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A brachiopod biotope associated with rocky bottoms at the shelf-break in the central Mediterranean Sea: geo-biological traits and conservation aspects

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Abstract

1) In the Recent, brachiopods only seldom occur in benthic communities. A biotope dominated by Megerlia truncata was identified in 2013 by Remotely Operated Vehicle (ROV) exploration of the south-easternmost Adriatic margin.

2) Emerging rocky substrates next to the shelf-break at ca. 120 m appear intensely exploited by this eurybathic rhynchonelliformean brachiopod attaining a population of >300 individuals/m².

3) Calcareous red algae are almost ubiquitous at this site and preferentially encrust sectors of the substrate where brachiopods are minimal.

4) This Megerlia biotope is a novel finding for this part of the Mediterranean Sea, similar to a situation previously observed in the Western Basin, off the Mediterranean French coast.

5) It is proposed that this remarkable brachiopod biotope and the adjacent Rhodolith bed are considered important for conservation management.

Keywords: Brachiopoda, Megerlia truncata, Mediterranean Sea, ROV, habitat mapping, natural heritage, conservation

Introduction

Brachiopods have been an important component of the benthic marine realm since the Cambrian (Santagata, 2015; Carlson, 2016). They achieved an astonishing diversity and abundance in the Paleozoic and, Mesozoic, with some 30,000 described species. A net decline took place in the Cenozoic, with ca. 400 species known in the modern ocean (Emig, Bitner, & Álvarez, 2013). At present, rhynchonelliformean brachiopods are prevalently throughout temperate to polar regions (e.g., Foster, 1974; Campbell & Fleming, 1981; Tunnicliffe & Wilson, 1988; Hiller, 1991; Lee, 1991; Roux & Bremec, 1996; Baird, Lee & Lamare, 2013; Emig, 2017; Gordillo, Muñoz, Bayer & Malvé, 2018), and, more rarely, at tropical latitudes (Laurin, 1997; Kowalewski, Simões, Carroll, & Rodland, 2002; Simões, Kowalewski, Mello, Rodland, & Carroll, 2004). These filter-feeders settle on mobile to hard substrates from subtidal to abyssal depths (Emig et al., 2013). Today, as for the past, their occurrence is controlled by oceanographic factors, above all current strength, nutrient availability and oxygen content (Fürsich, & Hurst, 1974; Tunnicliffe & Wilson, 1988; Kowalewski et al., 2002; Gordillo, Muñoz, Bayer, & Malvé, 2018). Overall, brachiopods play a minor role in modern benthic communities but there are a few examples where they achieve high abundances, like fjords of the

Canadian Pacific (Tunnicliffe & Wilson, 1988), Chilean Patagonia (Baumgarten, Laudien, Jantzen, Häussermann, & Försterra, 2014) and New Zealand (Bowen, 1968), or the California shelf-break (Pennington, Tamburri, & Barry, 1999). Post-mortem subtidal brachiopod shell accumulations are also only seldom recorded (Simões & Kowalewski, 2003; Simões, Rodrigues, de Moraes Leme, & Pires-Domingues, 2007).

The temperate Mediterranean Sea is home to a relatively diverse brachiopod fauna that includes up to 13-14 species (Logan, 1979; Logan, Bianchi, Morri, & Zibrowius, 2004, Emig, 2014). Many such taxa are distributed at shallow depths, often in cryptic habitats (SPA/RAC-UN Environment/MAP, OCEANA, 2017), and six (Novocrania anomala, Gryphus vitreus, Terebratulina retusa, Megathiris detruncata, Platidia anomioides, Megerlia truncata) live deeper being either eurybathic (circalittoral-bathyal) or exclusively bathyal. The eurybathic *Gryphus vitreus* (= *Terebratula vitrea*) may form dense populations on mobile silty to coarser sediment on the outer continental shelf and upper slope (Pérès & Picard, 1964; Emig, 1989; Madurell et al., 2012; Aguilar et al., 2015; SPA/RAC-UN Environment/MAP, OCEANA, 2017), or colonize hard substrates (Fourt, Goujard, Perez, & Chevaldonné, 2017). Large subfossil accumulations of G.vitreus of Pleistocene age are sometimes found (Emig, 2018, 34-35). Many equivalent fossil situations with terebratulid assemblages are documented in the Neogene to Pleistocene record of the Mediterranean basin (e.g., Gaetani & Saccà, 1983). Terebratulina retusa is often recorded from hard substrates at considerable depths (Taviani et al., 2017) and also frequently occurs in the Mediterranean fossil record. The inarticulate brachiopod Novocrania anomala can be found in considerable numbers attached to dead biogenic frames, hardgrounds or bedrock, but documentation of this in fossil record is not known (Barrier et al., 1996).

