Mediterranean Marine Science

Vol 15, No 2 (2014)

Spatial and temporal variability of mobile macro-invertebrate assemblages associated to coralligenous habitat

R. BEDINI, L. BONECHI, L. PIAZZI

doi: 10.12681/mms.442

To cite this article:

BEDINI, R., BONECHI, L., & PIAZZI, L. (2014). Spatial and temporal variability of mobile macro-invertebrate assemblages associated to coralligenous habitat. *Mediterranean Marine Science*, *15*(2), 302–312. https://doi.org/10.12681/mms.442

Research Article

Mediterranean Marine Science
Indexed in WoS (Web of Science, ISI Thomson) and SCOPUS
The journal is available on line at http://www.medit-mar-sc.net
Doi: http://dx.doi.org/10.12681/mms.442

Spatial and temporal variability of mobile macro-invertebrate assemblages associated to coralligenous habitat

R. BEDINI, L. BONECHI and L. PIAZZI

Istituto di Biologia ed Ecologia Marina, Piazza G. Bovio 4, 57025 Piombino, Italy

Corresponding author: bedini@biomare.it

Handling Editor: Carlo Nike Bianchi

Received: 22 April 2014; Accepted: 24 January 2014; Published on line: 17 March 2014

Abstract

The study aimed to investigate patterns of spatial and temporal variability of mobile macroinvertebrate assemblages associated to coralligenous habitat. A multi-factorial sampling design was used to test the hypotheses that the structure of assemblages and their spatial and temporal variability changed in relation to substrate inclination. Moreover, macroalgae and sessile macro-invertebrates were also investigated in order to detect eventual relationships between sessile and mobile assemblages. A total of 236 mobile macro-invertebrate taxa were identified, among them 2 Platyhelminthes, 4 Sipuncula, 6 Nemertea, 27 Mollusca, 86 Annelida, 103 Arthropoda, 8 Echinodermata. The results of the study show that mobile macro-invertebrate assemblages of coralligenous habitat were little influenced by the inclination of substrate and by the morphology of sessile organisms, as patterns of variation were different between the two assemblages. Mobile macro-invertebrate assemblages changed among sampling dates within a one-year period and showed high variability at the spatial scale examined.

Keywords: coralligenous habitat, substrate orientation, macro-invertebrates, Mediterranean Sea, deep subtidal.

Introduction

In the Mediterranean Sea, deep subtidal rocky bottoms (from 20 to 120 m as limit values, Ballesteros, 2006) are characterised by a biogenic habitat, named “coralligenous”, constituted by calcareous organisms, mainly encrusting Rhodophyta belonging to Corallinales and Peyssonneliales (Ballesteros, 2006). Coralligenous assemblages show a stratified structure with encrusting Corallinales colonised by prostrate and erect algae and sessile invertebrates (Ballesteros, 2006). Coralligenous habitat is one of the most important habitats of the Mediterranean Sea in terms of extension, biodiversity, production and role played in the carbonate cycle (Laborel, 1961, 1987; UNEP, 2007). Moreover, coralligenous assemblages are sensitive to anthropogenic pressure and are considered suitable indicators of the ecological quality of coastal systems (Hong, 1983; Gatti *et al*., 2012; Piazzi *et al*., 2012).

The structure and patterns of spatial and temporal variability of macroalgal and sessile macro-invertebrate assemblages of coralligenous habitat have been widely studied (Boudouresque, 1973; Ferdeghini *et al*., 2000; Cocito *et al*., 2002; Cocito, 2004; Piazzi *et al*., 2004, 2010; Balata *et al*., 2005, 2006; Virgilio *et al*., 2006; Abbiati *et al*., 2009; Piazzi & Balata, 2011; Ponti *et al*., 2011). On the contrary, information about mobile macro-invertebrate assemblages of coralligenous habitat is limited to the knowledge of the species composition of several areas (Bellan, 1964; Laubier, 1966; Hong, 1980, 1982; Huelin & Ros, 1984; Zabala, 1984; Martin, 1987; Jimeno & Turon, 1995; Casellato & Stefanon, 2008), while little is known about patterns of variability. Mobile macro-invertebrates represent an important component of coastal systems and are considered good biological indicators (Teixeira *et al*., 2009). Thus, the knowledge of structure, species composition and patterns of temporal and spatial variability of coralligenous macro-invertebrate assemblages is to be considered an important goal for the assessment of the ecological quality of coastal systems. In fact, according to international legislation (Habitats Directive 92/43/CE) and conventions (Barcelona Convention 1995), coralligenous habitat is considered as a habitat of special scientific and biodiversity interest, and is also a “special habitat type” category of the European Marine Strategy Framework Directive (EC, 2008). Thus, each contribution to the knowledge of coralligenous assemblages, especially for less known taxa, may represent an important goal for ecologists.

Mobile hard bottom macro-invertebrate assemblages may change in relation to many factors. Among them, inclination of substrate is recognized as a main cause of changes in structure, composition and spatial variability of benthic assemblages in temperate seas (Benedetti Cecchi *et al*., 2000; Glasby & Connell, 2001). In fact, differences in substratum inclination may cause variations of abiotic factors, such as light availability and sedimentation rates and may influence recruitment or biotic interactions such as predation and competition (Dirnberg, 1993; Goldberg & Forster, 2002). Morphological characteristics of substrate may also affect the distribution of mobile macro-invertebrates, creating refuges and protection from predators (Alexander, 2011). Moreover, the structure of sessile assemblages may deeply influence mobile organisms selecting particular taxa in relation to different morphological features of habitat-forming species (Chemello & Milazzo, 2002; Wikström & Kautsky, 2007; Cacabelos *et al*., 2010).

The aim of this study was to investigate patterns of spatial and temporal variability of mobile macroinvertebrate assemblages associated to coralligenous habitat. In particular, the following hypotheses were tested: the structure of assemblage changes between vertical and horizontal substrata and among dates during a one-year period; the patterns of spatial and temporal variability change in relation to substrate inclination. A multi-factorial sampling design was used to achieve these objectives. Macroalgae and sessile macro-invertebrates were also investigated in order to detect eventual relationships between sessile and mobile assemblages.

Material and Methods

The study was carried out at Pianosa Island, in the Tuscan Archipelago National Park (north-western Mediterranean Sea). The island is far from sewage flows and all activities are forbidden within a stretch of 1.8 km around it. Thus, it may be considered as characterised by pristine ecological conditions. Coralligenous habitat, mostly constituted by the Rhodophyta *Mesophyllum alternans* (Foslie) Cabioch and Mendoza, *Mesophyllum macroblastum* (Foslie) W.H. Adey and *Lithophyllum stictaeforme* (Areshough) Hauck, develops on rocky bottom below 30 meters of depth (Balata & Piazzi, 2008).

