Depth and sediment granulometry effects on subtidal meiofaunal assemblages of the subtropical coast of Granada (Alboran Sea)

Efectos de la profundidad y granulometría en comunidades submareales de meiofauna de la costa subtropical de Granada (Mar de Alborán)

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Palabras clave: Meiofauna, submareal, Mar de Alborán, estructura de la comunidad.

ABSTRACT

Hypotheses about relationships of meiofaunal assemblages to depth and sediment granulometry were tested. Samples were taken at 3 and 15 metres depth, in sediments classified according to grain size as 'coarse', 'medium' and 'fine'. The meiofaunal community was analysed at a high taxonomic level. The most representative taxa were Nematoda, Copepoda, Polychaeta, Gastrotrichia, Ostracoda, Turbellaria, and nauplius larvae. At three metres depth diversity was lesser than at the deeper site. Moreover, multivariate analyses showed differences in meiofaunal assemblages according to depth. No significant differences related to the granulometry of the sediment were detected.

RESUMEN

Se estudiaron las diferencias en la comunidad de meiofauna en relación a la profundidad y la granulometría del sedimento. Las muestras se tomaron a 3 y

5 metros de profundidad en sedimentos clasificados como 'grueso', 'medio' y 'fino'. La comunidad de la meiofauna fue analizada a niveles taxonómicos superiores. Los taxones más representativos fueron Nematodos, Copépodos, Poliquetos, Gastrotricos, Ostrácodos, Turbelarios y larvas nauplios. A tres metros de profundidad la diversidad fue menor que en el punto de muestreo situado a mayor profundidad. Además, los análisis multivariantes mostraron diferencias en la comunidad de la meiofauna respecto a la profundidad. No se detectaron diferencias significativas relacionadas con la granulometría del sedimento.

INTRODUCTION

Meiofauna (from the Greek 'μειος', smaller) are defined as all metazoans that range between 42-500 μm (Mare, 1942). Although most studies have been carried out in the marine environment, meiofauna occur in a wide range of habitats from inland waters to marine ones, where they appear from shallow waters to deeper areas, from gravel to clay sediments or as epiphytes on plants and animals. Meiofauna are taxonomically more diverse than any other component of marine benthic biota (Kennedy & Jacoby, 1999). In fact, out of the thirty-four metazoan phyla at least twenty-four higher taxa have meiobenthic representatives (Vincx, 1996).

According to the Water Framework Directive (WFD, Directive 2000/60/EC) biological descriptors are essential for evaluating and monitoring environmental conditions in order to ensure effective protection strategies and management of marine systems. In this regard many macrofauna indicators have been described, but in recent years the use of the meiofauna as a biological indicator has demonstrated advantages for assessing and monitoring aquatic ecosystems (Coull & Chandler, 1992). The large densities and diversity found within the meiofauna have promoted its research (Arroyo, 2002) and, over the last thirty years, many studies on meiofauna have increasingly proven the value of these small animals in marine sediments, indirectly by means of bioturbation processes (exposure of buried sediments) and inducing bacterial metabolism, as well as a resource for higher trophic levels that feed on them, such as fish (Gee, 1989). In this sense, meiofaunal assemblages largely determine the abundance and distribution of the macrofauna. Their life cycle occurs entirely in the substrate, which gives them an important role in the decomposition of detritus in the cycle of nutrients and energy flow (Warwick, 1987; Higgins & Thiel, 1988; Green & Montagna, 1996).Thus, integrated responses of meiofauna over time are being directly influenced by both abiotic and biotic factors, and therefore meiofauna are considered a sensitive tool to assess ecological patterns under stress (Giere, 2009; Goodsell *et al.,* 2009; Moreno *et al.,* 2011). Following this, numerous studies have

been carried out in sewage outfalls (Sandulli & De Nicola, 1991), fish farms (Mazzola *et al.,* 1999; Mirto *et al.,* 2010, 2012) and harbours (Fichet *et al.,* 1999; Moreno *et al.,* 2008).

Our case study is located on the subtropical coast of Granada (Alboran Sea), where Atlantic waters come from the Gibraltar Strait in the form of an anticyclonic gyre together with strong westerly winds and generate an upwelling of deep waters along the coast (Fig. 1) (Lanoix, 1974; Parrilla & Kinder, 1987; Rodríguez, 1990; Minas *et al.*, 1991; Tintoré *et al.*, 1991). Characterisation of macrofaunal assemblages and their distribution has been done in this upwelling zone (Templado *et al.*, 1986; Templado *et al.*, 1993; Maldonado, 1992, 1993; Ocaña *et al.,* 2000; Cebrián & Ballesteros, 2004) but few data focused on meiofauna have been described.

