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HARD AND SOFT-BOTTOM MACROZOOBENTHOS IN SUBTIDAL COMMUNITIES AROUND AN INACTIVE HARBOUR AREA (GRAN CANARIA, CANARY ISLANDS)

R. RIERA[1*#], *M. RODRÍGUEZ*[1], *E. RAMOS*[1], *Ó. MONTERROSO*[1], *J. D. DELGADO*[2]

[1] *Centro de Investigaciones Medioambientales del Atlántico (CIMA SL), C/Arzobispo Elías Yanes, 44, 38206 La Laguna, Tenerife, Canary Islands, Spain*

[2] *Área de Ecología, Departamento de Sistemas Físicos, Químicos y Naturales, Facultad de Ciencias Experimentales, Universidad Pablo de Olavide, Ctra. de Utrera km 1, 41013 Sevilla, Spain*

 # Current address: Department of Biodiversity, Qatar Environment and Energy Research Institute (QEERI), 5825 Doha, Qatar

** Corresponding author: rodrigo@cimacanarias.com*

BENTHOS
ENVIRONMENTAL IMPACT
HARD BOTTOMS
SOFT BOTTOMS
POLYCHAETA
AMPHIPODA
CANARY ISLANDS
ATLANTIC OCEAN

ABSTRACT. – Pressure by human activities is one of the main concerns in coastal ecosystems. Port areas harbour heavily modified benthic assemblages. However, there is scarce information about responses of diverse and patchy benthic communities in the context of marine harbour infrastructures (dykes, groins, etc.) which remain inactive after construction. We studied the benthic macrofaunal assemblages on rocky substrates (epifauna) and sandy seabeds (infauna) in a harbour of Gran Canaria (Canary Islands, NE Altantic Ocean). We found that both patches of macroalgae (hard substrata) and *Cymodocea nodosa* seagrass meadows (soft substrata) maintained a highly diverse macrofauna in this inactive harbour. The abundance of individuals and species richness was higher in hard bottoms than in soft bottoms. Species richness showed no consistent changes between both seabeds. However, sampling stations located at higher distances and depths from the dock were proportionally the most diverse, suggesting a distance-effect independently of port infrastructure activity.

INTRODUCTION

Littoral benthic communities are globally affected by coastal occupation by humans, degradation and disturbance (Airoldi & Beck 2007, Martínez-Lladó *et al*. 2007). Port and surrounding urban, touristic and industrial pressures can heavily alter benthic communities in coastal areas, and harbours maintain bottom habitats under usually high disturbance intensities (i.e. pollution, mechanical alteration of substrata) (Wildish & Thomas 1985, Chapman 2003). Potential variables affecting community structure, composition and biodiversity include shifts on wave energy, current patterns, temperature and light regimes, sediment stability, grain size properties, nutrient levels, food availability, mobility and available habitat, as well as, integrity of food webs, among others (Borja *et al*. 2000, Martin *et al*. 2005, Riera *et al*. 2011b). Natural patterns of zonation or spatial arrangement of communities, complexity and patchiness in littoral areas is affected by gradients of human influence (Short & Willie-Echeverria 1996).

Islands are especially fragile environments with high comparative biodiversity and rarity in their benthic communities, and where impacts derived from marine transport infrastructures are most conspicuous (Hall 2001). Littoral urbanization and construction of harbours and ports continue threatening coastal habitats of islands and particular fragile communities such as seagrass meadows, coral reefs, marl beds, and algal communities on rocky substrata (Burak *et al*. 2004). Recovering of these habitats is slow as growing rates are low for communities such as maërl and *Cymodocea nodosa* beds (Blake & Maggs 2003, Sciberras *et al*. 2009, Riera *et al*. 2012). Recovering also depends on preservation of sources of organism diaspores (Roberts *et al*. 2001). The highly diverse soft and hard bottoms in the littoral of the Canary Islands are threatened by disturbances from coast urbanization and harbour construction (Riera *et al*. 2011a), overexploitation of marine resources (Tuya *et al*. 2004), pollutants from agriculture and industry (Riera *et al*. 2011b), and invasive species favoured by ecosystem impoverishment and biotic homogenization (e.g. Hernández *et al*. 2008). Impacts derived from non-operating infrastructures may appear small if compared with those in larger harbours with heavy activity. However, there can be environmental effects caused by the presence of the pier and breakwater, which could affect littoral dynamics and sublittoral habitats, and hence the distribution and structure of benthic communities.

In this study, we describe the community structure of macrofauna benthic communities from hard bottoms (rocky seabeds) and soft-bottoms (sandy seabeds) around an inactive harbour in Gran Canaria (Canary Islands, NE Atlantic Ocean). We aimed to assess the impact of the harbour presence on the benthic macrofauna assemblages of the surrounding seabeds. Specifically, we asked whether distance of contrasting seabed types to the constructed inactive pier influences the community composition, abundance and diversity.

MATERIAL AND METHODS

Samples were taken off the coastline in and around the Arinaga harbour (E Gran Canaria, Canary Islands, Fig. 1). The main dock and breakwater is *ca*. 500 m long and aligned in a WNW-ESE bearing, whereas the dominant regional-scale marine current is the Canary Current, established along a NE-SW direction (10-20 cm s^{-1}) throughout the year (Fig. 1). Highest wind speeds are also most frequent in NE-SW direction along the east coast of the island (Barton *et al*. 2001).

