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Macro- and megafauna recorded in the submarine Bari Canyon (southern Adriatic, Mediterranean Sea) using different tools

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Abstract

Macro- and megafauna were recorded in the submarine Bari Canyon, located in the southern Adriatic Sea (Mediterranean Sea) during an oceanographic cruise carried out in May-June 2012 and an experimental fishing survey conducted in November 2013. During the former, 20 benthic samples were taken using a Van Veen grab at depths between 268 and 770 m and four deployments of a baited lander, for approximately 43 hours of video records, were carried out at depths between 443 and 788 m. During the latter, eight longline fishing operations were conducted from 338 m down to 612 m. Eighty-five living benthic and benthopelagic species were recorded: 29 Porifera, 1 Cnidaria, 2 Mollusca, 11 Annelida, 1 Arthropoda, 19 Bryozoa, 3 Echinodermata, and 19 Chordata. Fifty-one species are new records for the Bari Canyon, and 29 species are new records for the Adriatic Sea. Among the Porifera *Cerbaris curvispiculifer* is a new addition for the Italian sponge fauna. The first confirmed record of living specimens of the bryozoan *Crisia tenella longinodata* is reported. A total of six Mediterranean endemic species have been identified, four Porifera and two Annelida. The bathymetric range of some species has been extended. New information acquired for deep sea species confirms their importance in the structure of cold-water coral communities. This study has updated knowledge on the biodiversity of the Adriatic Sea, as well as of the Bari Canyon in particular, one of the sites designated as “jewels of the Mediterranean” for which urgent conservation measures are needed.

Keywords: Canyon, Deep-sea coral, Macrofauna, Megafauna, Distribution, Biodiversity, Mediterranean.

Introduction

The Mediterranean Sea is a semi-enclosed basin characterised by more than 500 submarine canyons widespread along the continental margin (Harris & Whiteway, 2011). Some of them, mostly in the western Mediterranean, have long been investigated in relation to their morpho-sedimentology and oceanographic processes (e.g. Berné *et al.*, 1999; Canals *et al.*, 2004, 2009; Puig *et al.*, 2008) as well as to their biodiversity and fishery resources (e.g. Cartes *et al.*, 1994; Stefanescu *et al.*, 1994; Gili *et al.*, 2000; Palanques *et al.*, 2005; Sardà *et al.*, 2009; Farrugio, 2012; Revenga Martínez de Pazos, 2012; Fabri *et al.*, 2014). In the last two decades, the canyons have been investigated as a part of national projects carried out in different countries as well as in the context of European projects designed to gain new insight into the biodiversity, ecosystem structure, and function in the deep sea (e.g. EUROMARGE, HERMES, HERMIONE). In fact, canyons act as conduits favouring dense shelf water cascades and transport of sediments, organic matter and nutrients from the continental

shelf to the deep sea, enhancing the abundance and the diversity of benthic and benthopelagic fauna (De Leo *et al.*, 2010; Ramirez-Llodra *et al.*, 2010). Canyons can provide spawning and recruitment areas for this type of fauna (e.g. Sardà *et al.*, 1994, 2009). The upwelling generated by the local water mass dynamics enhances local primary productivity, influencing the food chain up to mammals and birds (e.g. Danovaro *et al.*, 2010; Vella & Vella, 2012; Würtz, 2012). Moreover, the increasing interest in the bioecology of the Mediterranean canyons is also related to the high rates of endemism and the presence of Cold-Water Corals (CWC) (e.g. Gili *et al.*, 2000; Freiwald *et al.*, 2009; Orejas *et al.*, 2009). The downwelling currents, which enhance the availability of trophic resources associated with the complex physical setting, make canyons favourable habitats for suspension feeders such as CWC (Freiwald *et al.*, 2009; Orejas *et al.*, 2009; Madurell *et al.*, 2012).

One of these Mediterranean canyons characterised by the presence of CWC, episodic cascading processes and habitat heterogeneity is located off the city of Bari in the southern Adriatic Sea (central Mediterranean). The role

of this canyon in sediment transport and water cascading processes has been well documented (Ridente *et al.*, 2007; Trincardi *et al.*, 2007; Turchetto *et al.*, 2007; Verdicchio *et al.*, 2007; Rubino *et al.*, 2010) whereas less effort has been devoted to the assessment of its biodiversity. In this respect, the Bari Canyon was explored during the HERMES and HERMIONE cruises, using Remotely Operated Vehicles (ROVs) and revealing a CWC community mainly structured by *Madrepora oculata* and to a lesser extent, by *Lophelia pertusa* and *Dendrophyllia cornigera* (Freiwald *et al.*, 2009). Solitary corals, sponges, serpulids, boring clams, and colonies of bryozoans were also recorded during these cruises (Freiwald *et al.*, 2009; Bo *et al.*, 2012; Sanfilippo *et al.*, 2013). In particular, the sponge *Pachastrella monilifera* mixed with living colonies of the scleractinian *M. oculata* dominates the deep assemblage in the Bari Canyon, between 380 and 500 m (Bo *et al.*, 2012). A remarkable abundance of the tubeworm *Serpula vermicularis* associated with *M. oculata* build-ups and other stony corals were also observed to increase the biogenic frameworks and habitat complexity (Sanfilippo *et al.*, 2013). The study of dead molluscs from the Bari Canyon led to 55 species being identified, from typical epibathyal mollusc communities currently present in the Mediterranean basin as well as those from Würmian paleocommunities (Panetta *et al.*, 2013). Corals and a variety of sessile benthic organisms contribute to creating complex three-dimensional habitats exposed to high sedimentation rates and attract numerous species of mobile invertebrates (mainly echinoderms) and fish, as recently reported by Angeletti *et al.* (2014). Fish faunal composition and behaviour have also recently been investigated using a baited lander (D'Onghia *et al.*, 2014).

Benthic macro- and megafauna were collected using a grab during an oceanographic cruise carried out in 2012 and benthic-pelagic megafauna was recorded using

a lander equipped with digital cameras. A benthic-pelagic megafauna was also caught during an experimental longline survey carried out in 2013. The results on the taxonomy and distribution of the macro- and megafauna collected during these cruises are provided in this paper with the aim of updating knowledge on the biodiversity in the Bari Canyon. Due to the different tools (grab, lander, longline) used on different substrates as well as the different sampling period and effort by tool, no quantitative analyses have been undertaken here.

Materials and Methods

The Bari Canyon System (BCS) is a complex morphological structure that cuts through the south-western Adriatic shelf with a west-east trend. It is 10 km wide and 30 km long ranging between 200 and 1700 m in depth. The BCS consists of two main branches separated by a mounded relief, a slope-confined trough between 500 and 700 m in depth. The southern branch is wider (approximately 4 km), markedly asymmetrical and U-shaped with a very steep wall (Fig. 1) (Ridente *et al.*, 2007; Trincardi *et al.*, 2007).

An oceanographic survey was carried out from 28 May to 1 June 2012 using the R/V MINERVA UNO. The fauna was sampled using a grab and observed by means of a baited lander. Samples were taken using a Van Veen grab with a collection surface of 0.2 m² and a sediment volume of up to 0.06 m³. Van Veen grab samples were collected at depths between 268 and 770 m, both on the rocky walls and on the soft seafloor of the canyon. Due to the steep slope of the walls only 20 positive samples were obtained, 7 on rocky substrate and 13 on the sediment (Table 1). The samples were washed in multiple sieves. Soft-bodied animals belonging to Cnidaria and Annelida were immediately anaes-

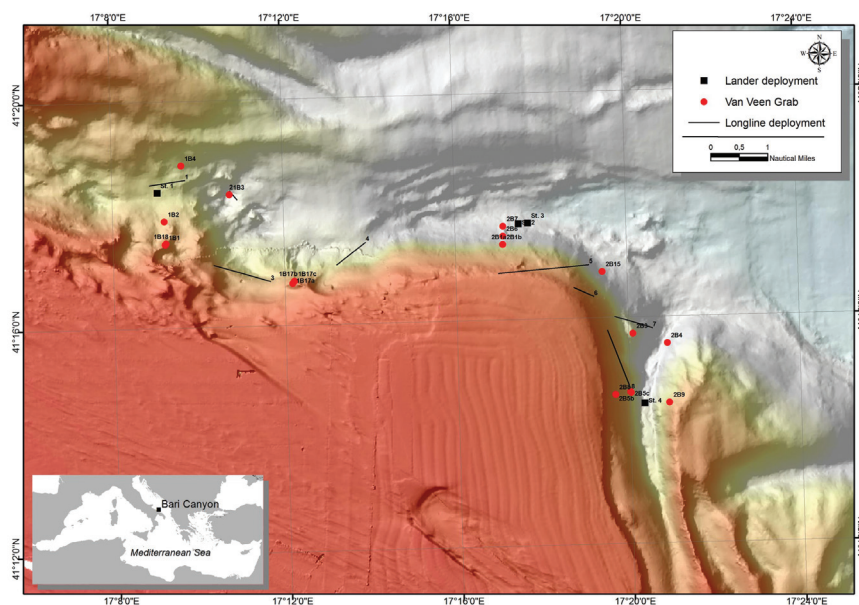


Fig. 1: Study area: location of the Bari Canyon within the Mediterranean and indication of the sampling stations with the different gears.

