Effects of sea bass and sea bream farming (Western Mediterranean Sea) on peracarid crustacean assemblages

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Abstract

Effects of sea bass and sea bream farming (Western Mediterranean Sea) on peracarid crustacean assemblages.— Benthic soft–bottom assemblages are good indicators of environmental disturbance, such as coastal aquaculture, considering their rapid response in terms of diversity and abundance. The aim of this study was to evaluate the response of peracarid assemblages to the release of waste from coastal farming as these organisms play an important ecological role. Abundance and species richness did not show significant differences between farm and control localities but did show a high spatial variability at the two studied scales. Non–metric multi–dimensional scaling (MDS) analysis showed a separation between farms and controls, indicating that peracarid assemblages are modified as a result of aquaculture activities, and some species such as *Ampelisca* spp. showed statistical differences. Peracarids, at both species and community level, may therefore be applied as helpful indicators to assess benthic effects of coastal farming.

Key words: Benthos, Aquaculture, Impact, Indicators, Management, Sustainability.

Resumen

Efectos del cultivo de la lubina y la dorada (Mediterráneo occidental) sobre las comunidades de crustáceos peracáridos.— Las comunidades bentónicas de fondos blandos son buenas indicadoras de perturbaciones ambientales, tales como la acuicultura costera, teniendo en cuenta sus cambios relativamente rápidos en términos de diversidad y abundancia. El objetivo del presente estudio es evaluar la respuesta de las comunidades de peracáridos a la liberación de desechos de las instalaciones de acuicultura costeras, dado el importante papel ecológico de estos organismos. La abundancia y la riqueza de especies no mostraron diferencias significativas entre áreas con impacto y de control, pero si una importante variabilidad espacial a las dos escalas estudiadas. El análisis no métrico de escalas multidimensionales (EMD) mostró una separación entre las piscifactorías y los controles, lo que indica que las comunnidades de peracáridos se ven modificadas como resultado de las actividades de las piscifactorías, donde algunas especies, como *Ampelisca* spp. mostraron diferencias significativas. Por lo tanto, los peracáridos, tanto a nivel de especie como de comunidad, pueden ser utilizados como buenos indicadores para evaluar el efecto de la acuicultura sobre el fondo marino en ambientes costeros.

Palabras clave: Bentos, Acuicultura, Impacto, Indicadores, Gestión, Sostenibilidad.

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Introduction

Aquaculture activities have increased greatly in coastal marine areas during the last decades (Mazzola et al., 2000; Mirto et al., 2000; Borja, 2002; Klaoudatos et al., 2006; Sánz–Lázaro & Marín, 2006; Sutherland et al., 2007; Grego et al., 2009). This situation has been induced by progressive advances in cage building, which facilitated mooring of cage farms and their establishment on relatively deep bottoms and exposed sites (Maldonado et al., 2005). Since floating cages for intensive aquaculture started to appear, general concern has increased for the potential impact of this activity on marine ecosystems (Mazzola et al., 2000; Mirto et al., 2000; Klaoudatos, 2002; Sánz–Lázaro & Marín, 2006; Sutherland et al*.,* 2007). These effects include: organic enrichment, derived from excess of uneaten food and fish excretions, chemical pollution, related with medicines and antifouling products, genetic effects and introduction of non–native species, resulting from both the escapes and alterations of adjacent benthic and pelagic fauna (Borja, 2002; Dempster et al., 2002; Macías et al., 2005; Holmer et al., 2007, Borja et al., 2009). From among these possible impacts, the most evident effect of fish cages on seabeds is the accumulation of organic matter, which generates significant changes in the chemical, physical and biological characteristic of the sediment (Karakassis et al., 2000; Mirto et al., 2002; Klaoudatos, 2002; Maldonado et al., 2005; Martí et al., 2005; Marbà et al., 2006; Sánz–Lázaro & Marín, 2006; Lampadariou et al., 2008; Grego et al., 2009; Mirto et al., 2010). These effects can be noted within a range of tens to hundreds of meters (Mazzola et al., 1999; Mirto et al., 2002; Aguado–Giménez & García–García, 2004; Tomassetti et al., 2009).