Vertical and horizontal rocky bottoms at a depth of 35 meters were sampled at three random dates throughout the year 2011 (May, July and November). Three sites at a distance of 100 m from each other were considered for each inclination and date. At each site, inclination and date, 3 replicate samples of 400 cm^2 were collected by completely removing the surface layer of the bottom using a hammer and chisel, and holding a plastic bag below the sampling plot in order to minimize the loss of organisms. At the laboratory, all organisms were identified. Abundance of sessile invertebrates and seaweeds was evaluated as the surface occupied by vertical projection of organisms and expressed as percentage of sampling surface (Boudouresque, 1971). Abundance of mobile macro-invertebrates was expressed as number of organisms per sample; diversity was evaluated as number of species per sample and as evenness (expressed according to Pielou's index).

Species composition and abundance of both sessile and mobile macro-invertebrate assemblages and species number, evenness and abundance of mobile macroinvertebrates were analysed by Permutational Multivariate Analysis of Variance (PERMANOVA, Anderson, 2001). A 3-way model was used with Inclination (Vertical vs. Horizontal) as the fixed factor; Date (3 levels) as the random factor crossed to Inclination; and Site (3 levels) as the random factor nested in the interaction Inclination x Date. Data were square root transformed before calculation of the Bray Curtis similarity index. Monte-Carlo procedures were used when the permutation number was less than 999. The SIMPER method was used to identify the taxa contributing most to the differences among conditions (Clarke & Warwick, 1994).

Results

A total of 86 seaweed species (8 Chlorophyta, 11 Ochrophyta, 67 Rhodophyta) and 162 sessile macro-invertebrates (40 Porifera, 19 Cnidaria, 13 Bivalvia, 30 sessile Polychaeta, 50 Bryozoa, 7 Echinodermata, 3 Ascidiacea) were identified. PERMANOVA analysis applied to sessile assemblages showed significant differences between horizontal and vertical assemblages and among sites, while no significant differences were detected among sampling dates (Table 1). The SIMPER test showed that most seaweeds (the Chlorophyta *Flabellia petiolata* and *Halimeda tuna* and the Rhodophyta *Peyssonnelia* spp., *Womersleyella setacea*, *Osmundea pelagosae*, *Acrodiscus vidovichii*, *Laurencia chondrioides* and *Meredithia microphylla*) and the hydroid *Eudendrium rameum* were more abundant on horizontal bottoms, while most animals (the Bryozoa *Pentapora fascialis*, *Myriapora truncata*, *Smittina cervicornis*, *Schizobrachiella sanguinea* and *Cradoscrupocellaria reptans,* the Anthozoa *Parazoanthus axinellae*, *Leptopsammia pruvoti* and *Eunicella cavolini*, the Porifera *Penares euastrum*, *Agelas oroides* and *Dictyonella incisa*) and the Chlorophyta *Palmophyllum crassum* were more abundant on vertical bottoms (Table 2).

A total of 235 mobile macro-invertebrate taxa were identified, among them 2 Platyhelminthes, 4 Sipuncula, 6 Nemertea, 27 Mollusca, 86 Polychaeta, 102 Arthropoda

Table 1. Results of PERMANOVA analysis on species composition and abundance of sessile coralligenous assemblages of Pianosa Island. Significant effects are in bold.

Source	df	MS	Pseudo-F	P(MC)	perms
Inclination = I	1	11950	39.61	**0.00**1	995
Date = D	2	567	0.60	0.86	997
I × D	2	301	0.32	0.992	997
Site(I × D)	12	932	17.16	**0.001**	996
Residual	36	543			
Total	53				

Table 2. Results of the SIMPER test showing sessile organisms mostly responsible for differences between assemblages of horizontal (H) and vertical (V) bottoms.

TAXA	Phylum	R(%) H	R(%) V	Contrib% 40.22
Peyssonnelia spp.	Rhodophyta	57.87	41.3	11.8
Flabellia petiolata (Turra) Nizamuddin	Chlorophyta	12.09	6.20	9.99
Halimeda tuna (J. Ellis e*t* Solander) J.V. Lamouroux	Chlorophyta	8.46	4.41	9.10
Pentapora fascialis (Pallas, 1766)	Bryozoa	2.70	7.41	5.05
Penares euastrum (Schmidt, 1868)	Porifera	1.34	5.63	4.86
Womersleyella setacea (Hollenberg) R.E. Norris	Rhodophyta	4.82	0.39	4.61
Osmundea pelagosae (Schiffner) F.W. Nam	Rhodophyta	5.19	1.71	4.44
Myriapora truncata (Pallas, 1766)	Bryozoa	0.33	4.24	4.04
Agelas oroides (Schmidt, 1864)	Porifera	1.78	3.74	3.42
Smittina cervicornis (Pallas, 1766)	Bryozoa	0.84	3.94	3.35
Dictyonella incisa (Schmidt, 1880)	Porifera	0.80	3.59	3.13
Parazoanthus axinellae (Schmidt, 1862)	Cnidaria	0	2.54	2.72
Leptopsammia pruvoti Lacaze-Duthiers, 1897	Cnidaria	0	2.27	2.34
Schizobrachiella sanguinea (Norman, 1868)	Bryozoa	1.62	3.26	2.23
Palmophyllum crassum (Naccari) Rabenhorst	Chlorophyta	0	2.00	2.09
Acrodiscus vidovichii (Meneghini) Zanardini	Rhodophyta	2.02	0.16	2.04
Laurencia chondrioides Børgesen	Rhodophyta	1.68	0.50	1.76
Meredithia microphylla (J. Agardh) J. Agardh	Rhodophyta	1.80	2.04	1.68
Cradoscrupocellaria reptans (Linnaeus, 1758)	Bryozoa	0.27	1.67	1.57
Eudendrium rameum (Pallas, 1766)	Cnidaria	1.07	0.83	1.52
Eunicella cavolini (Koch, 1887)	Cnidaria	0	1.26	1.50

(51 Amphipoda, 25 Decapoda, 2 Tanaidacea, 9 Isopoda, 2 Picnogonida), 8 Echinodermata (Table 3).

The mean number of organisms per sample was higher on horizontal than on vertical bottom, while evenness showed an opposite pattern; no significant differences were detected among dates. No significant differences were detected for mean species number in relation to inclination and date (Table 4, Fig. 1).

PERMANOVA analysis applied to mobile macro-invertebrate assemblages showed a significant Inclination x Date interaction (Table 5). The pair-wise test showed that vertical and horizontal assemblages differed only at one date. Differences among sites were also significant (Table 5).

Discussion

Results of the study showed that mobile macro-invertebrate assemblages of coralligenous habitat were occasionally influenced by the inclination of substrate, while they showed high variability at the spatial scale examined.

