Molluscan assemblages in littoral soft bottoms of the Alboran Sea (Western Mediterranean Sea)

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Abstract
The structure of the molluscan assemblages inhabiting the subtidal bottoms off the west coast of Malaga province (southern Spain) and their relation to sediment characteristics were analysed with both univariate and multivariate parameters. Five significantly different molluscan assemblages were identified and assigned to ‘sables fins bien calibrés’ (SFBC, well sorted fine sands); ‘détritique côtier’ (DC, coastal bioclastic sands); ‘détritique envasé’ (DE, muddy bioclastic sands); and ‘corallige`ne’ (CO, coralligenous) biocoenoses of Péres and Picard classification. A total of 234 molluscan species were identified, with gastropods as the dominant group (135 species). An increase of diversity and evenness with depth has been observed, with the highest values for both indexes on a rocky outcrop, and the lowest in the shallower fine sand assemblage dominated by few species. The different molluscan assemblages inhabiting these sublittoral bottoms were conditioned by depth, percentage of gravel and percentage of clay. A large proportion of tropical West African species is found in the area, some of them reaching their distributional limit towards the Mediterranean Sea. The southern Iberian coasts, in the confluence of Atlantic and Mediterranean waters and between Africa and Europe, are therefore highlighted as one of the areas with highest molluscan species richness in Europe, and require a conservation policy in order to preserve this unique European biodiversity heritage.

Key words: Alboran Sea, assemblages, bivalve, gastropod, soft bottoms, species richness

Introduction
The Alboran Sea is the confluence point of three different biogeographical regions (Ekman 1953): Lusitanian region (temperate–cold), Mauritanian region (warm–subtropical), and the Mediterranean region and, therefore, supports the coexistence of species from such different regions as northern Europe or tropical western Africa (Rueda & Salas 1998; Rueda & Gofas 1999; Rueda et al. 2000, 2009; Gofas & Zenetos 2003; Urra & Gofas 2009). In fact, the Alboran Sea is considered an ecoregion worth considering separately in Spalding et al. (2007), with equal rank to the much larger Western Mediterranean basin and South European Atlantic shelf. Considering this, the coasts of the southern Iberian Peninsula promote one of the largest assemblage of invertebrate biodiversity along the European coasts (e.g. for molluscs: Gofas 1999; Rueda et al. 2000, 2009; Peñas et al. 2006) and its study would be a first step to improve the management and conservation strategies of this highly species-rich area.

In marine benthic communities, molluscs are one of the dominant groups that contribute largely to the local biodiversity of different habitats such as seagrasses (Hemminga & Duarte 2000; Templado et al. 2004), hard bottoms (Gabriele et al. 1999; Balles­teros 2006; Casellato & Stefanon 2008) or soft bottoms (Sanvicente-Anorve et al. 2002; Labrune et al. 2008). Molluscs are also important components of the benthic system due to their feeding activity and also because they represent an important food source for higher trophic levels (Edgar & Shaw 1995). Therefore, studies of molluscan assemblages are of importance for further studies on other components of the benthic community.

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Despite the importance of the Alboran Sea for marine invertebrate fauna, there have been very few studies regarding the composition and structure of the molluscan assemblages inhabiting different types of sublittoral soft bottoms. Most of them give only faunistic lists (Luque 1983, 1986; Salas 1987; Martínez & Peñas 1996), contrary to those carried out in other types of habitats that have been widely studied such as seagrass beds (Templado et al. 2004; Rueda et al. 2009). Information on assemblages associated with soft bottoms is of importance because they support commercial trawling, so this information is necessary for improving the management of coastal areas. In the particular case of the study area, part of this coastline has been approved as a Site of Community Importance (SCI) focused on a seagrass meadow nearshore, but information on the surrounding soft bottoms is also needed for management purposes.

The aims of this research were therefore (1) to study the composition and structure of molluscan assemblages living in sublittoral bottoms (5–25 m depth) along a stretch of coastline around SCI in the Alboran Sea; (2) to characterize the different molluscan species and types of assemblages; and (3) to relate the distribution of these assemblages to the sediment characteristics. The starting hypothesis is that these soft bottoms may support high numbers of species when compared to similar ones in other parts of Spain and Europe, and therefore a conservation status should be considered in order to preserve this large reservoir of molluscan biodiversity.

Material and methods

Study site

The study site is located in southern Spain (Alboran Sea, western Mediterranean Sea) (Figure 1). The sampling was carried out between ‘Punta de Calaburras’ (36°30.4’N 04°38.3’W), near Fuengirola, and the marina of Cabopino (36°29’N 04°44.3’W) near Marbella, both places located within the Málaga province and within the township of Mijas (Costa del Sol). This area is one of the few stretches of coastline in the province featuring natural rocky bottoms (intertidally and subtidally). It is also remarkable in being one of the westernmost points in the distributional range of the endemic Mediterranean seagrass species Posidonia oceanica (Linnaeus) Delile (Moreno et al. 2004). Fragmented beds of this species, as well as of the seagrass Cymodocea nodosa (Ucria) Ascherson, occur amongst shallower rocky outcrops down to ca. 5 m depth. Soft bottoms are very abundant in this area, including those with fine, medium and coarse sand as well as with bioclasts, and extend beyond the patchy seagrass beds. The studied zone borders a marine Site of Community Importance (Calahonda; code ES6170030, Official Journal of the E.U. of 21.09.2006), which is part of the Natura 2000 network.

Sample collection and laboratory procedures

Samples were collected in September and November 2004 and February and May 2005, at three different
depths (5, 15, 25 m) along four transects, each oriented perpendicularly to the coastline (Figure 1). This resulted in 11 sampling stations, as one could not be sampled with the dredge due to the presence of abrupt rocky outcrops interspaced with soft bottoms. In each sampling campaign, three replicates were generally taken at each sampling station (126 samples in total). These samples were collected using a small heavy rock dredge, with a rectangular frame of 42 × 22 cm and a mesh size of 4 mm knot to knot. In spite of the mesh size, the large amount of material collected stretched the net and clogged the mesh size, so the underestimation of the abundance of juveniles was minimized. The sampling area covered in each occasion could span 130 m², calculated from the width of the rock dredge and the boat speed of about 2 knots for 5 min. The surface actually sampled may be somewhat smaller if the dredge departs from the bottom at times, but care was taken to control the continuity of operation through the tension of the rope. This sampling area is much larger than the one needed for the collection of molluscs, but it was chosen because it was appropriate for the collection of other invertebrate groups, such as decapods, also included in this research project (García Muñoz et al. 2008). Each sample of fauna was carefully sieved over mesh sizes of 10, 5, 3 and 1 mm, storing each size fraction in 70% ethanol. This was done in order to facilitate sorting at the species level, and to help separate juveniles from adults of some species. The molluscs collected alive were subsequently extracted from the sediment and then identified and counted. Additional species collected only as shells in the thanatocenosis are not considered.