Table 1. List of the sampling stations carried out in the Bari Canyon using the Van Veen grab (VG), the MEMO baited lander (MM) and the longline (LL).

Date	Station	Gear	Depth	Start		End		Substrate
	code		(m)	Latitude	Longitude	Latitude	Longitude	
29/05/12	1B1	VG	280	41°17.4859'N	17°09.2288'E	-	-	Hard
29/05/12	1B2	VG	383	41°17.8923'N	17°09.2197'E	-	-	Soft
29/05/12	1B3	VG	608	41°18.3484'N	17°10.7525'E	-	-	Soft
29/05/12	1B4	VG	473	41°18.8777'N	17°09.6334'E	-	-	Soft
31/05/12	1B17a	VG	268	41°16.7562'N	17°12.1886'E	-	-	Soft
31/05/12	1B17b	VG	309	41°16.7965'N	17°12.2247'E	-	-	Soft
31/05/12	1B17c	VG	327	41°16.7965'N	17°12.2247'E	-	-	Soft
31/05/12	1B18	VG	277	41°17.5027'N	17°09.2463'E	-	-	Soft
30/05/12	2B1a	VG	534	41°17.3453'N	17°17.1193'E	-	-	Hard
30/05/12	2B1b	VG	534	41°17.3406'N	17°17.1218'E	-	-	Hard
30/05/12	2B3	VG	528	41°15.7191'N	17°20.1068'E	-	-	Soft
30/05/12	2B4	VG	720	41°15.5336'N	17°20.9063'E	-	-	Soft
30/05/12	2B5a	VG	475	41°14.6799'N	17°20.0352'E	-	-	Hard
30/05/12	2B5b	VG	450	41°14.6863'N	17°20.0143'E	-	-	Hard
30/05/12	2B5c	VG	458	41°14.6880'N	17°20.0210'E	-	-	Hard
30/05/12	2B6	VG	686	41°17.4941'N	17°17.1274'E	-	-	Hard
30/05/12	2B7	VG	770	41°17.6681'N	17°17.1303'E	-	-	Soft
31/05/12	2B8	VG	325	41°14.6424'N	17°19.6654'E	-	-	Soft
31/05/12	2B9	VG	377	41°14.4876'N	17°20.9294'E	-	-	Soft
31/05/12	2B15	VG	722	41°16.8250'N	17°19.4239'E	-	-	Soft
29/05/12	St. 1	MM	443	41°18.4085'N	17°09.0622'E	-	-	Soft
30/05/12	St. 2	MM	787	41°17.7093'N	17°17.4949'E	-	-	Soft
30-31/05/2012	St. 3	MM	788	41°17.7127'N	17°17.7126'E	-	-	Soft
31/05-1/06/2012	St. 4	MM	577	41°14.4876'N	17°20.3415'E	-	-	Soft
08/11/13	1	LL	492	41°18.6160'N	17°09.7290'E	41°18.5340'N	17°08.8710'E	Mixed
08/11/13	2	LL	612	41°18.4110'N	17°10.7590'E	41°18.2440'N	17°10.9390'E	Mixed
08/11/13	3	LL	338	41°16.7900'N	17°11.6750'E	41°17.1080'N	17°10.3480'E	Mixed
08/11/13	4	LL	608	41°17.4410'N	17°13.9140'E	41°17.0580'N	17°13.2180'E	Mixed
09/11/13	5	LL	551	41°16.9460'N	17°19.1280'E	41°16.8360'N	17°16.9970'E	Mixed
09/11/13	6	LL	376	41°16.3810'N	17°19.2250'E	41°16.5510'N	17°18.7400'E	Mixed
09/11/13	7	LL	601	41°15.8040'N	17°20.5760'E	41°16.0230'N	17°19.6820'E	Mixed
09/11/13	8	LL	378	41°14.7140'N	17°20.0380'E	41°15.7870'N	17°19.5170'E	Mixed

thetized with a saturated solution of menthol in sea water for 2-4 hours depending on the nature and size of the individual or colonies. All species were fixed on board in 5% formaldehyde solution with sea water and afterwards preserved in 70% ethanol. All specimens were identified in the laboratory to the lowest possible taxonomic level and counted. Invertebrate species identification was performed using the most recent identification manuals. For sponges, slides of dissociated skeletal elements were prepared and observed under an optical microscope. In addition, for the identification of some sponge species, transverse sections of paraffin wax-embedded samples were prepared and observed using an optical microscope. The nomenclature adopted for the different taxonomic groups is that reported in the relevant

updated check-lists. In particular, for bryozoans, systematic order follows the working list available online at <http://www.bryozoa.net>, while for all the other taxa the systematic order is that reported online at <http://www.marinespecies.org> (WoRMS, or the World Register of Marine Species).

The MEMO (Marine Environment MONitoring system) lander was also deployed in the southern branch of the Bari Canyon. This lander, developed as part of the CoralFISH EU_7FP project, consisted of a stainless steel metal frame, two digital cameras (Sony ICX414) with two LED lights (12 V, 700 mA), an electronic compass, inclinometer and altimeter, a multiparametric probe, a doppler current meter, four Deep-Sea batteries for power supply, and an ICT infrastructure capable of managing

the entire system (D'Onghia *et al.*, 2014). On the seabed the lander is linked by a zinc-coated steel cable to buoys which keep the cable under tension and then to a surface floating signalling buoy. Continuous connection is maintained via an acoustic modem with an onboard PC software platform, making images and sensor data available. A total of four deployments between 443 and 788 m were carried out, for a total time of 43 hours of video recordings (Table 1). Considering that the MEMO system takes four video frames each second, 619,200 video frames were taken by each camera. During each deployment the lander was baited with specimens of the teleost fish *Scomber scombrus*. The bait produces an odour plume stretching downstream from the lander and attracting animals in view of the camera (Bailey *et al.*, 2007). The hydrographic parameters at each station were also recorded by means of CTD and a current meter. The mean salinity recorded on the bottom was 38.72 psu, the mean temperature values varied from 13.32 to 13.38°C, and those of the current speed from 0.06 to 0.14 m s⁻¹.

The different species were identified using morphological characteristics observed in the video frames. In addition, the single individuals of all recorded species could often be distinguished by their different sizes and morphological features, such as marks and scars on the skin. This was not the case for the blackspot sea bream *Pagellus bogaraveo* since individual numbers gradually increased after lander touchdown but with individuals moving in and out of camera view it was impossible to distinguish between the individuals (D'Onghia *et al.*, 2014).

A longline experimental survey was carried out in the Bari Canyon during November 2013. A commercial fishing vessel was hired, equipped with a 3 km monofilament longline with 500 hooks and snoods of 2.5 m in length; the types of hooks employed were J-hook 7 and J-hook 10. *Sardina pilchardus* was used as bait. The longline is a selective gear and its selectivity mostly depends on the size of hooks. The number 10 J-hook was used with the aim of catching *P. bogaraveo* which seems to be a fish species associated with the presence of corals (D'Onghia *et al.*, 2010, 2011, 2012). Eight longline deployments were carried out at depths between 338 and 612 m. The set-time lasted three hours on average and the fishing effort was 2000 hooks/day. A total of four hauls with hook size 7 and 4 with hook size 10 were carried out in the Bari Canyon (Table 1). Total length (TL) (in mm), weight (in g), and sex were recorded for each specimen collected.

Results and Discussion

A total of 85 species were recorded using the three different sampling gears, including 65 benthic and 20 benthopelagic taxa (Table 2). Most benthic species were collected associated to *Madrepora oculata* colonies at station 1B1 (280 m). Van Veen grab samples differed markedly from each other in the presence and abundance of living organ-

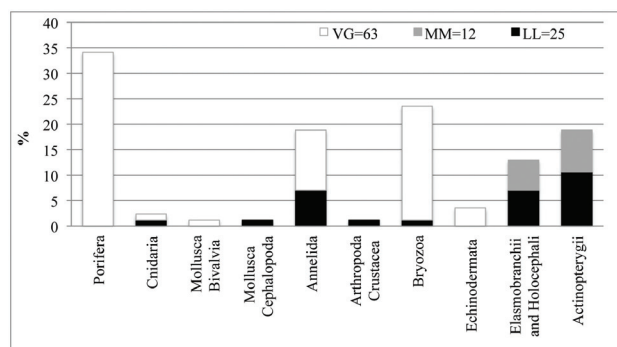


Fig. 2: Percentage of different taxa recorded in the Bari Canyon using the Van Veen grab (VG), the MEMO baited lander (MM) and the longline (LL), with indication of the total number of species collected by each gear.

isms. The MEMO lander allowed the identification of 12 benthopelagic fish (5 cartilaginous and 7 teleost). The longline collected 25 species: one colony of *Madrepora oculata* and seven encrusting species accidentally sampled, one crustacean, one cephalopod, six cartilaginous fish, and nine teleosts. The percentages of the taxa collected using the different tools are presented in Figure 2.