The bay forms part of a protected natural space ("Arinaga Natural Monument"). The coast is a platform covered by quaternary alluvial sediments area, with boulders alternated with rocky and small sandy beaches, small dunes, and a partially dismantled volcanic cone at the Arinaga lighthouse. The materials are mostly basaltic, sedimentary and from eolian deposits. The basal rock layer in soft and hard bottoms in this study is also basaltic in origin. Main urbanized areas lie north of the dock, whereas main agricultural zones with greenhouse orchards extend to the south (Fig. 1).

The port subject of our study was envisaged in 1997, and approved in 2005 to give support to bulk carrying vessels and vehicle/passengers traffic, to complement the Puerto de La Luz y de Las Palmas infrastructure, and to give support to the allegedly largest industrial pole in Spain (Autoridad Portuaria de Las Palmas 2008). However, it has been virtually abandoned after construction, and it has been not completed to date, although it is projected to start operating in the near future (Autoridad Portuaria de Las Palmas 2008). As noted in evaluations for an Environmental Impact Assessment process, the breakwater seems to fulfil technical properties to avoid leaching from the above concrete body of the dock (Sánchez *et al*. 2011). The water mass sheltered (and hence the potentially impacted area) south off the main dock seems relatively small (Sánchez *et al*. 2011).

Sixteen stations were located in the harbour area for sampling benthic communities (Table I). Eight sampling stations were placed on hard bottoms in the rocky subtidal zone (stations coded starting with "R") and eight on soft subtidal bottoms (stations coded "S"). Four stations were surveyed to the NE, and 12 to the SW of the harbour pier south of Arinaga to the Formas harbour (Fig. 1, Table I). Three individual replicates were taken at each of these stations for a total of 48 samples (24 from hard bottoms and 24 from soft bottoms).

All stations, regardless of bottom type, were grouped as a function of distance to the Arinaga dock, the potential focus of disturbance, into the following categories or situations: "Control" (Hard bottoms, Sta. R4M1, R4M2, Soft bottoms, Sta. S1M1, S1M2, S4M2), "Influence" (Hard bottoms, Sta. R1M1, R1M2, R3M1, R3M2; Soft bottoms, Sta S3M1, S3M2, S4M1) and "Impact" (Hard bottoms, Sta R2M1, R2M2; Soft bottoms, Sta S2M1, S2M2) (Table I).

In hard bottoms, the replicates were taken at each station

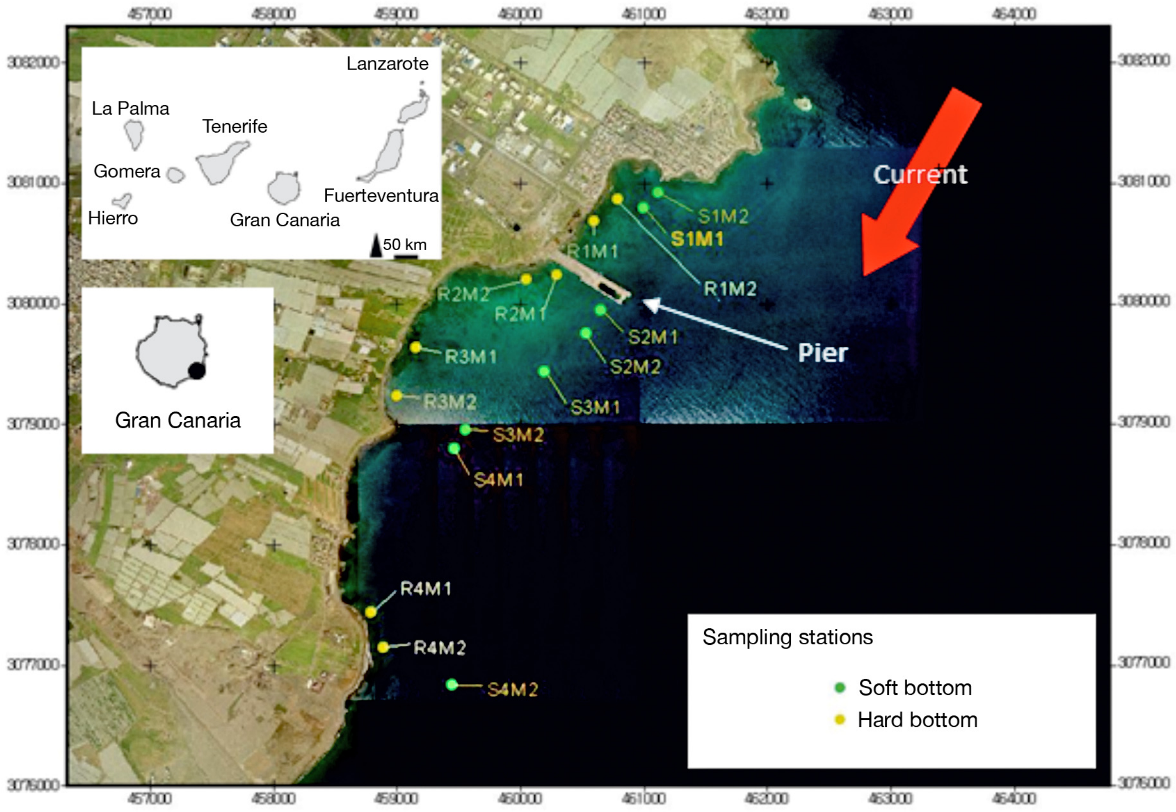

Fig. 1. – Location of sampling stations in hard (R) and soft (S) bottoms around the Arinaga dock (Gran Canaria, Canary Islands).

