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Coral assemblage off the Calabrian Coast (South Italy) with new observations on living colonies of *Antipathes dichotoma*

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Abstract
The discovery of a small population of the black coral *Antipathes dichotoma* in the deep waters off the Calabrian coast (South Italy, Tyrrhenian Sea) is reported. The specimens have been photographed and a piece of colony has been collected with the aid of an ROV during an oceanographic cruise on board of the R/V *Astrea* of ICRAM, within the project *Monitoring of the Calabrian Marine Biodiversity* (MoBioMarCal). This finding completes the systematic picture of the oldest-described antipatharian species, giving an account of the living colonies and polyps, their cnidome and the habitat of the species, characterised by a rich and diverse coral community.

Keywords: *Antipatharians, deep corals, Mediterranean Sea, habitat, ROV imaging*

Introduction

The Mediterranean deep sea environments offer an exceptional opportunity to study deep coral species, whose evolution has been subjected to peculiar adaptations to live in a semi-enclosed basin characterised by unique oceanographic features. Nevertheless, the present knowledge regarding the deep fauna for this basin is poor. Particularly for cnidarians, if the scientific data concerning the basilar ecological features of Mediterranean deep-water scleractinians, forming notable cold water coral reefs, are scarce (Freiwald et al. 2009), then what is known for deep flexible corals (antipatharians and gorgonians), forming extended forests, is exceptionally limited (Mortensen & Buhl-Mortensen 2004).

Antipatharians have been proven to hold an important structuring role both in tropical reefs and in temperate ecosystems (Bo et al. 2008, 2009). Their characteristic branched and arborescent three-dimensional morphology generally hosts a rich associated fauna characterised by unique coevolutive strategies (Tazioli et al. 2007). All black corals species are protected under a number of international agreements, European directives and national laws: a greater knowledge of their natural history is therefore mandatory for their management.

In the Mediterranean Sea, black corals are usually restricted to deep habitats, probably to avoid strong seasonal fluctuations of temperature (Bo et al. 2009). Five species are described for the Mediterranean Sea (Opresko & Försterra 2004): *Antipathes dichotoma* Pallas, 1766, *Antipathes fragilis* Gravier, 1918 (Family Antipathidae), *Parantipathes larix* (Esper, 1790) (Family Schizopathidae), *Leiopathes glaberrima* (Esper, 1792) (Family Leiopathidae), and *Antipathella subpinnata* (Ellis and Solander, 1786) (Family Myriopathidae). Morri et al. (2008) recently summarised their distribution in Italian waters. On the basis of the existing knowledge, only *A. subpinnata*, also thriving at deep diving depth, may form extended and dense meadows of colonies (Bo et al. 2008, 2009). In the Mediterranean Sea, observations of other black coral species are not common and concern mainly the pink–orange colonies of *L. glaberrima*, found commonly at depths exceeding 600 m, associated with the white coral reefs in the Ionian Sea (Mastrototaro et al.

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2002; Tursi et al. 2004). Records of the other species are usually made possible by fortuitous fishery by-catches.

A. dichotoma, characterised by tall colonies with loose, long, flexible branches and large polyps, represents the type species of the genus *Antipathes*. Opresko (2003) revised the historical taxonomic background concerning this species. It was first collected almost 300 years ago by Marsigli (1725), but only later Pallas (1766) described formally the species. It is a typical Atlanto-Mediterranean species, whose tropical records have been considered unreliable and probably belongs to separate taxa (Gray 1832; van Pesch 1914; Grigg & Opresko 1977; Zhou & Zou 1984; Opresko 2003). For example, the Hawaiian specimens have recently been identified as the new species *Antipathes griggi* (Opresko 2009).

Its discovery in the twilight zone off the Calabrian coast of Vibo Marina has shed light on its aspect *in vivo* and revealed details on its habitat.

Materials and methods

Five colonies of *A. dichotoma* were observed on a rocky shoal in front of Vibo Marina (Calabria, South Tyrrhenian Sea, Lamezia Gulf; 38°46'8''N 16°7'54''E, 5.5 km off the coast, approximately 30,000 m^2) through a Remotely Operated Vehicle survey (ROV 'Pollux') conducted in July 2008 on board of the R/V *Astrea* of ISPRA between 90 and 132 m depth (Figure 1). The twilight zone of Vibo was characterised by a system of shoals surrounded by a flat soft bottom, made of mud or detritic material and lashed by currents of moderate intensity.

The ROV was equipped with a digital camera (Nikon D80, 10 megapixel), an underwater strobe (Nikon SB 400), a high definition video camera (Sony HDR-HC7) and three jaw grabbers to take samples. Additionally it had a depth sensor, a compass, and two parallel laser beams providing a 10-cm scale for measuring the sampling areas on the substratum and the height of the colonies. Ninety-six photographs were analysed and both density (± SE) and percent composition data for each species were averaged to describe the community structure of the shoal at the considered depth range (90–132 m) and to study the general morphology of the black coral colonies and their polyps *in vivo*.

One sample, a 40-cm high branch, was collected for the morphological analysis of spines and polyps and was preserved, partly in 95° ethanol, partly in 4% formaldehyde in filtered seawater, while the remaining pieces were dried. Small pieces of each ramification type (major branch and branchlets) were cleaned from the coenenchyme with successive $NaHClO_4$ baths then mounted on stubs and sputtered with a 2-μm thick layer of gold–palladium. Morphology, size and arrangement of spines were observed under scanning electron microscopy (Phillips XL20).

The same technique was used to study the polyp external morphology, while cold-curing resin inclusion of zooids (Technovit 8100) and successive cut of 5–10 μm thick sections were employed to analyse the internal anatomy of the polyps. The complete set of cnidocysts was determined with the optical microscope analysing different portions of the polyp (tentacles, mouth and interpolypar coenenchyme).

Finally a biogeographic revision was made, discussing the existing literature data concerning the distribution of this species and integrating them with the most recent, unpublished records.