Porifera

The analysis of the hard ground block and *M. oculata* colony sampled at station 1B1 allowed us to detect a total of 29 sponge taxa (Table 2). Two classes are represented, Homoscleromorpha and Demospongiae, with 1 and 28 species, respectively. The order Poecilosclerida comprises more than 70% of the recorded Demospongiae. The remaining five orders detected (Astrophorida, Hadromerida, Agelasida, Haplosclerida, Verongida) only include a few taxa each; except for two Bubaridae, all the recorded sponges were identified to species level. Among the 29 taxa identified, more than 80% (24 species) were exclusively found on the hard ground block, three were exclusively found on the coral colony, and only two species were recorded on both substrates. Most of the sponges occurred as small thin incrustations on the exposed side of the hard ground block or on the branches of the coral colony. The few massive sponge detected were *Pachastrella monilifera* and *Poecillastra compressa* and the pedunculate erect *Phakellia robusta*. Only one boring species was recorded, *Siphonodictyon infestum*, which heavily attacks the basal portion of a coral colony up to a few centimetres from the living coral tissue. The species *Cerbaris curvispiculifer* represents a new addition to the Italian sponge fauna (Pansini & Longo, 2008) (Fig. 3); including *C. curvispiculifer*, 17 species are new records for the Adriatic Sea and five species are new records for the southern Adriatic Sea (Table 2).

Most of the sponge fauna detected have an Atlanto-Mediterranean distribution. Four species (13.8%) are Mediterranean endemics (Table 2) (Pansini & Longo, 2003; Soest *et al.*, 2014). With the exception of *E. cinctum* and *E. topsenti*, all the remaining species are known from substrates deeper

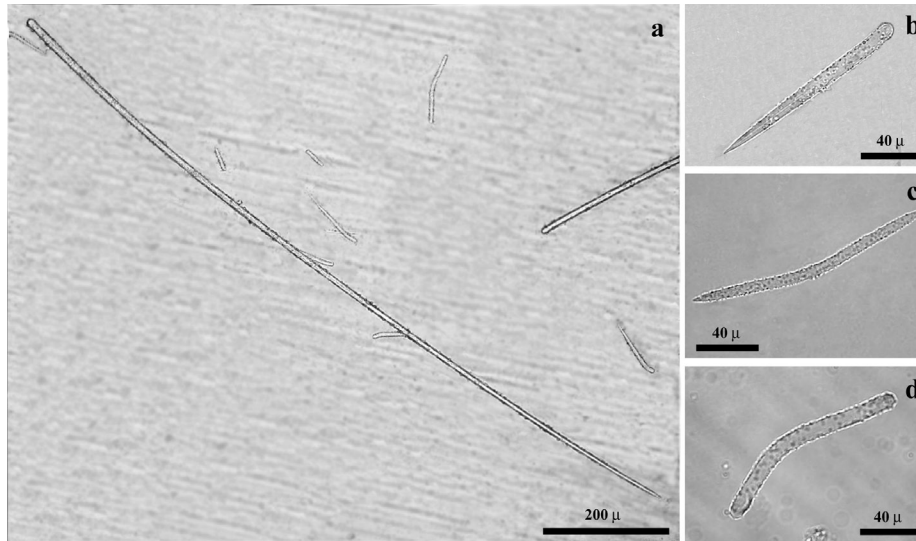


Fig. 3: Spicules of *Cerbaris curvispiculifer*: (a) style; (b) acanthorhabdostyle; (c) acanthoxea; (d) acanthostrongyle.

Table 2. List of the species collected in the Bari Canyon using the Van Veen grab (VG), the MEMO baited lander (MM) and the longline (LL), with indication of the new records, the presence of endemic species and the depth range of occurrence (* first record for the Mediterranean Sea; ** new records for the Adriatic Sea; *** new records for the Southern Adriatic Sea; ✓ new record for the Italian Sponge Fauna; § new records for the Bari Canyon; E Mediterranean endemic species).

PHYLUM				Depth range (m)	Gear
Class	Order	Family	Species		VG MMLL
PORIFERA					
Homoscleromorpha	Homosclerophorida	Plakinidae	<i>Plakortis simplex</i> Schulze, 1880	280	+
Demospongiae	Astrophorida	Ancorinidae	<i>Jaspis incrustans</i> (Topsent, 1890) **§	280	+
		Pachastrellidae	<i>Pachastrella monilifera</i> Schmidt, 1868	280	+
		Vulcanellidae	<i>Poecillastra compressa</i> (Bowerbank, 1866)	280	+
	Hadromerida	Suberitidae	<i>Prosuberites longispinus</i> Topsent, 1893 ***§	280	+
	Poecilosclerida	Microcionidae	<i>Clathria (Microciona) gradalis</i> Topsent, 1925 **§	280	+
			<i>Antho (Antho) involvens</i> (Schmidt, 1864)	280	+
		Raspailiidae	<i>Eurypon cinctum</i> Sarà, 1960**§	280	+
			<i>Eurypon topsenti</i> Pulitzer-Finali, 1983 **§ E	280	+
			<i>Eurypon viride</i> (Topsent, 1889) **§	280	+
		Hymedesmiidae	<i>Plocamionida tylotata</i> Brøndsted, 1932 **§	280	+
		Desmacellidae	<i>Biemna parthenopea</i> Pulitzer-Finali, 1978 **§ E	280	+
			<i>Biemna tenuisigma</i> Pulitzer-Finali, 1978 **§ E	280	+
			<i>Desmacella inornata</i> (Bowerbank, 1866) **§	280	+
		Hamacanthidae	<i>Hamacantha (Vomerula) papillata</i> Vosmaer, 1885 **§	280	+
			<i>Hamacantha (Hamacantha) johnsoni</i> (Bowerbank, 1864) **§	280	+
		Latrunculiidae	<i>Sceptrella insignis</i> (Topsent, 1892) **§	280	+
	Halichondrida	Axinellidae	<i>Axinella pumila</i> Babic, 1922 ***§	280	+
			<i>Phakellia robusta</i> Bowerbank, 1866**§	280	+
		Bubaridae	<i>Bubaris subtyla</i> Pulitzer-Finali, 1983 **§	280	+
			<i>Bubaris vermiculata</i> (Bowerbank, 1866)	280	+
			<i>Bubaris</i> sp. 1 <i>sensu</i> Vacelet, 1969	280	+
			<i>Bubaris</i> sp. 2	280	+
			<i>Cerbaris curvispiculifer</i> (Carter, 1880) ✓§	280	+

(continued)

Table 2 (continued)

PHYLUM				Depth	Gear					
Class	Order	Family	Species	range (m)	VG	MM	LL			
CNIDARIA	Agelasida	Hymerhabdiidae	<i>Hymerhabdia oxytrunca</i> Topsent, 1904 **§	280	+					
			<i>Hymerhabdia typica</i> Topsent, 1892 ***§	280	+					
	Haplosclerida	Chalinidae	<i>Haliclona (Gellius) flagellifera</i> (Ridley & Dendy, 1886) ***§	280	+					
		Phloeodictyidae	<i>Siphonodictyon infestum</i> (Johnson, 1889) ***§	280	+					
	Verongida	Ianthellidae	<i>Hexadella pruvoti</i> Topsent, 1896 **§ E	280	+					
Anthozoa	Scleractinia	Oculinidae	<i>Madrepora oculata</i> Linnaeus, 1758	280-551	+		+			
MOLLUSCA										
Bivalvia	Pectinoidea	Pectinidae	<i>Delectopecten vitreus</i> (Gmelin, 1791)	280-475	+					
Cephalopoda	Oegopsida	Ommastrephidae	<i>Todarodes sagittatus</i> (Lamarck, 1798) §	608			+			
ANNELIDA										
Polychaeta	Sabellida	Serpulidae	<i>Serpula vermicularis</i> Linnaeus, 1767	277-551	+		+			
			<i>Serpula concharum</i> (deep form) Langerhans, 1880**§	277	+					
			<i>Vermiliopsis monodiscus</i> Zibrowius 1968 E	277-280	+					
			<i>Metavermilia multicristata</i> (Philippi, 1844)	277-280	+					
			<i>Filogranula gracilis</i> Langerhans, 1884	277-551	+		+			
			<i>Janita fimbriata</i> (Delle Chiaje, 1822)	277-551	+		+			
			<i>Placostegus tridentatus</i> (Fabricius, 1779)	280	+					
			<i>Hyalopomatus madreporae</i> Sanfilippo, 2009 E**§	551			+			
			<i>Filograna implexa</i> Berkeley 1835	280-551	+		+			
			<i>Filograna</i> sp. 1 *§	280	+					
			<i>Eunice norvegica</i> (Linnaeus, 1767)	280-551	+		+			
			ARTHROPODA							
			Crustacea	Decapoda	Homolidae	<i>Paromola cuvieri</i> (Risso, 1816)	338			+
BRYOZOA										
Stenolaemata	Cyclostomatida	Plagioeciidae	<i>Entalophoroecia deflexa</i> (Couch, 1842) §	277-280	+					
		Crisiidae	? <i>Crisia ramosa</i> Harmer, 1891§	280	+					
			<i>Crisia tenella</i> Calvet, 1906, <i>longinodata</i> Rosso, 1989*§	277-280	+					
Gymnolaemata	Cheilostomatida	Aeteidae	<i>Aetea truncata</i> (Landsboroug, 1852) §	280	+					
		Flustridae	<i>Gregarinidra gregaria</i> (Heller, 1867) §	280	+					
		Candidae	<i>Scrupocellaria delilii</i> (Audouin, 1826) §	280-551	+		+			
		Cribrilinidae	<i>Puellina (Glabrilaria) pedunculata</i> Gautier, 1956**§	277-280	+					
			<i>Puellina (Cribrilaria) radiata</i> (Moll, 1803) §	277-280	+					
			<i>Puellina (Cribrilaria) venusta</i> (Canu & Bassler, 1925)**§	280	+					
		Smittinidae	<i>Smittina crystallina</i> (Norman, 1867)**§	280	+					