A rather common eurybathic rhynchonelliformean brachiopod in the Mediterranean Sea is Megerlia truncata (Linnaeus, 1767). Its geographic range extends to the eastern Atlantic Ocean and occurs at depths between 5-800 m (Logan, 1979; Brunton, 1988; Anadón, 1994; Logan, Bianchi, Morri, Zibrowius, & Bitar, 2002; Logan et al., 2004; Çinar, 2014; Emig, 2014, 2018; Gerovasileiou & Bailly, 2016; Álvarez, Emig, & Tréguier, 2017). In the Recent, M. truncata is generally associated with coarse detritic substrates, hardgrounds and bedrock, and with cold-water coral frames from the circalittoral to the bathyal zones (Madurell et al., 2012; Fourtet al., 2017; Emig, 2014, 2018), their dead shells being abundant in submarine deposits (Remia & Taviani, 2005; Taddei Ruggiero, Buono & Raia, 2006). Although it may be common locally, it is not known to play a dominant role in benthic communities, with the exception of the assemblage found at ca. 105 m at Banc d'Esquine, off the Mediterranean French coast (Fourt et al., 2017). Finally, there are situations where some of the taxa

mentioned above (*G. vitreus, T. retusa, M. truncata, M. detruncata* and *N. anomala*) share the same
hard substrates at depth (Fourt et al., 2017).

Here we report the first discovery of a distinct brachiopod biotope dominated by *Megerlia truncata* (Linnaeus, 1767) in the central Mediterranean Sea, offshore the Albanian-Greek shelf at the boundary between the Adriatic and Ionian seas. To the best of our knowledge, a comparable biotope has been previously identified only in the Western Mediterranean at similar depth and type of substrate (Fourt et al., 2017). This new finding is discussed in terms of biological characteristics, oceanographic and geo-sedimentary conditions, actuo-paleontological potential and conservation issues.

73 Material and Methods

The study-area is located in the Bay of Saranda at ca. 20 km from the Albanian coast at ca. 130 m depth (Figure 1). The site was surveyed during the COCOMAP13 oceanographic cruise R/V Urania (May 2013). Bathymetric data, Remotely Operated Vehicle (ROV) images, bottom samples, and hydrological casts were collected. Swath bathymetry was acquired using a hull-mounted Kongsberg Simrad EM302, with a nominal frequency of 30 kHz, swath coverage of ca. 4x greater than water depth and 512 beams per second acquired with Reson PDS2000 software. All data were plotted in the Transverse Mercator – UTM34N-WGS84 Coordinate System. A morphobathymetric map (Figure 1b), with a cell size of 1x1 m, was obtained using CARIS SIS and HIPS software. Physical properties of the seawater were sourced from the World Ocean Atlas 2013 version 2 (WOA13v2) dataset (Locarnini et al., 2013), which provided long-term averaged (1955-2013) temperature and salinity values of 14.43 °C and 38.60, respectively.