**Characterization of the sediment**

Sediment samples were collected in order to study the grain size distribution and the organic matter content of the sediment in each sampling station. These samples were collected using a blind semi-circular-toothed dredge with a 20 cm mouth. For the granulometric analysis, sediment samples of a similar weight (around 1000 g) were washed over a 0.063 mm sieve, in order to separate the mud fraction (silt and clay) that was then computed as the difference in dry weight before and after the wash. Later, the sediment was sieved over a column of sieves (6.30, 4, 2, 1, 0.5, 0.25 and 0.125 mm), weighing (dry weight) the fractions retained on each sieve. Buchanan classification (Buchanan 1984) was used to characterize the type of sediment. Median (Q50) and sort coefficient (S0) (Trask 1932) were also estimated for each sediment sample. The percentage of organic matter (%OM) in samples of dry sediment (three replicates of 20 g per sampling station) was obtained from the weight loss on ignition at 500°C for 1 h. Similarities of the sediment composition in the different samples were analysed by multivariate methods, using group-average sorting classification (CLUSTER) and multidimensional scaling (MDS) ordination with the Bray–Curtis similarity index.

**Characterization of the molluscan fauna**

The different molluscan species were scored according to their abundance (N: number of individuals of a species in the sample), Dominance index (%D: percentage of individuals of a species from the total) and Frequency index (%F: percentage of samples in which the species is present). The molluscan assemblage from each sampling station was characterized according to the abundance of molluscs (N), species richness (S), the Shannon Index (H: log2) (Krebs 1989) and the evenness index (J) (Pielou 1969).

One-factor ANOVAs (Analysis of Variance) were carried out for testing the differences in the values of the species richness, abundance, diversity index and evenness between groups of samples collected in each sampling station or those belonging to the same type of assemblage. A post-hoc Tukey test (p < 0.05) was used for posterior multiple comparisons. Two-factor ANOVAs were also carried out to test differences in the values of the previously mentioned indexes according to depth and location (transect). Analyses to test the normality (Kolmogorov–Smirnov) and to verify the homogeneity of variances (Barlett) were executed prior to ANOVA analyses. These statistical procedures were performed using the software SYSTAT 9 (SPSS).

Nonparametric multivariate techniques, such as classification (CLUSTER) and MDS ordination, were applied on both qualitative (presence/absence) and quantitative data (fourth root abundance data), in order to identify the molluscan assemblages occurring in the studied area and to analyse the similarities between these assemblages. A resemblance matrix between all samples collected in the 11 sampling stations (126 samples) was assembled using the Bray–Curtis similarity index. Before the analysis, a fourth root transformation on species abundance data was applied in order to normalize the data and reduce the weighting of highly dominant species (Field et al. 1982). ANOSIM (ANalysis Of SIMilarity) was used for testing the differences between groups of samples according to different factors (e.g. depth, transect, sediment type) (Clarke & Green 1988; Clarke & Warwick 1994). The SIMPER procedure was also used to evaluate the contribution
of the different species to the different groupings of samples.

The faunistic and environmental ordinations of samples were also contrasted by using the BIOENV (BIOnic and ENVironmental linking) analysis. Prior to this, the environmental variables were screened and those which presented a correlation of more than 0.9 (after Spearman correlation analysis, \( p_{iso} \)) were not considered further. Environmental data expressed as \( x \) were transformed \( \log(x+1) \). The BIOENV analysis results in different combinations of environmental variables which are highly correlated to the ordination of faunistic samples. These multivariate analyses were executed using the PRIMER v6.0 software from Plymouth Marine Laboratory, UK (Clarke & Warwick 1994).

Results

Sediment

The granulometric composition and organic matter content of each sampling station are shown in Table I. Sampling stations clearly separated into five groups at 50% of similarity, obtained by multivariate (CLUSTER and MDS) methods (Figure 2). Group I corresponded to a rocky outcrop called ‘Laja del Almirante’, which expands towards the southeast, and harbours an important coralligenous community, a characteristic formation of biogenic origin in Mediterranean benthic environments, produced by the accumulation of calcareous encrusting algae growing in dim light conditions (Ballesteros 2006). Sediments from group II were those occurring in the shallow sampling stations (5 m), with fine and medium sand, a low proportion of mud (1.5–2.1%) as well as of organic matter (0.79–1.26%). Sediments belonging to group III corresponded to medium and coarse sand occurring in the deepest sampling stations of transects 1 and 2 (25 m), with a moderate proportion of mud (2.5–11.6%), a high content of larger bioclasts, and the largest values of organic matter content from all sampling stations (1.97–3.04%). The sampling stations at 15 and 25 m depth of the transect 3 and 4 formed the group IV, with fine sands and a high content of mud (12.6–20.7%), probably influenced by the sediment input of the ‘Cala del Moral’ river. Most of the sampling stations of this group displayed moderate organic matter contents (1.43–1.82%) and poor sediment sorting (2–2.5\( \phi \)). Finally, the last group (group V) corresponded to a single sampling station (15 m) with coarse sands, an intermediate proportion of mud (5.1%), a lower organic content (1.24%) in comparison to other sampling stations, and a bad sediment sorting.
In general, mud percentage increased in transects located from west to east (transects 1–4) (Figure 3). The percentage of organic matter increased significantly with depth in all sampling transects, displaying a high correlation ($r_{x} = 0.949$) as was also found for percentage of bioclasts with depth ($r_{x} = 0.905$). For such reason, percentages of organic matter and of bioclasts were not considered in the BIOENV analysis.