The mobile macro-invertebrate assemblages of Pianosa Island showed high values of species richness and comparable with those reported for coralligenous assemblages of other Mediterranean Sea areas (Bellan, 1964; Laubier, 1966; Hong, 1980; Huelin & Ros, 1984; Martin, 1987). A high diversity of coralligenous mobile macro-invertebrate assemblages may be related to the morphology of substrate. In fact, encrusting Corallinales generate physical structures modifying the complexity of bottom and providing space and microhabitats for associated organisms (Cocito, 2004). Increased spatial heterogeneity allows a high number of organisms to share the same space. Moreover, a higher availability of refuges offers valuable protection from predation, water movements and light irradiance (Alexander, 2011).

The most abundant taxa in the studied assemblages were Polychaeta, Mollusca and Crustacea, mostly Amphipoda and Decapoda. Coralligenous habitat may be considered suitable for sessile and mobile polychaetes because of the high structural complexity of concretion and the availability of food related to the role of trapping organic matter of calcareous structures (Bellan, 1964; Laubier, 1966; Hong, 1980; Martin, 1987). Molluscs found in this study were less abundant than those reported for the coralligenous habitat of other areas (Laubier, 1966; Hong, 1980; Huelin & Ros, 1984), while crustaceans represented a main component of Pianosa assemblages. Calcareous structures may represent a suitable habitat for cryptic Decapoda, as shown by the high number of species found during this study and reported by other authors (Laubier, 1966; Hong, 1980; Garcia-Raso & Fernandez Munoz, 1987). Decapoda assemblages of coralligenous habitat are not considered peculiar in comparison with other sciafilous coastal assemblages. However, several species particularly related to calcareous Corallinales were found at Pianosa Island, such as *Alpheus dentipes*, *Athanas nitescens*, *Pilumnus hirtellus*, *Pilumnus spinifer*, *Galathea intermedia* (Garcia-Raso,

Table 3. List of taxa of macro-invertebrate assemblages. H = horizontal bottom, V = vertical bottom, D1, D2, D3 = sampling dates.

TAXA	H			V		
	D1	D2	D3	D1	D2	D3
PLATYHELMINTHES						
Leptoplana tremellaris (Müller OF, 1773)	+	+	+	+	+	+
Notoplana alcinoi (Schmidt, 1862)	+	+	+	+	+	+
SIPUNCULA						
Aspidosiphon (Aspidosiphon) muelleri muelleri Diesing, 1851	+	+	+	+	+	+
Golfingia (Golfingia) vulgaris vulgaris(De Blainville, 1827)	+	+	+	+	+	+
Phascolion (Phascolion) strombus strombus (Montagu, 1804)	+	+	+	+	+	+
Phascolosoma (Phascolosoma) granulatum Leuckart, 1828	+	+	+	+	+	+
NEMERTEA						
Amphiporus lactifloreus (Johnston, 1828)	+	+	+	+	+	+
Cerebratulus fuscus (McIntosh, 1874)	-	-	+	+	+	+
Leucocephalonemertes aurantiaca (McIntosh, 1874)	+	+	+	+	+	+
Micrura purpurea (Dalyell, 1853)	-	-	-	-	-	+
Nipponnemertes pulcher (Johnston, 1837)	+	+	+	+	+	+
Punnettia splendida (Keferstein, 1862)	-	-	-	-	+	+
MOLLUSCA						
Polyplacophora						
Acanthochitona crinita (Pennant, 1777)	-	-	+	-	-	-
Gastropoda						
Alvania cimex (Linnaeus, 1758)	-	-	-	-	-	+
Alvania discors (Allan, 1818)	+	+	-	-	-	-
Bittium latreillii (Payraudeau, 1826)	+	+	+	+	+	+
Bittium reticulatum (da Costa, 1778)	+	+	+	+	+	+
Bolma rugosa (Linnaeus, 1767)	-	-	-	-	+	-
Bosellia mimetica Trinchese, 1891	-	+	-	-	-	-
Calliostoma granulatum (Born, 1778)	-	-	-	-	-	+
Chauvetia mamillata (Risso, 1826)	+	+	+	-	+	-
Columbella rustica (Linnaeus, 1758)	-	+	-	-	-	-
Coralliophila meyendorffii (Calcara, 1845)	-	+	-	-	-	-
Cuthona caerulea (Montagu, 1804)	+	-	-	-	-	-
Fusinus syracusanus (Linnaeus, 1758)	-	-	-	-	+	-
Hermaea variopinta (A. Costa, 1869)	+	-	-	-	-	-
Hero blanchardi Vayssière, 1888	-	-	-	+	-	-
Homalopoma sanguineum (Pruvot-Fol, 1951)	+	+	+	+	+	+
Jujubinus exasperatus (Dautzenberg, 1881)	+	-	-	+	+	-
Jujubinus striatus (Linnaeus, 1758)	+	+	-	-	-	-
Muricopsis cristata (Olivi, 1792)	+	+	+	+	+	+
Ocinebrina edwardsii (Born, 1778)	+	-	-	-	-	-
Pollia dorbignyi (Payraudeau, 1826)	-	-	-	-	+	-
Raphitoma linearis (Montagu, 1803)	-	+	+	-	-	+
Raphitoma purpurea (Montagu, 1803)	-	-	-	-	-	+
Rissoa variabilis (Von Mühlfeldt, 1824)	-	-	-	-	-	+
Rissoa violacea Desmarest, 1814	-	-	-	-	-	+
Rissoina bruguieri (Payraudeau, 1826)	-	-	-	-	-	+
Vexillum (Pusiolina) tricolor (Gmelin, 1791)	-	-	+	-	-	-
ANNELIDA (Polychaeta)						
Amblyosyllis formosa (Claparède, 1863)	+	-	-	-	-	-
Aphrodita aculeata Linnaeus, 1758	+	-	-	-	-	-
Ceratonereis (Composetia) costae (Grube, 1840)	-	+	-	+	-	-
Ceratonereis (Composetia) hircinicola (Eisig, 1870)	+	-	-	-	-	-
Chrysopetalum debile (Grube, 1855)	-	-	-	+	-	-
Dorvillea rubrovittata (Grube, 1855)	+	+	-	+	-	-
Drilonereis filum (Claparède, 1868)	-	-	+	-	-	-
Eumida sanguinea (Örsted, 1843)	+	+	-	-	-	-
Eunice floridana (Pourtalès, 1867)	+	-	-	+	-	-
Eunice oerstedi Stimpson, 1853	-	+	-	-	+	-
Eunice pennata (O.F. Müller, 1776)	-	-	+	-	-	-
Eunice schizobranchia Claparède, 1870	-	-	-	-	-	+
Eunice vittata (Delle Chiaje, 1828)	+	+	+	+	+	+

(continued)

Table 3 (continued)