The ROV dive (COC13-28) was performed using a Pollux III (Global Electric Italiana) equipped with a low resolution CCD video camera for navigation and a high resolution video camera (SonyHDR-HC7) with an image frame of 2304x1296 dpi; three laser beams positioned 20 cm from each other provided the scale bar on the videos (metadata are reported in Table 1). The ROV was equipped with an underwater acoustic tracking system which provides position and depth every 1s. Taxonomic identifications were made using high resolution still image analysis, while low resolution images were analysed for habitat mapping along the ROV track (Figure 1c-d). Low-resolution still frames were automatically extracted every 10s, all images were georeferenced using Adelie and ESRI ArcGIS software. Macro- (>0.5 mm) and mega-benthic organisms (>2 cm) were identified to the lowest taxonomic rank (Table 2); taxa that could not be identified from images to species-level, such

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as sponges, were identified only as morphospecies or morphological categories (e.g., Bell & Barnes, 95 2001; Santín et al., 2019). Taxonomic names conform to the World Register of Marine Species 96 database (WoRMS Editorial Board, 2019). A large volume (60 l) modified Van Veen grab was used 97 to collect sediments from this site (sample COC13-29) which are stored at the ISMAR-CNR 98 10 Repository in Bologna. 99

A 3D model (Figure 3b) was reconstructed using Agisoft Photoscan Professional Edition V. 1.2.5. A 100 set of georeferenced high-definition images from ROV videos was selected to reconstruct both the 101 102 brachiopod- and sponge-dominated rocky outcrops. Firstly, pictures were aligned at high accuracy to create a dense-point cloud. Meshes were then constructed with a high polygon count and a texture 18 103 layer of the outcrops was created using a mosaic blending mode and superimposed on the meshes. 104

₂₅ 106 Results

²⁷ 107 The outer shelf of the Albanian-Greek continental margin, where the site is located, is characterized 29 108 by a complex geomorphologic setting that includes rocky highs, blocks and concretions surrounded ₃₁ 109 by vast stretches of coarse biogenic-detrital sediment enriched in rhodoliths (Figure 1). It extends over an area of ca. 10 km² and is characterized by a structural high reaching a maximum elevation of 110 ³⁴ 111 ca. 100 m (from 201 to 107 m) and oriented northwest-southeast. The top of this tectonially-driven structure is dominated by small-scale (only few metres) geomorphic reliefs and backscatter (i.e., 36 112 38[°] 113 reflectivity) image analysis shows high reflectivity that indicates the presence of a hard (rocky and/or ³⁹ 114 pebbly) substrate (Figure 1).

44 The survey covered a total length of 1322 m between 108-130 m, and explored the area with the 116 45 ⁴⁶ 117 maximum reflectivity value (Figure 1, Table 1). Two main biotopes were identified and mapped along 47 the ROV track: (1) a Brachiopod-dominated biotope (Bb) settled on hard substrates for a total length 48 118 49 ₅₀ 119 of 417 m covering an area of 1251 m²; (2) a Rhodolith bed (Rb) distributed over a generally flat 51 120 surface (Figure 1c). The Brachiopod biotope is characterized by two main facies, one dominated by 52 53 121 brachiopods, and another where brachiopods and encrusting/erect sponges co-occur (for a length of 54 55 122 279 m). A third facies was observed on top of the blocks, characterized by small patches of 57 123 56 Filograna/Salmacina complex with Axinella vaceleti and A. verrucosa (linear extension of 14 m).