**Composition of the molluscan assemblages**

A total of 31,913 molluscs were collected alive during the survey, belonging to 234 species. The gastropods were represented by 134 species, being the dominant group both in number of species (57.4%) and individuals (17,975 individuals, 56.3%), followed by bivalves with 94 species (40.0%) and 13,885 individuals (43.5%). Scaphopods and cephalopods were generally scarce in the samples and both groups were represented by 3 species each (1.3%), with 28 (0.09%) and 25 (0.08%) individuals, respectively. Within the group of gastropods, the family Conidae (with species belonging to the traditional ‘turrids’ s.l.) displayed the highest number of species (17 spp., 7.2% of the total) and Nassariidae the highest abundance (7958, 24.9% of the total of molluscs). Among the bivalves, the families Tellinidae and Veneridae displayed the highest number of species with 12 species each (5.1%), while Mactridae presented the highest number of individuals (5356, 16.8%), due to *Spisula subtruncata* (da Costa, 1778) being the most dominant species overall (5351, 16.8%). A complete list of species, indicating author and date of each taxon and the number of specimens per haul, is presented as supplementary Table S1 (available online on the supplementary content tab of the article’s page on the Journal’s website: http://dx.doi.org/10.1080/17451001003660301).

The mean species richness (number of species 130 m$^{-2}$) displayed significantly different values in the sampling stations (one-factor ANOVA: $F = 15.76; n = 126; p < 0.001$), being highest at the sampling station T2-25m (131 spp. collected in total) (Table II; Figure 4A). In general, species richness values increased with depth, with the exception of sampling stations T1-15m (rocky bottom) and T2-15m (coarse sand) that displayed values similar to those of deeper ones (T2-25m). Conversely, the lowest number of species were recorded at T2-5m (28 spp. collected in total). Such differences in species numbers are highly significant according to depth and transect (Table III), and followed a similar trend in both gastropods and bivalves.

The mean abundance of molluscs (individuals 130 m$^{-2}$) was also significantly different among the sampling stations (one-factor ANOVA: $F = 2.54; n = 126; p < 0.01$), being highest at T2-15m (coarse sand) (4543 ind. considering all replicates), and lowest at T1-15 m (1593 ind. considering all replicates) (Table II; Figure 4B). The abundance values were not significantly different according to transect or depth (Table III). Gastropods were generally more abundant than bivalves, except in the shallow samples at 5 m (dominated by *Spisula subtruncata*) and at T2-15m.

The evenness index displayed significantly different values, being low at shallow sampling stations (5 m depth) (one-factor ANOVA: $F = 1.95; n = 126; p < 0.05$) and high at those stations located at 15 and 25 m (Table II; Figure 4C). Mean evenness values increased according to depth but these were not significantly different according to transect (Table III).

The diversity values displayed a similar but more acute trend than that found for the evenness, with the lowest values registered at shallow sampling
stations (5 m depth), (one-factor ANOVA: $F = 17.40; n = 126; p < 0.001$) (Table II; Figure 4D) and the highest value at station T1-15m (rocky bottoms). As for evenness, diversity values were significantly different according to depth but not according to transect (Table III).

**Spatial distribution of the molluscan assemblages**

Four main assemblages at 40% of similarity were obtained for qualitative and quantitative data (CLUSTER and MDS) (Figure 5A,B). These groupings were found to be statistically significant ($R_{\text{ANOSIM}} = 0.889; p < 0.001$), and adjust to the pattern found in the sediment characteristics as shown in Figure 2. Samples from station T1-15m formed a genuine assemblage (group I) linked to the mainly rocky bottoms. The second assemblage includes species from shallowest samples (group II), which live in fine and medium sand bottoms. The third group was composed by species living at 25 m on bioclastic bottoms (group III). A large suite of species lives between 15 and 25 m, in muddy fine sand bottoms with some bioclastic material (group IV). Samples from station T2-25m clustered with group IV when analysed quantitatively, but with group III when only qualitative composition was considered. This highlights the transitional character of this bottom, singled out as group V from the sedimentary characters, located between different types of sediments and fauna and for such reasons this molluscan assemblage was further analysed independently.

Both depth ($R_{\text{ANOSIM}} = 0.621; p < 0.001$) and type of sediment ($R_{\text{ANOSIM}} = 0.44; p < 0.001$) are factors influencing significantly the similarity of samples. Differences between samples related to transect were less acute but also significant ($R_{\text{ANOSIM}} = 0.227; p < 0.001$). Molluscan assemblages from shallow bottoms (5 m depth) differed significantly from those located at 15 m depth ($R_{\text{ANOSIM}} = 0.675; p < 0.001$) and at 25 m depth ($R_{\text{ANOSIM}} = 0.979; p < 0.001$), but differences between the two latter were less acute ($R_{\text{ANOSIM}} = 0.215; p < 0.001$).

**Characterization of molluscan assemblages**

The list of dominant and frequent species which are involved in the groupings obtained from the Cluster and MDS analyses is shown in Table IV. Figure 6 shows the characterization of such groups in terms of species richness, abundance of individuals, evenness and diversity, with differences between groups scored as significant or not according to results of ANOVA (Table V).

**Group I (rocky bottom).** This type of bottom was found in one sampling station (T1-15m) and is characterized by the presence of rocky outcrops with abundant gorgonians (*Eunicella singularis* (Esper, 1791), *E. labiata* Thomson, 1927, *Leptogorgia serrmentosa* (Esper, 1791)) and bryozoans (*Pentapora fasicalls* (Pallas, 1766), *Myriapora truncata* (Pallas, 1766)). A total of 119 molluscan species were identified from 1593 individuals collected, being twice more abundant the gastropods (72 spp. and 485 ind.) than the bivalves (44 spp. and 485 ind.).

The top dominant species were *Calyptrocha chinensis* (Linnaeus, 1758) (24.0%), *Nassarius incrassatus* (Ström, 1768) (8.4%), *Digitaria digitaria* (Linnaeus, 1758) (5.7%), *Ocinebrina aciculata* (Lamarck, 1822) (5.4%) and *Fujubah esasperatus* (Pennant, 1777) (3.5%) and the most frequent species were *O. aciculata* and *N. incrassatus* (100%). Some of the dominant and frequent species are strictly associated with gorgonians, such as *Neosimnia spela* (Linnaeus, 1758), or with red and calcareous macroalgae, such as *Bohna rugosa* (Linnaeus, 1767), *J. esasperatus*, *Gibbula fanulum* (Gmelin, 1791) and *Tectura virginea* (Müller, 1776). Other species such as the bivalve...
D. digitaria live in the pockets of bioclastic gravel interspersed among the coralligenous. This assemblage displayed the highest evenness and diversity index values when compared to other types of assemblages (Figure 6C,D).