Although differences in the diversity and distribution of meiofaunal communities have been attributed both to depth (Danovaro & Fraschetti,

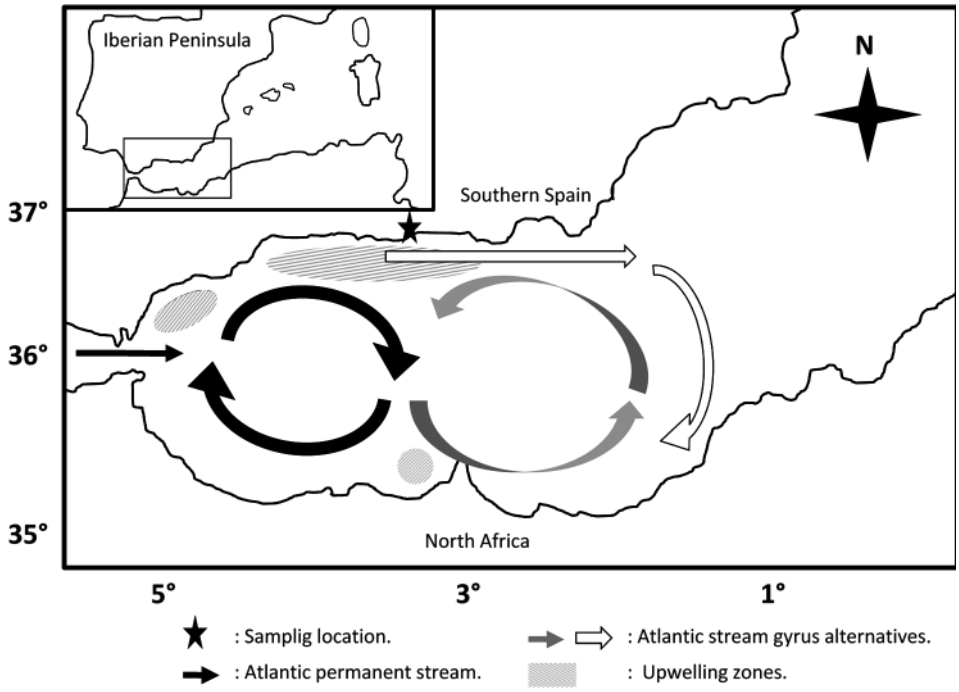

Fig. 1.—Sampling location, diagram of circulation of Atlantic streams and nutrient upwellings in the area.

Fig. 1.—Punto de muestreo, diagrama de circulación de las corrientes del Atlántico y afloramiento de nutrientes en el área.

2002) or sediment granulometry gradients (Duplisea & Drgas, 1999), the interaction between both factors has never been studied. Thus, our aim is to describe the community and distribution patterns of meiofaunal assemblages according to different depths and sediment granulometry in the upwelling area of the Alborán Sea, and provide comparable baseline data for future studies based on disturbances in the zone.

MATERIALS AND METHODS

Study site and sampling

Samples were taken in November 2012 at two points in the locality of Almuñecar (Granada, Spain) (Fig. 1): Playa Galera, 36° 44' 42.29'' N, 3° 39' 21.04'' O and Marina del Este, 36° 43' 22.10'' N, 3° 43' 35.97'' O. This is an area of ecological and biogeographic interest due to the upwelling system generated by the marine currents on the north side of the permanent geostrophic gyre of the Alborán Sea (Templado *et al*., 2006). A sandy bottom at 3 metres depth was only found at Playa Galera, whereas a sandy bottom at 15 metres depth was only found at Marina del Este in the prospected area of Almuñecar. At each depth, three different granulometries were considered: coarse, medium and fine. Three sites were randomly sampled per granulometric type, separated each other by tens of meters. Three replicates were taken via scuba diving using cylindrical cores of 125 cm^3 (4 cm diameter, 10 cm high). For analyses of granulometry and chemical parameters, two additional samples were collected for each depth and granulometric class. Granulometry analyses were previously carried out in order to select appropriate types of sediment.

Physicochemical analysis

Granulometric parameters were determined following the method proposed by Guitián and Carballas (1976). Samples for chemical analysis of the sediment were immediately stored frozen until the laboratory analyses. In the laboratory, sediment samples were air-dried, crushed and sieved though a 2 mm sieve and then ground to <60 μm. The sediments were analysed for determining Organic Matter, Total Organic Carbon and Nitrogen. Organic Matter (MO) and total organic carbon (TOC) was analysed by dichromate oxidation and titration with ferrous ammonium sulphate (Walkley & Black, 1934). Nitrogen was determined by the Kjeldahl digestion method to convert

organic nitrogen to ammonia. The digestate was alkalized, the ammonia distilled into boric acid and titrated with an acid of known concentration.