(continued)

Table 2 (continued)

PHYLUM				Depth range (m)	Gear VG	MMLL	
Class	Order	Family	Species				
		Bitectiporidae	<i>Smittoidea</i> cf. <i>ophidiana</i> (Waters, 1879)**§	280	+		
			<i>Schizomavella discoidea</i> (Busk, 1859) §	280	+		
			<i>Schizomavella linearis</i> (Hassall, 1841) §	280	+		
		Lanceoporidae	<i>Stephanotheca arrogata</i> (Waters, 1879)**§	277-280	+		
			<i>Stephanotheca watersi</i> Reverter, Souto & Fernandez, 2012 ?**§	280	+		
		Escharinidae	<i>Escharina vulgaris</i> (Moll, 1803) §	277-280	+		
			<i>Herentia hyndmanni</i> (Johnston, 1847) §	277-280	+		
		<i>incertae sedis</i>	<i>Hippomenella mucronelliformis</i> (Waters, 1899)**§	280	+		
		Celleporidae	? <i>Turbicellepora coronopus</i> (Wood, 1844)**§	280	+		
		ECHINODERMATA					
Ophiuroidea	Ophiurida	Ophiotrichide	<i>Ophiothrix quinquemaculata</i> (Delle Chiaje, 1828)	280	+		
		Amphiuridae	<i>Amphiura filiformis</i> (O.F. Müller, 1776)	309-770	+		
Echinoidea	Camarodonta	Echinidae	<i>Gracilechinus acutus</i> (Lamarck, 1816)	325	+		
CHORDATA							
Elasmobranchii	Hexanchiformes	Hexanchidae	<i>Hexanchus griseus</i> (Bonnaterre, 1788)	443-787		+	
	Squaliformes	Centrophoridae	<i>Centrophorus granulosus</i> (Bloch and Schneider, 1801)	612-787		+	+
		Etmopteridae	<i>Etmopterus spinax</i> (Linnaeus, 1758)	492-787		+	+
		Dalatiidae	<i>Dalatias licha</i> (Bonnaterre, 1788)	443		+	
	Carcharhiniformes	Scyliorhinidae	<i>Galeus melastomus</i> Rafinesque, 1810	338-612		+	+
		Scyliorhinidae	<i>Scyliorhinus canicula</i> (Linnaeus, 1758) §	376			+
	Myliobatiformes	Dasyatidae	<i>Pteroplatytrygon violacea</i> (Bonaparte, 1832) §	338-608			+
	Holocephali	Chimaeriformes	Chimaeridae	<i>Chimaera monstrosa</i> Linnaeus, 1758 §	608		
Actinopterygii	Anguilliformes	Congridae	<i>Conger conger</i> (Linnaeus, 1758)	338-788		+	+
	Beryciformes	Trachichthyidae	<i>Hoplostetis mediterraneus</i> Cuvier, 1829	577		+	
	Gadiformes	Gadidae	<i>Micromesistius poutassou</i> (Risso, 1827) §	376-492			+
		Lotidae	<i>Molva dypterygia</i> (Pennant, 1784) §	612			+
		Merlucciidae	<i>Merluccius merluccius</i> (Linnaeus, 1758)	338-612		+	+
		Phycidae	<i>Phycis blennoides</i> (Brünnich, 1768)	338-612			+
	Perciformes	Trichiuridae	<i>Lepidopus caudatus</i> (Euphrasen, 1788)	443-577		+	
		Polyprionidae	<i>Polyprion americanus</i> (Bloch & Schneider, 1801)	378-577		+	+
		Sparidae	<i>Pagellus bogaraveo</i> (Brünnich, 1768)	443-787		+	+
		Scorpaeniformes	Scorpaenidae	<i>Scorpaena elongata</i> Cadenat, 1943 §	338		
	Sebastidae		<i>Helicolenus dactylopterus</i> (Delaroche, 1809)	338-787		+	+

than 100 m depth in the Mediterranean Sea. Some studies carried out on the biological community of the Bari Canyon have only recently documented a very abundant sponge fauna referred to five sponge taxa (*Rhizaxinella pyrifer*, *Poecillastra compressa*, *Pachastrella monilifera*, *Haliclona* sp., *Hexadella* sp.) (Anonymous, 2009; Freiwald *et al.*, 2009; Bo *et al.*, 2012; Angeletti *et al.*, 2014). The present study, recording 29 sponge taxa, demonstrates that, as already known in Mediterranean and Atlantic CWC communities, poriferans are one of the most common benthic organisms inhabiting these deep biocoenosis, also in terms of species richness (Longo *et al.*, 2005; Soest & Lavaleye, 2005; Soest *et al.*, 2007; Mastrototaro *et al.*, 2010; Calcinai *et al.*, 2013).

The sponge assemblage described consists mainly of species (59.3%) already reported in association with Mediterranean CWC (Vacelet, 1969; Longo *et al.*, 2005; Mastrototaro *et al.*, 2010; Calcinai *et al.*, 2013), even though, eleven species (*Prosuberites longispinus*, *Antho* (*Antho*) *involvens*, *Eurypon cinctum*, *E. topsenti*, *Biemna parthenopea*, *B. tenuisigma*, *Axinella pumila*, *Bubaris subtila*, *Cerbaris curvispiculifer*, *Hymenabdia typica* and *Hexadella pruvoti*) were found for the first time in association with Mediterranean CWC. Eleven species of our records have also been recorded by Vacelet (Vacelet, 1969) in the Gulf of Lion, and 10 of the species recorded here are in common with the sponge assemblage from the Santa Maria di Leuca (SML) CWC province (Longo *et al.*, 2005; Mastrototaro *et al.*, 2010). Only four of the species recorded are also on the sponge species list reported by Calcinai *et al.* (2013) for the CWC from the Strait of Sicily. Currently, 112 sponge species have been found associated with the four closely studied Mediterranean CWC communities in the Gulf of Lion, SML CWC province, the Strait of Sicily, and the Bari Canyon, but only three species are always present at all these sites - *Desmacella inornata*, *Jaspis incrustans*, and *Poecillastra compressa*.

According to the Mediterranean literature, the order Poecilosclerida is the most represented (Vacelet 1969; Longo *et al.* 2005; Calcinai *et al.*, 2013), whereas the number of species belonging to the order Astrophorida found during the present study is low (only three species recorded), in contrast to those reported in other CWC Mediterranean biocoenosis. The percentage of Mediterranean endemic species found associated with CWC in the Bari Canyon (13.8%) is comparable to literature data on other CWC biocoenosis (Vacelet, 1969; Longo *et al.* 2005; Calcinai *et al.* 2013). The sponge assemblage described here is characterized by the rather scarce presence of boring sponges, with only one species recorded (*S. infestum*). This feature is consistent with previous observations on Mediterranean and Atlantic CWC biocoenosis, where little more than five species infesting the scleraxis of CWC colonies have been reported (Vacelet, 1969; Jensen & Frederiksen, 1992; Longo *et al.*, 2005; Beuck *et al.*, 2007, 2010; Calcinai *et al.*, 2013). Despite the low number of species, boring sponges may greatly affect white coral colonies (see also Jensen & Frederiksen, 1992; Beuck *et al.*, 2007, 2010), with heavy excavating activity mainly limited to the

dead portion of the colonies, as observed in the present study. However, the availability of a single colony of *M. oculata* does not permit us to generalize about the frequency or the impact of boring species in the Bari Canyon.

