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# *Antipathella subpinnata* (Antipatharia, Myriopathidae) in Italian seas

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**Abstract**

The distribution of *Antipathella subpinnata* in Italian seas is herein given and discussed. *A. subpinnata* is a large, white, branched antipatharian with an Atlanto-Mediterranean distribution. It is probably the most commonly observed black coral in this basin and it is possible to find large populations of this species at diving depths. Personal records of the occurrence of the species in the Strait of Messina, together with a wide census involving diving centres along all the Italian coasts, have been used to create a distribution data set. A description of the species, including in vivo measurements of the polyps, is given. Information concerning the habitat, the population density, the substrate, the epibionts and the environmental conditions of the sites where the species was found are also included. This study confirms the importance of *A. subpinnata* as a common component of the lower fringe of the circalittoral twilight environment, below 50 m depth, in localities where hard substrata are available.

**Keywords:** *Black corals*, Antipathella, *geographic distribution, endangered species, twilight zone, Mediterranean Sea*

## Introduction

Black corals are among the most common azooxanthellate corals in tropical reefs, sometimes showing high diversities and considerable abundances (Tazioli et al. 2007). The group is also present in temperate and polar waters with fewer species but, in unique habitats, they may be found at very high abundances (Grange 1985, 1988; Grange & Singleton 1988). Data about ecology, distribution and population structure of black corals are rare mainly due to the paucity of field studies that have focused on this group.

Five species of black corals are known to occur in 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), *Antipathella subpinnata* (Ellis and Solander, 1786) (Family Myriopathidae). *A. subpinnata* is probably the most widespread species according to the records in the literature. The aim of this paper is to describe the distribution of this species in Italian seas together with some morphological details of the colonies and polyps.

*A. subpinnata* represents the type species of the genus *Antipathella* Brook, 1889 (Family Myriopathidae, Opresko 2001). The inclusion of this species in the family has been recently confirmed by molecular analyses (Lapian et al. 2007). The genus, comprised of five species, is characterised by a branched corallum with simple elongated pseudopinnules arranged irregularly in one to four rows (Gray 1857; Lacaze-Duthiers 1865; Opresko 2001; Opresko & Baron-Szabo 2001). Following the original description of *A. subpinnata*, various other authors found and redescribed the species. In many cases it was only matter of a new geographic record (Grasshoff 1985; Vafidis & Koukouras 1998) or a brief and un-detailed description (Lamouroux 1821; Roule 1905; Gravier 1921); sometimes, however, some morphological information was given (Gray 1857; Brook 1889; von Koch 1889; Schultze 1896; Gravier 1918; Dantan 1920; Pax et al. 1987). The majority of these authors studied colonies or fragments collected from deep-water using trawls and dredges. Lacaze-Duthiers (1865) thoroughly investigated the anatomy and morphology of the species maintaining colonies alive for several days in an

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aquarium. Brook (1889) gave a detailed morphological description of the species and incorporated it in the new genus *Antipathella*, which at that time was included in the family Antipathidae. Dantan (1920) considered not only the histological-anatomical characteristics of *A. subpinnata*, but also some biological aspects, like reproduction, nutrition and defence.

In 2001, Opresko clarified the systematic position of the species by including the genus *Antipathella* in the new family Myriopathidae and, since the holotype of Ellis and Solander was lost, he designated a neotype collected in the Gulf of Naples, based on the concept of the species as presented by Brook (1889) and later workers. From an historical point of view however it is possible that the first record of this species in the Mediterranean belongs to the Adriatic Sea. In fact, Pax and Müller (1962) considered it likely that the *Gorgonia dichotoma* described by Linnaeus in 1758 for the Adriatic Sea was a specimen of *A. subpinnata*, a record nearly 30 years earlier than that of Ellis and Solander (1786) in the Gibraltar Strait. However, this record is now considered doubtful since it is possible that Linnaeus was describing a specimen of *Antipathes dichotoma* Pallas, 1766.