Meiofaunal analysis

Each sample was mixed with magnesium chloride 7.5% $MgCl_2$ in distilled water and, after 10 minutes, sieved through a 0.5 mm sieve (in order to retain macrobenthos) and a 30 μm sieve (in order to obtain meiofauna). This process was repeated three times for each sample and, subsequently, the animals were fixed with ethanol 70% and stained with Rose Bengal. In the laboratory, the meiofaunal specimens were identified at a high taxonomic level (phylum, class or order) under a stereomicroscope.

Statistical analysis

The mean and standard deviation of abundance of each taxon were calculated for each sampling site, as well as the Shannon–Wiener diversity index (H'; Shannon & Weaver, 1963) and the total number of taxa (S). Two different statistical approaches (univariate and multivariate) were used to identify potential changes in community structure, based on the null hypothesis of no differences in the composition of the community structure between depths, granulometries and sites.

To test whether the number of taxa and diversity of meiofauna communities were similar between depths, granulometries and sites, a multifactorial analysis of variance (ANOVA) was used with the following factors: 'Depth' (De), a fixed factor, with two levels (*3m* and *15m*); 'Granulometry' (Gr), a fixed factor, with three levels (*coarse, medium* and *fine*) and orthogonal with Depth, and 'Site' (Si), a random factor, nested with 'Depth and Granulometry', with three random sites. Three samples (n = 3) were considered for each site. Prior to the ANOVA, homogeneity of variance was tested with a Cochran's C-test. When the ANOVA indicated a significant difference for a given factor, the source of difference was identified using the Student–Newman–Keuls (SNK) test. Analyses with balanced data were conducted with GMAV5 (Underwood *et al.*, 2002). An unbalanced one-way ANOVA was undertaken, using SPSS© 15.0, to test differences in diversity among depths.

Permutational multivariate analysis of variance (PERMANOVA) was used to test hypotheses regarding differences in community structure between depths (*3m* and *15m*) and granulometry (*coarse*, *medium* and *fine*). Multivariate statistics, i.e. UPGMA method (Unweighted Pair-Group Method

using arithmetic averages) and nMDS (non-metric multidimensional scaling) were also used based on the Bray-Curtis similarity index. nMDS was used to test for differences in the community structure between depths and among granulometries. Clusters of sites identified as statistically significant using the profile test SIMPROF ($P<0.05$) were considered to have a similar community structure. For the nMDS, Kruskal's stress coefficient was used to test the ordination (Kruskal & Wish, 1978). The data were previously fourth-root transformed. The percentage similarity (SIMPER) procedure was then used to calculate the contribution of each taxon to the dissimilarity between depths and granulometries. A cut-off criterion was applied to allow identification of a subset of taxa whose cumulative percentage contribution reached 20% of dissimilarity. Multivariate analyses were carried out using the PRIMER v.6+PERMANOVA package (Clarke, 1993).

RESULTS

Community structure and descriptive analysis

A total of 18 higher taxa were identified, 7 of which were always present at all stations (station being defined as each specific depth and granulometry where a factor site was nested). These 7 higher taxa comprised copepods, nematodes, polychaetes, gastrotrichs, nauplius larvae, ostracods and turbellarians (Tables I and II). Granulometric analyses showed a prevalence of the fine sand fraction (0.063–0.25 mm) for '3m fine' and '15m fine' stations, a prevalence of coarser sandy fractions (0.5–2 mm) for '3m coarse' and '15m coarse' stations, whereas '3m medium' and '15m medium' stations were similar in grain size composition to '3m fine' and '15m coarse', respectively (Fig. 2). Values of all variables were low and similar between stations, although levels of T.O.C. and O.M. were slightly higher at '15m' stations (Table III).

Results of the three-way ANOVA comparing number of taxa, diversity (H') and abundance are shown in Table IV. The number of taxa did not show significant differences for any factor (Fig. 3B). A significant interaction between Granulometry (Gr) and Depth (De) was detected. The SNK test revealed that this interaction was due to significant differences at the '15m medium' station, where the number of taxa was higher than at other stations (data not shown). One-way ANOVA showed significant differences between depths for diversity values; SNK test detected a higher mean value at '15m' stations. Finally, abundance showed significant differences between depths and an interaction between sites Si (DexGr). According to the SNK test, abundance was higher at '3m' stations (Fig. 3A) and the interaction between

Table I. —Meiofaunal taxa abundance (ind/10 cm^2) at 3 m depth across the different grain sizes. Data showed are average values ± standard deviation.
Tabla I. —Abundancia de los taxones de meiofauna (ind/10 cm^2) a 3 m de profundidad en función de los distintos tamaños de grano. Los datos mostrados corresponden al valor medio ± desviación estandar.