Results

Description of the specimens (Figures 2 and 3)

Opresko (2003) has produced a detailed description of the species on the basis of preserved specimens coming from the Bay of Naples (Mediterranean Sea) and from the Atlantic Ocean. Nevertheless, some details can be added to this description, mainly in relation to the aspect of the living colonies.

The Vibo specimen is a 40-cm high and 30-cm wide (Figure 2A) living portion of a 1-m tall colony whose basal part is dead and covered by epibiontic hydroids. Four other colonies have been studied on the basis of underwater photographs. Just-collected polyps are opaque ochre yellow (Figure 2A) and produce a notable amount of mucous.

The colonies are characterised by numerous, long and flexible ramifications (Figures 2A,B; 3A–D). Branches emerge from the bearing ramifications at 45–90° upwards, but the longest ones, not ramified at their apex, bend downwards giving the colonies a willow-like aspect (Figures 3A,B). The major branches converge in a single stem showing a basal diameter of, on average, 1.5 cm and a single anchorage, covered by living tissue. From the photographs only traces of polyps are observed on the basal plates (Figure 3E). Branchlets of various lengths (up to 60 cm, spaced several cm apart) are arranged irregularly or dichotomously (Figure 2B), reaching the fifth order of ramification. Buds of branches (up to 0.6 cm long) are randomly sparse along the ramifications. No anastomoses are observed.

On the major branches (2.5 mm in diameter), acute, smooth, conical spines are arranged in 5–6 longitudinal rows as seen from one view (1–2 spines per mm, 0.6 mm apart) (Figure 2C). The spines show no significant difference in height between the polypar and abpolypar side and never present bifurcations of

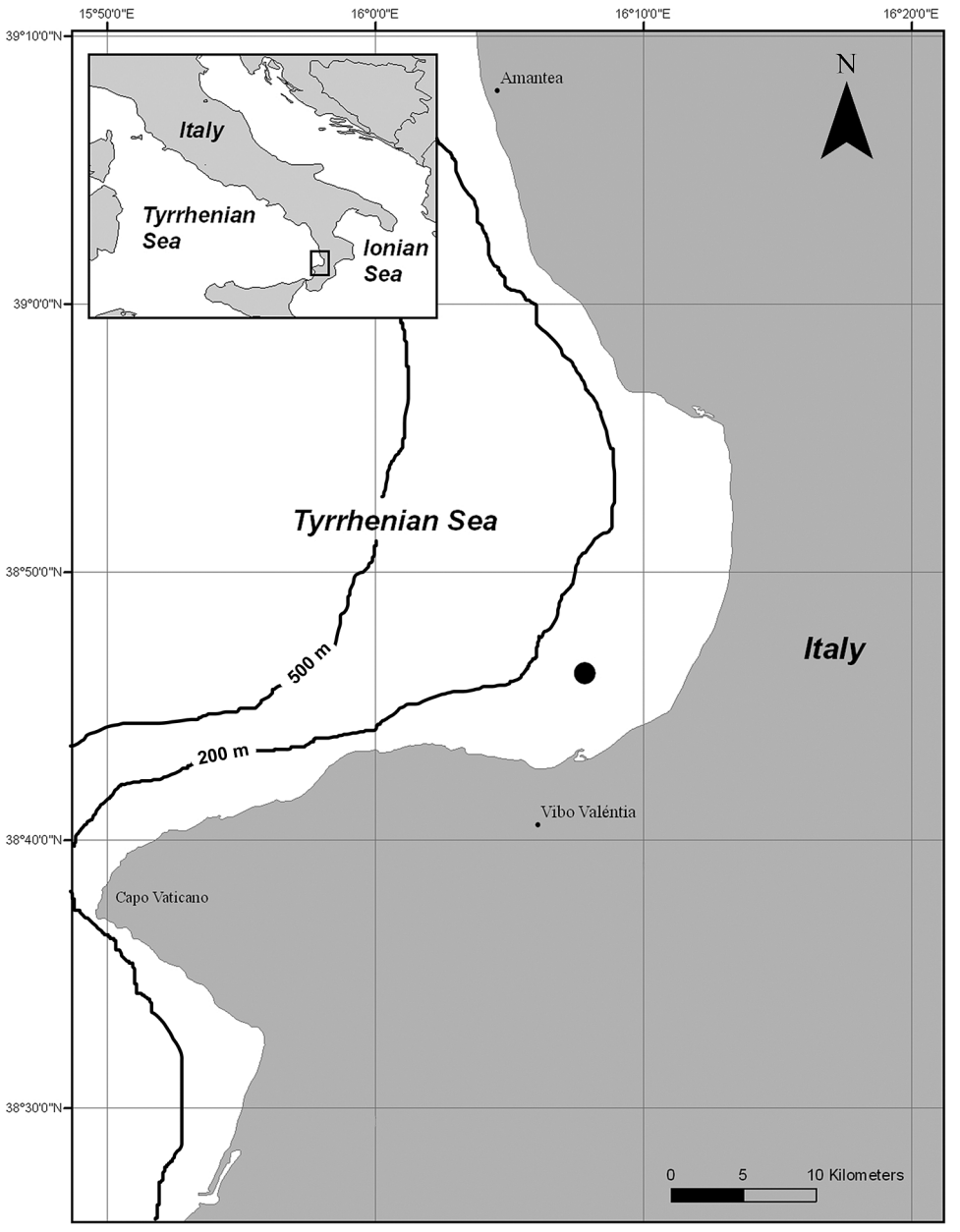

Figure 1. Maps of the sampling area. Localisation of the explored shoal along the Calabrian coast (black dot).

their apex, which always lack papillae. They measure 0.2 mm high and 0.1 mm width on the major branch, while they are 0.14–0.18 mm high and 0.12–0.16 mm wide on higher-order ramifications (portions 0.4–0.9 mm in diameter). On the branchlets the spines are more distally inclined and arranged in 5 rows with a density of 1–2 spines per mm (0.8 mm distance on average) (Figures 2D–F). As indicated by Opresko (2003), spines do not vary significantly in shape, size and density between branches of different diameter, which is different to what is usually observed for antipatharians of large dimensions.