The two species can be distinguished by the morphology of spines, which are conical and smooth, 0.2 mm or more tall in *A. dichotoma* while 0.1–0.2 mm in *A. subpinnata*, where they can bifurcate on the stem, and for the polyp size (2.0–2.4 mm in transverse diameter in *A. dichotoma* and 1 mm in *A. subpinnata*) (Opresko 2001, 2003). Also the pattern of ramification is different: in the tall colonies of *A. dichotoma*, the long flexible branches are irregularly distributed on all sides of the stem and lower branches, occasionally uniserially arranged and inclined with an angle often close to 90° (Opresko 2003). At times branching is dichotomous and more branches arise at the same level (Rossi 1971). In *A. subpinnata* the elongated thin pseudopinnules arise vertically with an angle of 30–70° and are arranged in 1–4 irregular rows around the stem giving rise to a more densely branched colony (Opresko 2001). The colonies are smaller and the apical branches show an almost feather-like disposition (Rossi 1971). The depth range of *A. dichotoma* (60–250 m) overlaps that of *A. subpinnata* (Opresko & Försterra 2004).

## Materials and methods

### *Specimen collection*

Two specimens of *A. subpinnata* were collected by diving in the Messina Strait in October 2004 and November 2005 at a site on the Calabrian coast between Scilla and Favazzina. The bottom is composed of a geomorphologic system formed by six smaller shoals and a major one called "Secca dei Francesi" surrounded by depths ranging from 55 to 70 m. The eastern side of the explored shoal is directed towards the shore and gently levels off at 58 m depth on a sea bottom composed of detritic materials, whereas the western wall is directed towards the open sea and declines drastically and vertically to depths of 65–70 m onto a coarse sandy bottom. The habitat is exposed to strong currents in N–S and E–W directions.

### *Analysis of the material*

The colonies were kept alive in natural seawater for laboratory analyses of the zooids and their cnidome. They were preserved dry for the study of pinnules and spines. Branches were preserved in 4% formaldehyde and alcohol 95°, and polyps were relaxed with $MgCl_2$. The cnidome of the samples was examined by squeezing some polyps or different parts of polyps (mouth, tentacles and coenenchyme) on a slide and observing the cnidocysts with the optical microscope (100 × oil immersion).

For the SEM analysis, fragments of branches were washed with distilled water, dehydrated in a graded ethanol series samples, and dried in a Critical Point Dryer. Finally, they were coated with gold–palladium in a Balzer Union evaporator and examined with a Philips EM 515 SEM.

### *Distribution data set*

A data set of the distribution of *A. subpinnata* in Italian Seas was created using all available literature data, along with observations of professional divers, who were mainly diving instructors and professional photographers. We sent a questionnaire to many diving centres located along the Italian coasts, asking for information concerning the presence of black corals in their area of interest, the population density, the depth range and the habitat features. When possible the information was checked through the study of the images taken in situ by different authors.

## Results

### *Description of the specimen*

The largest specimen, that we are here describing, has a size of 78 cm in height, 39 cm in width and 33 cm in thickness (Figure 1A). Underwater the colour is transparent-white (Figure 2A–I). Immediately after collection, even if the sample