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3 Brachiopods colonized mostly steep hard substrates (along the ROV track, for a length of 138 m). 125 4 Megerlia truncata was the species that typified this biotope (Figures 2a, c-e; 3a-c), which attained a 126 5 mean density of 176±128 individuals/m² and maximum density of >300 individuals/m² (Figure 3b). 127 8 Brachiopods were preferentially distributed on rocks facing towards to the coast, from West to 128 10 129 Southwest, while Rb faced both sides (Figure 1d). The Bb is bathed by the Eastern Adriatic Current 11 (EAC) that flows northward (e.g., Cushman-Roisin, Gačić, Poulain & Artegiani, 2013; de Ruggiero 12 130 13 131 et al., 2018), however, as shown by the Adriatic Forecasting System model 14 15 132 (http://oceanlab.cmcc.it/afs/), the main water mass at 100 m depth in the Bay of Saranda flows 16 southward. In general, *M. truncata* dominates over sessile and encrusting macrofauna (e.g., sponges), 17 133 18 however, encrusting red algae seldom develop on living Magerlia truncata shells (ca. 10% of the 19 134 20 135 imaged brachiopods) and represents the main epibiosis affecting brachiopod shells (Figures 3c; S1b). 21 ²² 136 There was no evidence of other macroinvertebrates (e.g., bryozoans) was recorded on the surface of 23 the living brachiopods. Rhabderemia sp. and Hexadella pruvoti are the most common sponges 24 137 25 26 138 recorded together with crustose coralline algae (CCA) on hard substrates (Figure 2c-e). Cnidarians, ²⁷ 139 such as the sea anemones cf. Hormathia coronata and the solitary coral Carvophyllia calveri are 28 29 140 relatively common, and among annelids Protula sp. and Serpula vermicularis are the dominant 30 31 141 species (Figure S1b-d). The red lance urchin Stylocidaris affinis and the hatpin urchin 32 Centrostephanus longispinus are vagile organisms that commonly occur also with abundant juvenile 142 33 34 specimens (<3 cm in diameter) of C. longispinus in the explored area (Figures 2a; S1b). Demersal 143 35 fish fauna is represented mainly by *Phycis phycis* and by the rare parrot seaperch *Callanthias ruber* 36 144 37 ₃₈ 145 that shelter under substrate cavities and ledges (Figure S2a, d; Table 2). All identified M. truncata 39 146 specimens were alive, often feeding (Figure S1b-d); no dead shells where found excepted for those 40 ⁴¹ 147 recorded loose on the sedimentary cover at the base of hard substrates (Figures 3c-g; S1a). 42

43 The Rhodolith bed extends for 668 metres, with a live coralline-algae coverage estimated at ca. 3 km² 44 148 45 149 using backscatter mapping (Figure 1c). No detailed analysis of the living algal component is possible 46 ⁴⁷ 150 based only on the ROV images, and floras have been generally indicated as CCA. The surveyed area 48 49 151 represents one of the deepest living Mediterranean rhodolith beds (Aguilar, Pastor, de la Torriente & 50 51¹⁵² García, 2009; Basso, Babbini, Ramos-Esplá & Salomidi, 2017), and the 2005-2009 averaged value ⁵² 153 of Photosynthetically Active Radiation (PAR) on the seafloor, extracted from EUSeaMap 2016 53 54 154 dataset (European Marine Observation Data Network (EMODnet) Seabed Habitats project, 55 56 155 http://www.emodnet-seabedhabitats.eu/) indicate a value of 0.0014 that corresponds to the lowest 57 5, 156 58 possible occurrence of red CCA (Runcie, Gurgel & Mcdermid, 2008 with references therein). In ⁵⁹ 157 general, rhodoliths take the form of small boxworks (< 2 cm) which define the bed thickness (Bracchi 60 et al., 2019). Biodiversity of the Rb is characterized by few dominant taxa (Table 2), mostly erect 158

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sponges, such as the fan-shaped cf. Poecillastra compressa and the erect Aplysina cavernicola (Figure 159 2e). Vagile fauna is dominated by Stylocidaris affinis, while demersal fishes of some commercial 160 value are Pagellus erythrinus and Pagrus pagrus. The lobster Palinurus elephas reprents an 161 invertebrate recorded in the IUCN Red List as Vulnerable (IUCN, 2019). 162

Finally, in the northernmost surveyed area (Figures 1b), the encrusting sponge Dendroxea cf. lenis 11 163 ₁₃ 164 covers a wide portion of the substrate that prevents the settlement of other organisms, including 165 brachiopods.