TAXA	H			V		
	D1	D2	D3	D1	D2	D3
Euphrosine foliosa Audouin & Milne Edwards, 1833	-	+	-	+	+	-
Eusyllis assimilis Marenzeller, 1875	-	+	-	-	-	-
Eusyllis blomstrandi Malmgren, 1867	-	-	-	-	-	+
Eusyllis lamelligera Marion & Bobretzky, 1875	-	-	-	-	-	+
Glycera capitata Örsted, 1843	-	+	-	-	-	-
Glycera rouxi Audouin & Milne Edwards, 1833	-	-	-	+	-	-
Glycera tesselata Grube, 1840	+	+	+	+	+	+
Goniada emerita Audouin & Milne Edwards, 1833	-	+	-	-	-	-
Haplosyllis spongicola (Grube, 1855)	+	-	-	-	+	-
Harmothoe areolata (Grube, 1860)	-	+	-	-	+	-
Harmothoe extenuata (Grube, 1840)	+	-	+	-	-	-
Harmothoe imbricata (Linnaeus, 1767)	-	-	+	-	-	-
Harmothoe impar (Johnston, 1839)	+	-	-	-	-	-
Harmothoe spinifera (Ehlers, 1864)	-	-	+	+	-	-
Hesiospina aurantiaca (M. Sars, 1862)	+	-	-	-	-	-
Hilbigneris gracilis (Ehlers, 1868)	+	-	+	+	-	-
Kefersteinia cirrata (Keferstein, 1862)	+	+	+	+	+	+
Leocrates claparedii (Costa in Claparède, 1868)	+	-	-	-	-	-
Leodice harassii Audouin & Milne Edwards, 1833	+	+	+	+	+	+
Leodice torquata (Quatrefages, 1866)	-	+	+	-	+	-
Lepidonotus squamatus (Linnaeus, 1758)	-	-	+	-	-	-
Lumbrineris coccinea (Renier, 1804)	+	+	+	+	+	+
Lumbrineris impatiens Claparède, 1868	-	-	-	+	-	+
Lumbrineris latreilli Audouin & Milne Edwards, 1834	-	-	+	+	+	-
Lumbrineris tetraura (Schmarda, 1861)	-	-	+	-	-	-
Lysidice collaris Grube, 1870	+	-	+	-	-	+
Lysidice hebes Verril, 1900	+	+	+	+	-	-
Lysidice ninetta Audouin & Milne Edwards, 1833	+	+	+	+	+	+
Malmgreniella lunulata (Delle Chiaje, 1830)	-	-	-	+	-	-
Marphysa bellii (Audouin & Milne Edwards, 1833)	-	-	-	+	-	-
Marphysa fallax Marion & Bobretzky, 1875	-	+	-	-	+	+
Mysta picta (Quatrefages, 1865)	+	-	-	+	-	+
Neanthes agulhana (Day, 1963)	-	-	-	-	+	-
Neanthes fucata (Savigny in Lamarck, 1818)	+	-	-	-	+	-
Neanthes irrorata (Malmgren, 1867)	-	+	-	-	+	-
Nereis falsa Quatrefages, 1866	-	+	-	-	-	-
Nereis pelagica Linnaeus, 1758	-	-	-	-	+	-
Nereis rava Ehlers, 1864	+	-	-	+	+	-
Nereis zonata Malmgren, 1867	-	-	+	+	+	-
Odontosyllis ctenostoma Claparède, 1868	-	-	-	+	-	-
Odontosyllis cucullata (McIntosh, 1908)	-	+	-	-	-	-
Palola siciliensis (Grube, 1840)	+	-	-	+	-	-
Perinereis cultrifera (Grube, 1840)	+	+	-	+	-	-
Perinereis macropus (Claparède, 1870)	+	+	-	-	-	-
Pionosyllis lamelligera Saint Joseph, 1887	+	+	-	+	-	-
Pionosyllis longocirrata Saint Joseph, 1887	+	-	-	-	-	-
Pirakia punctifera (Grube, 1860)	+	-	-	-	-	-
Platynereis coccinea (Delle Chiaje, 1822)	+	+	+	+	+	+
Platynereis dumerilii (Audouin & Milne Edwards, 1833)	+	+	+	+	+	+
Polynoe scolopendrina Savigny, 1822	-	+	-	-	-	+
Polyophthalmus pictus (Dujardin, 1839)	-	-	-	+	+	-
Pontogenia chrysocoma (Baird, 1865)	+	-	-	-	-	-
Salvatoria limbata Claparède, 1868	-	-	-	-	+	-
Subadyte pellucida (Ehlers, 1864)	-	+	-	+	+	-
Syllides fulvus (Marion & Bobretzky, 1875)	-	-	-	-	-	+
Syllides longocirratus (Örsted, 1845)	-	-	-	-	-	+
Syllis amica Quatrefages, 1866	-	+	-	-	-	+
Syllis armillaris (O. F. Müller, 1776)	+	-	-	+	+	+
Syllis corallicola Verril, 1900	+	-	-	+	+	-
Syllis cornuta Rathke, 1843	-	+	-	-	+	-
Syllis garciai (Campoy, 1982)	+	+	+	+	+	+

(continued)

Table 3 (continued)