Group II (fine and medium sand bottoms). These bottoms were located at sampling stations at 5 m depth and the assemblage is mainly characterized by infaunal bivalve species. A total of 58 molluscan species (35 gastropods, 21 bivalves and 2 cephalopods) were identified from 7317 individuals collected, with Spisula subtruncata as the top dominant species (29.4%, 2150 ind.), followed by Nassarius reticulatus (Linnaeus, 1758) (19.9%, 1461 ind.) and N. granum (Lamarck, 1822) (12.4%, 908 ind.) and bivalve species of commercial value such as Donax venustus (12.2%, 898 ind.) and Chamelea gallina (Linnaeus, 1758) (11.3%, 832 ind.), the latter being the only species found in every replicate. In spite of the high species richness of gastropods (35 spp. with 3007 ind.), there was a higher abundance of bivalves (4291 ind.), with half of them being S. subtruncata. This assemblage displayed the lowest species richness, evenness and diversity index values when compared to other types of assemblages (Figure 6A,C,D).

Group III (bioclastic bottoms). This type of bottom occurs in the deepest stations of transect 1 and 2 (T1-25m, T2-25m) where the total number of species collected was the highest, with 147 spp. and 6756 individuals. Gastropods dominated both in terms of number of species (85 spp.) and individuals (3931 ind.), whereas 60 bivalve species were identified with 2811 individuals collected. The top dominant species of this assemblage was again Calyptraea chinensis (35.2%, 2382 ind.), whereas C. chinensis, Nucula hanleyi Winckworth, 1931, Timoclea ovata (Pennant, 1777) and Corbula gibba (Olivi, 1792) were the most frequent (100%).

Group IV (muddy fine and coarse sand bottoms). These types of bottoms occur in different sampling stations (T3-15m, T3-25m, T4-15m, T4-25m) in which a total of 112 molluscan species were identified from 11,704 individuals, including 57 gastropod species (7968 individuals) and 53 bivalve species (3724 ind.). The species with the highest, albeit moderate, dominance values were Nassarius reticulatus (20.2%, 2367 ind.), Calyptraea chinensis (15.7%, 1840 ind.), Spisula subtruncata (15.5%, 1823 ind.) and all three were also dominant in other assemblages. Euspira pulchella (Risso, 1826) and N. reticulatus were found in all samples taken in these types of bottoms, followed by Euspira macilenta (Philippi, 1844) and Nassarius elatus (Gould, 1845) (97.9%). The presence of three rare species of Architectonicidae such as Pseudotorinia architae (Costa, 1841), Heliacus fallacious (Tiberi, 1872) and Basisulcata lepida (Bayer, 1942) is remarkable. These gastropod species are associated with Cnidarians on which they feed. In the bioconesos of these sampling stations, dense populations of Epizoanthus cf. incrustans (Duben & Koren, 1847) were also found and could be the host for these gastropod species. Other rare species occurred in these bottoms, such as the subtropical Mathilda quadricarinata (Brocchi, 1814) and the pyramidellid Eulimella carinatae Peñas and
Group V (coarse sand bottoms). The molluscan assemblage found in the coarse sand bottoms of the station T2-15m was characterized by 116 species identified from 4543 individuals. As in other assemblages, *Spisula subtruncata* dominated this taxocoe-nosis (29.4%, 1335 ind.), followed by *Nassarius pygmaeus* (Lamarck, 1822) (16.8%, 764 ind.), *Calyptraea chinensis* (7.8%, 353 ind.), *Nassarius reticulatus* (6.9%, 313 ind.) and *Chamelea striatula* (da Costa, 1778) (6.3%, 287 ind.) also present in other assemblages.

A similar number of gastropod (61 spp.) and bivalve (52 spp.) species were found in this assemblage, but bivalves (2574 ind.) were more abundant than gastropods (1964 ind.), again due to the high abundances of *S. subtruncata*. This assemblage displayed the highest species richness and abundance values when compared to other types of assemblages (Figure 6A,B).

SIMPERR analyses singled out the species that most contributed to forming those groups of samples.

- Rocky coralligenous bottoms at 15 m (group I): gastropods *Nassarius incrassatus*, *Ocinerina aciculata*, *Calyptraea chinensis*, *Fujubinus exasperatus*, *Pollia scabra* Locard, 1892, *Nassarius reticulatus* and *Tectura virginea* (in decreasing order, accumulative contribution = 45.00%, average similarity = 32.30%).
- Shallow and medium sand bottoms at 5 m (group II): *Donax venustus* Poli, 1791, *Nassarius reticulatus*, *Chamelea gallina*, *Spisula subtruncata*, *Nassarius granum* and *Acanthocardia tuberculata* (Linnaeus, 1758) (accumulative contribution = 82.82%, average similarity = 50.76%).
- Bioclastic bottoms at 25 m in transects 1 and 2 (group III): *Calyptraea chinensis*, *Nucula hanleyi*, *Timoclea ovata*, *Parvicardium scabrum* (Philippi, 1844), *Corbula gibba*, *Gouldia minima* (Montagu, 1803) and *Euspira pulchella* (accumulative contribution = 52.62%, average similarity = 46.94%).
- Muddy fine sand at 15–25 m in transects 1 and 2 (group IV): *Nassarius reticulatus*, *Euspira pulchella*, *Euspira macilenta*, *Calyptraea chinensis*, *Nassarius elatus* and *Spisula subtruncata* (accumulative contribution = 55.80%, average similarity = 51.32%).
- Mixed coarse sands bottoms of T2-15m (group V): *Spisula subtruncata*, *Calyptraea chinensis*, *Nassarius pygmaeus*, *Callista chione* (Linnaeus, 1758), *Nassarius reticulatus*, *Digitaria digitaria* and *Euspira pulchella* (accumulative contribution = 51.39%, average similarity = 45.13%).

The environmental variables that were correlated to the ordination of the molluscan assemblages, according to BIO-ENV analysis, were (1) depth –% gravel (0.804), and (2) depth –% gravel –% clay (0.791). The influence of these environmental variables in the ordination of molluscan assemblages...
occurring in different sampling stations was also observed when performing a MDS using average abundance data of species considering all samples collected in each of the sampling stations (Figure 7).