Granulometry	*Site*	*Cnidaria*	*Turbellaria*	*Nemertina*	*Nematoda*	*Gastrotrichia*	*Kynorhyncha*	*Polychaeta*
Coarse	S1	0 ± 0	2 ± 2	0 ± 0	66 ± 31	16 ± 14	0 ± 0	32 ± 11
	S2	0 ± 0	5 ± 3	2 ± 2	66 ± 39	5 ± 5	0 ± 0	25 ± 9
	S3	0 ± 0	6 ± 4	0 ± 0	33 ± 11	3 ± 3	0 ± 0	12 ± 3
Medium	S1	0 ± 0	2 ± 2	0 ± 0	139 ± 114	2 ± 3	0 ± 0	21 ± 10
	S2	1 ± 1	1 ± 1	0 ± 0	38 ±22	0 ± 0	0 ± 0	52 ± 18
	S3	0 ± 0	2 ± 2	0 ± 0	70 ± 22	2 ± 3	0 ± 0	29 ± 22
Fine	S1	0 ± 0	2 ± 2	0 ± 0	79 ± 64	12 ± 11	0 ± 0	4 ± 1
	S2	0 ± 0	9 ± 6	0 ± 0	97 ± 36	17 ± 15	1 ± 1	6 ± 5
	S3	0 ± 0	4 ± 2	1 ± 1	95 ± 36	10 ± 9	0 ± 0	3 ± 2
		Oligochaeta	*Tardigrada*	*Nauplii*	*Ostracoda*	*Copepoda*	*Amphipoda*	*Acarina*
Coarse	S1	2 ± 2	0 ± 0	13 ± 12	7 ± 5	91 ± 32	0 ± 0	2 ± 2
	S2	0 ± 0	0 ± 0	27 ± 33	7 ± 6	234 ± 4	0 ± 0	2 ± 1
	S3	0 ± 0	0 ± 0	6 ± 5	3 ± 2	70 ± 33	0 ± 0	0 ± 0
Medium	S1	0 ± 0	0 ± 0	2 ± 4	4 ± 3	32 ± 28	2 ± 1	1 ± 1
	S2	0 ± 0	1 ± 1	10 ± 2	2 ± 1	66 ± 11	0 ± 0	0 ± 0
	S3	0 ± 0	0 ± 0	6 ± 3	5 ± 3	67 ± 30	1 ± 1	0 ± 0
Fine	S1	0 ± 0	0 ± 0	2 ± 1	2 ± 1	13 ± 7	2 ± 2	0 ± 0
	S2	0 ± 0	0 ± 0	3 ± 3	2 ± 1	25 ± 11	0 ± 0	1 ± 1
	S3	0 ± 0	0 ± 0	2 ± 2	2 ± 3	22 ± 2	1 ± 0	0 ± 0

Table II.—Meiofaunal taxa abundance (ind/10 cm^2) at 15 m depth across the different grain sizes. Data showed are average values ± standard deviation.
Tabla II.—Abundancia de los taxones de meiofauna (ind/10 cm^2) a 15 m de profundidad en función de los distintos tamaño de grano. Los datos mostrados corresponden el valor medio ± desviación estandar.