Table I. – Coordinates, depth and biotope types of sampling stations.

Station	Seabed	Coordinates (UTM)	Depth (m)	Biotopes
R1-M1	Rocky	460600 X / 3080811 Y	4 m	*Cystoseira abies-marina-Sargassum furcatum*
R1-M2	Rocky	460802 X / 3081011 Y	5 m	*Cystoseira abies-marina-Sargassum furcatum*
R2-M1	Rocky	460004 X / 3080287 Y	4 m	*C. abies-marina-Dictyota* spp.
R2-M2	Rocky	460267 X / 3080323 Y	4.5 m	*C. abies-marina-Dictyota* spp.
R3-M1	Rocky	459031 X / 3079676 Y	4.5 m	*Halophytis incurnus*
R3-M2	Rocky	458853 X / 3079234 Y	4.5 m	*Halophytis incurnus*
R4-M1	Rocky	458627 X / 3077276 Y	4 m	*C. abies-marina-Dictyota* spp.
R4-M2	Rocky	458742 X / 3076956 Y	6.5 m	*C. abies-marina-Dictyota* spp.
S1-M1	Sandy	461030 X / 3080934 Y	8 m	*Cymodocea nodosa* meadows
S1-M2	Sandy	461159 X / 3081071 Y	9 m	*Cymodocea nodosa* meadows
S2-M1	Sandy	460660 X / 3080012 Y	15 m	*Caulerpa* spp. meadows
S2-M2	Sandy	460530 X / 3079800 Y	16.4 m	*Caulerpa* spp. meadows
S3-M1	Sandy	460160 X / 3079454 Y	15.5 m	*Caulerpa* spp. meadows
S3-M2	Sandy	459461 X / 3078929 Y	17 m	*Cymodocea nodosa* meadows
S4-M1	Sandy	459363 X / 3078754 Y	15.5 m	*Cymodocea nodosa* meadows
S4-M2	Sandy	459348 X / 3076620 Y	19 m	*Cymodocea nodosa* meadows

by scrapping the surface of rocks with quadrats (sampling area per quadrat: 20 x 20 cm). To sample soft bottoms, the replicates were taken by inserting a 20 cm inner diameter core (area: 0.06 m^2) to a maximum depth of 20 cm. Samples were sieved through a 0.5 mm mesh, and specimens fixed in 10 % seawater formaldehyde solution and transferred to 70 % alcohol for sorting under a dissection microscope. Macrofaunal specimens were determined to species level, whenever possible, by means of a binocular microscope, or with a LEICA DMLB microscope equipped with Nomarski interference.

Abundance of individuals and parametric indices of species diversity (Shannon's *H'*, species richness or absolute number of species *S*, and Pielou's Evenness *J*) were used as dependent or response variables to describe these contrasting communities. To analyze the variation in macrofaunal community structure at the local scale between bottom types we used Student's t tests on these dependent variables. We performed a canonical discriminant analysis of communities to classify samples and communities from their compositional and structural traits. These analyses and the Wilk's lambda and chi-square tests for significance were performed in SPSS (Ferrán 1996). To analyze differences among treatments and vegetation types in these parametric descriptors we used one-way ANOVA (Sokal & Rohlf 1995).

RESULTS

A total of 14,456 individuals (from 147 species/morphospecies) and 1,101 individuals (from 128 species/morphospecies) (15,557 individuals from all 14 higher taxa and both bottom types) were obtained respectively from hard and soft bottoms in the Arinaga harbour.

Hard bottoms were characterized by the presence of several amphipods with densities > 100 individuals (Appendix 1). *Podocerus variegatus* (3,939 ind., 27.25 %), *Amphitoe rubricata* (1,244 ind., 8.60 %), and *Iphimedia obtusa* (1,128 ind., 7.80 %) were dominant. Amphipods contributed with 10,569 individuals (73.12 % total abundance), followed by polychaetes (1,273 ind., 8.81 %) and decapods (679 ind., 4.7 %) (Appendix 1).

Soft bottoms were clearly dominated by polychaetes (401 ind., 36.32 %) and amphipods (365 ind., 33.06 %). The amphipod *Leptocheirus pectinatus* (143 ind., 12.95 %) and the polychaete *Aponuphis bilineata* (114 ind., 10.33 %) were the most abundant species, followed by the tanaid *Apseudes talpa* (82 ind., 7.43 %). Molluscs and ostracods were the following most abundant groups, both contributing equally (6.61 %) to community composition (Appendix 1).

Caulerpa patches on hard substrata were largely dominated by the ophiurid *Amphipholis squamata* (22.1 %) and amphipods (*Elasmopus* aff. *canarius*, 10.6 %; *Orchomene humilis*, 8.4 %, and *Amphitoe rubricata*, 7.8 %). However, *Caulerpa* patches showed distinctive composition and high dominance when growing on soft substrata, with only six species forming up to ~72 % of the community, especially the widely distributed tanaid *Apseudes talpa* (~23.5 %), but also the polychaetes *Aponuphis bilineata, Scoloplos (Leodamas)* sp., and *Nereis* sp., and the amphipods *Photis longicaudata* and *Leptocheirus pectinatus*.