Discussion

The presence of different types of bottoms in this area, together with other environmental factors (e.g. upwellings, currents), promotes the existence of contrasted sublittoral macrofauna communities. This partly explains the large faunistic list for molluscs in Cabopino-Calaburras, as was observed also for the decapods (García Muñoz et al. 2008), but the geographical location of this area, between Africa and Europe and the Atlantic Ocean and the Mediterranean Sea, also represents an important factor influencing this high biodiversity (García Raso et al. 1992; Salas 1996; Rueda et al. 2000, 2009; Peñas et al. 2006). The faunistic list obtained in this study is significantly larger than those of similar studies carried out using a sampling design that included different types of subtidal bottoms in both the Atlantic (Sanvicente-Álvarez et al. 2001; Lourido et al. 2006; Bolam et al. 2008) or Mediterranean coasts of Europe (Koulouri et al. 2006; Labrune et al. 2008; Mastrotopetro et al. 2008).

Different environmental variables (depth, percentage of gravels and mud) were related to the observed patterns of distribution of molluscan assemblages. This is in accordance to other similar studies in other parts of Europe (Lourido et al. 2006; Cosentino & Giacobbe 2008; Labrune et al. 2008) and it highlights the role of depth as a major factor influencing other environmental variables related to the water column (e.g. hydrodynamics and wave action) or the sediment (e.g. grain size, % of organic matter) and therefore the distribution of molluscan assemblages. These groups of environmental variables from the water column and sediment are generally playing a major role in the spatial variability of subtidal benthic communities associated with unvegetated soft bottoms (Snellgrove & Butman 1994) and those of this study are not an exception regarding that.

The molluscan assemblages identified in this study can be matched with the benthic communities defined for the Mediterranean by Pérez & Picard (1964), with some qualifications resulting from the geographical location far to the south and close to the Atlantic Ocean.

The molluscan assemblage located in the shallow fine and medium sand bottoms at 5 m depth (group II) corresponds to the biocoenosis named as 'Sables Fins Bien Calibrés' or 'SFBC' (well-sorted fine sands). This type of assemblage is very common in Europe, between 2.5 and 20 m depth and it has been studied in different parts along the Atlantic (Salvat 1967; Tolemont 1972) and Mediterranean coasts (Pérez & Picard 1964; Salas 1984; García Raso et al. 1992; Bellan-Santini et al. 1994; Koulouri et al. 2006; Labrune et al. 2008). Among the most dominant species collected, *Spisula subtruncata*, *Donax venustus*, *Acanthocardia tuberculata*, *Ensis minor* (Chenu, 1843) and *Glycymeris insubrica* (Brocchi, 1814 [ = G. violaceens (Lamarck, 1819)]) are named by Pérez & Picard (1964) as characteristic and so is stated the predominance of bivalves overall. Nevertheless, the number of species found in Cabopino-Calaburras is high in comparison to those mentioned studies, with the presence of some tropical components such as *Mesalia varia* (Kiener, 1844), *Gibberula epigraus* (Reeve, 1865) and *Nassarius vaucheri* (Pallary, 1906). The number of species of this assemblage is less than for other assemblages in this area, but includes important commercial

Figure 5. Non-metric multidimensional scaling ordination (MDS) based on quantitative (A) and qualitative (B) similarities (Bray-Curtis similarity index) among the molluscan assemblages found in all samples collected in the different sampling stations. Similarity values between encircled groups are less than 40% according to the clusters. Group I (CO): coralligenous in rocky bottoms; group II (SFBC): well-sorted fine sand; group III (DC): coastal detritic; group IV (DE): muddy detritic; group V (MX): mixed assemblage.
Table IV. Top 20 dominant (%D) and frequent (%F) molluscan species in the different types of assemblages found in the littoral bottoms between Cabopino and Calaburras. Total number of individuals collected (Nt) is also indicated. CO: coralligenous in rocky bottoms; DC: coastal detritic; DE: muddy detritic; MX: mixed assemblage; SFBC: well-sorted fine sand.

### Group I (CO)

| SPECIES | Nt   | %D  | SPECIES | %F  |
|---------|------|-----|---------|-----|
| Nassarius pygmaeus (Linnaeus, 1758) | 2382 | 35.18 | Calyptraea chinensis (Linnaeus, 1758) | 100 |
| Parvicardium scabrum (Philippi, 1844) | 548  | 8.09  | Nucula hanleyi Winckworth, 1931 | 100 |
| Nassarius pygmaeus (Lamarck, 1822) | 504  | 7.44  | Timoela ovata (Pennant, 1777) | 100 |
| Anomia ephippium Linnaeus, 1758 | 446  | 6.59  | Corbula gibba (Olivi, 1792) | 100 |
| Gibbula magus (Pennant, 1777) | 193  | 2.85  | Euspira pulchella (Risso, 1826) | 95.65 |
| Mangelia attenuata (Montagu, 1803) | 199  | 2.85  | Parvicardium scabrum (Philippi, 1844) | 91.30 |
| Gibbula magus | 193  | 2.85  | Euspira pulchella | 91.30 |
| Mangelia attenuata | 199  | 2.85  | Parvicardium scabrum | 91.30 |
| Gibbula magus | 193  | 2.85  | Euspira pulchella | 91.30 |
| Mangelia attenuata | 199  | 2.85  | Parvicardium scabrum | 91.30 |
| Gibbula magus | 193  | 2.85  | Euspira pulchella | 91.30 |
| Mangelia attenuata | 199  | 2.85  | Parvicardium scabrum | 91.30 |
| Gibbula magus | 193  | 2.85  | Euspira pulchella | 91.30 |
| Mangelia attenuata | 199  | 2.85  | Parvicardium scabrum | 91.30 |