Cnidaria

One live colony of the scleractinian *M. oculata* was sampled at 280 m in depth using the Van Veen grab (station 1B1). Living polyps were present at the top of the colony while its lower part was dead, with exposed skeleton completely covered by serpulids, sponges and bryozoans. Another live colony of *M. oculata* was also collected by longline at station 5 (551 m). As shown by the ROV images (Freiwald *et al.*, 2009; Sanfilippo *et al.*, 2013; Angeletti *et al.*, 2014), the vertical walls of the canyon host an extended *facies* of *M. oculata*. Although *M. oculata* seems to be the most abundant cold-water coral, other species, both colonial (*Lophelia pertusa*, *Dendrophyllia cornigera*) and solitary (*Desmophyllum dianthus*, *Stenocyathus vermiformis*), inhabit this canyon (Freiwald *et al.*, 2009) but these species were not recorded in this study. Recently, the anemone *Peachia* sp. has been recorded using an ROV (Angeletti *et al.*, 2014).

Mollusca

One Bivalvia and one Cephalopoda were recorded, the Pectinidae *Delectopecten vitreus* and the Ommastrephidae *Todarodes sagittatus*. One living specimen of *D. vitreus* was found to be associated with the *M. oculata* colony sampled at station 1B1, at a depth of 280 m, and two other living specimens were collected at station 2B5a on hard ground located at 475 m depth. A single large specimen of *T. sagittatus* was caught at station 4 (608 m in depth) using a longline (4 LL in Table 1). The presence of *D. vitreus* on hard substrates of Bari Canyon at station 1B1 confirms the association of this species with CWC (Tursi *et al.*, 2004; Mastrototaro *et al.*, 2010; Rosso *et al.*, 2010a; Taviani *et al.*, 2011). Living benthic molluscs were not found on soft substrates of the Bari Canyon where, on the contrary, a large number of shells of dead molluscs were identified to 55 species belonging to the typical epibathyal mollusc communities currently present in the Mediterranean Sea (Panetta *et al.*, 2013). *Todarodes sagittatus* was the only cephalopod collected in this study. Although this ommastrephid squid has been previously reported in the southern Adriatic Sea (Ungaro *et al.*, 1999), its occurrence represents the first record in the Bari Canyon; it is a common pelagic and benthic-pelagic species in the Mediterranean where it preys actively in deep waters (Rosas-Luis *et al.*, 2014).

Annelida

The living communities from samples 1B1 and 1B18 consisted of eight and nine species, respectively. Serpulids from sample 1B1 were found on living and dead *M. oculata* colonies as well as on a hard ground block approximately 30

cm in size. Sample 1B18 consisted of slabs of lithified mud (hard substrate). The species detected in both samples were *Serpula vermicularis*, *Filogranula gracilis*, *Metavermilia multicristata*, *Vermiliopsis monodiscus*, *Janita fimbriata* and *Placostegus tridentatus*. The species *Serpula concharum* (deep sea morphotype), *Filograna implexa*, and a new species belonging to the same genus here called *Filograna* sp. 1, were relatively abundant on coral branches (Fig. 4). *Hyalopomatus madreporae* was also present on the branches of a *Madrepora* colony. Further differences were also observed in serpulid structure between communities on corals or hard substrates: serpulids were more abundant on *Madrepora* branches, where specimens of *Filograna implexa* and *Filograna* sp.1 prevailed. Conversely, communities on the hard base surfaces consisted of a lower number of specimens although the species richness was higher; *F. gracilis*, *M. multicristata*, and *J. fimbriata* were the dominant taxa here. Besides serpulids, the only other polychaete species was *Eunice norvegica*, a single specimen found associated with the living colony of *M. oculata* in sample 1B1.

Most of the detected species are widely distributed in the eastern Atlantic and Mediterranean (Ben-Eliahu & Fiege, 1996; Castelli *et al.*, 2008; Sanfilippo, 2009; Mastrototaro *et al.*, 2010). *Serpula vermicularis*, *F. gracilis*, *M. multicristata*, and *V. monodiscus* have previously been recorded in the same study area (Freiwald *et al.*, 2009; Sanfilippo *et al.*, 2013). The latter species is endemic, though more abundant in the western and central Mediterranean (Zibrowius, 1968). *Serpula concharum* (deep sea morphotype) and *Hyalopomatus madreporae* are new records for the Adriatic Sea; the latter is also endemic in the Mediterranean, recently recorded in the northern Ionian Sea (Sanfilippo, 2009; Mastrototaro *et al.*, 2010). It is worth noting the discovery of *Filograna* sp. 1, a species that still needs to be formally described: tubes of this species are extremely abundant on living and dead coral branches and resemble those of *F. implexa*, being perfectly circular in cross-section, but their diameter is smaller (approximately half) and they do not seem to branch off for scissiparity. Both species of *Filograna* form aggregations with their tubes extensively covering the branches and calices of *M. oculata*. In particular, *Filograna* sp. 1 seems to be cryptic, mainly colonising the sheltered cavities of the internal parts of the *Madrepora* calices, also observed for other small-sized serpulids (Sanfilippo, 1998). As a whole, the serpulid communities of the studied samples comprised species distributed in deep-circalittoral to bathyal environments, as well as at shallower depths in coral-ligenous sciaphilic habitats and within caves (Bianchi & Sanfilippo, 2003; Rosso *et al.*, 2013). They have been previously recorded on deep-water scleractinians (*M. oculata*, *Dendrophyllia cornigera*) in the Mediterranean Sea (Zibrowius 1968, 1971; Bourcier & Zibrowius, 1972; Di Geronimo *et al.*, 1993; Mastrototaro *et al.*, 2010).

Mediterranean fossil records of serpulids from cold-water Plio-Pleistocene deposits of the Messina Straits (Barrier *et al.*, 1989) as well as from Pleistocene upper circalittoral (within sciaphilic microhabitats) to bathyal palaeo-environments (Di

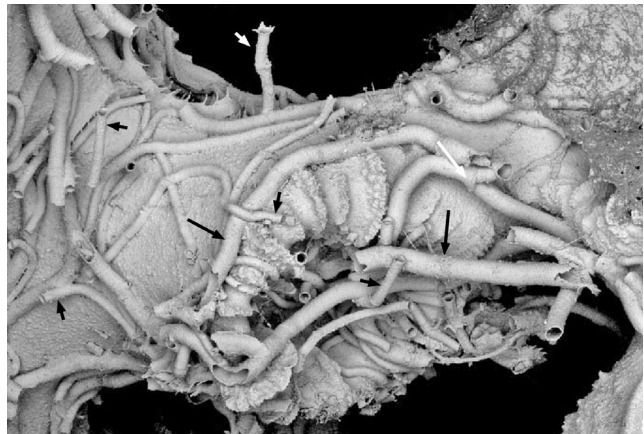


Fig. 4: Calice of *Madrepora oculata* heavily encrusted by *Filograna implexa* (long black arrows) and *Filograna* sp.1 (short black arrows). Erect distal part of the tube of *Filogranula gracilis* is also visible (short white arrow). The long white arrow indicates scissiparous tubes of *Filograna implexa*.

Geronimo & Sanfilippo, 1992; Di Geronimo *et al.*, 1998) have been recorded. Some of these species are also known from canyon habitats; in particular, *S. vermicularis* has been recorded in the Cassidaigne and Cape de Creus canyons in the Gulf of Lion, NW Mediterranean (Bourcier & Zibrowius, 1972; Orejas *et al.*, 2009; Sanfilippo *et al.*, 2013), where white coral communities occur at comparable depths. Recently, large specimens of *S. vermicularis* have also been found forming coral-serpulid build-ups (*Madrepora*, *Lophelia*, *Desmophyllum*) from the Bari Canyon at greater depths (Sanfilippo *et al.*, 2013; Angeletti *et al.*, 2014). Finally, *F. implexa*, *M. multicristata*, and *V. monodiscus* have been recorded by Bourcier and Zibrowius (1972) associated to *Madrepora* and *Dendrophyllia* colonies from the Cassidaigne canyon.

The recurrent interaction between *E. norvegica* and CWC is noteworthy, and has yet to be investigated in detail. This polychaete lives in close association with the coral host, building a parchment tube between the living coral branches, and somehow stimulating the coral to produce additional exoskeletal calcification on the thin tube of the polychaete. This interaction contributes to a strengthening of the reef framework by thickening and connecting coral branches, acting as a positive feedback on the development of CWC bio-constructions, although it is still not clear whether or not this process also enhances the food relationship between corals and *E. norvegica* (Roberts, 2005; Carlier *et al.*, 2009; Mueller *et al.*, 2013). This Eunicidae is widespread on CWC reefs and its presence on the Bari Canyon CWC bio-constructions was already known, in association with both *M. oculata* and *L. pertusa* colonies (Roberts *et al.*, 2006, 2009).

Arthropoda

Only one large specimen of the crustacean decapod *Paromola cuvieri* was caught using a longline at 338 m depth (station 3). This homolid crab had previously been observed in the Bari Canyon using an ROV (Angeletti *et al.*, 2014).