Patches of *Cystoseira* (only on hard bottoms) were also widely dominated by amphipods with four species, *Podocerus variegatus, Amphitoe rubricata, Iphimedia obtusa* and *Caprella acanthifera*, making up to ~57.1 % of the composition of this facies.

Cymodocea seagrass patches were dominated by the amphipod *Leptocheirus pectinatus* (15.76 %) and the polychaete *Aponuphis bilineata* (8.74 %), followed by the

Table II. – Descriptors of macroinvertebrate communities in the two substrata types (hard and soft bottoms) in the Arinaga harbour. Shown are overall means and standard deviation (SD).

Bottom type	**Parameters**	**Mean**	**SD**
Hard	Abundance (n° ind)	602.375	462.363
(20 x 20 cm)	Richness (species number)	37.250	8.258
	Shannon's (H')	2.454	0.465
	Pielou's (J)	0.685	0.133
Soft	Abundance (n° ind)	46.000	29.603
(20 cm diameter core)	Richness (species number)	16.875	4.456
	Shannon's (H')	2.386	0.305
	Pielou's (J)	0.863	0.092

Table III. – Tests of effects of bottom type (independent samples *t* tests), treatments and habitat type (one-way ANOVA) for the invertebrate communities in the Arinaga harbour. df : degrees of freedom, *** highly significant p < 0.0001, ns: not significant.

	DISTANCE TO PIER (“control”, “influence”, and “impact” stations)		
	F	**df**	***p***
Abundance (n° ind.)	1.647	2	0.204 ns
Richness (species number)	0.865	2	0.428 ns
Shannon's (H')	0.171	2	0.843 ns
Pielou's (J)	0.235	2	0.791 ns
	Habitat type		
	F	**df**	***p***
Abundance (n° ind.)	11.633	3	0.000***
Richness (species number)	13.488	3	0.000***
Shannon's (H')	0.115	3	0.951 ns
Pielou's (J)	8.987	3	0.000***

ostracod *Cypridina mediterranea* (6.71%) and the amphipod *Ampelisca brevicornis* (6.08 %). The first two species were also the dominant ones in sandy bare stations (*A. bilineata*: 14.41% and *L. pectinatus*: 13.56 %).

Organism abundance and species richness were significantly higher in hard than in soft bottoms (Tables II, III, Appendix 1). Species diversity showed no significant differences between both bottom types, but soft bottoms presented significantly higher evenness than hard bottom ones (Tables II, III). Species richness was higher in soft than in hard bottoms providing the contrasting sample size in terms of number of individuals collected from each bottom type. Macrofaunal species density (i.e. number of species per area) was higher at hard bottoms than at sandy substrates). Species richness (i.e. number of species per number of individuals) was higher at soft bottoms than at hard bottoms because of the higher macrofaunal densities observed in rocky substrates. Figure 2 shows the canonical discriminant classification of samples regarding their pertinence to the community types studied (discriminant functions were significant: Wilks' lambda = 0.380, chi-square = 41.595, p < 0.001). Through canonical discriminant analysis we found a neat separation in terms of composition, abundance and diversity between hard and soft bottom assemblages, and between both *Cystoseira* and *Caulerpa* assemblages (Fig. 2). Sandy bare communities and *Cymodocea* meadows were very similar in composition (Fig. 2). *Caulerpa* bottoms seemed to share some compositional and structural community traits with the *Cymodocea* ones, judging from the proximity of the centroids of their distributions (Fig. 2).

With data from both seabed types combined as well as analyzed apart, we did not find significant differences among treatments categorizing effect of distance to pier (i.e. effect of location of stations relative to the Arinaga harbour) in any of the univariate parameters regarding harbour effects [all tests with 2 (between groups) and 21 (within groups) degrees of freedom] (*F* tests, Table III). No pairwise comparison among treatments resulted in significant differences in abundance or diversity parameters after Bonferroni *post-hoc* tests (all tests p > 0.05) (Table III).

Patch cover type and its inherent spatial variation were apparently more influential in the structure of benthic communities than proximity to the pier. The *C. racemosa* and *C. abies-marina* patches held the highest abundances and overall species richness. *Caulerpa*-dominated patches presented higher abundances and were species-richer