The polyps are monoserial on the pinnules (Figures 2G–J, 3F–J), with the exception of the stem, where polyps are arranged irregularly in several rows (Figure 3E). Living polyps show a slightly sagittally elongated outline, with the two lateral couples of tentacles close to the oral cone and the sagittal tentacles, slightly longer, emerging from a lower level (Figure 2H). *In vivo*, polyps show the characteristic *Antipathes* arrangement of tentacles, being the lateral ones directed upwards around the oral cone and the sagittal one directed backwards (Tazioli et al. 2007) (Figures 3F,G). Adult polyps have a transverse diameter of 1.8–2.2 mm (slightly smaller on branches)

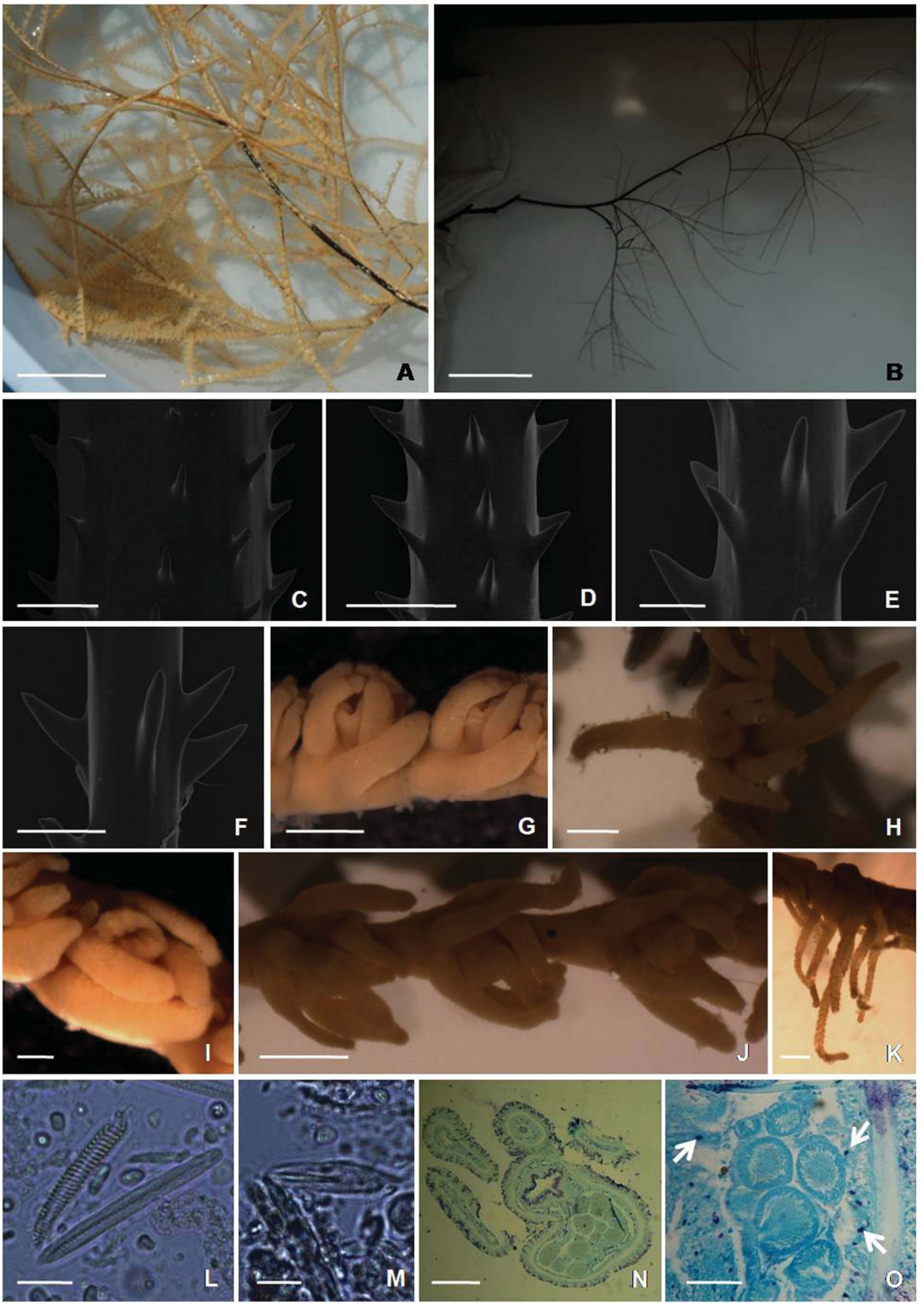

Figure 2. Morphological characters of *Antipathes dichotoma*. **A**, freshly collected specimen showing ochre polyps; **B**, dichotomous ramification of branches; **C**–**F**, shape and arrangement of spines along branches of decreasing diameter; **G**, lateral view of the polyps and their oral cones along a major branch; **H**, frontal view of a polyp with expanded sagittal tentacles; **I**, ridges on the oval-shaped mouth; **J**, polyps arrangement on a branchlet; **K**, sweeper tentacles extremely extended and thin; **L**, spirocyst and isorhiza found in the tentacles; **M**, p-mastigophore microbasic found in the mouth; **N**, transversal section of a fertile male polyp showing the arrangement of mesenteries and the sperm cysts; **O**, details of sperm cysts with included foreign bodies (arrows). Scale bars: A,B, 5 cm. J, 2 mm. G,H,K, 1 mm. C,D,I,N, 0.5 mm. E,F,O, 0.2 mm. L,M, 10 μm.