Additionally, the increase of organic matter and sediment structure is affected by silting, increased oxygen demand, anoxic sediment generation and toxic gases (Borja, 2002; Martí et al., 2005). All of these effects could modify the structure and characteristics of the benthic assemblages (Mazzola et al., 1999, 2000; Mirto et al., 2000; Maldonado et al., 2005; Martí et al., 2005; Marbà et al., 2006; Klaoudatos et al., 2006; Lampadariou et al*.,* 2008). Due to their small size, high abundance, direct relation with the sediment, high turnover and fast response time to perturbations, Benthic fauna are presently utilized as a useful indicator to detect environmental changes due to pollution (Boyra et al., 2004; Sutherland et al., 2007; Grego et al., 2009; Fabi et al., 2009). Crustaceans are one of the most important taxa in the benthic fauna, in terms of diversity and abundance. Several groups belonging to this taxon are very ecologically sensitive organisms. As a consequence, a high number of species appear as good indicators of different environmental conditions.

Several studies have effectively applied copepods harpacticoids (*e.g.* copepods–nematods index; Raffaeli & Mason, 1981), ostracods (Ruiz et al., 2005), cumaceans (Corberá & Cardell, 1995) and amphipods (Conradi et al., 1997; Gómez–Gesteira & Dauvin, 2000; Sánchez–Jerez et al., 2000; Guerra–García & García–Gomez, 2001) for assessing different types of environmental impacts. However, there are no studies directly assessing the effects of coastal farming on peracarid assemblages in the Western Mediterranean. Consequently, to evaluate the environmental impact of fish farming using peracarid assemblages we applied a multi–control impact design with a spatial replication at different scales to understanding the natural spatial variability with regards to the influence of the fish farming activity.

Material and methods

Study area and sampling method

Three Mediterranean fish farms located east off the coast of Guardamar del Segura (Alicante, SE Spain: 38° 5' 45.88'' N; 0° 36' 15.84'' W) were selected for the study. All farms cultured sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*). In addition, three control zones in the same area were also selected. They were located at least 1.5 km away from the farms to minimize the potential interactions with dispersed farm wastes. Samples were collected in March 2009. Regarding fish farm–impact monitoring, punctual sampling can be relevant, because if important environmental and biotic parameters are affected, the differences between controls and farms should be detectable at any time (Maldonado et al., 2005).

To study benthic community, three random replicates were collected at each site using a Van Veen grab (0.04 m^2), sieved in seawater through a 500 μm mesh and preserved in 4% formalin. In the laboratory, the peracarids were separated, identified at the lower possible taxonomic level and counted.

An additional sample was collected at each location for sediment analysis. Sediment particle size was determined by the wet sieve method, and organic matter content by incinerating a known dried sample in a muffle furnace at 450°C for 4 h (Buchanan, 1984).

Data analysis

We tested the differences of peracarid assemblages between control areas and farms using both univariate and multivariate statistical analyses.

Univariate analysis

We analysed the number of species and total abundance of the peracarids, and abundance of the most important species using analysis of variance (ANOVA). The experimental design incorporated three factors: control/farm (fixed and orthogonal with two levels), locality (random and nested in treatment, with three levels), and site (random and nested in Locality, with two levels). Prior to ANOVA, heterogeneity of variance was tested with Cochran's *C*–test and data were $\sqrt{x+1}$ transformed in cases where the variances were significantly different, with $P < 0.05$, and $\log(x+1)$ transformed where the variance was still heterogeneous (Underwood, 1997). *Post hoc* Student–Neuman Kuels (SNK) tests were used if significant differences were found.