Granulometry	*Site*	*Cnidaria*	*Turbellaria*	*Nemertina*	*Nematoda*	*Gastrotrichia*	*Rotifera*	*Kynorhyncha*	*Priapula*	*Polychaeta*
Coarse	S1	0 ± 0	1 ± 1	0 ± 0	10 ± 2	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0
	S2	0 ± 0	2 ± 2	1 ± 1	13 ± 5	0 ± 0	0 ± 0	0 ± 0	0 ± 0	1 ± 0
	S3	0 ± 0	2 ± 2	0 ± 0	61 ± 30	10 ± 6	1 ± 0	0 ± 0	0 ± 0	10 ± 8
Medium	S1	1 ± 1	9 ± 10	1 ± 1	71 ± 54	12 ± 12	1 ± 1	0 ± 0	1 ± 1	16 ± 4
	S2	0 ± 0	9 ± 6	0 ± 0	77 ± 49	5 ± 4	0 ± 0	0 ± 0	0 ± 0	23 ± 13
	S3	0 ± 0	7 ± 2	1 ± 1	78 ± 64	13 ± 11	0 ± 0	1 ± 1	0 ± 0	25 ± 21
Fine	S1	0 ± 0	3 ± 2	0 ± 0	18 ± 10	0 ± 0	0 ± 0	0 ± 0	0 ± 0	3 ± 2
	S2	0 ± 0	2 ± 1	0 ± 0	66 ± 25	8 ± 5	0 ± 0	0 ± 0	0 ± 0	1 ± 1
	S3	0 ± 0	1 ± 1	1 ± 1	9 ± 2	0 ± 0	0 ± 0	1 ± 1	0 ± 0	4 ± 4
		Oligochaeta	*Tardigrada*	*Nauplii*	*Ostracoda*	*Copepoda*	*Tanaidacea*	*Amphipoda*	*Acarina*	*Entoprocta*
Coarse	S1	0 ± 0	0 ± 0	0 ± 0	3 ± 3	4 ± 3	0 ± 0	1 ± 0	0 ± 0	0 ± 0
	S2	0 ± 0	0 ± 0	1 ± 0	2 ± 1	6 ± 9	0 ± 0	1 ± 0	0 ± 0	0 ± 0
	S3	0 ± 0	0 ± 0	15 ± 13	0 ± 0	34 ± 19	0 ± 0	0 ± 0	0 ± 0	0 ± 0
Medium	S1	1 ± 0	0 ± 0	4 ± 4	3 ± 3	22 ± 21	0 ± 0	0 ± 0	1 ± 1	0 ± 0
	S2	1 ± 1	1 ± 1	2 ± 1	0 ± 0	15 ± 3	0 ± 0	0 ± 0	0 ± 0	0 ± 0
	S3	0 ± 0	0 ± 0	2 ± 1	2 ± 2	21 ± 20	0 ± 0	1 ± 1	0 ± 0	1 ± 0
Fine	S1	0 ± 0	0 ± 0	1 ± 1	2 ± 2	10 ± 5	0 ± 0	2 ± 1	0 ± 0	0 ± 0
	S2	0 ± 0	0 ± 0	16 ± 11	1 ± 0	22 ± 20	0 ± 0	2 ± 2	0 ± 0	0 ± 0
	S3	0 ± 0	0 ± 0	0 ± 0	2 ± 1	13 ± 1	1 ± 1	3 ± 2	0 ± 0	0 ± 0

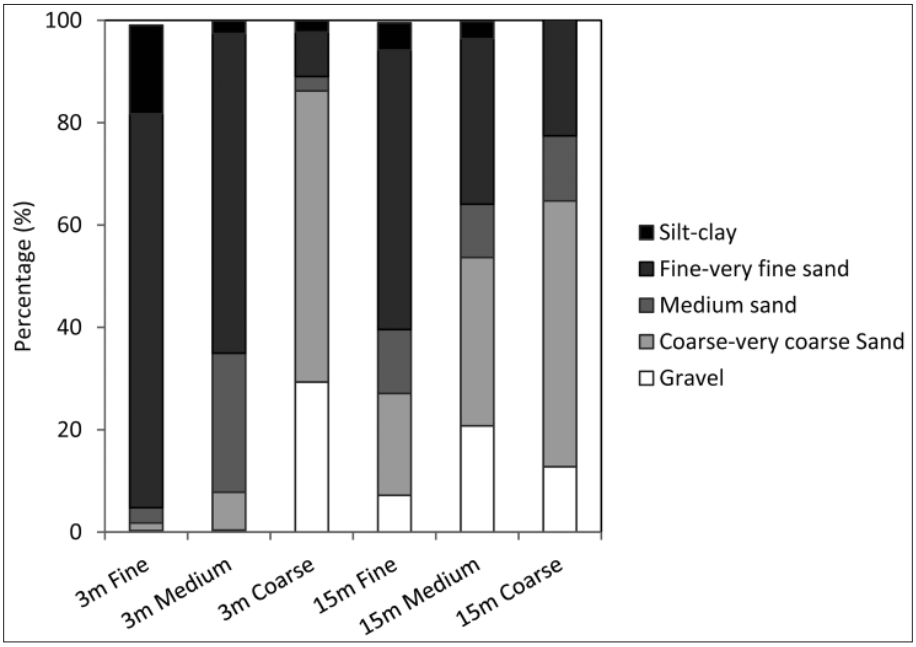

Fig. 2.—Sediment granulometry for each station. Silt-clay < 0.063 mm; 0.25 mm > Fine-very fine sand > 0.063 mm; 0.5 mm > Medium sand > 0.25 mm; 2 mm > Gross-very gross sand > 0.5 mm; Gravel > 2 mm.
Fig. 2.—Granulometría del sedimento para cada estación. Limo-arcilla < 0.063 mm; 0.25 mm > Arena fina-muy fina > 0.063 mm; 0.5 mm > Arena media > 0.25 mm; 2 mm > Arena gruesa-muy gruesa > 0.5 mm; Grava > 2 mm.

sites was only due to a small variation between sites at only one station, i.e. '3m coarse' (data not shown).