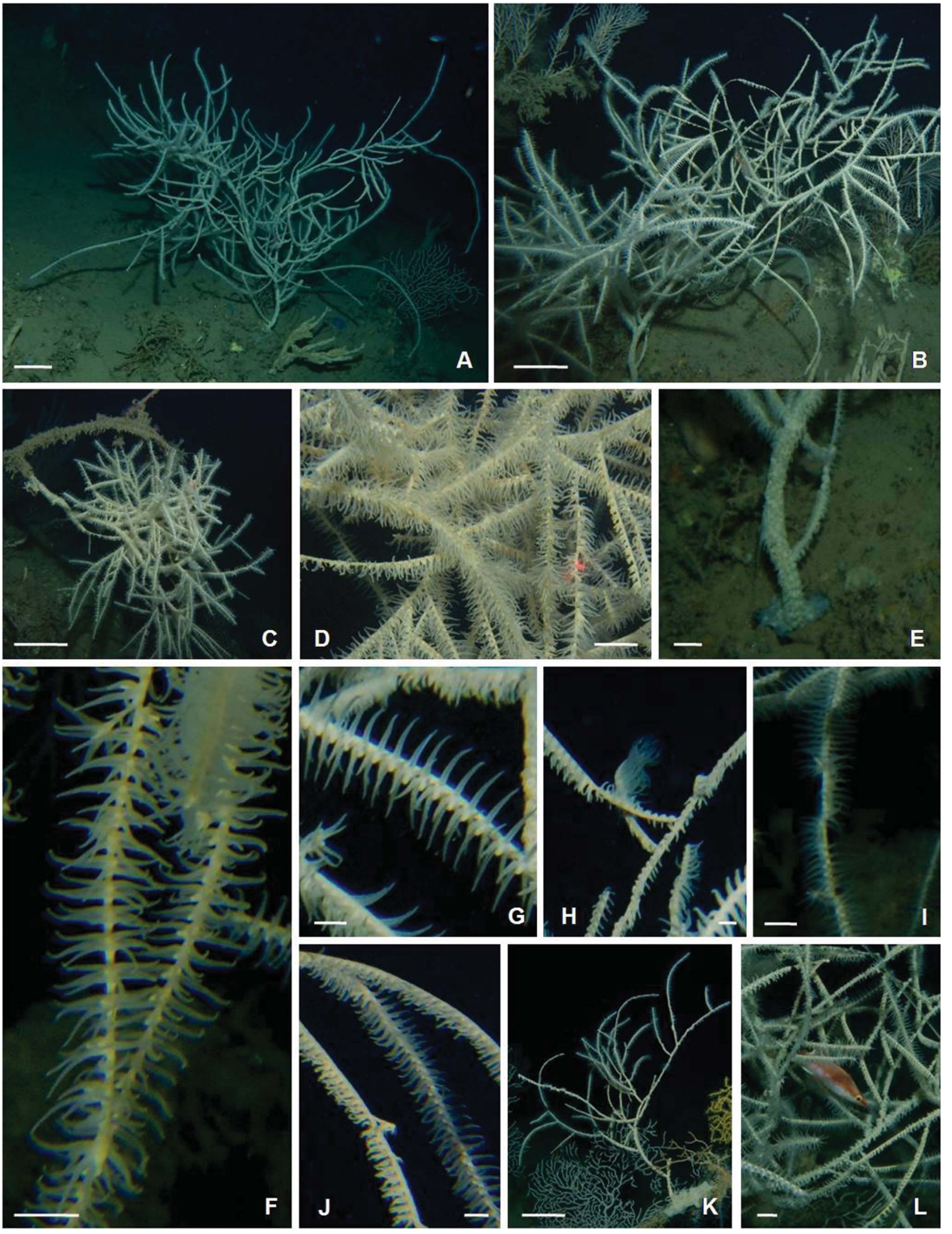

Figure 3. Living colonies of *Antipathes dichotoma* and close-up view of the polyps. **A,B**, entire colonies showing the long, flexible branches directed downwards; **C**, living portion of the collected specimen; **D**, close-up view of the ramifications showing expanded polyps; **E**, close-up view of the anchorage, covered by living tissue, and the stem, showing the irregular arrangement of polyps; **F,G**, polyps in a distinct monoserial arrangement with zooids fully expanded and sagittal tentacles directed backward respect to lateral ones; **H**, portion of a branchlet characterised by polyps showing long sweeper tentacles; **I**, rotating arrangement of polyps along a branchlet; **J**, comparison of living tentacles in their contracted and expanded status; **K**, sessile fauna growing on the dead portion of the coral skeleton; **L**, the labrid *Lappanella fasciata* finding refugee amidst the coral ramifications. Scale bars: A,B,C, 10 cm. K, 5 cm. E,L, 2 cm. D, 1 cm. H, 5 mm. F,G,I,J, 4 mm.

and their tentacles *in vivo* are much elongated (on average 4 mm long), cylindrical, with a pointed tip. The tentacles are partially contractible and when they are not completely expanded, hang in the water as soft cones (Figures 3H,J). Not all the polyps of the colony are expanded at the same time; in fact, there are random portions with partially contracted polyps (Figure 3J).

Preserved zooids have tentacles 2.8 mm long (between 2 and 3.75 mm) (Figures 2G–J). Underwater photographs have shown the presence of extremely long sweeper tentacles (6 mm) in polyps at the apex of one pinnule (Figure 3H), also found in some preserved zooids (Figure 2K). Long sweeper tentacles were observed also at the base of a major branch in contact with an ascidian. The length of sagittal tentacles reported by Opresko (2003) is 5 mm or more, much longer in comparison with the average measure we observed. An exception is represented by the sweeper tentacles, reaching up to 5.6 mm in length and probably shown also in figures 1a and c of the neotype description (Opresko 2003, p. 483).

The interpolypar distance ranges from 0.6 mm along major branches to 1.6 mm on branchlets, the density ranging from 4 to 3 polyps per cm, respectively. Small polyps (1.5 mm in transverse diameter) are irregularly distributed between the adult ones. There is no distinct polypar side in the colony, since the zooids are not arranged on the same side of all ramifications (Figure 3D). Underwater observations also indicate that within the same pinnule polyps may be oriented differently (Figure 3I). The oral cone is elevated (0.7 mm on average) and the mouth opening is usually sagittally oval in shape (on average 0.75 × 0.7 mm) and surrounded by thick oral margins (Figures 2G–J).

The cnidome of *A. dichotoma* consists of basitrich isorhizas, microbasic p-mastigophores and spirocysts (Figures 2L,M).