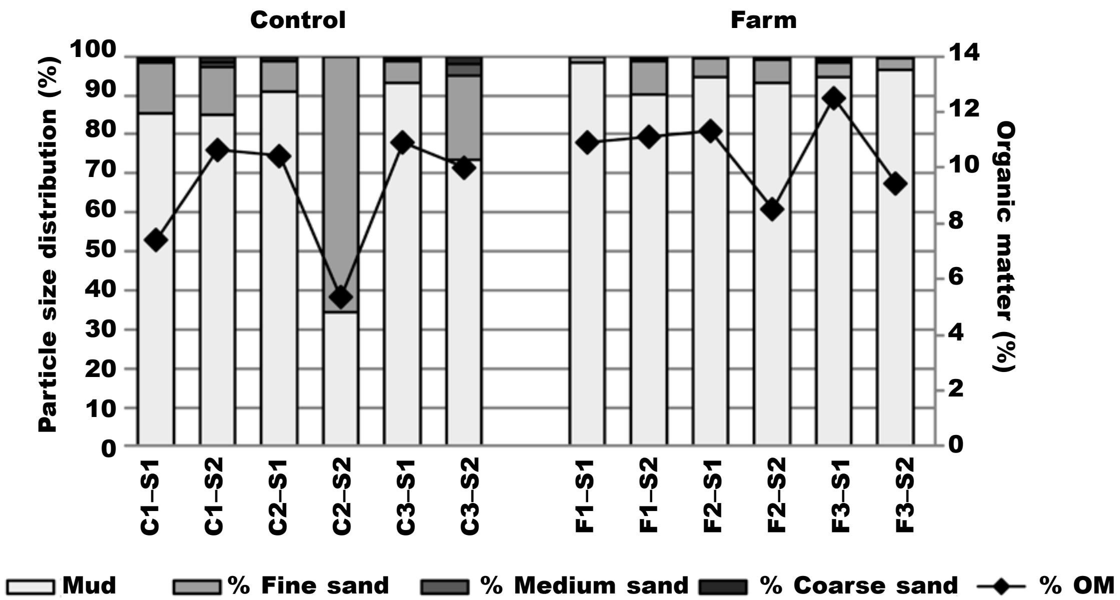


Fig. 1. Granulometric structure of sediment at the studied zones, expressed as the relative abundance (dry weight percentage) of the different grain–size fractions and organic matter content in samples: C. Control; F. Farm.

Fig. 1. Estructura granulométrica del sedimento en las zonas estudiadas, expresada como abundancia relativa (porcentaje de peso seco) de las distintas fracciones según el diámetro de partícula y contenido de materia orgánica de las muestras: C. Control; F. Granja.

Multivariate analysis of assemblage structure

Non–parametric multidimensional scaling (MDS) was used as the ordination method to explore differences in the peracarid assemblage composition (Clarke & Warwick, 1994). For this test, data were transformed with fourth root and the similarity matrix was calculated using the Bray–Curtis index. The percentage similarities (SIMPER) procedure was then used to calculate the contribution of each species to the dissimilarity between control time and impact (PRIMER software; Clarke, 1993). A permutation test (PERMANOVA software; Anderson, 2004) was used to analyse differences of the overall species composition following the same experimental design as the univariate analysis.

Results

Characterization of the sediment

The seabed was dominated by soft non–vegetated substrates in which the predominant sediment type was mud, but significant differences were found between farm and control treatments. Remarkable similarity was found in grain–size structure among farm sediments since all of them contained a silt/clay (< 0.063 mm) proportion higher to 90%. However, sediment structure for control sites was different, with large variations in the sand proportion across sites. The highest fine sand content was measured in sampling site C2–S2 (fig. 1). Results of two–way ANOVA test (Control/Farm and Locality factors) showed significant differences for coarse sand and fine sand proportion, which were higher in control areas, and for mud proportion higher in farm areas (table 1).

In general, levels of organic matter in sediment samples were relatively high (fig. 1). Organic content of the sediment was lower in control areas (mean value 9.12%) than in farm areas (mean value 10.63%), but without significant differences. The minimum value recorded in the sediment was in C2–S2, which was related with the fine sand proportion.

Peracarids assemblages

A total of 708 individuals were found: amphipods (64.97%), of which 55.40% were gammarids and 9.75% caprellids, tanaids (20.20%), cumaceans (14.41%) and isopods (0.42%). Therefore, amphipod gammarids were the most abundant group, especially due to the high abundance values recorded for *Ampelisca* spp. (30.65% of total abundance). Tanaids were the second most representative taxonomic group, with *Apseudes latreillei* contributing with 18.50% of the total abundance.

Table 1. Results of analysis of variance (ANOVA) for sediment variables: S. Source; C/F. Control/farm; L. Locality; R. Residual; CT. Cochran test; T. Transformation; MS. Mean square; *P*. Level of significance; df. Degrees of freedom; ns. Non–significant.