Multivariate analysis

Community structure differences were portrayed via nMDS plots acoordimg to depth. The '3m', 'fine' and 'coarse' sites were separated as independent groups and had a similar community structure as showed by SIMPROF, while similarity among 'medium' sites was less apparent (Fig. 4). At '15m', SIMPROF clearly separated two groups, one corresponding to 'fine' and 'coarse' sites while 'medium' sites grouped separately (Fig. 5).

PERMANOVA test showed significant differences in community structure between depths (Table V). Moreover, the analysis showed a DexGr interaction, again due to the higher abundance at a '15m medium' site.

Table III.—Values obtained for sediment variables at the sampling stations. Tabla III.—Valores obtenidos para las variables del sedimento en las estaciones de muestreo.

Sample	*Depth (m)*	*T.O.C. (%)*	*O.M. (%)*	*N.k (%)*
Fine	3	0.057	0.10	0.024
Medium	3	0.067	0.12	0.020
Coarse	3	0.081	0.14	0.010
Fine	15	0.131	0.23	0.019
Medium	15	0.091	0.16	0.014
Coarse	15	0.137	0.24	0.021

T.O.C.: Total organic carbon; O.M.: organic matter; N: total nitrogen; k: Kjeldahl digestion method.

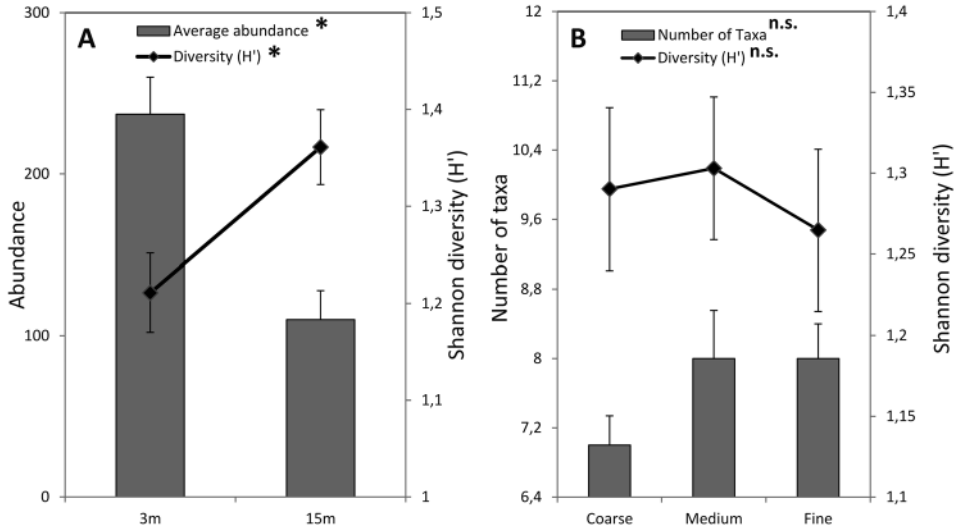

Fig. 3.—(A) Mean values ± SE of diversity and abundance for each depth. (B) Mean values ± SE of diversity and number of taxa. Significance of differences between depths is also represented. * = P < 0.05. n.s. = non significant.
Fig. 3.—(A) Valores medios ± SE de la diversidad y abundancia para cada profundidad. (B) Valores medios ± SE de la diversidad y el número de taxones. La significancia de las diferencias entre profundidades también se representa. * = P < 0.05. n.s. = no significativo.

Table IV.—Results of the three-factor ANOVA for number of taxa, Shannon-Wiener diversity and abundance.
Tabla IV.—Resultado del ANOVA de tres factores para el número de taxones, la diversidad de Shannon-Wiener y la abundancia.