TAXA	H			V		
	D1	D2	D3	D1	D2	D3
Syllis gerlachi (Hartmann-Schröder, 1960)	-	-	+	+	-	-
Syllis gracilis Grube, 1840	-	+	-	-	+	+
Syllis hyalina Grube, 1863	+	+	+	+	+	+
Syllis krohni Ehlers, 1864	+	+	-	+	+	-
Syllis prolifera Krohn, 1852	+	-	-	-	-	-
Syllis rosea (Langerhans, 1879)	-	-	+	-	-	+
Syllis variegata Grube, 1860	+	+	+	+	+	+
Syllis vivipara Krohn, 1869	-	+	-	-	+	-
Trypanoyllis (Trypanosyllis) coeliacas Claparède, 1868	-	+	-	-	-	-
Xenosyllis scabra (Ehlers, 1864)	-	-	-	+	-	-
ARTHROPODA (CRUSTACEA)						
Malacostraca						
Decapoda						
Achaeus cranchii Leach, 1817	+	-	-	-	-	-
Alpheus dentipes Guérin, 1832	+	+	+	+	+	+
Alpheus macrocheles (Hailstone, 1835)	+	+	+	+	+	+
Athanas nitescens (Leach, 1813)	+	+	+	+	+	+
Calcinus tubularis (Linnaeus, 1767)	+	-	-	+	-	-
Cestopagurus timidus (Roux, 1830)	+	+	+	+	+	+
Clibanarius erythropus (Latreille, 1818)	-	+	-	-	-	-
Ebalia edwardsii Costa, 1838	-	-	+	-	-	-
Eualus cranchii (Leach, 1817)	+	+	+	+	+	+
Eurynome aspera (Pennant, 1777)	-	-	-	-	+	-
Galathea strigosa (Linnaeus, 1761)	+	+	+	+	+	+
Galathea intermedia Liljeborg, 1851	-	-	-	-	-	+
Liocarcinus pusillus (Leach, 1816)	-	+	-	-	-	-
Lysmata seticaudata (Risso, 1816)	-	-	+	-	-	-
Macropodia linaresi Forest & Zariquiey Alvarez, 1964	+	+	-	-	-	-
Macropodia rostrata (Linnaeus, 1761)	-	-	-	-	+	-
Macropodia tenuirostris (Leach, 1814)	-	+	-	+	+	-
Pagurus anachoretus Risso, 1827	+	+	+	+	+	+
Pilumnus hirtellus (Linnaeus, 1761)	+	+	+	+	+	+
Pilumnus spinifer H. Milne Edwards, 1834	-	+	-	-	-	-
Pilumnus villosissimus (Rafinesque, 1814)	-	-	+	-	-	-
Pisa nodipes (Leach, 1815)	+	-	-	-	-	-
Processa macrophthalma Nouvel & Holthuis, 1957	-	-	-	-	+	-
Synalpheus gambarelloides (Nardo, 1847)	-	-	-	-	-	+
Tanaidacea						
Leptochelia savignyi (Kroyer, 1842)	+	-	-	-	-	-
Tanais dulongii (Audouin, 1826)	-	-	+	+	-	-
Isopoda						
Cymodoce truncata Leach, 1814	-	-	-	+	-	-
Dynamene edwardsi (Lucas, 1849)	+	-	-	-	-	+
Eurydice pulchra Leach, 1815	-	-	-	+	-	+
Eurydice truncata (Norman, 1868)	-	-	-	+	-	-
Gnathia vorax (Lucas, 1849)	-	-	-	-	+	-
Ianiropsis breviremis (Sars, 1883)	-	+	-	-	+	-
Idotea emarginata (Fabricius, 1793)	-	-	-	-	-	+
Jaera (Jaera) hopeana Costa, 1853	-	-	-	-	-	+
Joeropsis brevicornis brevicornis Koehler, 1885	-	-	+	+	-	-
Amphipoda						
Ampelisca rubella A. Costa, 1864	-	-	+	-	-	-
Ampelisca tenuicornis Liljeborg, 1855	-	+	-	-	-	-
Ampithoe ramondi Audouin, 1826	+	+	+	+	+	+
Ampithoe riedli Krapp-Schickel, 1968	-	+	-	-	-	-
Apherusa alacris Krapp-Schickel, 1969	-	-	+	-	-	-
Apherusa mediterranea Chevreux 1911	-	+	-	-	-	+
Apherusa chiereghinii Giordani- Soika, 1949	-	-	+	-	-	-
Apocorophium acutum (Chevreux, 1908)	-	-	-	-	-	+

(continued)

Table 3 (continued)

TAXA	H			V		
	D1	D2	D3	D1	D2	D3
Apolochus neapolitanus (Della Valle, 1893)	-	-	+	+	-	-
Atylus guttatus (A. Costa, 1851)	-	+	-	-	-	-
Atylus swammerdami (Milne-Edwards, 1830)	-	+	-	-	-	-
Autonoe spiniventris Della Valle, 1893	-	-	-	-	+	-
Caprella acanthifera Leach, 1814	-	-	+	+	-	-
Caprella cavediniae Krapp-Schickel & Vader, 1998	-	-	-	+	-	-
Caprella lilliput Krapp-Schickel & Ruffo, 1987	-	-	-	-	-	+
Ceradocus (Ceradocus) orchestiipes Costa, 1853	-	-	-	-	+	-
Dexamine spiniventris (Costa, 1853)	+	+	+	+	+	+
Dexamine spinosa (Montagu, 1813)	+	+	+	+	+	+
Elasmopus pocillimanus (Bate, 1862)	-	-	-	+	+	-
Elasmopus rapax Costa, 1853	-	-	+	-	+	-
Ericthonius punctatus (Bate, 1857)	-	-	+	-	-	+
Gammaropsis crenulata Krapp-Schickel & Myers 1979	-	+	+	-	-	-
Gammarus aequicauda (Martynov, 1931)	-	-	-	-	-	+
Gammarus crinicornis Stock, 1966	-	+	-	-	+	+
Guernea (Guernea) coalita (Norman, 1868)	-	-	-	+	-	-
Harpinia dellavallei Chevreux, 1910	-	-	+	-	-	+
Hippomedon ambiguus Ruffo, 1946	-	-	-	-	+	+
Hyale schmidti (Heller, 1866)	-	-	+	-	+	-
Ichnopus spinicornis Boeck, 1861	-	-	-	-	+	-
Iphimedia gibbula Ruffo & Schiecke, 1979	-	-	+	-	-	-
Leptocheirus bispinosus Norman, 1908	+	-	-	-	+	-
Leptocheirus guttatus (Grube, 1864)	-	-	+	-	-	+
Leptocheirus pectinatus (Norman, 1869)	+	-	-	+	+	-
Leucothoe occulta Krapp-Schickel, 1975	-	+	-	-	-	-
Leucothoe spinicarpa (Abildgaard, 1789)	-	+	+	-	-	+
Liljeborgia dellavallei Stebbing, 1906	+	-	-	-	-	+
Lysianassa costae (Milne-Edwards, 1830)	-	-	+	-	-	+
Lysianassina longicornis Lucas, 1849	-	-	+	+	-	-
Maera ariadne Krapp, Marti & Ruffo, 1996	-	-	+	-	-	-
Maera grossimana (Montagu, 1808)	+	-	-	-	-	-
Maera inaequipes (Costa, 1857)	-	+	+	-	-	+
Orchomene humilis (A. Costa, 1853)	-	+	-	-	+	-
Pardia punctata (Costa, 1851)	-	+	-	-	-	-
Perrierella audouiniana (Bate, 1857)	+	-	-	+	-	-
Phtisica marina Slabber, 1769	-	-	+	+	-	+
Pseudoprotella phasma Montagu, 1804	-	-	-	+	-	+
Rhinolabia parthenopeia Ruffo, 1971	+	-	-	-	-	-
Stenothoe eduardi Krapp Schickel, 1975	-	-	-	-	-	+
Tryphosella simillima Ruffo, 1985	-	+	-	-	-	-
Urothoe pulchella (Costa, 1853)	-	-	+	-	-	-
Pycnogonida						
Achelia echinata Hodge, 1864	+	-	-	-	+	+
Callipallene emaciata (Dohrn, 1881)	-	-	+	+	-	-
Copilia mediterranea (Claus, 1863)	-	-	-	-	-	+
ECHINODERMATA						
Asteroidea						
Asterina gibbosa (Pennant, 1777)	-	-	+	-	+	-
Echinoidea						
Echinocyamus pusillus (O. F. Müller, 1776)	-	-	-	-	+	-
Psammechinus microtuberculatus (Blainville, 1825)	-	-	-	-	-	+
Ophiuroidea						
Amphipholis squamata (Della Chiaje, 1828)	+	-	+	-	+	+
Amphiura chiajei Forbes, 1843	+	-	+	-	+	-
Ophiopsila aranea Forbes, 1843	-	-	-	+	-	-
Ophiothrix fragilis (Abildgaard, in O. F. Müller, 1789)	+	-	-	+	+	+
Ophiotrix quinquemaculata (Delle Chiaje, 1828)	-	-	-	-	+	-