Tabla 1. Resultados del análisis de varianza (ANOVA) para las variables del sedimento: S. Fuente; C/F. Control/granja; L. Localidad; R. Residual; CT. Test de Cochran; T. Transformación; MS. Media de los cuadrados; P. *Nivel de significación; df. Grados de libertad; ns. No significativo.*

		Coarse sand		Medium sand		Fine sand		Mud		OM		
S	df	MS	*P*	MS	*P*	MS	*P*	MS	*P*	MS	*P*	F *vs.*
C/F	1	1.2706	0.047	0.0956	0.299	3.8579	0.0083	598.71	0.031	6.836	0.141	L(C/F)
L(C/F)	4	0.1573	0.713	0.0672	0.413	0.1641	0.8962	56.571	0.806	2.039	0.769	R
R	24	0.2913		0.0579		0.6422		143.19		4.517		
CT		0.5009		0.7743		0.5401		0.7803		0.4723		
		ns		ns		ns		ns		ns		
T		None		√(x+1)		Ln (x+1)		ArcSin(%)		None		

Regarding species richness and total abundance, a similar pattern was observed for both variables. For species richness, there was a slight decrease from control (mean value 8.08 species) to farm areas (mean value 4.72 species). In relation to the mean total abundance, it was also lower in farm areas (29.30 ± 4.16 ind./m^2) than in control areas (89.37 ± 8.16 ind./m^2) (fig. 2). A high spatial variability was found between localities and sites, which probably contributed to the absence of significant differences in both variables between farm and control treatments (table 2).

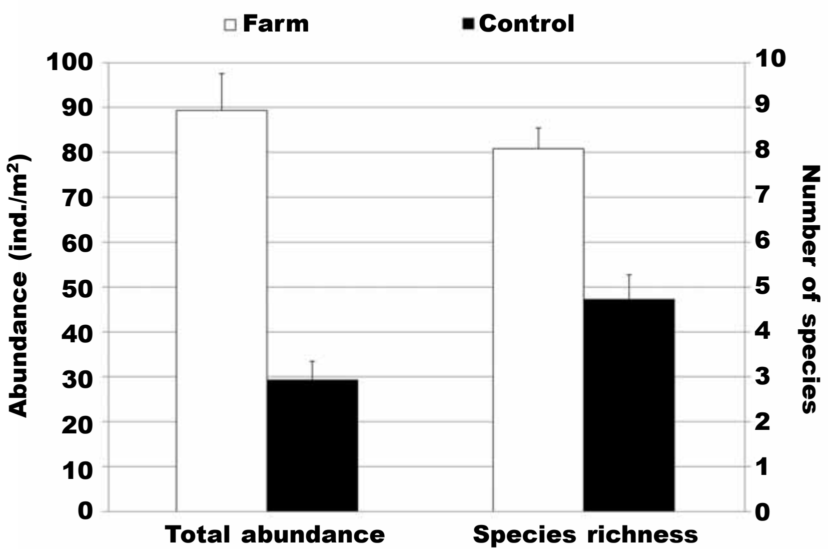


Fig. 2. Values (± SE) of total abundance (ind./m^2) and number of species of peracarid.

Fig. 2. Valores (± EE) de abundancia total (ind./m^2) y de número de especies de peracáridos.

Table 2. Results of analysis of variance (ANOVA) for species richness, total abundance and abundance of the most important peracarid species. C/F. Control/farm; L. Locality; S. Site; R. Residual; CT. Cochran test; T. Transformation; MS. Mean square; *P*. Level of significance; df. Degrees of freedom; ns. Non–significant.