		Number of taxa (S)			*Shannon diversity (H')*			*Abundance*		
Source of variation	*df*	*MS*	*F*	*P*	*MS*	*F*	*P*	*MS*	*F*	*P*
De	1	1.500	0.76	0.4013	0.2870	4.78	0.0494*	217995.5741	12.97	0.0036**
Gr	2	1.6852	0.85	0.4514	0.0096	0.16	0.8540	30355.0185	1.81	0.2062
Si (DexGr)	12	1.9815	0.49	0.9067	0.0601	1.67	0.1152	16807.4815	2.17	0.0365*
DexGr	2	10.7222	5.41	0.0211*	0.0928	1.54	0.2529	38878.2407	2.31	0.1414
RESIDUAL	36	4.0370			0.0359			7757.3519		
TOTAL	53									
Cochran's C-		0.1697			0.1701			0.1788		
test		NS			NS			NS		
Transformation		None			None			None		

MS: mean square; P: level of significance; df: degrees of freedom; NS: non significant; *P<0.05; **P<0.01.

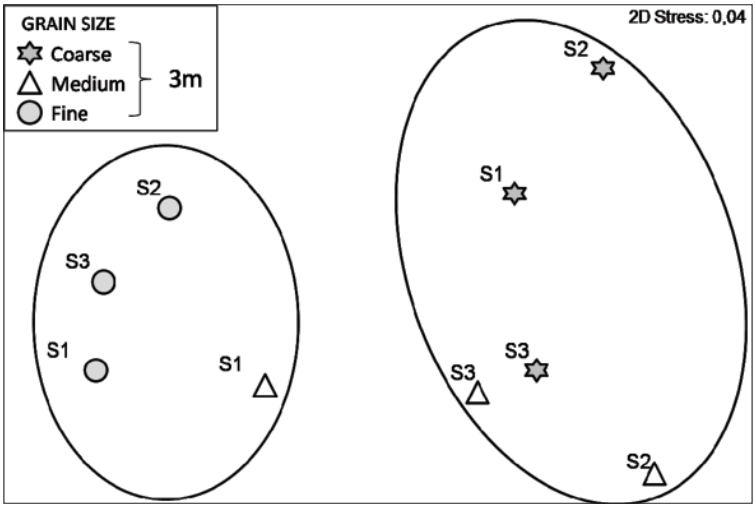

Fig. 4.—Two-dimensional MDS plot for community structure based on meiofaunal taxa at 3 m. Sites were grouped based on the results of SIMPROF test. Abundance data were square-root transformed.
Fig. 4.—Gráfico MDS bidimensional de la estructura de la comunidad basado en los taxones de meiofauna a 3 m. Los sitios se agruparon a partir de los resultados del test SIMPROF. Los datos de abundancia se transformaron a la raíz cuadrada.

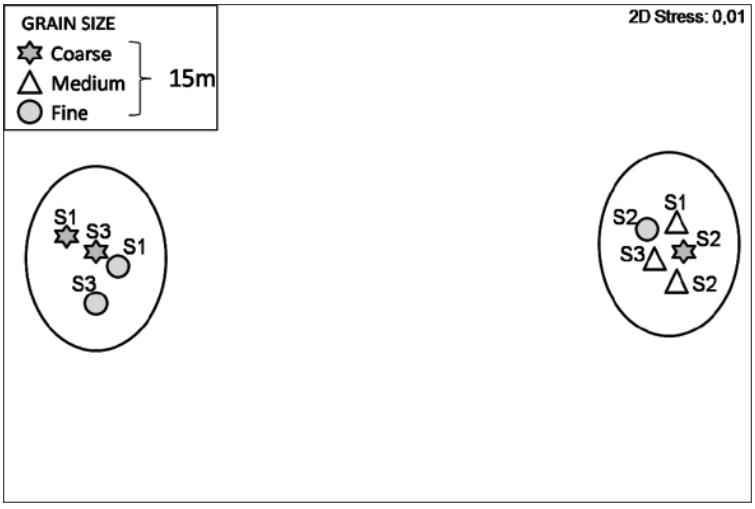

Fig. 5.—Two-dimensional MDS plot for community structure based on meiofaunal taxa at 15 m. Sites were grouped based on the results of SIMPROF test. Abundance data were square-root transformed.
Fig. 5.—Gráfico MDS bidimensional de la estructura de la comunidad basado en los taxones de meiofauna a 15 m. Los sitios se agruparon a partir de los resultados del test SIMPROF. Los datos de abundancia se transformaron a la raíz cuadrada.

Table V.—Results of multivariate analysis PERMANOVA for meiofaunal assemblages based on Bray-Curtis dissimilarity index of fourth-root transformed data.
Tabla V.—Resultados del análisis multivariante PERMANOVA para las comunidades meiofaunales basado en el índice de disimilitud de Bray-Curtis de los datos transformados con la raíz cuarta.