Bryozoa

Living bryozoans were only found at two stations, namely 1B1 and 1B18, in the depth interval 277-280 m. Nineteen species, distributed within 11 families, were identified: 3 cyclostomes and 16 cheilostomes (3 anascans and 13 ascophorans) (see Table 2). Bryozoans were found to be more abundant and diversified (103 colonies and 19 species) in sample 1B1, where they colonised a large hard ground slab (Rosso *et al.*, 2014) and some branches of *M. oculata* (Fig. 5). In contrast, they were markedly less abundant and diversified (14 colonies and 7 species) in sample 1B18. Two species, *Smittidea* cf. *ophidiana* and *S. linearis*, were exclusively found on exposed coral skeletons, whereas *Crisia tenella longinodata*, *Aetea truncata*, *Scrupocellaria delilii*, *Smittina crystallina*, *Stephanotheca watersi*, *Stephanotheca arrogata*, and *Herentia hyndmanni* were only found on hard ground pieces. The most abundant species was *Puellina* (*Glabrilaria*) *pedunculata* followed by *Escharina vulgaris* and *S. watersi*, *Puellina* (*Cribrilaria*) gr. *venusta*, *S. delilii*, and *C. tenella longinodata*, *Gregarinidra gregaria*, ?*Turbicellepora coronopus*, and *H. hyndmanni*. Encrusting morphotypes largely prevailed, consisting of both multi-serial species forming spots (*S. crystallina*, *P. (G.) pedunculata*, *H. hyndmanni*, and *Schizomavella discoidea*) or patches of single or multiple layers (*G. gregaria*, *Puellina* spp., *E. vulgaris*, *Stephanotheca* spp., and *H. mucronelliformis*) and uni-serial runners (*Entalophoroecia*). Erect morphotypes were represented by flexible *Crisia* and *Scrupocellaria* colonies.

Bryozoans were first reported in the Bari Canyon by Freiwald *et al.* (2009) who, using an ROV, recorded red-coloured colonies up to 20 cm high associated with sponges and white corals in the depth range 600-664 m. Specimens at 306 m were identified as *Myriapora truncata* (Freiwald *et al.*, 2009), but colonies collected at approximately the same depth near build-ups of scleractinian-serpulid concretions were revealed as belonging to *Smittina cervicornis* (Sanfilippo *et al.*, 2013). Thus, the presence of *M. truncata* remains to be ascertained. None of these conspicuous species was found in the present samples. However, at least one of these two unidentified species from Freiwald *et al.* (2009) should be added to the reported 19 taxa, raising to 20 (or even to 21) the number of bryozoan species presently known in the Bari Canyon, between depths of 277 and 306 m.

None of the species recorded seems to be specifically adapted to colonising exposed coral skeletons, which appear to be only one of the exploitable substrata. Indeed, species found on corals were also present as dead specimens on hard grounds and other substrata, suggesting that they are not actually selective. Some species not found on corals in the examined samples have been reported as encrusting coral skeletons in other Mediterranean localities (Zabala *et al.*, 1993; Mastrototaro *et al.*, 2010).

As many as nine of the bryozoan species reported here from the Bari Canyon, namely *E. deflexa*, *C. ramosa*, *G. gregaria*, *S. discoidea*, *S. linearis*, *A. truncata*, *S. delilii*, *P.*

(*C.*) *radiata*, and *E. vulgaris*, had previously been recorded from the Adriatic Sea (Rosso *et al.* 2010b). Nevertheless, most of them were only known in the northern sector, and the last four species from northern and southern sectors but not from the intermediate areas (Rosso *et al.*, 2010b). *Stephanotheca watersi* could be added to this group because this newly erected species (Reverter-Gil *et al.*, 2012) could include some specimens previously reported as *Schizomavella rudis* (Rosso *et al.*, 2010b). All other species are reported here for the first time from this area, but nearly all of them were already known from the Ionian Sea, whereas *H. mucronelliformis* and *S. watersi* were known from the Tyrrhenian Sea and the Messina Strait (Rosso *et al.*, 2010b) and from the Tyrrhenian Sea (Reverter-Gil *et al.*, 2012), respectively. Most species have already been reported from cold-water coral ecosystems of the Mediterranean Sea. *Scrupocellaria delilii*, *S. crystallina*, *H. hyndmanni*, *P. (G.) pedunculata*, and *C. tenella longinodata* were known from greater depths in the SML CWC province (Mastrototaro *et al.*, 2010). The first three species, together with *E. deflexa*, *G. gregaria*, *P. (C.) radiata*, *S. ophidiana*, *S. linearis*, *E. vulgaris* and *T. coronopus*, have also been reported as epibionts on live and/or dead *Madrepora* and *Lophelia* colonies collected within canyons along the Catalonia slope, off Blanes and Banyuls-sur-Mer in the entire 180-350 m sampled depth range, or in parts of it (Zabala *et al.*, 1993). Almost all of these species are also typically widespread on shelf environments with the possible exception of *H. hyndmanni*, *S. crystallina* and *P. (G.) pedunculata*, seemingly restricted to the very outer shelf and the upper slope (Berning *et al.*, 2008; Mastrototaro *et al.*, 2010); only the latter is able to live at shallow depths, in submarine caves (Harmelin, 1970; Rosso *et al.*, 2013; Sanfilippo *et al.*, 2014). A further species, *S. arrogata*, has been recorded only once as encrusting on dead *Madrepora* skeletons in waters 105-110 m deep, in the Sicily Strait (Gautier, 1962). The discovery of *C. tenella longinodata* in the Bari Canyon is worthy of note because it definitely confirms that this taxon is still living in the Mediterranean. This species was described as a Lower Pleistocene deep-water bryozoan by Rosso (1998) and considered as an extinct endemic taxon (Rosso & Di Geronimo 1998; Rosso *et al.*, 1998; Rosso, 2005). Comparable specimens found in the SML coral province were named *Crisiidae* sp. due to the absence of gonozooids, hampering a reliable taxonomic attribution (Mastrototaro *et al.*, 2010). This taxon seems to be typically restricted to bathyal environments. In contrast, *S. discoidea* and *H. mucronelliformis* presently known from shelf environments (Gautier, 1962; Hayward & Ryland, 1999) but extending to deeper waters, had never previously been reported from cold-water coral ecosystems. *Smittina cervicornis* (and even the doubtfully present *M. truncata*) might be added to this stock of species with wide bathymetric distributions. This is probably the deepest record for *S. watersi*, so far known from shelf bottoms (Reverter-Gil *et al.*, 2012). The described bryozoan community lacks some of the typical Mediterranean bathyal species as well as some ubiquitous deep-water taxa reported by Harmelin & d'Hondt,