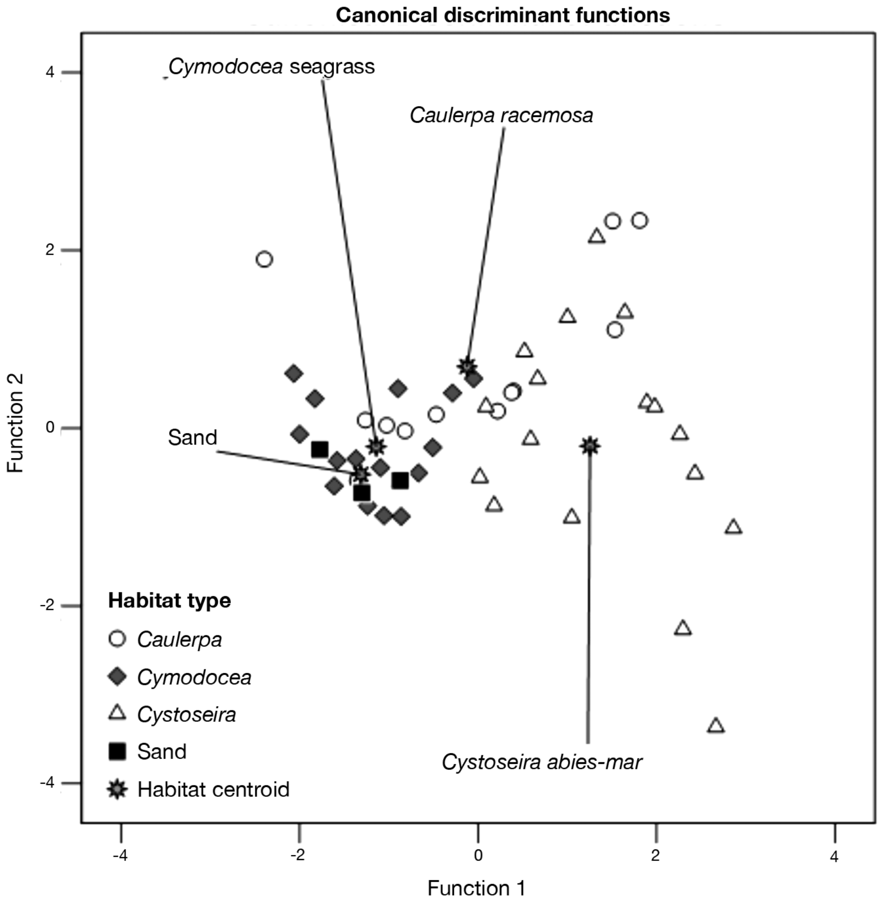

Fig.2. – Canonical discriminant analysis of the studied benthic communities regarding community parameters (Species richness, Shannon´s diversity, Pielou´s evenness and Abundance of individuals). Functions 1 and 2 accounted for 86.5 % and 13 % of the variance respectively. Hard bottoms are represented by stations dominated by *Cystoseira* (triangles), soft-bottoms are represented by seagrass meadows (*Cymodocea nodosa*) (rhombus), *Caulerpa* meadows (circles) and sandy unvegetated substrates (squares).

Table IV. – Descriptors of macroinvertebrate communities per substrata types (hard and soft bottoms) and habitat type in the Arinaga harbour. Shown are overall means and standard deviation (SD).

		Hard (20 x 20 cm)		**Soft** (20 cm diameter core)	
Habitat type *	**Parameters**	**Mean**	**SD**	**Mean**	**SD**
Cystoseira abies-marina	Abundance (nº ind)	678.167	502.658		
	Richness (species number)	36.444	8.024		
	Shannon’s (H’)	2.387	0.508		
	Pielou’s (J)	0.671	0.149		
Caulerpa racemosa meadows	Abundance (nº ind)	375.000	203.979	57.500	38.135
	Richness (species number)	39.667	9.245	16.000	4.733
	Shannon’s (H’)	2.656	0.228	2.220	0.332
	Pielou’s (J)	0.727	0.062	0.834	0.079
Cymodocea meadows	Abundance (nº ind)			42.733	27.340
	Richness (species number)			17.333	4.761
	Shannon’s (H’)			2.425	0.308
	Pielou’s (J)			0.866	0.102
Sand seabed	Abundance (nº ind)			39.333	25.813
	Richness (species number)			16.333	3.055
	Shannon’s (H’)			2.523	0.106
	Pielou’s (J)			0.909	0.052

*Habitat type: characterized by dominant plant or algal species, excepting for “Sand” (no vegetative cover).

(and showed slightly higher diversity) when it grew on hard than on soft substrata (Table IV). Samples of substrata from *Cymodocea*-dominated patches showed levels of invertebrate abundance, richness and diversity similar to those of sand unvegetated habitat (Table IV). Unfortunately, we collected a small number of replicates in bare sands and seagrasses to establish reliable comparisons.

DISCUSSION

Our results showed an overall high species richness in this harbour area. In addition, the diverse mixture of patches of algae and seagrass beds reveals the importance of such areas for maintaining a highly diverse benthic fauna (i.e. compare for example 75 crustacean species in our relatively small sampling area in Gran Canaria, with 25-54 crustacean species from other temperate areas (Sánchez-Moyano *et al.* 2007). *Cymodocea nodosa* meadows are, in addition, of great value as bioindicators, due to its high sensitivity to sediment stability in transitions between intertidal and subtidal zones (Reyes *et al.* 1995, Oliva *et al.* 2011).

Higher species richness and abundances were found on rocky seabeds, but soft bottoms, at higher distances and depths from the dock infrastructure, were proportionally more diverse and equitable. Differences between hard and soft bottoms are thus partly explained considering the gradient along which different substrate types appear (i.e. zonation). The habitat mosaic (i.e. habitat patchiness), rather than the inactive Arinaga pier, seems to explain the extant variation in the benthic invertebrate communities. This has been shown also for other benthic habitats near larger port infrastructures (for example, high dependence of algal cover, Sánchez-Moyano *et al.* 2007). Complexity of macroalgal covers increases with diversity of algal or plant species, and this in turn determines diversity of faunal assemblages (Connell 1972). However, other factors such as different predation intensities and active habitat selection have been invoked to explain patchiness in amphipod-dominated submarine meadows (i.e. Dean & Connell 1987, Poore & Hill 2006, Vázquez-Luis *et al.* 2009). In our study area, taxonomic composition differed greatly even at a much-reduced spatial scale, and amongst cover types, without presenting remarkable differences regarding distance to the pier. In Hawaii, infaunal assemblages of soft bottoms around artificial reefs (dominated by polychaetes) did not differ substantially from soft bottoms communities in nearby natural areas without artificial structures (Fukunaga *et al.* 2008). This kind of results suggest that extended time lapses after deployment of submarine structures may favour recovery of these native benthic communities, if subsequent disturbances (i.e. if port activity or coastal works such as dumping or dredging are resumed or initiated; see Wildish & Thomas 1985) do not hamper the process.