### Group II (SFBC)

| SPECIES | Nt   | %D  | SPECIES | %F  |
|---------|------|-----|---------|-----|
| Spisula subtruncata (da Costa, 1778) | 2150 | 29.38 | Chamelea gallina (Linnaeus, 1758) | 100 |
| Nassarius reticulatus (Linnaeus, 1758) | 1461 | 19.96 | Nassarius reticulatus (Linnaeus, 1758) | 97.22 |
| Nassarius granum (Lamarck, 1822) | 908  | 12.41 | Donax venustus Poli, 1795 | 97.22 |
| Donax venustus Poli, 1795 | 898  | 12.27 | Spisula subtruncata (da Costa, 1778) | 77.78 |
| Chamelea gallina (Linnaeus, 1758) | 832  | 11.37 | Nassarius granum (Lamarck, 1822) | 69.44 |
| Nassarius pygmaeus (Lamarck, 1822) | 249  | 3.40  | Acanthocardia tuberculata (Linnaeus, 1758) | 66.67 |
| Acanthocardia tuberculata (Linnaeus, 1758) | 154  | 2.10  | Bela zonata (Locard, 1892) | 58.33 |
| Gibberula epigris (Reeve, 1865) | 133  | 1.82  | Callista chione (Linnæus, 1758) | 55.56 |
| Bela zonata (Locard, 1892) | 82   | 1.12  | Nassarius pygmaeus (Lamarck, 1822) | 38.89 |
| Callista chione (Linnæus, 1758) | 81   | 1.11  | Gibberula epigris (Reeve, 1865) | 33.33 |
| Ensis minor (Chenu, 1843) | 65   | 0.89  | Philine aperta (Linnaeus, 1767) | 33.33 |
| Mesalia varia (Kiener, 1844) | 34   | 0.46  | Glycymeris violaceascens (Lamarck, 1819) | 33.33 |
| Philine aperta (Linnaeus, 1767) | 34   | 0.46  | Mesalia varia (Kiener, 1844) | 27.78 |
| Glycymeris violaceascens (Lamarck, 1819) | 27   | 0.37  | Pandora inaequivalvis (Linnaeus, 1758) | 27.78 |
| Donax trunculus Linnaeus, 1758 | 23   | 0.31  | Euspira pulchella (Risso, 1826) | 22.22 |
| Donax trunculus Linnaeus, 1758 | 17   | 0.23  | Bela costulata (Risso, 1826) | 22.22 |
| Sepiola rondeleti Steenstrup, 1856 | 17   | 0.23  | Ensis minor (Chenu, 1843) | 22.22 |
| Aplysia parcula Building in March, 1863 | 16   | 0.22  | Corbula gibba (Olivi, 1792) | 22.22 |
| Mangelia attenuata (Montagu, 1803) | 12   | 0.16  | Sepiola rondeleti Steenstrup, 1856 | 19.44 |
| Euspira pulchella (Risso, 1826) | 11   | 0.15  | Donax trunculus Linnaeus, 1758 | 16.67 |

### Group III (DC)

| SPECIES | Nt   | %D  | SPECIES | %F  |
|---------|------|-----|---------|-----|
| Calyptraea chinensis (Linnaeus, 1758) | 2382 | 35.18 | Calyptraea chinensis (Linnaeus, 1758) | 100 |
| Parvilimacina scabrum (Philippi, 1844) | 548  | 8.09  | Nucula hanleyi Winckworth, 1931 | 100 |
| Nassarius pygmaeus (Lamarck, 1822) | 504  | 7.44  | Timoela ovata (Pennant, 1777) | 100 |
| Anomia ephippium Linnaeus, 1758 | 446  | 6.59  | Corbula gibba (Olivi, 1792) | 100 |
| Gibbula magus (Pennant, 1777) | 193  | 2.85  | Euspira pulchella (Risso, 1826) | 95.65 |
| Nucula hanleyi Winckworth, 1931 | 444  | 6.56  | Parvicardium scabrum (Philippi, 1844) | 91.30 |
| Timoela ovata (Pennant, 1777) | 193  | 2.85  | Gibbula magus (Linnaeus, 1767) | 82.61 |
| Corbula gibba (Olivi, 1792) | 149  | 2.20  | Crassopleura maravignae (Bivona, 1838) | 82.61 |
| Euspira pulchella (Risso, 1826) | 102  | 1.51  | Parvicardium scabrum (Philippi, 1844) | 78.26 |

CO: coralligenous in rocky bottoms; DC: coastal detritic; DE: muddy detritic; MX: mixed assemblage; SFBC: well-sorted fine sand.
Table IV. (Continued)

| Species                        | Nt  | %D   | Species                        | %F  |
|--------------------------------|-----|------|--------------------------------|-----|
| Craspedea maravignae (Bivona, 1838) | 97  | 1.43 | Parvicardium papillosum (Poli, 1795) | 73.91 |
| Parvicardium papillosum (Poli, 1795) | 93  | 1.37 | Laevicardium crassum (Gmelin, 1791) | 69.57 |
| Neosimnia spelta (Linnaeus, 1758) | 93  | 1.34 | Nassarius incrassatus (Strömf, 1768) | 60.87 |
| Gibbula magus (Linnaeus, 1767) | 88  | 1.30 | Bela costulata (Risso, 1826) | 60.87 |
| Fusinus pulchellus (Philippi, 1844) | 82  | 1.21 | Anomia ephippium Linnaeus, 1758 | 60.87 |
| Nassarius reticulatus (Linnaeus, 1758) | 73  | 1.08 | Clausinella fasciata (da Costa, 1778) | 60.87 |
| Nassarius incrassatus (Strömf, 1768) | 60  | 0.89 | Pitar rudis (Poli, 1795) | 60.87 |
| Bora costulata (Risso, 1826) | 51  | 0.75 | Nassarius pygmeaus (Lamarck, 1822) | 56.52 |
| Laevicardium crassum (Gmelin, 1791) | 45  | 0.66 | Turritella turbona Monerosato, 1877 | 47.83 |
| Tapes rhomboides (Pennant, 1777) | 34  | 0.50 | Nassarius reticulatus (Linnaeus, 1758) | 47.83 |

Group IV (DE)

| Species                        | Nt  | %D   | Species                        | %F  |
|--------------------------------|-----|------|--------------------------------|-----|
| Nassarius reticulatus (Linnaeus, 1758) | 2367 | 20.18 | Euspira pulchella (Risso, 1826) | 100 |
| Calyptraea chinensis (Linnaeus, 1758) | 1840 | 15.54 | Euspira pulchella (Philippi, 1844) | 97.87 |
| Spisula subtruncata (da Costa, 1778) | 1823 | 15.54 | Calyptraea chinensis (Linnaeus, 1758) | 95.74 |
| Euspira macilenta (Philippi, 1844) | 730  | 6.22  | Nassarius reticulatus (Gould, 1846) | 91.49 |
| Euspira pulchella (Risso, 1826) | 545  | 4.65  | Spisula subtruncata (da Costa, 1778) | 89.36 |
| Chamelea striatula (da Costa, 1778) | 259  | 2.21  | Cancellaria cancellata (Linnaeus, 1767) | 87.23 |
| Nuculana pella (Linnaeus, 1676) | 232  | 1.98  | Corbula gibba (Oliv, 1792) | 76.60 |
| Bola sp1 | 140  | 1.19  | Acanthocardia paucicostata (Sowerby, 1834) | 65.96 |
| Acanthocardia paucicostata (Sowerby, 1834) | 134  | 1.14  | Tectonatica sagraiana (Ophigny, 1842) | 61.70 |
| Corbula gibba (Oliv, 1792) | 122  | 1.04  | Bola sp1 | 51.06 |
| Tellina compressa Brocchi, 1814 | 118  | 1.01  | Bola costulata (Risso, 1826) | 51.06 |
| Nuculana nitidosa Winckworth, 1930 | 106  | 0.90  | Pitar rudis (Poli, 1795) | 51.06 |
| Tapes rhomboide (Pennant, 1777) | 106  | 0.90  | Ringicula auricula (Menard, 1811) | 42.55 |
| Nuculana hanleyi Winckworth, 1931 | 92   | 0.78  | Mangelia attenuata (Montagu, 1803) | 38.30 |
| Bora costulata (Risso, 1826) | 70   | 0.60  | Nuculana nitidosa Winckworth, 1930 | 38.30 |
| Tectonatica sagraiana (Ophigny, 1842) | 69   | 0.59  | Timoclea vovata (Pennant, 1777) | 38.30 |