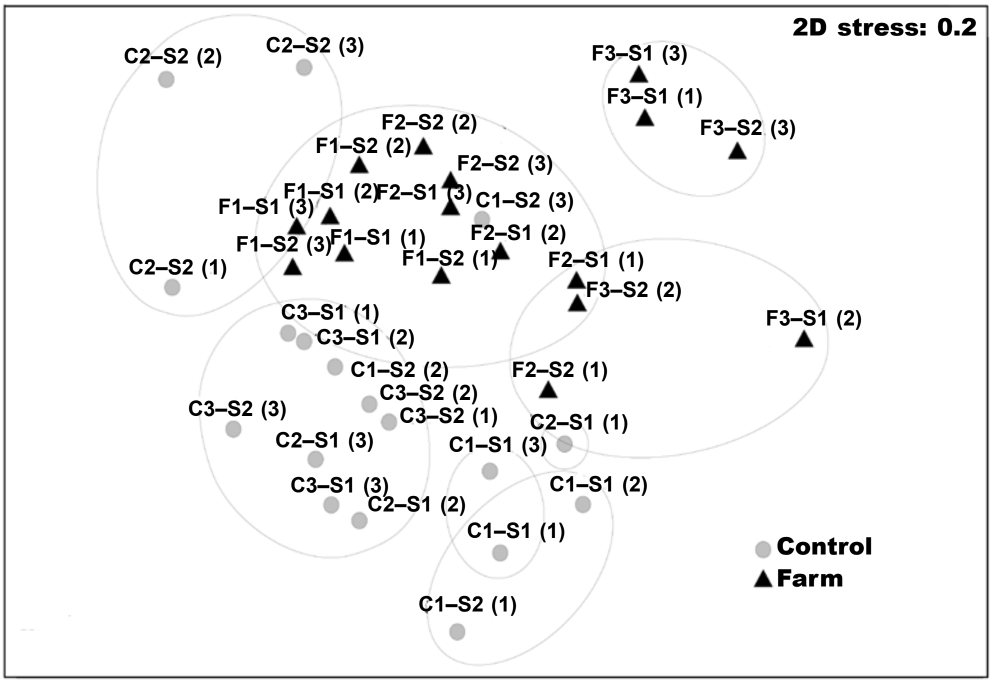
Tabla 2. Resultados del análisis de varianza (ANOVA) para la riqueza específica, la abundancia total y la abundancia de las especies de peracáridos más importantes: C/F. Control/granja; L. Localidad; S. Sitio; R. Residual; CT. Test de Cochran; T. Transformación; MS. Media de los cuadrados; P. *Nivel de significación; df. Grados de libertad; ns. No significativo.*

		Species richness		Total abundance		*Ampelisca* spp.			
Source	df	MS	P	MS	P	MS	P	$P_{pooling}$	F *vs.*
C/F	1	64.000	0.263	78.624	0.197	17.228	0.050	0.0207	L(C/F)
L(C/F)	4	37.805	0.083	33.061	0.063	2.2568	0.485		S (C/F x L)
S (C/F x L)	6	12.777	0.026	8.1704	0.023	2.3123	0.000		R
R	24	4.3333		0.6820		0.2701			
CT		0.2500		0.2739		0.3871			
		ns		ns		ns			
T		None		√(x + 1)		√(x + 1)			

		Apseudes latreillei		*Liropus elongatus*		*Caprella dilatata*		
Source	df	MS	P	MS	P	MS	P	F *vs.*
C/F	1	1.0783	0.5554	1.0354	0.2563	1.1062	0.0234	L(C/F)
L(C/F)	4	2.6101	0.5299	0.5911	0.1262	0.0869	0.3304	S (C/F x L)
S (C/F x L)	6	2.9798	0.0001	0.2119	0.2796	0.0607	0.7143	R
R	24	0.3664		0.1585		0.0984		
CT		0.2808		0.3782		0.3354		
		ns		ns		ns		
T		Ln (x + 1)		√(x + 1)		√(x + 1)		

		Jassa marmorata		*Medicorophium runcicorne*		*Iphinoe tenella*		
Source	df	MS	P	MS	P	MS	P	F *vs.*
C/F	1	10.028	0.1748	1.9124	0.3420	2.7778	0.4997	L(C/F)
L(C/F)	4	3.6944	0.4495	1.6477	0.1506	5.0556	0.0041	S (C/F x L)
S (C/F x L)	6	3.4722	0.0370	0.6564	0.0144	0.3889	0.6251	R
R	24	1.2778		0.1934		0.5278		
CT		0.6087		0.2986		0.2105		
		($P < 0.01$)		ns		ns		
T		None		√(x+1)		None		

The MDS analysis, based on species abundance (fig. 3), showed a separation between farm and control assemblages. Peracarid assemblages of the different farms were more similar between them than the control assemblages, indicating a homogenisation of species structure in these areas. At control areas, species compositions showed higher variability, highlighting the separation of C2–S2 from the others which was evident and probably due to the presence of a higher proportion of fine sand.



Transform: fourth root
Resemblance: S17 Bray Curtis similarity

Fig. 3. Non–metric multi–dimensional scaling (MDS) plot in two dimensions for benthic peracarid species abundance: C. Control; F. Farm; S. Site. (The number indicates the replicate samples.)