Discussion 167

22 168 General traits. Dense aggregations of pedunculate brachiopods on hard substrates, such as vertical walls or large boulders, have been rarely reported in the literature. Examples are from the Bay of 24 169 26¹⁷⁰ Fundy in the Canadian Atlantic where *Terebratulina septentrionalis* reaches an average density of ²⁷ 171 471 individuals/m² (Logan & Noble, 1971), the Chilean fjordland where Magellania venosa may 29 172 attain a density of 200 individuals/m² (Baumgartenet al., 2014) and in Canadian fjords of British Columbia where brachiopods (such as the Rhynchonelliformea ₃₁ 173 Laqueus californianus and Terebratulina unguicula) reach a maximum of 945 individuals/m², with an average density of 190 174 ³⁴ 175 individuals/m² (Tunnicliffe & Wilson, 1988).

₃₇ 176 The only other occurrence of *M. truncata* aggregations on rocky substrates at similar depths is that 30 39 177 on the French coast mentioned above (Fourt et al., 2017). No data are reported for the French site but 40 178 the density is comparable to the central Mediterranean site. The high abundance of this almost mono-41 specific aggregation of *M. truncata* on the shelf-break seems to be a function of the following 42 179 43 44 180 conditions. Firstly, the peculiar geomorphology of a shelf typified by mobile sediments (and inhabited 45 181 by a related infauna and mobile epifauna), but complicated by the local occurrence of rocky blocks 46 47 182 that offer a substrate for sessile fauna. Secondly, the relatively high colonization potential of a 48 49 183 pedunculate brachiopod that displays a eurytopic distribution in terms of depth (5-600 m) and 50 184 substrate (coarse-particulate to hard); a key factor promoting this may be the recruitment of Mergerlia 51 ⁵² 185 larvae from different suitable habitats nearby. Thirdly, favourable oceanographic conditions that can 53 54 186 sustain a dense population of filter feeders, with bottom currents capable of transporting food particles 55 ₅₆ 187 and winnowing the substrate; this oceanographic condition is guaranteed by the NE-flowing current 57 58 188 that flushes the shelf-break here, and is bound by the Adriatic Surface Water and the deeper Levantine 59 189 Intermediate Water deeper (Cushman-Roisinet al., 2013; de Ruggiero et al., 2018 with reference 60 therein). 190