Group V (MX)

| Species                        | Nt  | %D   | Species                        | %F  |
|--------------------------------|-----|------|--------------------------------|-----|
| Spisula subtruncata (da Costa, 1778) | 1335 | 29.28 | Calyptraea chinensis (Linnaeus, 1758) | 100 |
| Nassarius pygmeaus (Lamarck, 1822) | 764  | 16.75 | Spisula subtruncata (da Costa, 1778) | 100 |
| Calyptraea chinensis (Linnaeus, 1758) | 353  | 7.74  | Callista chione (Linnaeus, 1758) | 100 |
| Nassarius reticulatus (Linnaeus, 1758) | 313  | 6.86  | Euspira pulchella (Risso, 1826) | 90.91 |
| Chamelea striatula (da Costa, 1778) | 287  | 6.29  | Nassarius pygmeaus (Lamarck, 1822) | 90.91 |
| Digitaria digitaria (Linnaeus, 1758) | 211  | 4.63  | Nassarius reticulatus (Linnaeus, 1758) | 90.91 |
| Euspira pulchella (Risso, 1826) | 111  | 2.43  | Digitaria digitaria (Linnaeus, 1758) | 90.91 |
| Callista chione (Linnaeus, 1758) | 106  | 2.32  | Nuculana pella (Linnaeus, 1767) | 81.82 |
| Tellina distorta Poli, 1791 | 53   | 1.16  | Pitar rudis (Poli, 1795) | 81.82 |
| Crassopleura maravignae (Bivona, 1838) | 52   | 1.14  | Corbula gibba (Oliv, 1792) | 81.82 |
| Goodiala triangularis (Montagu, 1803) | 52   | 1.14  | Crassopleura maravignae (Bivona, 1838) | 72.73 |
| Bola sp1 | 50   | 1.10  | Nucula hanleyi Winckworth, 1931 | 72.73 |
| Mesalia varia (Kiener, 1844) | 47   | 1.03  | Gouldia minima (Montagu, 1803) | 72.73 |
| Pitar rudis (Poli, 1795) | 43   | 0.94  | Hexaplex trunculus (Linnaeus, 1758) | 63.64 |
| Corbula gibba (Oliv, 1792) | 42   | 0.92  | Bola costulata (Risso, 1826) | 63.64 |
| Acanthocardia tuberculata (Linnaeus, 1758) | 39   | 0.86  | Ringicula auricula (Menard, 1811) | 63.64 |
| Laevicardium crassum (Gmelin, 1791) | 38   | 0.83  | Acanthocardia tuberculata (Linnaeus, 1758) | 63.64 |
| Gouldia minima (Montagu, 1803) | 34   | 0.75  | Laevicardium crassum (Gmelin, 1791) | 63.64 |
| Thracia distorta (Montagu, 1803) | 34   | 0.75  | Parvicardium scabrum (Philippi, 1844) | 63.64 |
| Parvicardium scabrum (Philippi, 1844) | 30   | 0.66  | Chamelea striatula (da Costa, 1778) | 63.64 |
bivalves such as *Chamelea gallina*, *Acanthocardia tuberculata*, *Donax trunculus* (Linnaeus, 1758), *Donax venustus* and *Callista chione*, highlighting the economic importance of these types of bottoms for local fisheries.

On bottoms of transects 1 and 2 at 25 m depth, with medium-coarse sands and a high proportion of bioclasts (group III), the dominant species were rather ubiquitous species like *Calyptraea chinensis*, *Nassarius pygmaeus* and *Anomia ephippium* (Linnaeus, 1758). The species *Flexopecten flexuosus* (Poli, 1795) and *Crassopleura maravignae* (Bivona, 1838), recorded by Péres & Picard (1964) as characteristic of the ‘Détritiques Côtières’ or ‘DC’ (coastal bioclastic sands), were found in numbers in our samples, although they were not the most dominant. Some Cardidae (*Parvicardium papillosum* (Poli, 1795), *Parvicardium scabrum* and *Laevicardium crassum* (Gmelin, 1791)) were also found specifically in this assemblage. This biocoenosis is located shallower than in the rest of the Mediterranean (Péres & Picard 1964; Bellan-Santini et al. 1994), which may be a consequence of the generally low transparency of waters in this area. This type of molluscan assemblage is quite similar to that found by Rueda et al. (2000) in coastal bioclastic bottoms of the Strait of Gibraltar area. Nevertheless, in Cabopino-Calaburras, it is also possible to find some sessile animals that can develop over small hard substrates and are also common in coralligenous bottoms (Péres & Picard, 1964), such as the gorgonians *Leptogorgia lusitanica* Stiasny, 1937 and *L. sarmentosa*. These species increase the habitat complexity of the bottom, which is already complex due to the heterogeneous sediment composed by coarse sands and bioclasts. This normally results in a high number of species when compared to homogeneous substrates, as has been indicated in this study.

The community named as ‘Détritiques Envasés’ or ‘DE’ (muddy bioclastic sands) by Péres & Picard (1964) is found essentially in the same depth range as DC, but with increased input of mud under the influence of coastal streams. This applies to the assemblage associated with the muddy fine sand bottoms (group IV) situated in front of ‘Cala del Moral’ river at 15–25 m depth. Apart from extremely ubiquitous species like *Nassarius reticulatus*, *Nassarius pygmaeus*, *Calyptraea chinensis* and *Corbula gibba*, other species also occur in these bottoms such as *Tellina distorta* Poli, 1791 and *Tellina compressa* Brocchi, 1814 (replacing *T. serrata* Brocchi, 1814 in this area). Nevertheless, this assemblage displays a certain affinity to the ‘Vases Terrigènes Côtières’ or ‘VTC’ (coastal terrigenous muds) of Péres & Picard (1964), with the presence of the diagnostic species *Acanthocardia paucicostata* (Sowerby, 1834).