Fig. 3. Análisis de escalamiento multidimensional no paramétrico (MDS) en dos dimensiones a partir de los valores de abundancia de las especies de peracáridos bentónicos. C. Control; F. Granja; S. Sitio. (El número indica las distintas réplicas.)

The PERMANOVA test indicated no significant differences for species composition between farms and control areas, but it revealed a high variability among localities (p = 0.001) as well as among sites (p = 0.01) (table 3).

The SIMPER analysis showed that the gammarid amphipods *Ampelisca* spp., *Jassa marmorata* and *Medicorophium runcicorne,* the tanaid *Apseudes latreillei*, the caprellid amphipods *Liropus elongatus* and *Caprella dilatata* and the cumaceans *Iphinoe tenella* and *Bodotria scorpioides* were the species that contributed most to the dissimilarity between farm and control areas (table 4). These species were also most responsible for the similarity within the farm and control samples. The abundance values of *Ampelisca* spp., *A. latreillei*, *L. elongates*, *I. tenella* and *B. scorpioides* were higher in control areas, while *C. dilatata*, *J. marmorata* and *M. runcicorne* were more abundant in farm sediments (fig. 4), but only two of these species presented significant differences for the abundance between farm and control treatments: *Ampelisca* spp. and *Caprella dilatata* (P < 0.05, table 2). Significant differences at localities and sites for many of the variables reflected a high variability of the peracarid abundance at a scale of hundreds of meters to tens of kilometres, thus reducing the power of the ANOVA.

Discussion

The study of the peracarid crustacean assemblages under aquaculture influence showed that the species *Ampelisca* spp. and *Caprella dilatata* are affected by fish farming activities. A drastic decrease in the total abundance and species richness was detected, even though significant differences were not found. In addition, changes in the sediment structure due to an increase of finer material were also detected. This silting has been previously described associated with organic enrichment from fish aquaculture waste (Sutherland et al., 2001; Borja, 2002; Porrello et al., 2005; Sánz–Lázaro & Marín, 2006; Aguado–Giménez et al., 2007). However, the use of grain size distribution as an impact indicator is not appropriate but it is a very useful parameter for describing the environment and interpreting some phenomena (Aguado–Giménez et al., 2007).

Table 3. Results of PERMANOVA analysis for peracarid assemblages: C/F. Control/farm; L. Locality; S. Site; R. Residual; df. Degrees of freedom; MS. Mean square; *P*. Level of significance.

Tabla 3. Resultados del análisis de PERMANOVA de las poblaciones de peracáridos: C/F. Control/ granja; L. Localidad; S. Sitio; R. Residual; df. Grados de libertad; MS. Media de los cuadrados; P. *Nivel de significación.*

Source	df	MS	P(perm)	F *vs.*
C/F	1	10090	0.198	L(C/F)
L(C/F)	4	5,287.6	0.001	S (C/F x L)
S (L(C/F))	6	1,957.3	0.010	R
Rs	24	1,177.9		
Total	35			

The effects of aquaculture activities on bottom sediments are well known and have been reported worldwide (*e.g.* Hall et al., 1990; Wu, 1995; Karakassis et al., 1998, Borja, 2002: Borja et al., 2009). In the Mediterranean Sea, these effects are well documented for sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*) farming (*e.g.* Karakassis et al., 1998; Mazzola et al., 1999; Mirto et al., 2002; Vita et al., 2002; Aguado–Giménez & Garcia, 2004, Maldonado et al., 2005; Tomassetti & Porrello, 2005; Marbá et al., 2006; Aguado–Giménez et al., 2007, Tomassetti et al., 2009) and shellfish farming, particularly mussel farming (Mirto et al., 2000; Fabi et al., 2009).

Fish farm sediments are assumed to represent organic enriched conditions (Hall et al., 1990; Hargrave et al., 1993; Delgado et al., 1997; Karakassis et al., 1998) if they are compared to reference areas. However, in this study, significant differences in organic matter loads between farm and control areas could not be detected. Other studies (*e.g*. Maldonado et al., 2005; Aguado–Giménez et al., 2007) showed a similar lack of differences because the magnitude of this increase in organic matter is different between farms and mainly depends on local variables such as hydrographic regime, sediment type, water depth, as well as management variables such as fish production, efficiency of feeding method and feed quality (Tomassetti et al., 2009).