192 Conservation aspects

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8 Brachiopod-dominated assemblages are commonplace in the geological record, and to a lesser degree 193 9 in the Recent. Regarding the Mediterranean Basin, one fossil site of Pliocene age is characterized by 10 194 11 12 195 a distinct terebratulid paleocommunity, which has been anecdotally proposed for protection (Pavia & 13 196 Zunino, 2008). Modern brachiopod communities of the Mediterranean Sea are not identified for 14 15 197 conservation, which is guaranteed if they occur in ecologically-valuable areas. This is the case of 16 Banc de l'Esquine off the French Riviera, which is located within the Calangues National Park. The 17 198 18 ₁₉ 199 uniqueness of the Brachiopod biotope dominated by M. truncata located at the Albanian-Greek shelf-20 200 break calls for taking formal conservation action, also given that it co-occur with a deep-water 21 22 201 rhodolith bed (e.g., Salomidi et al., 2012; Basso, Babbini, Kaleb, Bracchi, & Falace, 2016, Bracchi et 23 al., 2019). The ecological value is further strengthened by the presence here of invertebrates (Table 24 202 25 203 2 and Figure 2a) listed in the 'Protocol concerning Specially Protected Areas and Biological Diversity 26 ²⁷ 204 in the Mediterranean' of the Barcelona Convention, such as the erect sponge Aplysina cavernicola, 28 29 205 the lobster Palinurus elephas, and the hatpin urchin Centrostephanus longispinus (Annex IV of 30 31 206 Habitat Directive, Appendix II of Bern Convention and Annex II of the protocol of the Barcelona 32 Convention). ROV images document the existence of juvenile specimens of C. longispinus, what 207 33 34 208 makes the site highly interesting in terms of larval recruitment and, possibly, nursery grounds. Besides 35 the presence of these important taxa, the complex morphology of the site produces cryptic 36 209 37 38 210 microtopographic situations, ideal for various other sessile and mobile invertebrates, but also for 39 211 demersal fish (Table 2). At the time of our ROV survey (springtime 2013), there was no evidence of 40 41 212 noticeable impacts (e.g., excessive litter or trawl and longline fishing). Anthropogenic-driven 42 43 213 stressors, such as global warming and ocean acidification could potentially compromise the Good 44 45 214 Environmental Status of this biotope in the future. Especially important might be global warming, ⁴⁶ 215 which could modify the water mass sustaining the brachiopod community by affecting nutrient 47 content, current strength and flows path. The effects of ocean acidification on brachiopod calcite are 48 216 49 ₅₀ 217 less likely to hinder the shell calcification process (Ye et al., 2018; Cross, Peck & Harper, 2018). 51 218 Thus, we do not foresee major concerns over the short-midterm for the continued survival of the Bb. 52 53 219 As a precautionary approach, however, we suggest that protective measures are needed to prevent 54 55 220 future disturbances to the biotope (dumping, infrastructure, fishery), such as the implementation of 56 57 221 marine protected area. Alternatively, this site should be considered as a Site of Community ⁵⁸ 222 Importance (SCI), in agreement with the EU Directive 92/43/CEE. The justification is to consider 59 this Bb as a subtype of 'reef' in the Habitat Directive. We propose a region that encompasses the most 60 223

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3 22 4	valuable ecological components of this sector of the shelf, centered on the Bb and su	urrounding
5 22	Rhodolith bed, with a reasonably-wide buffer area (Figure 4), of 10 km ² and 17 km ² , respe	ectively.
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10 <u>22</u> 11	7 Conclusions	
12 13 22	1. A biotope dominated by the pedunculate brachiopod <i>Megerlia truncata</i> has been id	lentified in
¹⁴ 15 22	the Albanian-Greek offshore, Mediterranean Sea; a comparable biotope was previo	ously only
16 <u>2</u> 3	known for the Western Mediterranean, off the French coast.	
17 18 23	2. This biotope is located at the shelf-break at ca 120 m, where hard substrates emerg	e from the
19 20 23	mobile sediment represented by a rhodolith bed.	
21 23	3. The combined Brachiopod biotope and Rhodolith bed host taxa of recognized co	nservation
22 23 2 3	value. The site is home to a variety of sessile and mobile invertebrates and demersa	al fish.
24 25 23	4. Conservation-wise, we suggest that this rare biotope and adjacent rhodolith bed de	serve
26 27 23	protection status and the best area to implement a MPA is proposed.	
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31 - 3 32 33 23 34	9 Acknowledgements	
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Figure captions

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Figure 1. Location and morphobathymetric maps of the investigated area. Habitats along the ROV path are also shown on the backscatter and aspect maps.

Figure 2. Main characteristics of biotopes in the area. a) Brachiopod biotope, bar = 20 cm; b) Rhodolith bed, with *Poecillastra compressa*, bar = 20 cm; c) detail of the Brachiopod biotope, note substrate occupancy by brachiopods and crustose coralline algae (CCA), bar = 10 cm; d) detail of the Brachiopod biotope showing a predominance of *Hexadella pruvoti* (yellow sponge) and CCA over *Megerlia truncata*, bar = 10 cm; e) co-dominance of CCA, *Megerlia truncata* and sponges, bar = 10 cm; f) *Filograna/Salmacina* complex with the sponges *Axinella vaceleti* and *A. verrucosa*, bar = 20 cm.