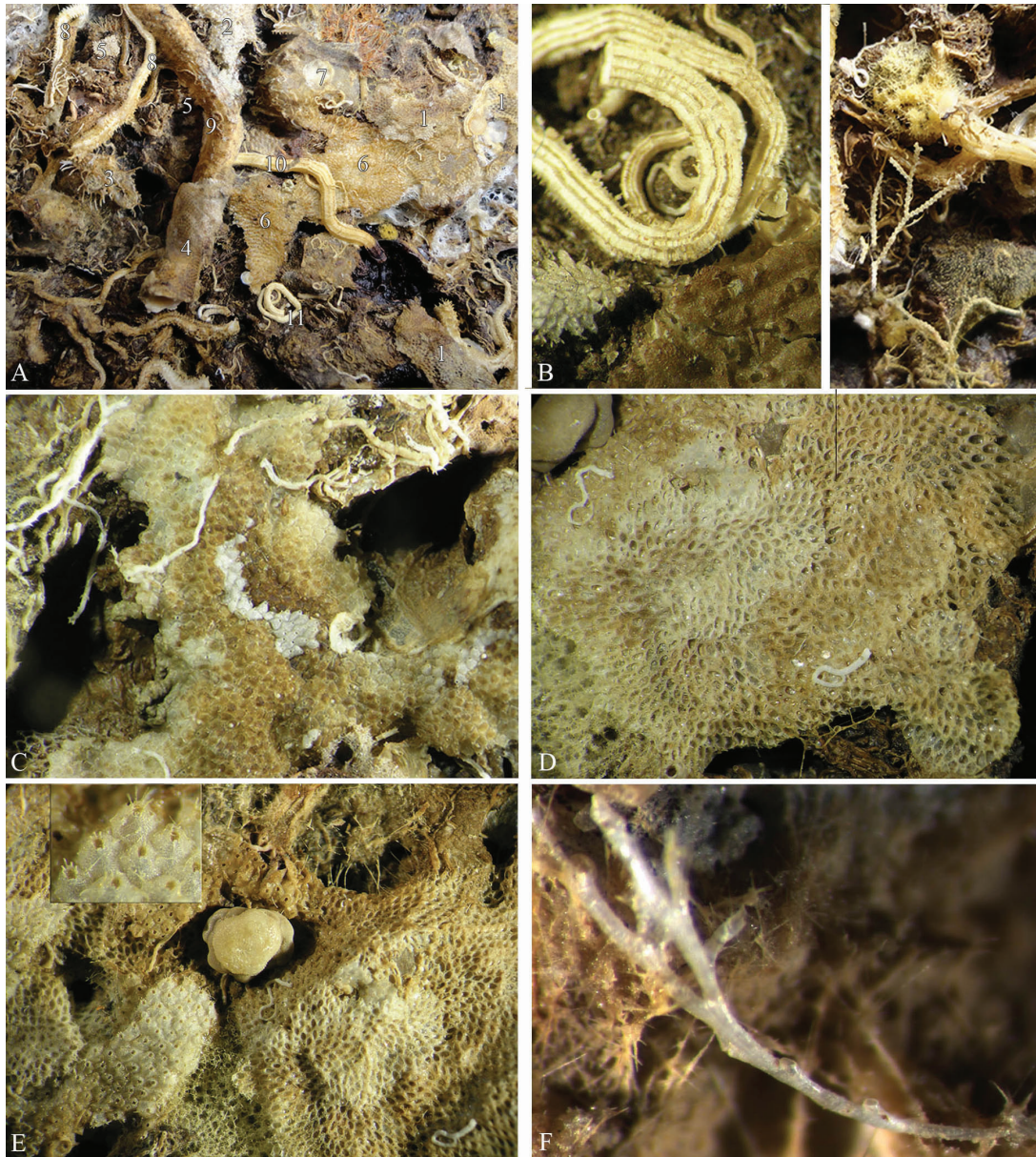


Fig. 5: A. Colonisation of the hardground slab sampled at station 1B1. Several serpulids and encrusting bryozoan colonies exhibiting uni-to-multilaminar or running growth habit are obvious. Bryozoans include: *Gregarinidra gregaria* (1), *Hippomenella mucronelliformis* (2), *Entalophoroecia deflexa* (3), *Puellina* (*Cribrilaria*) *radiata* (4), *P. (Glabrilaria) pedunculata* (5), *Smittoidea ophidiana* (6) and *Escharina vulgaris* (7). Serpulids include: *Janita fimbriata* (8), *Serpula vermicularis* (9), *Serpula concharum*, deep morphotype (10) and *Metavermilium multicristata* (11). For bryozoans, only larger, mostly living, colonies are indicated, but several smaller ones are present. B. Close-up of the central part of the bottom of A to show *Puellina* (*G.*) *pedunculata* and *M. multicristata* (left) and a small erect flexible colony of *Scrupocellaria delilii* (right). C. *Puellina* (*Cribrilaria*) *venusta*: whitish recently budded zooids are evident against older colony portions already coated by more or less heavy oxidation crusts. D. Large colony of *G. gregaria* partly overgrown by a lobate colony of *E. vulgaris*. E. Again *G. gregaria* partly covered by *H. mucronelliformis*. A detail of this last species is shown in insert (top left). F. Fertile colony of *Crisia tenella longinodata*. A gonozooid, facing towards the substratum, is present on the left branch.

(1992), Rosso & Di Geronimo, (1998), and Mastrototaro *et al.* (2010). Interestingly, the bryozoan association in the Bari Canyon coral ecosystem explored so far appears to be different from that recorded in the SML coral province, with which it shares only five species (nearly 25%). A higher number of species (ten: 50%) is shared with the bryozoan communities of the Catalonia canyons from where as many as 36 species have been recorded (Zabala *et al.*, 1993).

The special compositional features of the Bari Canyon bryozoan community and its particular affinity with that of the Catalonia canyons could be related to the relatively shallow location of the investigated sites (in comparison to SML coral community, 500 to 800 m in depth; Mastrototaro *et al.*, 2010) and/or to the locations within a canyon. In particular, the presence of *H. mucronelliformis*, a species common in current-swept communities in submarine caves (Taddei-Rug-

giero *et al.*, 1996) and at the sill of the Messina Strait (Rosso, personal observations), could indicate strong hydrodynamic activity. The peculiar water circulation and energy could explain the shift to deeper waters of some species. Nevertheless, further knowledge about deep-water bryozoan communities and their distribution, as well as about the peculiar systems represented by canyons is needed to really understand what parameters affect/force the observed species distributions.

Echinodermata

Living echinoderms were found at 10 stations, both on hard and soft substrates. In particular, the ophiuroid *Amphiura filiformis* was sampled at nine stations, with 8 and 10 specimens at stations 1B17c and 2B3, respectively. Four specimens of *Ophiothrix quinquemaculata*, a large orange ophiuroid, were found to be associated to *M. oculata* and on the hard substrate sampled at station 1B1. Only one specimen of the regular echinoid *Gracilechinus acutus* was sampled at station 2B8. The widespread presence of *A. filiformis* in most of the sampling stations is not surprising; in fact, even though there are no studies of echinoderms in the Bari Canyon, it is well known that this ophiuroid is quite common in the bathyal muddy sediments of the Mediterranean (Tortonese 1965, 1980). On the contrary, our finding of *O. quinquemaculata* at 280 m in depth slightly extends the bathymetrical range (previously 40 - 250 m) reported for this species by Tortonese (1965) in the Mediterranean Sea. The record of this species on a *M. oculata* colony and on the hard ground confirms that, even though it is usually reported as a soft-bottom species, *O. quinquemaculata* may prefer small hard substrates (e.g. stones, shells, big pebbles) scattered upon the sediment (Czihak, 1954; Tortonese, 1965).

Elasmobranchii and Holocephali

Eight cartilaginous species of fishes (seven Elasmobranchii and one Holocephali) were observed during this study. Those observed both with the MEMO lander and caught using longline were *Centrophorus granulosus*, *Etmopterus spinax*, and *Galeus melastomus*. The sharks *Dala-*

tias licha and *Hexanchus griseus* were only identified during the video records (Fig. 6) while *Scyliorhinus canicula*, *Pteroplatytrygon violacea*, and *Chimaera monstrosa* were only caught using a longline (Table 2). The most frequently caught cartilaginous fish was the blackmouth cat shark *G. melastomus*. The widest depth distribution of 344 m was observed for *H. griseus* (caught between 443-787 m). The species *S. canicula*, *P. violacea*, and *C. monstrosa* are new records for the Bari Canyon; however, they belong to the southern Adriatic fish fauna (Ungaro *et al.*, 1999; De Zio *et al.*, 2000). The cartilaginous fishes represent 42% of the fishes collected. The presence of species at the top of the marine food web such as *C. granulosus* and *H. griseus* considered “vulnerable” on the published IUCN Mediterranean Regional Red List (Abdul Malak *et al.*, 2011) could emphasize the role of the Bari Canyon as a refuge because fishing is poorly developed in this site. This is further confirmed by the frequent capture of *G. melastomus* in this canyon, since this shark is generally removed from fishing grounds by commercial trawl fishing.

Actinopterygii

Eleven species of osteichthyes were identified in the Bari Canyon: one Anguilliformes, one Beryciformes, four Gadiformes, three Perciformes, and two Scorpaeniformes encompassing 11 families, each of them present with only one species. Seven species were recorded during the MEMO lander deployments and nine were collected by longline (Table 2). Most of them were detected by both lander and longline while two species, *Hoplostethus mediterraneus* and *Lepidopus caudatus*, were only recorded during the video recording and four species, *Micromesistius poutassou*, *Molva dypterygia*, *Phycis blennoides*, and *Scorpaena elongata*, were only caught by longline. The Anguilliformes *Conger conger* and the Scorpaeniformes *Helicolenus dactylopterus* showed the widest depth distribution (338-788 m) and were recorded by both lander and longline while the Scorpaenidae *S. elongata* was only collected at the shallowest station by longline (Table 2). The species *C. conger*, *P. blennoides*, *Pagellus bogaraveo* and *H. dactylopterus* were found to be associated with

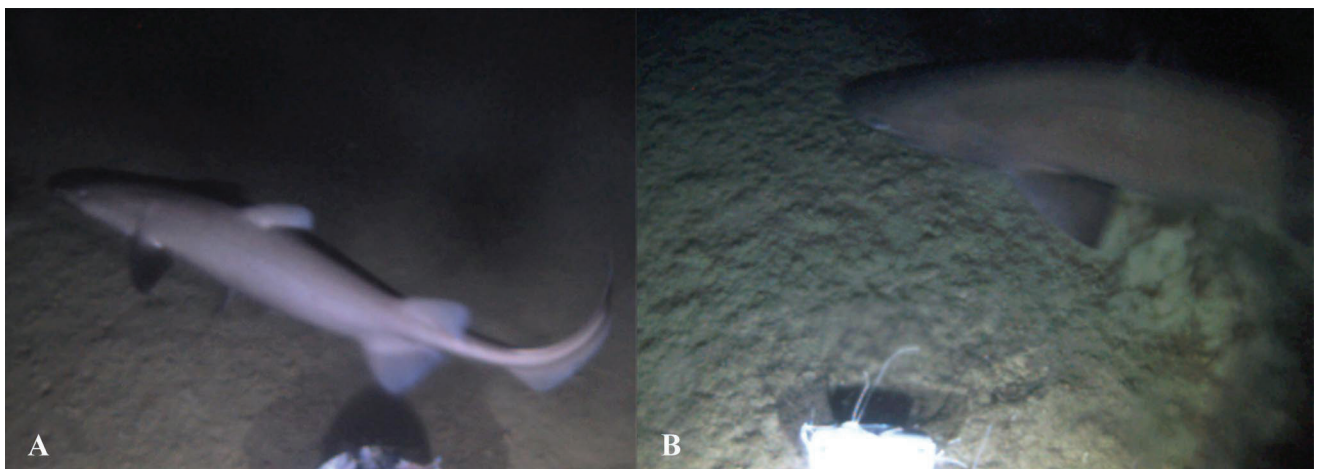


Fig. 6: The sharks *Dalatias licha* (A) and *Hexanchus griseus* (B) swimming near the MEMO lander in the Bari Canyon.

the cold-water coral *M. oculata* which was directly entangled in the longline as coral by-catch at station 5 (551 m). Apart from *H. mediterraneus*, which is always discarded, all the recorded species are of commercial interest in the Adriatic fisheries, although with different economic values. The species *P. bogaraveo*, *C. conger*, and *H. dactylopterus* were the teleost fishes most frequently observed during the MEMO lander deployments (Fig. 7); other fish species were recorded less frequently. Using longline, *H. dactylopterus* was the most collected species, and other commonly caught species were the Gadiformes *P. blennoides* and *Merluccius merluccius*, and the Anguilliformes *C. conger*.