1. Basitrich isorhizas are recorded in the size 25 × 2.5 μm. They are present in all examined portions, but are numerous especially in tentacles and coenenchyme;
2. Microbasic p-mastigophores drop-like, 23 × 7.5 μm, with a distinct V-notch on the undischarged shaft. Mastigophores are found mainly in the mouth;
3. Spirocysts (23 × 3.5 μm) are present in all examined portions of the polyps, but are densely packed in batteries only in the tentacular epidermis.

The histological sectioning identified fertile male polyps (Figures 2N,O). The sperm cysts are on average 25 per polyp, with an average diameter of 0.2 mm.

A notable amount of foreign bodies, probably fine sand grains (on average 0.04 mm in diameter), was found within the gastroderm of polyps and in their interpolypar coenenchyme (Figure 2O).

Biogeography of the species (Table I, Figure 4)

Biogeographic accounts of *Antipathes dichotoma* have been provided by Vafidis and Koukouras (1998), being the first to record the species in the eastern Mediterranean Sea (North Aegean Sea), and by Opresko (2003), retracing the systematic history of this coral. The majority of the specimens have been collected in the Tyrrhenian Sea, especially in the Bay of Naples (Brook 1889; Von Koch 1889; Opresko 2003), Marseilles (Marsigli 1725) and Vibo Marina (present study). Recently the coral has been observed with the aid of ROV on the white coral banks of S. Maria di Leuca in the Ionian Sea (Mastrototaro et al. in press; Vertino et al. in press; IFREMER, personal communication). Oceana (personal communication) filmed colonies of *A. dichotoma* living on maërl at more than 75 m depth at Filicudi island (Sicily). At almost 300 m, in the same area, sparse colonies of *A. dichotoma* and *L. glaberrima* were observed. The two black coral species were found also on the deep seabeds facing Cape San Vito, in Sicily together with *Antipathella subpinnata*. One specimen collected along the Albanian coast of the Otranto Strait and identified as *Antipathella subpinnata* could be a misidentified sample of *A. dichotoma*, especially in relation to the large polyps reported by the author (Pax 1952; Bo et al. 2008). Several specimens have been considered valid records for the Atlantic Ocean, along the coast of Morocco (Opresko 2003), representing the southernmost record, and in the Bay of Biscay (Koehler 1896; Roule 1905; Opresko 2003). Three unpublished records have been verified by Dr Molodtsova and concern two already known localities for the species (Marseilles and the Bay of Biscay) and one new site in the Alboran sea. Some Mediterranean records were reported without a precise indication of the collection site (Brook 1889; Gravier 1918; Pax & Müller 1955; Altuna Prados & López-González 2003).

The bathymetric distribution of the records indicates an approximate depth range for the species included between 58 and 1410 m depth, with the deepest specimens found in the Atlantic Ocean.

The coral assemblage

The habitat of *Antipathes dichotoma* in the area of Vibo Marina was a 42 m high rocky shoal arising from a 132-m deep flat fine sand bottom. The irregular

Table I. Biogeographic records of *Antipathes dichotoma*.

Author, Year	Locality	Depth (m)	Notes
Marsigli, 1725	Off Marseilles, Tyrrhenian Sea	140	Specimen lost (Lithophyte No. 9). Used by Pallas (1766) for the species description.
Brook, 1889	Bay of Naples, Tyrrhenian Sea	200	Specimen 29 cm tall. The author designated *A. dichotoma* as type species of the genus *Antipathes*.
	Mediterranean Sea	58–98	Specimen 35 cm tall, described as *Antipathes ? mediterranea* and synonymised with *A. dichotoma* by Opresko (2003). Specimen found on rocks covered with coralline algae, in Zool. Stat. Naples.
Von Koch, 1889	Bay of Naples, Tyrrhenian Sea	Unknown	Specimen 1 m tall, described as *Antipathes aenea* and synonymised with *A. dichotoma* by Opresko (2003).
Koehler, 1896	Bay of Biscay, east Atlantic Ocean	400–1410	Specimens (number not specified) collected by dredge on a coral bottom during the *Caudan* Expedition. Stn 4 (21 August): 6°21' W, 45°57' N, together with *Stichopathes gravieri* (1410 m). Stn 24 (30 August): 6°58' W, 46°40' N, together with *Saropathes (Antipathes) scoparia* and *Antipathella subpinnata* (400/500 m). One specimen 28 cm tall (BMNH 1897.4.3.5, Koehler) observed by Opresko (2003).
Roule, 1905	Gulf of Gascoigne, off Ferrol Canyon, east Atlantic Ocean	300	Specimen described as *Antipathes aenea* and synonymised with *A. dichotoma* by Opresko (2003). Specimen 1 m tall, collected the 9 August 1886 at Stn. 60, on rocks by trawling.
Gravier, 1918	Western Mediterranean	Unknown	Fragments (one reported to be 19 cm high) present in the Zool. Stat. of Naples.
Pax, 1952	Albanian coasts of Otranto Strait, Ionian Sea	236–256	Fertile feminine specimen described as ?*Antipathes subpinnata*, synonymised with *A. dichotoma* by Opresko (2003). Record made during the Hvar Expedition in 1948, Stn. 167 by fishing trawl. Fragment of a colony, preserved in the Oceanographic Institute in Split, but currently lost. Muddy bottom, together with *Isidella elongata*.
Pax & Müller, 1955	Unknown	Unknown	Two specimens (50 and 100 cm tall) deposited in the Museum of Natural History Of Trieste placed originally under the name of *Antipathes virgata*, then renamed *A. dichotoma* subspecies *dichotoma*, as reported by Pax, 1932 (p. 420).
Vafidis & Koukouras, 1998	North Aegean Sea	80	One colony, 110 cm tall, attached on calcareous algae. Collected by fishing trawl at Stn. 140b. Material deposited in the Museum of the Dept. of Zoology, University of Thessaloniki.
Opresko, 2003	Bay of Naples, Tyrrhenian Sea	Unknown	Neotype (RMNH Coel. 4891, 28 cm tall) and schizoneotype (USNM 100927), by G. Stiasny, 1924.
		Unknown	MCZ 53537, by G. Bacci, Zool. Stat. Naples, 25.10.1946.
	Off Cap Blanc du Nord, Morocco, east Atlantic Ocean	320	RMNH Coel. 32183, 27.3.1976, Onversaagd Madeira–Marokko Exped., Stn. 139.
	Tyrrhenian Sea		USNM 100084.
OCEANA, personal communication	Filicudi Island and adjacent bank, Aeolian islands, Tyrrhenian Sea	75–300	Colonies of *A. dichotoma* on maërl sometimes mixed with coralligenous assemblages at more than 75 m depth. At almost 300 m dispersed colonies of *A. dichotoma* and *L. glaberrima*. Oceana Mar Viva Med Expedition 2008.
	Cape San Vito, Sicily, Tyrrhenian Sea	275–286	Black coral community dominated by *L. glaberrima*, including also *A. dichotoma* and *A. subpinnata*.
IFREMER personal communication; Vertino et al. in press (reported also by Mastrototaro et al. in press)	S. Maria di Leuca, Ionian Sea	630–640	IFREMER: specimen classified by Dr. Tina Molodtsova and collected during the M70-1 cruise (Chief scientist A. Freiwald). Others: several colonies observed by ROV in the Coral Mound Province both in the coral framework and hardground. Sometimes together with *L. glaberrima*. Colonies on boulders colonised by sponges (*Pachastrissa pathologica* ?) and *Madrepora oculata*; decapods were observed grazing on *Antipathes* branches and *Helicolenus dactylopterus* swimming close to the colony base.
Unpublished records (provided by Dr. Tina Molodtsova)	East Marseilles, Tyrrhenian Sea	260	Camp. 1971 28.04.1971; Cassidaine Canyon on *Madrepora oculata*; collected by H. Zibrowius
	NE Alboran Sea	200–175	CALYPSO, Station Marine d'Endoume SME 1305; 04.09.1958; 36°01.8′N, 2°51.0′W
	NW Bay of Biscay, east Atlantic Ocean	300–390	Thalassa T451; 47°57.5′N, 07°50.7′W
Present study	Vibo marina, Tyrrhenian Sea	119–124	Five specimens 50–130 cm high on a rocky shoal.