Figure 3. a) Dense Megerlia truncata aggregations (> 350 individuals/0.36 m²), bar = 10 cm; b) 3-D image ₃₄ 422 423 of a block covered by brachiopods; c-d) photograph of brachiopod biotope and related artistic cartoon 37 424 highlighting living and dead *Megerlia truncata*, bar = 10 cm; e-g) station COC13-29, sediment collected 30 39 425 by grab from the Rhodolith bed: e) gravel-size/coarse sand fraction (> 1 cm), Rhodalgal facies showing the 40 426 absolute prevalence of rhodolith nodules over other biogenic components, bar = 3 cm; f) Foramol facies of 42 427 sand fraction (> 1 mm), S = serpulid, By = bryozoan, Bi = bivalve, G = gastropod (juvenile of Bolma ⁴³ 428 *rugosa*), bar = 1 mm; g) fine fraction > 63 μ m, brachiopod (B), bryozoan (By), foraminifer (F), bar = 0.5 45 429 mm.

Figure 4. Core and buffer areas deserving adequate protection to protect the Brachiopod biotope and adjacentRhodolith bed.

2 3 435 **Tables** 5 6 436 **Table** 1

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436 **Table 1.** ROV metadata.

Cruise	Station	Date	Start lat N [deg/min]	Start long E [deg/min]	Start depth [m]	End lat N [deg/min]	End long E [deg/min]	End depth [m]
COCOMAP13	coc13_28_rov	30/05/2013	40.0128	19.5605	106	40.0173	19.5576	113

Table 2. Living macrorganisms observed or sampled in the explored area. B indicates organisms that pertain to the newly described Brachiopod biotope while R to the surrounding Rhodolith bed. Asterisks indicate the legal instruments under which the species are protected: *Bern Convention, Appendix II, III (Convention on the Conservation of European Wildlife and Natural Habitats); **CITES, Appendix II (Convention on International Trade in Endangered Species of Wild Fauna and Flora); ***ASPIM Annex II, III; ****Habitat Directive, Annex II, IV, V.

		Phylum	Class	Taxon	Habita
					t
1	1 1	Rhodophyta	Florideophycea	Crustose Coralline Algae (CCA)	Rb, B
			e		
2	2 1	Foraminifera	Monothalamea	Pelosina sp.	Rb
2	3		Globothalamea	Miniacina miniacea (Pallas, 1766)	В
	1	Porifera	Demospongiae	sp. 1	Rb
				sp. 2	В
				sp. 3	В
				sp. 4	Rb
				sp. 5	В
				sp. 6	Rb, B
2	4			Tetractinellida spp.	В
4	5			cf. Poecillastra compressa (Bowerbank, 1866)	Rb. B
				cf. Suberites syringella (Schmidt, 1868)	B
é	6			Penares helleri (Schmidt, 1864)	В
-	7			cf Rhabderemia sp	B
5	, 8			Hamacantha cf. falcula (Bowerbank 1874)	B
Č	9			Mycale sp	Rb
-	10			cf Raspaciona aculeata (Johnston 1842)	B
	11			Avinella vaceleti Pansini 1984	B
-	12			Axinglia varrucosa (Esper 1704)	B
-	12			Dandroxag of Janis (Tonsent 1802)	B
	13			Haliolong op	D
	14			Arching organizada (Magalet 1050)*	D Dh/D
-	13			Aphysina cavernicola (Vacelei, 1959)	KU/D
	$\frac{1}{2}$	Out de ste		Hexadella pruvoli Topsent, 1896	В
4	23 (Inidaria	A .1	Hydrozoa spp.	В
4	24		Anthozoa	Alcyonium palmatum Pallas, 1766	В
4	25			Cerianthidae sp.	В
2	26			cf. Hormathia coronata (Gosse, 1858)	В
4	27			Actiniaria sp. 1	В

