern, 1914
Chone longiseta Giangrande, 1991
Euchone rubrocincta (Sars, 1861)
Euchone rosea Langerhans, 1884
Euratella salmacidis (Claparede, 1868)
Fabricia sp.
Fabricia sabella (Ehrenberg, 1837)
Fabriciinae sp.
Jasmineira elegans Saint-Joseph, 1894
Jasmineira caudata Langerhans, 1880
Potamilla torelli Malmgren, 1866
Pseudopotamilla reniformis (Mueller, 1771)
Sabellidae sp.
Hydroides uncinata (Philippi, 1844)
Hydroides nigra Zibrowius, 1971
Hydroides sp.
Metavermilia multicristata (Philippi, 1844)
Pomatoceros triqueter (Linnaeus, 1767)
Vermiliopsis striaticeps (Grube, 1862)
Vermiliopsis infundibulum (Philippi, 1844)
Serpula Lo Biancoi Rioja, 1917
Serpula concharum Langerhans, 1880
Serpulidae sp.
Spirobranchus polytrema (Philippi, 1844)

MISCELLANEA

Branchiostoma lanceolatum
Miniacina miniacea
Phtisica marina