Hard bottoms conformed by the rocky outcrop of Laja del Almirante were found at 15 m depth (group I), and some frequent components there included the gorgonians *Eunicella singularis* (Esper, 1791), *E. labiata* and *Leptogorgia sarmentosa* and the bryozoans *Pentapora fascialis* and *Myriapora truncata*, as well as calcareous macroalgal species. This also increases the habitat complexity, providing a higher number of niches that can be potentially occupied by a large number of species, as in other areas of the Mediterranean Sea with coralligenous habitat (Ballesteros 2006). The definition of ‘Coralligène’ or ‘CO’
biocoenosis by Pérès & Picard (1964) hardly involves any mollusc, but rather most of the sessile colonial species mention above. The most dominant mollusc occurring in our samples, such as Calyptrae a chinensis (top dominant), Nassarius incrassatus and Ocene brina aciculata, are ubiquitous species which are uninformative; Calyptrae a would occur in any place where it can settle inside shells of large bivalves on many subtidal bottoms. Some species such as Bolina rugosa, fujubinus exasperatus, Gibbula fanum and Tectura virginia are associated with the calcareous algae, whereas the gastropod Neosimnia spelta is strictly associated with the gorgonians on which it feeds and reproduces. This assemblage also yielded species such as Bela powisiana (Dautzenberg, 1887) that generally occurs in the Atlantic Ocean, with the Alboran Sea representing the geographical limit towards the Mediterranean Sea (e.g. Nassarius vaucheri and Gari pseudoweinkauffi von Cosel, 1990) or towards northern Europe (e.g. Cisterstrevia cochlea (Sowerby, 1844), Bivietiella cancellata (Linnaeus, 1767), Mathilda quadrinarina). Some of these African species (B. cancellata and Nassarius elatus) have dense and stable populations in the muddy bioclastic sand bottoms (DE) of this area as they displayed high values of dominance and frequency. Regarding number of western African species, the coarse sands bottoms at 15 m depth (MX) supported the largest amount (seven spp.), followed by the muddy bioclastic sand bottoms (six spp.), while the rocky outcrop (CO) and the coastal bioclastic sand bottoms (DC) displayed the lowest numbers (two spp.). The higher prevalence of tropical West African species in muddy and sandy soft bottoms may reflect the overwhelming prevalence of this kind of substrate and the scarcity of hard bottoms in the western African source area. The presence of African species on the coasts of southern Spain has been recorded previously in coastal bioclastic bottoms in the bay of Barbate (Rueda et al. 2000), and in soft bottoms in the bay of

| Source of variation | n  | df | SS       | MS    | F       | p     |
|---------------------|----|----|----------|-------|---------|-------|
| Species richness    | 126|     | 10,194.22| 2,548.55 | 23.78   | < 0.001|
| Type of assemblage  | 4  |    | 12,964.89| 107.15 |         |       |
| Error               | 121|     |          |        |         |       |
| Abundance           | 126|     | 467,458.62|116,864.65| 2.72    | < 0.05 |
| Type of assemblage  | 4  |    | 5,207,192.76|43,034.65|         |       |
| Error               | 121|     |          |        |         |       |
| Evenness            | 126|     | 0.25     | 0.06   | 4.49    | < 0.005|
| Type of assemblage  | 4  |    | 1.72     | 0.01   |         |       |
| Error               | 121|     |          |        |         |       |
| Diversity Shannon   | 126|     | 40.70    | 10.17  | 32.62   | < 0.001|
| Type of assemblage  | 4  |    | 37.74    | 0.31   |         |       |
| Error               | 121|     |          |        |         |       |

n, number of samples collected; df, degrees of freedom; SS, sums of squares; MS, mean square; F, F ratios of mean square; p, probability.

Table V. One-factor ANOVA analyses for testing differences in the values of the species richness, abundance, evenness and diversity index of Shannon in relation to the different types of molluscan assemblages (SFBC, DE, DC, MX, CO) found in the littoral bottoms between Cabopino and Calaburras. Results of post-hoc Tukey test are displayed in Figure 6.
Cádiz (Rueda et al. 2001), as well as in the coasts of Málaga (Rueda & Salas 1998; Rueda & Gofas 1999; Arroyo et al. 2006; Rueda et al. 2009), but some of these species have not been found in other locations of Europe, indicating the importance of this area for marine biodiversity in European seas.

This study has shown a diverse molluscan fauna occurring in coastal areas between Faro de Calaburras and Cabopino (Málaga), representing roughly one-quarter of the total number of molluscan species known from the Andalusian coastline. In other areas of southern Spain and the Alboran Sea, large numbers of species have also been found and this distinguishes the area as a species-rich area for Mollusca (van Aartsen et al. 1984; Gofas 1999; Rueda et al. 2000; Peñas et al. 2006). Along the European Atlantic coasts, Glémarec (1969) obtained only 112 species of molluscs from nearly 3000 dredge hauls covering a variety of soft bottoms on the continental shelf of Bay of Biscay. In the many published surveys with a comparable number of samples and individuals, the total number of molluscan species rarely exceeds 100, but comparisons are made difficult by the heterogeneity in sampling techniques.

Between Calaburras and Cabopino, there are other molluscan assemblages currently under study, inhabiting shallower habitats such as meadows of *Posidonia oceanica* (in one of its westernmost locations within the Mediterranean Sea) and of *Cymodocea nodosa*, and photophilous macroalgal beds settled on rocky bottoms. This may increase furthermore the faunistic list of molluscs for this small stretch of coastline (ca. 10 km), confirming the biological importance and interest of this area and the need for conservation status. Unlike traditional marine protected areas, this stretch of coastline is situated within a highly developed and impacted coastal area such as the Costa del Sol, with increasing anthropogenic impacts during the last decades (e.g. coastal development and infrastructures, fisheries, sewage). The current status as a Site of Community Importance is restricted to the seagrass beds and its extension has been requested, considering the results presented here, to the coralligenous and surrounding soft bottoms down to at least 25 m. There is generally an underrepresentation of marine areas in the general scheme of Natura 2000 network and we feel that the area of this study may represent a valuable contribution to the conservation of our heritage of marine fauna.

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