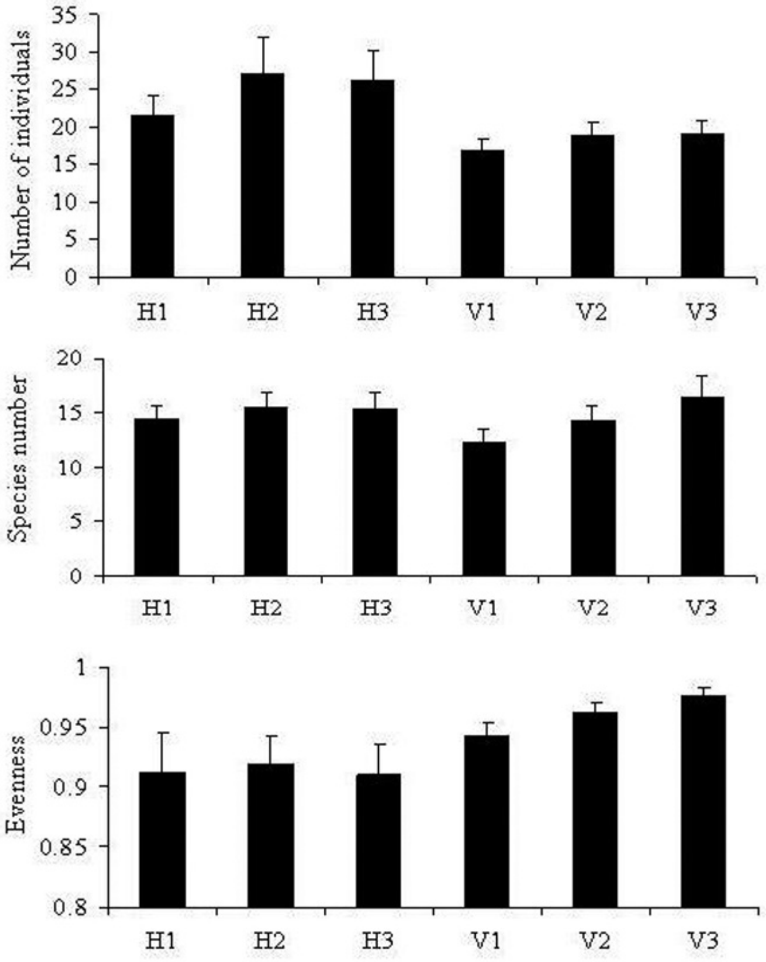

Fig. 1: Number of individuals (a), number of species (b) and evenness (c) of mobile macro-invertebrate assemblages of coralligenous habitat. H: horizontal bottom; V: vertical bottom. Numbers are referred to sampling dates (mean±ES, n=9).

Table 4. Results of PERMANOVA analysis on abundance, species number and evenness of mobile macro-invertebrate assemblages of coralligenous habitat of Pianosa Island. Significant effects are in bold.

		Number of organisms		**Species number**		**Eveness**	
Source	**df**	**Pseudo-F**	**P(MC)**	**Pseudo-F**	**P(MC)**	**Pseudo-F**	**P(MC)**
Inclination = I	1	140.41	**0.005**	0.90	0.445	23.75	**0.036**
Date = D	2	0.33	0.745	0.68	0.55	0.45	0.674
I x D	2	0.26	0.997	0.39	0.683	0.40	0.699
Site(IxD)	12	37.64	**0.003**	34.53	**0.002**	0.81	0.659
Residual	36						
Total	53						

Table 5. Results of PERMANOVA analysis on species composition and abundance of mobile macro-invertebrate assemblages of coralligenous habitat of Pianosa Island. H = horizontal bottom, V = vertical bottom, D1, D2, D3 = sampling dates. Significant effects are in bold.

Source	**df**	**MS**	**Pseudo-F**	**P(MC)**	**perms**
Inclination = I	1	7090	0.87	0.598	995
Date = D	2	11962	33.98	**0.001**	997
I x D	2	8107	23.07	**0.001**	997
Site(IxD)	12	3468	14.11	**0.001**	996
Residual	36	2457			
Total	53				
Pair-wise test (IxD)					
H, V P(MC):		D1=0.108**,**	D2=0.067,	D3=**0.008**	

1988). Amphipods are more associated with erect seaweeds, hydroids, sponges and bryozoans than Corallinales (Bellan-Santini, 1998); the high number of amphipods in the studied assemblages may be related to the presence of algal taxa with a three dimensional organization, suitable to host specialized amphipods, such as *Laurencia chondrioides, Osmundea pelagosae, Flabellia petiolata* and *Halimeda tuna*.

Differences in the structure of coralligenous sessile assemblages related to substrate orientation have been described previously (Virgilio *et al*., 2006). A higher abundance of seaweeds on horizontal substrate and of animals on vertical substrate is considered a common pattern (Balata *et al*., 2005, 2007), but it was particularly evident in this study where the ratio between percentage cover of seaweeds and animals was 8.5 on horizontal substrate and 1.9 on vertical substrate. Differences between sessile assemblages on horizontal and vertical substrate could be related to differences in environmental conditions such as light intensity and sediment deposition, but also to differences in recruitment linked to the different settling requirements of larvae and spores (Goldberg & Forster, 2002). These differences may be alleviated in areas subjected to environmental stress, such as pollution or high sedimentation (Balata *et al*., 2007), but they may be more significant under pristine conditions such as those characterizing Pianosa Island.