Source of variation	*df*	*MS*	*Pseudo-F*	*P*
De	1	816.69	3.065	0.046*
Gr	2	434.72	1.6315	0.163
DexGr	2	720.65	2.7046	0.045*
Residual	12	266.46		

MS: mean square; P: level of significance; df: degrees of freedom. *P<0.05.

Regarding the depth factor, SIMPER analysis showed an average dissimilarity of 34.48%, where copepods contributed 21.87%. Dealing with granulometry, copepods and nematodes were the main groups contributing to the dissimilarity between the 'coarse' and 'fine' groups (average dissimilarity 35.91%), and between 'coarse' and 'medium' groups (average dissimilarity 33.32%), while polychaetes were the most important taxa in contributing to the dissimilarity between 'medium' and 'fine' groups (average dissimilarity of 30.87%).

DISCUSSION

Meiofaunal assemblages are largely determined by spatial gradients in factors such as grain size, depth or organic matter content; therefore large variations in meiofaunal abundance depending on these factors might be expected (Giere, 2009; Deudero & Vincx, 2000). Patterns in meiobenthos distribution in the Mediterranean Sea have been mainly detected in bathyal zones (de Boveé *et al.*, 1990; Soetaert *et al.*, 1991; Danovaro *et al.*, 1995, 1999, 2000; Lampadariou, 2001; Tselepides *et al.*, 2004) and few were referred to subtidal zones (Sandulli *et al.*, 2010). Even though water depth has been proposed as an environmental factor that modifies meiobenthic assemblages (Deudero & Vincx, 2000), as well as grain size (Coull & Bell, 1979), there is a lack of knowledge on the relationship between them.

Water depth affects hydrodynamism, the deeper the profundity is, the lesser is the hydrodynamism at the bottom and therefore smaller grain sizes can be found. This fact, translates into higher sedimentation and organic accumulation rates (Parenzan, 1979; Guerra-García & García-Gómez, 2005).

In fact, one of the main factors determining meiofaunal assemblages is food supply (Vanreusel *et al*, 1995).

Our study showed a significantly higher diversity and different community structure at '15m' sites with respect to those at '3m', highlighting how ecosystem stability increases with depth, even at small scales, and how the settlement is determined by the degree of sediment stability (Gray & Elliott, 2009). These results are concordant with other subtidal meiofaunal assemblages (Riera *et al.*, 2012). On very dynamic sandy shores, waves and tidal currents can suspend fractions of sediment and, therefore, disturb the infauna (Murray *et al.*, 2002). Moreover, small animals may be more affected by water movement, which dwell in the upper few centimetres of sediment (Negrello Filho *et al.*, 2006). Thus, preventing settlement and colonization it can be observed a diminution of diversity.

Regarding abundances, the most important groups (nematodes and copepods) showed the highest densities at '3m', where the hydrodynamic conditions are expected to be more stressful. In fact, nematodes are more tolerant to stressful conditions than most other groups (Deudero & Vincx, 2000). T.O.C. and O.M. values were very similar between shallow and deeper sites and, therefore, we can reject the hypothesis that the higher abundances at '3m' could be due to pollution events, since it is known that nematodes have a higher persistence in gradients with increasing pollution (Raffaeli & Manson, 1981). Moreover, organic matter availability depends on bacterial densities (Moreno *et al.*, 2006), so further details on this aspect should be discussed.

Although grain size and the degree of sorting of the sand grains determine the available space for interstitial meiofauna and thus its abundance, our study did not show a significant relationship of the meiofaunal and granulometry. These results are consistent with other studies (Riera *et al*., 2012) but these data have to be taken into account carefully since a lower taxonomic level of identification could show up differences in community structure. It has been noted that to assess distribution patterns a more accurate taxonomic level identification should be addressed, highlighting the patchy nature of meiofauna (Giere, 2009). Moreover, although we did not study the meiofauna to family level, polychaetes belonging to the Syllidae family were easily identified due to their buds for reproduction. In this study we noticed during sampling analysis (data not shown) that Syllidae polychaetes showed a strong preference for coarse sediments. In any case, these data are valuable for future studies evaluating sources of stress influencing meiofaunal assemblages, since the responses of metazoan meiofauna to various ecosystem alterations are clearly detected at the highest taxonomic level, with a resolution similar to that provided by the analysis of lower taxonomic levels (Warwick., 1988; Kennedy & Jacoby, 1999; Mirto *et al.*, 2010).

In summary, depth was the main factor influencing meiofaunal assemblages in this Mediterranean area. Additionally, we provide quantitative and qualitative data for future assessment of shallow subtidal meiobenthic communities under natural or human-induced perturbations.

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