Figure 4. Distribution map of *Antipathes dichotoma* in the Atlanto-Mediterranean region. Circles = literature records, star = present study.

surface of the shoal is covered by a layer of sediment of variable thickness. Current was moderate and the sedimentation high. Apart from *A. dichotoma* the benthic assemblage was characterised by several coral species (Figure 5), namely the gorgonians *Eunicella cavolinii* (Koch, 1887), *Callogorgia verticillata* (Pallas, 1766), *Paramuricea macrospina* (Koch, 1882), and *Corallium rubrum* (Linnaeus, 1758). In the examined photographs, covering a total surface of 109.5 m^2, 536 coral colonies were counted with an average density of 9.0 ± 1.0 colonies m^{-2}. The antipatharian colonies (5 specimens) accounted for only 1 ± 0.4% of the total coral abundance, while the dominant species was *E. cavolinii* (58 ± 3.4%, 342 colonies) followed by the two other gorgonians *P. macrospina* and *C. verticillata* (16 ± 2.4%, 103 colonies and 14 ± 2.0%, 74 colonies, respectively) (Figure 6A). Small colonies, mostly dead, of *C. rubrum* were occasionally observed (2 ± 1.1%, 12 colonies).

The yellow colonies of *E. cavolinii* showed an average density of 5.4 ± 0.6 colonies m^{-2} (Figure 6B) with an average size (in terms of height and width) of 17.7 ± 0.6 × 17.9 ± 0.8 cm (Figure 5A). The colonies of *P. macrospina* showed an average density of 2.1 ± 0.2 colonies m^{-2} (Figure 6B) and an average size of 7.4 ± 0.5 × 7.3 ± 0.5 cm. Their colour was bright yellow, but pink and white specimens have also been observed (Figure 5B). *P. macrospina* was observed also as epibiont on both artificial (man-made refuse) and natural secondary substrates (dead portions of other corals (Figure 5C) including *A. dichotoma*). Both *E. cavolinii* and *P. macrospina* often hosted several ophiuroids and solenogastres. The latter showed their typical habitus, growing wrapped around sea-fan branches (Figure 5A inset). Their habitus and mantle sclerites (hollow and with a sharp pointed distal end) suggest they are *Anamenia gorgonophila* (Kowalevsky, 1881). The occurrence of solenogastres documented also in the Strait of Sicily in a deep-water coral biocoenosis (Mifsud et al. 2008).

The tall pink colonies of *C. verticillata* (on average 39.9 ± 3 × 30.7 ± 3.2 cm) (Figure 5D) showed an average density of 1.2 ± 0.3 colonies m^{-2} (Figure 6B). The flat biserial ramifications of these gorgonians were suitable substrates for sessile organisms, such as anemones (Figure 5E inset), but also for vagile invertebrates such as ophiuroids (Figure 5F), crinoids (*Antedon mediterranea* (Lamarck, 1816)) and a dendronotacean nudibranch tentatively identified as *Marionia blainvillea* (Risso, 1818) (Figure 5E inset). Colonies were often observed partially dead, especially the basal portions (Figures 5D, E), which were covered by ramified hydroids (Sertularidae), encrusting sponges, ascidians and bryozoans, the polychaete *Filograna* sp., and the soft coral *Alcyonium coralloides* (Pallas, 1766) (Figure 5G). The colonies of *C. rubrum* (on average 9.8 ± 2.3 × 9.7 ± 2.2 cm, average density 0.1 ± 0.1 colonies m^{-2}) were rarely found alive, being often covered by a thin layer of sediment (Figure 5H).