Differences in sessile assemblages were not coupled with mobile epifauna that showed small differences related to substrate inclination and limited to one sampling date. Mobile organisms may be directly influenced by substrate inclination, in relation to differences in environmental conditions, but also indirectly, as different sessile assemblages may host different associated mobile organisms (Russo, 1990; Viejo, 1999; Gestoso *et al*., 2011). However, in this study the main mobile species were distributed on both substrata and differences in assemblages were mostly due to a high abundance of organisms on horizontal bottom than to a difference in species composition. Mobile macro-invertebrates are probably more influenced by micro topography of habitat, such as rugosity or three dimensional bottom morphology (Alexander, 2011) than to larger morphological characteristics such as inclination of substrate. The morphological characteristics of macroalgae may influence associated mobile organisms (Chemello & Milazzo, 2002; Cacabelos *et al*., 2010), but in the studied assemblages the main macroalgal species (*Halimeda tuna, Flabellia petiolata, Osmundea pelagosae*) were distributed on both substrata, even if with different percentage cover. Moreover, the high spatial variability among sites may be partially responsible for the lack of significant differences between assemblages. Coralligenous sessile assemblages show higher variability at the scale of a few meters, due to the patchy distribution of organisms, and they are more homogeneous at scales of 100s and 1000s of meters (Ferdeghini *et al*., 2000; Piazzi *et al*., 2004). Mobile macro-invertebrates also showed high variability among distant sites (100s of meters). Further appropriate investigations are needed to understand the main scales of variation of mobile organisms in coralligenous habitat.

Mobile macro-invertebrates assemblages in Mediterranean shallow rocky habitat are characterised by important seasonal dynamics due to both the life cycle of organisms and modifications in the morphology of habitat caused by changes in macroalgal composition and/or thallus morphology (Arrontes & Anadón, 1990; Fraschetti *et al*., 2002). In coralligenous habitat, temporal variability was less evident. The total abundance and patterns of diversity of mobile assemblages were steady throughout the study period and differences among dates appeared to be related mostly to changes in relative abundance of polychaetes, crustaceans and molluscs. The lack of differences in sessile assemblages, mostly constituted by animals or perennial algal species, may lead to smaller temporal variability of mobile associated organisms.

The study provided a contribution to the knowledge of coralligenous habitat through the description of less studied mobile macro-invertebrate assemblages, showing interesting patterns of spatial and temporal variability. However, large-scale investigations may be necessary for a more complete knowledge of the structure and patterns of variation of these assemblages.

Acknowledgements

We are grateful to A. Giangrande, R. Pronzato and T. Krapp for their help in the determination of some doubtful taxa. We wish to thank the Coop Ormeggio of Piombino for logistic assistance. The study was supported by the Italian National Research Council (CNR) and Regione Toscana ("Tuscan Check" Project).

References

Abbiati, M., Airoldi, L., Costantini, F., Fava, F., Ponti, M. *et al.,* 2009. Spatial and temporal variation of assemblages in Mediterranean coralligenous reefs. p. 34-40. In: *Proceedings of the 1st Symposium on the Coralligenous and other calcareous bio-concretions of the Mediterranean Sea (Tabarka, 15-16 January 2009).*

Alexander, T.J., 2011. *Responses of temperate mobile macroinvertebrates to reef habitat structure and protection from fishing*. Unpublished PhD Thesis, University of Tasmania.

Anderson, M.J., 2001. A new method for a non-parametric multivariate analysis of variance. *Austral Ecology*, 26, 32-46.

Arrontes, J., Anadón, R., 1990. Seasonal variation and population dynamics of isopods inhabiting intertidal macroalgae. *Scientia Marina*, 54, 231-240.

Balata, D., Piazzi, L., 2008. Patterns of diversity in rocky subtidal macroalgal assemblages in relation to depth. *Botanica Marina*, 51, 464-471.

Balata, D., Piazzi, L., Cecchi, E., Cinelli, F., 2005. Variability of

Mediterranean coralligenous assemblages subject to local variation in sediment deposits. *Marine Environmental Research*, 60, 403-421.

Balata, D., Acunto, S., Cinelli, F., 2006. Spatio-temporal variability and vertical distribution of a low rocky subtidal assemblage in the north-west Mediterranean. *Estuarine Coastal and Shelf Sciences*, 67, 553-561.

Balata, D., Piazzi, L., Benedetti-Cecchi, L., 2007. Sediment disturbance and loss of beta diversity on subtidal rocky reefs. *Ecology*, 8, 2455-2461.

Ballesteros, E., 2006. Mediterranean coralligenous assemblages: a synthesis of present knowledge. *Oceanography and Marine Biology: An Annual Review*, 44, 123-195.

Bellan, G., 1964. *Contribution à l'étude systématique, bionomique et écologique des annélides polychètes de la Méditerranée*. These Doctorat. Faculte Sciences Marseille.

Bellan-Santini, D., 1998. Ecology. In *The Amphipoda of the Mediterranean, Part 4*, S. Ruffo (ed.). *Mémoires de l'Institut Océanographique (Monaco)* 13, 869-894.

Benedetti-Cecchi, L., Bulleri, F., Cinelli, F., 2000. The interplay of physical and biological factors in maintaining mid-shore and low-shore assemblages on rocky coasts in the north-west Mediterranean. *Oecologia*, 123, 406-417.

Boudouresque, C.F., 1971. Méthodes d'étude qualitative et quantitative du benthos (en particulier du phytobenthos). *Tethys*, 3, 79-104.

Boudouresque, C.F., 1973. Recherche de bionomie analytique structurale et expérimentale sur les peuplements benthiques sciaphiles de Méditerranée occidentale (fraction algale). Les peuplements sciaphiles de mode relativement calme sur substrats durs. *Bulletin du Muséum d'Histoire Naturelle de Marseille*, 33, 147-225.

Cacabelos, E., Olabarria, C., Incera, M., Troncoso, J.S., 2010. Effects of habitat structure and tidal height on epifaunal assemblages associated with macroalgae. *Estuarine Coastal and Shelf Sciences*, 89, 43-52.

Casellato, S., Stefanon, A., 2008. Coralligenous habitat in the northern Adriatic Sea: an Overview *Marine Ecology*, 29, 321-341.

Chemello, R., Milazzo, M., 2002. Effect of algal architecture on associated fauna: some evidence from phytal molluscs. *Marine Biology*, 140, 981-990.

Clarke, K.R., Warwick, R.M., 1994. *Changes in marine communities: an approach to statistical analysis and interpretation.* Natural Environment Research Council, Plymouth UK, pp. 144.

Cocito, S., 2004. Bioconstruction and biodiversity: their mutual influence. *Scientia Marina*, 68, 137-144.

Cocito, S., Bedulli, D., Sgorbini, S., 2002. Distribution patterns of the sublittoral epibenthic assemblages on a rocky shoal in the Ligurian Sea (NW Mediterranean). *Scientia Marina*, 66, 175-181.

Dirnberg, J.M., 1993. Dispersal of larvae with a short planktonic phase in the polichaete Spirorbis spirillum (Linnaeus). *Bulletin of Marine Science*, 52, 898-910.

EC., 2008. *DIRECTIVE 2008/56/EC of the European Parliament and of the Council, of 17 June 2008, establishing a framework for Community action in the field of marine environmental policy (Marine Strategy Framework Directive).* Official Journal of the European Commission, G.U.C.E. 25/6/2008, L 164/19.