The Actinopterygii species observed in the Bari Canyon using the MEMO lander and the longline have been commonly reported at a regional level in the southern Adriatic Sea (Ungaro *et al.*, 1998a, 1998b). Most of these species have been recently recorded in the Bari Canyon by *in situ* observations with an ROV and a baited lander (Angeletti *et al.*, 2014; D'Onghia *et al.*, 2014) and the vertical distribution of *P. bogaraveo* and *H. dactylopterus* in this area has also been updated (D'Onghia *et al.*, 2014). *M. poutassou*, *M. dypterygia*, and *S. elongata* previously recorded from the southern Adriatic Sea (Ungaro *et al.*, 1999) are here reported for the first time from Bari Canyon. Almost all the fish species found generally occur in other Mediterranean canyons (e.g. Stefanescu *et al.*, 1994; Ramirez-Llodra *et al.*, 2010; Company *et al.*, 2012; Farrugio, 2012; Watremez, 2012; Fabri *et al.*, 2014). The association of *C. conger*, *P. bogaraveo*, and *H. dactylopterus* with the cold-water coral *M. oculata* in the catch also confirms the preferred distribution of these species within the coral habitat, previously documented in the SML CWC province (D'Onghia *et al.*, 2010, 2011, 2012). Moreover, the most frequent observations of *C. conger* and *H. dactylopterus* in the present study using both baited lander and longline could be due to a preferential distribution of these fishes in a complex and heterogeneous habitat (D'Onghia *et al.*, 2014; Fabri *et al.*, 2014).

Conservation issues and concluding remarks

The use of different sampling equipment and the collaboration of different specialists has allowed the updating of knowledge on the macro- and megafauna biodiversity in

the Bari Canyon as well as in the Adriatic Sea. A total of 85 benthic and benthic-pelagic species was identified including 51 species that are new records for the Bari Canyon and 29 that are new records for the Adriatic Sea. Six Mediterranean endemic species were identified, four Porifera and two Annelida. The deepest and the shallowest bathymetric limits have been extended for some species and the first record of living specimens of the bryozoan *C. tenella longinodata* is reported. Most new records regard sponges, for which new information is reported for deep-sea species confirming their importance in the structure of CWC communities. An important contribution to the biodiversity is also presented for bryozoans, fishes, and annelids; many species previously reported from cold-water coral communities of the Mediterranean Sea (Longo *et al.*, 2005; Mastrototaro *et al.*, 2010; D'Onghia *et al.*, 2011; Fabri *et al.*, 2014) had not been recorded in the Bari Canyon.

Although the Bari Canyon has been mostly investigated using ROV and only recently, to date a total of 111 species have been recorded in it, suggesting that the Adriatic populations of benthic species in this canyon could be connected with the well known SML CWC province in the northern Ionian Sea (Fig. 8) along the south-western Adriatic margin, in agreement with Angeletti *et al.* (2014). The greater number of species recorded until now in the SML CWC province is mostly due to a greater number of studies and explorations carried out with different types of sampling gear (e.g. Tursi *et al.*, 2004; Longo *et al.*, 2005; Freiwald *et al.*, 2009; D'Onghia *et al.*, 2010, 2011, 2012; Mastrototaro *et al.*, 2010, 2013). The number of bryozoan species greater in the Bari Canyon than in the SML CWC province, is possibly derived from the different depth ranges and habitat settings investigated. The high biodiversity detected in this area could be due to the "canyon effect" (Ramirez-Llodra *et al.*, 2010), which is related to the increase in trophic resources in the canyon, the absence of trawl fishing and the presence of cold-water corals.

The Bari Canyon, like most Mediterranean canyons, might play an important role as protected habitats for many species and, probably, for others of fishing interest (Revenaga Martinez de Pazos, 2012). Several spatial designations and conservation plans have been put in place globally for the protection of these CWC ecosystems including areas with the presence of canyons (e.g. Micheli *et al.*, 2013). To



Fig. 7: The teleost fish *Conger conger* (A), *Pagellus bogaraveo* (B) and *Helicolenus dactylopterus* (C) observed during the MEMO lander deployments in the Bari Canyon.

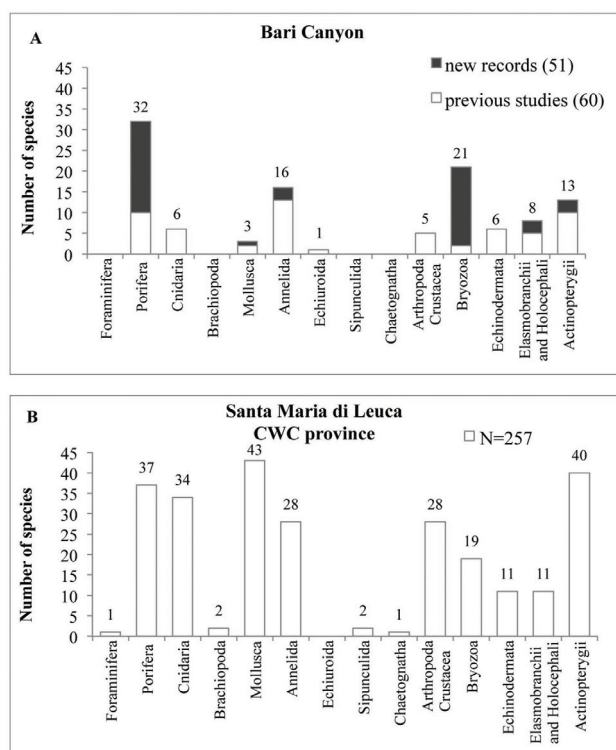


Fig. 8: Taxa composition in Bari Canyon and Santa Maria di Leuca CWC province (A: Freiwald *et al.*, 2009; Bo *et al.*, 2012; Sanfilippo *et al.*, 2013; Angeletti *et al.*, 2014; D'Onghia *et al.*, 2014; present paper; B: Tursi *et al.*, 2004; Longo *et al.*, 2005; Schönberg & Beuck, 2007; Carlier *et al.*, 2009; Freiwald *et al.*, 2009; D'Onghia *et al.*, 2010, 2011, 2012; Mastrototaro *et al.*, 2010, 2013, 2014).

date, apart from the Gulf of Lion, there are no protection measures in place for the Mediterranean submarine canyons (Marin & Aguilar, 2012), although UNEP-MAP-RAC/SPA (2010) suggests that canyons together with other deep-sea features should be protected through implementation of a Precautionary Principle as they are great reservoirs of biodiversity. The role of canyons and CWC ecosystems in marine biodiversity highlights the need for a representative network of Marine Protected Areas for the Mediterranean (Tudela *et al.*, 2004; de Juan and Leonart, 2010; Micheli *et al.*, 2013 and references therein). In particular, a recent proposal for protection of the Mediterranean, called MedNet, envisages various geomorphological features, such as seamounts, escarpments, mud volcanoes etc., also including submarine canyons (Oceana, 2011). The proposal contains a total of 28 submarine canyons and two trenches located in 20 MedNet areas. Within the network, 30 of those sites have been selected by Oceana as “jewels of the Mediterranean” for which urgent measures should be taken. The Bari Canyon is among these 30 jewels of the Mediterranean, with EBSA (Ecologically or Biologically Significant Marine Area) criteria 4 (vulnerability, fragility, sensitivity and slow recovery) and 6 (Biological diversity) (Marin & Aguilar, 2012). The present study suggests that other EBSA criteria (e.g. 1: Uniqueness or rarity; 3: Importance for threatened, endangered or declining species and/or habitats; 5: Biological

productivity; 7: Naturalness) as well as the VME (Vulnerable Marine Ecosystem) criteria (1: Uniqueness or rarity; 2: functional significance of the habitat; 3: fragility; 4: life-history traits that make recovery difficult; 5: structural complexity) (FAO, 2009) could also be assigned to the Bari Canyon in planning future marine protected areas and management measures in order to preserve its high biodiversity level in relation to the presence of cold-water coral species.

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