Antipathes dichotoma colonies were anchored to the rock with a basal plate, sometimes covered by the fine sediments. This species reached considerable sizes, being on average 68.8 ± 15.3 × 81.4 ± 13.8

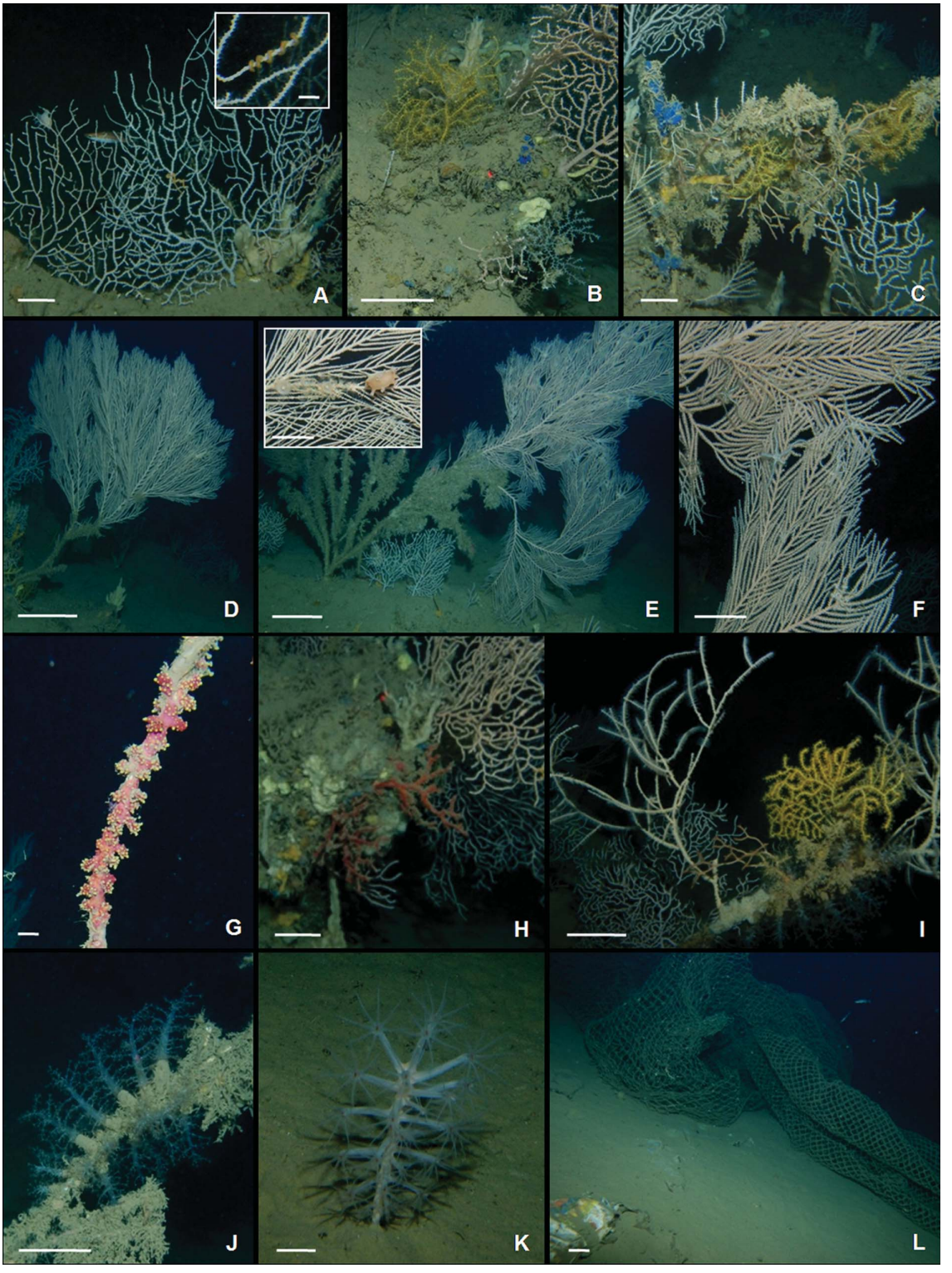

Figure 5. The coral assemblage. **A**, colonies of *Eunicella cavolinii*. Inset: Solenogastres; **B**, different colours of *Paramuricea macrospina* colonies; **C**, epibiontic colonies of *P. macrospina* on a dead gorgonian skeleton; **D**, entire colony of *Callogorgia verticillata*; **E**, colony of *C. verticillata* with the basal ramifications covered by hydroids. Inset: Anemones and nudibranch *Marionia blainvillea*; **F**, close-up view of the planar ramification of *C. verticillata* hosting ophiuroids; **G**, *Alcyonium coralloides* covering a dead gorgonian branch; **H**, small colonies of *Corallium rubrum* covered by a thin layer of sediment; **I**, epibionted portion of an *Antipathes dichotoma* colony; **J**, group of epibiontic *Paralcyonium spinulosum*; **K**, specimen of *Kophobelemnon* sp.; **L**, ghost net abandoned on the seafloor. Scale bars: D,E,L, 10 cm. A,B,H,I,K, 5 cm. E inset, J, 3 cm. A inset, C,F,G, 2 cm.

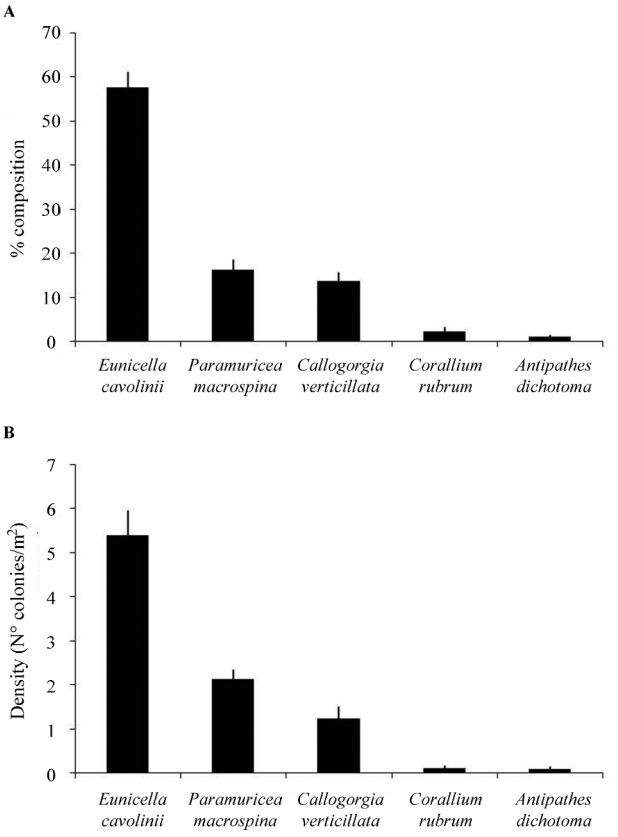

Figure 6. Coral community structure of the Vibo Marina shoal. **A**, density distribution of the coral species (average no. colonies $m^{-2} \pm SE$); **B**, percent distribution of the coral species.