Previous studies have demonstrated that the changes originated on the bottom can cause a strong impact on the structure and characteristics of the benthic communities, including effects on bacterial assemblages (Mirto et al., 2000; La Rosa et al., 2004); meiofauna (Mazzola, 1999, 2000; Sutherland, 2007; Grego et al., 2009; Mirto et al., 2010), macrofauna (Edgar et al., 2005; Tomassetti et al., 2009; Fabi et al., 2009) or seagrass species (Delgado et al., 1999; Ruiz et al., 2001; Marbá et al., 2006).

Even though several taxonomic groups, such as polychaeta (Tomassetti & Porrello, 2005; Sutherland et al., 2007) or nematode (Mirto et al., 2002), have been proposed as tools for monitoring the impact of organic enrichment following intensive aquaculture activities, few studies have focused on the effects of fish farming on benthic macrocrustacean assemblages. Hall–Spencer & Bamber (2007) described how epifaunal and infaunal benthic crustacean communities are affected for salmon farming on maerl bottoms. In our study, the peracarid assemblages also seem to be an adequate indicator of sea bass and sea bream farming activity. Specific richness and total abundance

Table 4. Result of SIMPER analysis and mean abundances (± SE) of most important peracarid species.

Tabla 4. Resultado del análisis SIMPER y abundancias medias (± EE) de las especies más importantes de peracáridos.

	Average dissimilarity = 64.51 farm and control		Mean abundance	
Species	Contrib.(%)	Cum.(%)	Control	Farm
Ampelisca spp.	9.17	9.17	24.44 ± 3.13	5.69 ± 0.98
Apseudes latreillei	6.75	15.92	15.42 ± 5.99	2.78 ± 0.82
Liropus elongatus	6.74	22.66	4.86 ± 1.14	0.97 ± 0.39
Caprella dilatata	6.33	28.98	0.56 ± 0.17	3.06 ± 0.47
Jassa marmorata	6.32	35.31	0.83 ± 0.31	3.47 ± 0.73
Medicorophium runcicorne	6.06	41.36	1.25 ± 0.37	6.11 ± 1.59
Iphinoe tenella	5.41	46.78	2.36 ± 0.49	0.97 ± 0.31
Bodotria scorpioides	5.17	51.94	2.36 ± 0.65	0.28 ± 0.13

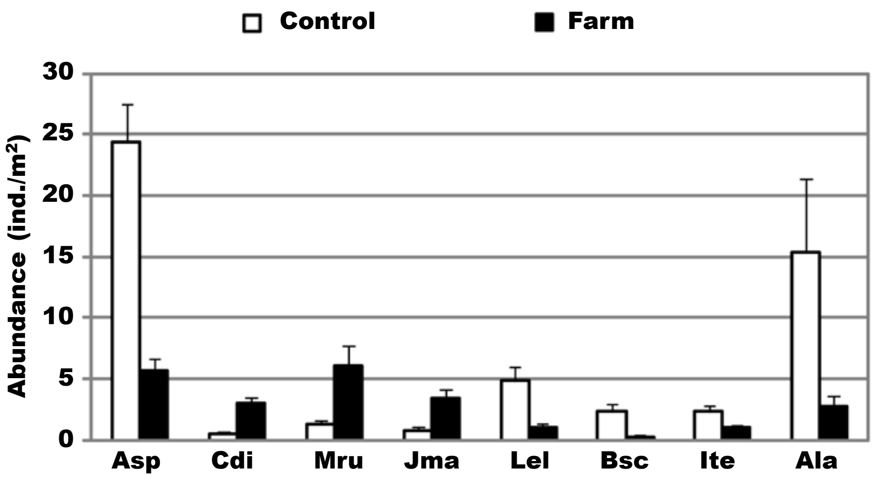


Fig. 4. Mean abundance of most important peracarid species (ind./m^2 ± SE): C. Control; F. Farm. Asp. *Ampelisca* spp.; Cdi. *Caprella dilatata*; Mru. *Medicorophium runcicorne;* Jma. *Jassa marmorata;* Lel. *Liropus elongatus;* Bsc. *Bodotria scorpioides*; Ite. *Iphinoe tenella;* Ala. *Apseudes latreillei*.