Fraschetti, S., Giangrande, A., Terlizzi, A., Miglietta, M., Della Tommasa, L. *et al.,* 2002. Spatio-temporal variation of hydroids and polychaetes associated with *Cystoseira amentacea* (Fucales: Phaeophyceae). *Marine Biology*, 140, 949-957.

Ferdeghini, F., Acunto, S., Cocito, S., Cinelli, F., 2000. Variability at different spatial scales of a coralligenous assemblage at Giannutri island (Tuscan Arcipelago, northwestern Mediterranean). *Hydrobiologia*, 440, 27-36.

Garcia-Raso, J.E., 1988. Consideraciones generales sobre la taxocenosis de crustaceos decapodos de fondos de concrecionamiento calcareo superficial del alga *Mesophyllum lichenoides* (Ellis & Sol.) Lemoine (Corallinaceae) del mar de Alboran. *Investigación Pesquera*, 52, 245-264.

Garcia-Raso. J.E., Fernandez-Munoz. R., 1987. Estudio de una comunidad de crustaceos decapodos de fondos "coraligenos" del alga calcarea *Mesophyllum lichenoides* del sur de Espana. *Investigación Pesquera*, 51, 301-322.

Gatti, G., Montefalcone, M., Rovere, A., Parravicini, V., Morri, C. *et al.,* 2012. Seafloor integrity down the harbor waterfront: the coralligenous shoals off Vado Ligure (NW Mediterranean). *Advances in Limnology*, 3, 51-67.

Gestoso, I., Olabarria, C., Troncoso, J.S., 2010. Variability of epifaunal assemblages associated with native and invasive macroalgae. *Marine and Freshwater Researches*, 61, 724-731.

Glasby, T.M., Connell, S.D., 2001. Orientation and position of substrata have large effects on epibiotic assemblages. *Marine Ecology Progress Series*, 214, 127-135.

Goldberg, N.A., Forster, M.S., 2002. Settlement and postsettlement processes limit the abundance of geniculate coralline alga *Calliarthron* on subtidal walls. *Journal of Experimental Marine Biology and Ecology*, 278, 31-45.

Hong, J.S., 1980. *Étude faunistique d'un fond de concrétionnement de type coralligène soumis à un gradient de pollution en Méditerranée nord-occidentale (Golfe de Fos)*. Unpublished These de Doctorat, Universite d'Aix- Marseille II.

Hong, J.S., 1982. Contribution à l'étude des peuplements d'un fond de concrétionnement Coralligène dans la région marseillaise en Méditerranée nord-occidentale. *Bulletin of Korea Ocean Research and Development Institute*, 4, 27-51.

Hong, J.S., 1983. Impact of pollution on the benthic community. Environmental impact of the pollution on the benthic corraligenous community in the Gulf of Fos, northwestern Mediterranean. *Bulletin of Korean Fisheries Society*, 16, 273-290.

Huelin, M.F., Ros, J., 1984. Els molluscs marins de les illes Medes. p. 457-504. In: *Els Sistemes Naturals de les Illes Medes*, J. Ros *et al*. (Eds), Arxius Secció Ciències.

Jimeno, A., Turon, X., 1995. Gammaridea and Caprellidae of the northeast coast of Spain: ecological distribution on different types of substrata. *Polskie Archiwum Hydrobiologii*, 42, 495-516.

Laborel, J., 1961. Le concrétionnement algal "coralligene" et son importance geomorphologique en Méditerranée. *Recueil des Travaux Scientifiques de la Station Marine d'Endoume*, 23, 37-60.

Laborel, J., 1987. Marine biogenic constructions in the Mediterranean, a review. *Scientific Report of Port-Cros National Park*, 13, 97-127.

Laubier, L., 1966. Le coralligène des Albères. Monographie biocenotique. *Annales de l'Institute Oceanographique de Paris*, 43, 137-316.

Martin, D., 1987. La comunidad de anelidos poliquetos de las concreciones de algas calcareas del litoral catalan. Caracterizacion de las especies. *Publicaciones del Departamento de Zoología de la Universidad de Barcelona*, 13, 45-54.

Piazzi, L., Balata, D., 2011. Coralligenous habitat: patterns of vertical distribution of macroalgal assemblages. *Scientia Marina*, 75, 399-406.

Piazzi, L., Balata, D., Pertusati, M., Cinelli, F., 2004. Spatial and temporal variability of Mediterranean macroalgal coralligenous assemblages in relation to habitat and substrate inclination. *Botanica Marina*, 47, 105-115.

Piazzi, L., Balata, D., Cecchi, E., Cinelli, F., Sartoni, G., 2010. Species composition and patterns of diversity of macroalgal coralligenous assemblages of northwester Mediterranean Sea. *Journal of Natural History*, 44, 1-22.

Piazzi, L., Gennaro, P., Balata, D., 2012. Threats to macroalgal coralligenous assemblages in the Mediterranean Sea. *Marine Pollution Bulletin*, 64, 2623-2629.

Ponti, M., Fava, F., Abbiati, M., 2011. Spatial-temporal variability of epibenthic assemblages on subtidal biogenic reefs in the northern Adriatic Sea. *Marine Biology*, 158, 1447-1459.

Russo, A.R., 1990. The role of seaweed complexity in structuring Hawaiian epiphytal amphipod communities. *Hydrobiologia*, 194, 1-12.

Teixeira, H., Magalhães Neto, J., Patrício, J., Veríssimo, H., Pinto, R. *et al.,* 2009. Quality assessment of benthic macroinvertebrates under the scope of WFD using BAT, the Benthic Assessment Tool. *Marine Pollution Bulletin*, 58, 1477-86.

UNEP, 2007. *Draft decision on the "Action plan for the protection of the coralligenous and other calcareous bioconcretions in the Mediterranean".* UNEP (DEPI)/MED WG.320/20, 2 pp + Annex.

Viejo, R.M., 1999. Mobile epifauna inhabiting the invasive *Sargassum muticum* and two local seaweeds on northern Spain. *Aquatic Botany*, 64, 131-149.

Virgilio, M., Airoldi, L., Abbiati, M., 2006. Spatial and temporal variations of assemblages in a Mediterranean coralligenous reef and relationships with surface orientation. *Coral Reefs*, 25, 265-272.

Wikström, S.A., Kautsky, L., 2007. Structure and diversity of invertebrate communities in the presence and absence of canopy-forming *Fucus vesiculosus* in the Baltic Sea. *Estuarine Coastal and Shelf Sciences,* 72, 168-176.

Zabala, M., 1984. Briozous de les illes Medes. p. 537–562. In: *Els Sistemes Naturals de les Illes Medes*, J. Ros *et al.* (Eds), Arxius Secció Ciències.