cm, with a maximum height of about 130 cm (average density 0.1 ± 0.1 colonies m^{-2}). Colonies tended to be larger than taller, being more expanded in the width direction, also because of the typical downwards arrangement of the external branchlets (Figures 3A,B). When completely healthy, the colonies were not epibionted by sessile organisms and could host the labrid *Lappanella fasciata* (Cocco, 1833) hidden between the ramifications (Figures 3L). A 3-cm long unidentified pycnogonid was observed walking along the branches. Two colonies were observed partially dead in their basal or central parts (Figures 3C,K; 5I). The dead skeleton was covered by numerous hydroids (unidentified Sertularids, *Antennella* sp.) entrapping a notable quantity of sediment, the gorgonians *E. cavolinii* and *P. macrospina*, the soft coral *Paralcyonium spinulosum* (Delle Chiaje, 1822), the orange erect bryozoan *Turbicellepora avicularis* (Hincks, 1860), and encrusting ascidians (Figures 5I,J).

The surrounding sand bottoms were colonised by cerianthids and several pennatulid anthozoans like *Kophobelemnon* sp. (Figure 5K), *Virgularia mirabilis* (Müller, 1776), *Pennatula phosphorea* Linnaeus, 1758 and *Funiculina quadrangularis* (Pallas, 1766).

In several areas of the shoal fishing long lines and ghost nets were present, abandoned on the sea bottom (Figure 5L). Their presence and the professional fishing activity have to be considered as possible causes affecting the biodiversity of the area, both through the destruction of the habitat and through the direct action of fishing gear on the coral colonies affecting the integrity of their coenenchyme and therefore enhancing their level of epibiosis (Bavestrello et al. 1997).

Discussion

ROV exploration represented a turning point in the observation of deep benthic fauna, providing not only new geographic and bathymetric records, but also allowing the description of living animals. This approach for antipatharians has been already suggested as a key factor in the description of species and their ecology (Tazioli et al. 2007; Bo et al. 2008).

The story of *Antipathes dichotoma* is a good example indeed. It has been the first antipatharian species to be described and it has been adopted has type species of the genus *Antipathes* (Brook 1889), the major taxon for the order. Despite its taxonomic importance and

large colony size, until now almost no photographs of living specimens were available in the scientific literature. The morphology of the polyps *in vivo* and particularly the position of their tentacles may provide useful information concerning the feeding strategy of a species. According to Tazioli et al. (2007), in unbranched black corals the large polyps bend their tentacles upwards, forming a basket-like structure around the mouth, while in the flabellate colonies all tentacles are extended out laterally, increasing the net effect produced by the branching pattern. The basket shape seems to be more suitable for the capture of large isolated prey, whereas the net strategy optimises the filtering of suspended particles. In spite of the large size of its polyps, *A. dichotoma* seems to belong to the last category with the intricate arrangement of the ramifications in the central portion of the colonies (Figure 3D) improving the filtering efficiency.

Reproduction of deep anthozoan species is a little explored aspect (Waller et al. 2002). The fertility of *A. dichotoma*'s polyps is in agreement with what found in the other Mediterranean antipatharian species, *Antipathella subpinnata*, found fertile in summer period, but not in autumn (Bo et al. 2008, 2009). Also the New Zealand species *Antipathella fiordensis* (Grange 1990) was recorded fertile in the austral summer (Parker et al. 1997). For this species, found at much shallower depths compared to the Mediterranean one, it was suggested that rising sea temperature could affect gametogenesis and spawning. Nevertheless, apart from temperature, day length and lunar phase are usually considered as important exogenous control factors for coral reproduction (Babcock et al. 1986).

A. dichotoma is a typical Atlanto-Mediterranean species with a wide bathymetric distribution range. This record is the first for the Calabrian coast and one of the shallowest ever reported. This work also enhanced our knowledge on the habitat of this species and on the associated corals. *A. dichotoma* is the largest species of an assemblage characterised by a group of branched corals (*Eunicella cavolinii*, *Paramuricea macrospina* and *Callogorgia verticillata*) adapted to rocky habitats characterised by moderate currents and high sedimentation.

A further output of this work concerns new data about the ecological requirements of the poorly known gorgonian *P. macrospina*. As suggested by Carpine and Grasshoff (1975), this species typically occupies isolated rocky habitat characterised by a smooth inclination and surrounded by detritic or muddy seafloors. Here we found *P. macrospina* also growing as a fouling and epibiontic organism, developing colonies both on rubbish and on dead branches of sea-fans, suggesting a fast growth rate. In contrast, the congeneric *P. clavata* (Risso, 1826) is the major representative of Mediterranean vertical walls and can build wide and highly dense facies. It is possible that larvae and juveniles of *P. macrospina* are more resistant to sedimentation and are therefore able to grow, different to what is usually reported for *P. clavata*, on horizontal surfaces.

Currents rich in suspended matter are probably the major environmental constraints influencing the coral composition of the communities studied along the Tyrrhenian Calabrian coast (unpublished data). Along this coast the assemblage here described is typical of the area of the Gulf of St. Eufemia north of Capo Vaticano, while, on the southern side of this cape, subjected to the strong currents of the Messina Strait, the coral assemblage is completely different and is mainly composed of the sea fan *P. clavata* and the black coral *A. subpinnata* (Bo et al. 2009).

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