Fig. 4. Abundancia media de las especies más importantes de peracáridos (ind./m^2 ± EE): C. Control; F. Granja. Asp. Ampelisca *spp.; Cdi.* Caprella dilatata*; Mru.* Medicorophium runcicorne*; Jma.* Jassa marmorata*; Lel.* Liropus elongatus*; Bsc.* Bodotria scorpioides*; Ite.* Iphinoe tenella*; Ala.* Apseudes latreillei.

in sediments was lower beneath the cages compared to control areas. Similarly, a drastic reduction (50–70%) in crustacean fauna abundances has been reported from other fish farm areas in the Mediterranean (Mazzola et al., 1999, 2000; Mirto et al., 2000; La Rosa et al., 2001; Klaoudatos et al., 2006).

At the lowest taxonomic level, this study revealed that some species and genera are sensitive to fish farming. The most important genus in this regard was *Ampelisca* spp., which was highly sensitive to farm effects. The genus *Ampelisca* showed a high sensitivity to significant increases in organic matter but also to toxins in the sediment (especially PCBs, pesticides, metals and PAHs) (Gómez–Gesteira & Dauvin, 2000), compounds that may be found in sediments beneath the cages (Tsapakis et al., 2010).

The abundances of cumaceans *I. tenella* and *B. scorpioides* were also drastically decreased in farm sediments. There is a limited number of cumacean species with adaptative strategies in response to eutrophication (Corberá & Cardell, 1995), so this taxon is considered sensitive to polluted areas.

Another species, the tanaid *A. latreillei,* was apparently affected to organic enrichment because its presence was reduced in farm sediments. Other authors have reported that this species may be vulnerable to hypoxic sediments (Gray et al., 2002; Guerra–García & García–Gómez, 2006; Sánchez–Moyano et al., 2002; Sánchez–Moyano & García–Gómez, 1998). However, the present work showed that this species was mainly associated with one control, which was characterized by fine sand sediments. These results are in agreement with other works (Bakalem et al., 2009; Bouchet & Sauriau, 2008; Marín–Guirao et al., 2005; Moreira et al., 2008; Lourido et al., 2008, De–la–Ossa–Carretero et al., 2010).

On the other hand, other species such as *Jassa marmorata*, *Caprella dilatata* and *Medicorophium runcicorne* increased their presence in farm sediments. In the case of *M. runcicorne*, species belonging to the family Corophiidae are generally linked to muddy and disturbed areas continuously exposed to toxics in the sediment (Diviacco & Bianchi, 1987; Guerra–García et al., 2003; Carvalho et al., 2006; Vázquez–Luis et al., 2008). *Medicorophium runcicorne* have been reported in yachting harbours where their presence seems to be influenced by factors other than grain size and organic matter, such as low hydrodynamics, higher sedimentation rate and availability of larvae (Guerra–García & Garcia–Gomez, 2009). Similar results have been found for the gammarid amphipod *J. marmorata*; their higher abundance at farm sediments must be due mainly to their trophic requirements and living habits since these species are tube–builders and deposit–feeders (Conradi et al., 1997; Guerra–García et al., 2003). But this species and *C. dilatata*, which is associated with buoys (Guerra–García et al., 2006), are present in fouling communities on aquaculture installations, so their presence in sediments could be due to a direct influence from water column structures to the seabed.

We found different structures of peracarid assemblages at control and farm sites. However, the high variability found in these soft–bottoms prevented finding statistical differences. The use of a more robust hierarchical design (high replication at several spatial scales) is needed to detect significant changes on assemblages, and these results were widespread as an indicator of environment involvement by aquaculture (Underwood, 1997).

Conclusions

This study revealed that peracarid assemblages are modified at sediments affected by fish farming, as has been described for other faunal groups such as polychaetes and nematods assessing responses to different environmental conditions. Peracarids may also therefore be used for this purpose. Moreover, peracarids play an important role as trophic resources for other crustaceans and macrofauna such as fish populations (Bell & Harmelin–Vivien, 1983; Edgar & Shaw, 1995; Sanchez–Jerez et al., 1999; Stergiou & Karpouzi, 2002; Stål et al., 2007). For example, they are a key component in the diet of key soft–bottom species like *Mullus barbatus*, where the proportion of crustaceans consumed can reach up to 70% of total prey (Aguirre Villaseñor, 2000). Consequently, peracarids assemblages are useful tools for describing the environmental impact of fish farming activities, but additionally they are important for assessing the potential effects on the trophic webs.

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