Seagrass communities along the coasts of the Canary Islands are threatened, highly fragmented, and diminishing in area. The burial of seagrass meadows resulting from constructive activities and the subsequent changes in coastal dynamics, sediment resuspension and transport, exemplifies how changes in soft bottom communities can occur along a gradient of disturbance from dock presence, such as the Arinaga harbour in this study (see review in Cabaço *et al.* 2008). Cabaço *et al.* (2008) pointed out that available population area is a critical factor for the maintenance of seagrass meadows, and that burial effects are highly species-specific. We lack, however, information on burial effects on *Cymodocea nodosa* beds or dock effects in rates of seed germination. Unfortunately, there are no previous studies to know how port construction has shaped the current communities.

Although nearby the mole pilings ("impact" and "influence" stations in this study), the change in habitat integrity and invertebrate associations could have been maximum in the past, this is not apparently the situation nowadays. Setting mole pilings, spilling of gravel and other materials have immediate or direct impacts on substrate and vegetation integrity and cover in their immediate vicinity, by locally altering current patterns and sedimentary regimes. This could affect not only the seagrass habitats but also the rocky bottom algal communities, which presented the highest faunal diversity in this area. Modification of currents, altered light regimes near the main structure, favoured bioturbation, leaching from traffic and dock operations and fuel discharges, mechanical and qualitative (i.e. granulometric) disturbance of the sediments by mobilization, resuspension and transport, among other factors, have been shown influential (e.g. Beal *et al.* 1999, Burdick & Short 1999, Nightengale & Simenstad 2001). High conservation value in terms of both habitats and species diversity of this area make it deserving of a special consideration if further coastal works are undertaken or port activity is resumed.

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Appendix 1. – List of species collected from soft and hard bottoms in the Arinaga coast (Gran Canaria, Canary Islands).

Taxonomic group	Species	Bottom type Hard	Bottom type Soft	Overall abundance
Amphipoda	*Ampelisca brevicornis*	2	42	44
Amphipoda	*Amphilochus neapolitanus*	14		14
Amphipoda	*Amphitoe (Pleonexes) gammaroides*	7		7
Amphipoda	*Amphitoe ramondi*	169		169
Amphipoda	*Amphitoe rubricata*	1244		1244
Amphipoda	*Ampithoe rubricata*		16	16
Amphipoda	*Aora typica*	76	5	81
Amphipoda	*Caprella acanthifera*	946		946
Amphipoda	*Caprella equilibra*	607		607
Amphipoda	*Caprella liparotensis*	12		12
Amphipoda	*Caprella penantis*	4		4
Amphipoda	*Corophium* sp.	92		92
Amphipoda	*Dexamine spinosa*	174	27	201
Amphipoda	*Elasmopus* aff. *canarius*	280		280
Amphipoda	*Elasmopus rapax*	50	1	51
Amphipoda	*Erichthonius brasiliensis*		6	6
Amphipoda	*Ericthonius brasiliensis*	106		106
Amphipoda	*Gammarella fucicola*		2	2
Amphipoda	*Gammaropsis maculata*	3	5	8
Amphipoda	*Gammaropsis sophiae*	134		134
Amphipoda	*Gammaropsis* sp.	14		14
Amphipoda	*Harpinia antennaria*	4	1	5
Amphipoda	*Hyale perieri*	129		129
Amphipoda	*Iphimedia obtusa*	1128		1128
Amphipoda	Jassidae sp.	3		3
Amphipoda	Jassidae sp.1	1		1
Amphipoda	*Leptocheirus pectinatus*	23	143	166
Amphipoda	*Leucothoe spinicarpa*	11	11	22
Amphipoda	*Liljeborgia pallida*	11		11
Amphipoda	*Maera grossimana*	24	8	32
Amphipoda	*Maera inaequipes*	11		11
Amphipoda	*Megamphopus cornutus*		4	4
Amphipoda	*Orchomene humilis*	377	3	380
Amphipoda	*Pariambus typicus*	13		13
Amphipoda	*Perionotus testudo*	19		19
Amphipoda	*Photis longicaudata*		57	57
Amphipoda	*Phthisica marina*		7	7
Amphipoda	*Phtisica marina*	32		32
Amphipoda	*Podocerus variegatus*	3939		3939
Amphipoda	*Pontocrates arenarius*		1	1
Amphipoda	*Pseudoprotella phasma*	188	7	195
Amphipoda	*Siphonoecetes kroyeranus*		1	1
Amphipoda	*Stenothoe marina*	707	1	708
Amphipoda	*Sunampithoe pelagica*		3	3
Amphipoda	*Urothoe marina*	10	11	21
Amphipoda	*Urothoe pulchella*	5	3	8
Cnidaria	*Anemona* sp.1	0		0