20			Carvonhvllia calveri Duncan 1873**	В
29	Mollusca	Gastropoda	cf. Juiubinus exasperatus (Pennant, 1777)	В
30		Cephalopoda	Senia officinalis Linnaeus 1758	Rb
31	Annelida	Polychaeta	Bonellia viridis Rolando 1822	Rb/
32	7 millendu	Torychaeta	Sabellidae spp	Rb/
33			Servula vermicularis Linnaeus 1767	B
34			Protula tubularia (Montagu 1803)	B
35			Filograna/Salmacina complex	B
36			Serpulidae spp.	Rb/
37	Arthropoda	Malacostraca	Plesionika narval (Fabricius, 1787)	Rb/
38			Palinurus elephas (Fabricius, 1787)*, ***	Rb
39	Brachiopoda	Rhvnchonellata	Megerlia truncata (Linnaeus, 1767)	В
40	Echinodermat	Echinoidea	Stylocidaris affinis (Philippi, 1845)	 Rb/
	a			
41	-		Centrostephanus longispinus (Philippi, 1845)*, *** ****	В
42	Echinodermat	Asteroidea	Peltaster placenta (Müller & Troschel, 1842)	B
	a			_
43			cf. Hacelia attenuata (Grav. 1840)	В
44	Chordata	Tunicata	cf. <i>Clavelina lepadiformis</i> (Müller, 1776)	В
45		Actinoptervgii	Macroramphosus scolopax (Linnaeus, 1758)	Rb
46			Callanthias ruber (Rafinesque, 1810)	В
47			Facciolella oxyrhyncha (Bellotti, 1883)	В
48			Ariosoma balearicum (Delaroche, 1809)	Rb
49			Chlorophthalmus agassizi Bonaparte, 1840	Rb
50			cf. <i>Molva macrophthalma</i> (Rafinesque, 1810)	Rb
51			<i>Phycis phycis</i> (Linnaeus, 1766)	В
52			Pagellus erythrinus (Linnaeus, 1758)	Rb
53			Pagrus pagrus (Linnaeus, 1758)	В
54			Spondyliosoma cantharus (Linnaeus, 1758)	Rb
			Spicara smaris (Linnaeus, 1758)	Rb
55			Spicara sp	в



Figure 1. Location and morphobathymetric maps of the investigated area. Habitats along the ROV path are also shown on the backscatter and aspect maps.

176x137mm (300 x 300 DPI)



Figure 2. Main characteristics of biotopes in the area. a) Brachiopod biotope, bar = 20 cm; b) Rhodolith bed, with Poecillastra compressa, bar = 20 cm; c) detail of the Brachiopod biotope, note substrate occupancy by brachiopods and crustose coralline algae (CCA), bar = 10 cm; d) detail of the Brachiopod biotope showing a predominance of Hexadella pruvoti (yellow sponge) and CCA over Megerlia truncata, bar = 10 cm; e) co-dominance of CCA, Megerlia truncata and sponges, bar = 10 cm; f) Filograna/Salmacina complex with the sponges Axinella vaceleti and A. verrucosa, bar = 20 cm.

209x178mm (300 x 300 DPI)



Figure 3. a) Dense Megerlia truncata aggregations (> 350 individuals/0.36 m2), bar = 10 cm; b) 3-D image of a block covered by brachiopods; c-d) photograph of brachiopod biotope and related artistic cartoon highlighting living and dead Megerlia truncata, bar = 10 cm; e-g) station COC13-29, sediment collected by grab from the Rhodolith bed: e) gravel-size/coarse sand fraction (> 1 cm), Rhodalgal facies showing the absolute prevalence of rhodolith nodules over other biogenic components, bar = 3 cm; f) Foramol facies of sand fraction (> 1 mm), S = serpulid, By = bryozoan, Bi = bivalve, G = gastropod (juvenile of Bolma rugosa), bar = 1 mm; g) fine fraction > 63 μm, brachiopod (B), bryozoan (By), foraminifer (F), bar = 0.5 mm.

209x178mm (300 x 300 DPI)





Figure 4. Core and buffer areas deserving adequate protection to protect the Brachiopod biotope and adjacent Rhodolith bed.

170x143mm (300 x 300 DPI)