Taxonomic group	**Species**	**Bottom type**		**Overall abundance**
		Hard	**Soft**	
Cnidaria	*Anemona* sp.2	2		2
Cumacea	*Cumella africana*		1	1
Cumacea	*Iphinoe canariensis*	1	8	9
Cumacea	*Iphinoe trispinosa*		2	2
Decapoda	*Acanthonyx lunulatus*	63		63
Decapoda	*Achaeus cranchii*		1	1
Decapoda	*Alpheus dentipes*	23		23
Decapoda	*Anapagurus laevis*	6	3	9
Decapoda	*Athanas nitescen*	5		5
Decapoda	*Calcinus tubularis*	111		111
Decapoda	*Clibanarius aequabilis*	128		128
Decapoda	*Clibanarius erythropus*	35		35
Decapoda	*Dardanus calidus*	1		1
Decapoda	*Hippolyte longicornis*	218		218
Decapoda	*Lysmata seticaudata*		1	1
Decapoda	*Maja squinado*	1		1
Decapoda	*Monopodia rostrata*		1	1
Decapoda	*Monopodia* sp.		1	1
Decapoda	*Pagurus anachoretus*	8	1	9
Decapoda	*Pagurus* sp.	2	2	4
Decapoda	*Palicus caronii*		1	1
Decapoda	*Philocheras bispinosus*	1		1
Decapoda	*Philocheras sculptus*		1	1
Decapoda	*Philocheras trispinosus*		3	3
Decapoda	*Pilumnus spinifer*	33		33
Decapoda	*Pirimela denticulata*	22		22
Decapoda	*Pisa carinimana*	1		1
Decapoda	*Pisa* cf. *carinimana*	1		1
Decapoda	*Pisa* sp.	2		2
Decapoda	*Pisa tetraodon*	3		3
Decapoda	*Polybius herislowi*	1		1
Decapoda	*Polybius zariquieyi*		1	1
Decapoda	*Processa canaliculata*	2		2
Decapoda	*Sirpus zariquieyi*	1		1
Decapoda	*Stenorhynchus lanceolatum*	1		1
Decapoda	*Xantho poressa*	6		6
Decapoda	*Xantho* sp.	4		4
Echinodermata	*Amphipholis squamata*	629	17	646
Echinodermata	*Amphiura filiformis*		2	2
Echinodermata	*Arbacia lixula*	32		32
Echinodermata	*Brissus unicolor*		1	1
Echinodermata	*Cocinasterias tenuispina*		1	1
Echinodermata	*Echinocyamus pusillus*		3	3
Echinodermata	*Ophiopsila aranea*		8	8
Echinodermata	*Ophiura* sp.		2	2
Echinodermata	*Paracentrotus lividus*	40		40
Isopoda	*Anthura gracilis*	13	3	16
Isopoda	*Arcturella damnoniensis*	6		6

Taxonomic group	**Species**	**Bottom type**		**Overall abundance**
		Hard	**Soft**	
Isopoda	*Bagatus minutus*	22	9	31
Isopoda	*Cymodoce truncata*	448	7	455
Isopoda	*Dynamene bidentata*	51		51
Isopoda	*Eurydice pulchra*		1	1
Isopoda	*Jaeropsis brevicornis*	15		15
Isopoda	*Synisoma capito*	22		22
Isopoda	*Zenobiana prismatica*		1	1
Mysidacea	*Anchialina agilis*		1	1
Mysidacea	*Gastrosaccus sanctus*		3	3
Mollusca	*Acanthochitona fascicularis*	1		1
Mollusca	*Aplysia* sp.	22	1	23
Mollusca	*Bittium latreillii*	21		21
Mollusca	*Cerithium vulgatum*	1		1
Mollusca	*Chauvetia submamillata*	5		5
Mollusca	*Clavatula bimarginata*		2	2
Mollusca	*Columbella adansoni*	47		47
Mollusca	*Comarmondia gracilis*		1	1
Mollusca	*Corbula gibba*		4	4
Mollusca	*Epitonium pischeri*		1	1
Mollusca	*Ervilia castanea*		1	1
Mollusca	*Gibberula* sp.	14	1	15
Mollusca	*Granulina guancha*		1	1
Mollusca	*Haminaea hydatis*	1		1
Mollusca	*Irus irus*	2		2
Mollusca	*Jujubinus exasperatus*	143	1	144
Mollusca	*Linga adansoni*		1	1
Mollusca	*Lucinella divaricata*		2	2
Mollusca	*Mitrella broderipi*	56		56
Mollusca	*Monophorus thiriotae*		1	1
Mollusca	*Musculus costulatus*	1		1
Mollusca	*Nassarius cuvierii*	17	14	31
Mollusca	*Nassarius incrassatus*	1	1	2
Mollusca	*Natica dillwynii*		2	2
Mollusca	*Opistobranquio*	1		1
Mollusca	*Parvicardium exiguum*	2	1	3
Mollusca	*Parvicardium scriptum*	212	2	214
Mollusca	*Parvioris microstoma*	1		1
Mollusca	*Plagiocardium papillosum*		4	4
Mollusca	*Psammobbia costulata*		1	1
Mollusca	*Smaragdia viridis*		9	9
Mollusca	*Solemya togata*		18	18
Mollusca	*Thracia papyracea*		1	1
Mollusca	*Tricolia pullus canarica*	31		31
Mollusca	*Turbonilla lactea*	1		1
Mollusca	*Vexillum (Pusia) zebrinum*	2		2
Mollusca	*Vitreolina philippii*		1	1
Mollusca	*Volvarina* sp.	1	2	3
Nematoda	*Cylicolaimus magnus*	1	1	2

Taxonomic group	Species	Bottom type		Overall abundance
		Hard	Soft	
Nematoda	*Synonchus fasciculatus*	1		1
Nemertea	Nemertea sp.1	12	7	19
Nemertea	Nemertea sp.2	2		2
Oligochaeta	*Grania* sp.	10	7	17
Oligochaeta	Tubificidae		4	4
Ostracoda	*Cypridina mediterranea*	2	45	47
Ostracoda	*Cypridina norvegica*	2	28	30
Polychaeta	*Aonides oxycephala*		16	16
Polychaeta	*Aponuphis bilineata*	1	114	115
Polychaeta	*Armandia cirrhosa*		5	5
Polychaeta	*Branchiomma vesiculosum*	1		1
Polychaeta	*Capitomastus minimus*		5	5
Polychaeta	*Cauleriella alata*	1	1	2
Polychaeta	*Cauleriella bioculata*	10		10
Polychaeta	*Chone collaris*		1	1
Polychaeta	*Chone duneri*		2	2
Polychaeta	*Chone filicaudata*		10	10
Polychaeta	*Chone* sp	1	1	2
Polychaeta	*Cirriformia tentaculata*	2		2
Polychaeta	*Cirrophorus* sp.		2	2
Polychaeta	*Demonax brachychona*	32		32
Polychaeta	*Euclymene lumbricoides*		2	2
Polychaeta	*Eunice* aff. *oerstedii*		1	1
Polychaeta	*Eunice vittata*		2	2
Polychaeta	*Exogone breviantennata*		1	1
Polychaeta	*Exogone naidina*	3		3
Polychaeta	*Fabricia sabella*	6		6
Polychaeta	*Glycera tesselata*		3	3
Polychaeta	*Glycera tridactyla*		1	1
Polychaeta	*Goniadides* sp.		1	1
Polychaeta	*Harmothoe* sp.1	1	3	4
Polychaeta	*Harmothoe* sp.2		1	1
Polychaeta	*Lanice conchilega*	1		1
Polychaeta	*Lepidonotus clava*	7		7
Polychaeta	*Lumbrineris cingulata*		1	1
Polychaeta	*Lumbrineris latreillii*	12		12
Polychaeta	*Malacoceros fuliginosus*	8		8
Polychaeta	*Manayunkia aestuarina*	1		1
Polychaeta	*Marphysa bellii*		17	17
Polychaeta	*Myxicola infundibulum*	1		1
Polychaeta	*Nematonereis unicornis*	4		4
Polychaeta	*Nephthys cirrosa*		1	1
Polychaeta	*Nereis funchalensis*	6		6
Polychaeta	*Nereis* sp.		32	32
Polychaeta	*Nicolea venustula*	1		1
Polychaeta	*Onuphis eremita*		15	15
Polychaeta	*Paramarphysa longula*	1		1
Polychaeta	*Petaloproctus terricola*		18	18

Taxonomic group	**Species**	**Bottom type**		**Overall abundance**
		Hard	**Soft**	
Polychaeta	*Phyllodoce laminosa*		2	2
Polychaeta	*Phyllodoce mucosa*		1	1
Polychaeta	*Phyllodoce* sp.	1		1
Polychaeta	*Pisione guanche*		1	1
Polychaeta	*Pista cristata*	3	1	4
Polychaeta	*Pista maculata*	2		2
Polychaeta	*Platynereis dumerilii*	898	2	900
Polychaeta	*Poecilochaetous serpens*		11	11
Polychaeta	*Polycirrus medusa*	4		4
Polychaeta	*Polygordius lacteus*		5	5
Polychaeta	*Polyophthalmus pictus*	159	1	160
Polychaeta	*Prionospio steenstrupii*		4	4
Polychaeta	*Psamathe fusca*		4	4
Polychaeta	*Rhynchospio glutaea*		6	6
Polychaeta	*Schistomeringos albomaculata*		4	4
Polychaeta	*Schistomeringos* sp.	1		1
Polychaeta	*Scolelepis* aff. *cantabra*	7		7
Polychaeta	*Scoletoma funchalensis*	2		2
Polychaeta	*Scoloplos (Leodamas)* sp.		71	71
Polychaeta	*Scoloplos armiger*	9		9
Polychaeta	*Scoloplos* sp.		8	8
Polychaeta	*Spio filicornis*	1	2	3
Polychaeta	*Streptosyllis* sp.		1	1
Polychaeta	*Syllis cornuta*	1		1
Polychaeta	*Syllis garciai*	15		15
Polychaeta	*Syllis krohnii*	33		33
Polychaeta	*Syllis prolifera*	24	15	39
Polychaeta	*Syllis* sp.	1	3	4
Polychaeta	*Theostoma oerstedi*	11		11
Pycnogonida	*Achelia longipes*		1	1
Pycnogonida	*Achelia longipes*	3		3
Pycnogonida	*Archelia echinata*	5		5
Pycnogonida	*Archelia* sp.	1		1
Pycnogonida	*Archelia vulgaris*	4		4
Sipuncula	*Aspidosiphon muelleri*		1	1
Sipuncula	*Sipunculus nudus*		3	3
Tanaidacea	*Apseudes talpa*	9	82	91
Tanaidacea	*Leptochelia dubia*	10		10
Tanaidacea	*Tanais dulongii*	10		10
Total abundance		**14456**	**1101**	**15557**