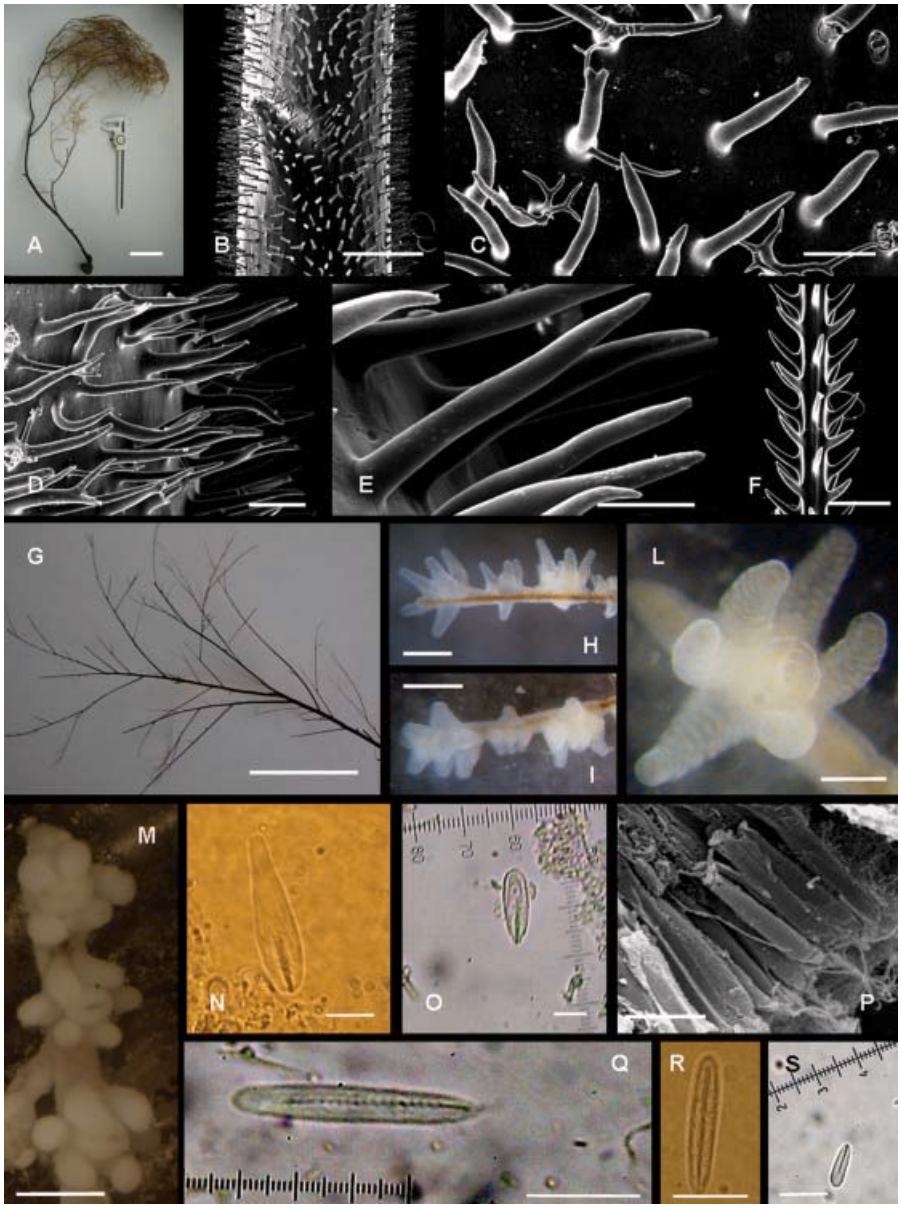


Figure 1. *Antipathella subpinnata.* **A**, dry colony. **B**, spines on an apical portion of the axis (2 mm in diameter). **C**, dendritic spines at the base of the axis. **D,E**, conical spines on a major branch (0.3 mm in diameter). **F**, spines on a primary pseudo-pinnule (0.1 mm in diameter). **G**, arrangement of pseudo-pinnules on a branch. **H,I**, arrangement of polyps on pinnules. **L**, living polyp. **M**, fixed polyps. **N**, p-Mastigophore microbasic 29 × 6 µm (shaft 9.6 µm long). **O**, p-Mastigophore microbasic 22 × 5 µm (shaft 8 µm long). **P**, SEM photo of tentacular spirocysts. **Q,R**, basitrich isorhizas 20 × 3 µm. **S**, basitrich isorhiza 9 × 2 µm. Scale Bar: N–S, 10 µm; E, 100 µm; C, D, F, L, 200 µm; H, I, M, 700 µm; B, 1 mm; G, 1 cm; A, 10 cm.

was kept in water, or after fixation, the polyps turned opaque white or light yellow and produced a considerable amount of mucous.

The colony is characterised by long, numerous and flexible ramifications. The major branches (up to the fifth order) converge basally in a single stem, 59 cm long, showing a basal diameter of 0.9 cm and a strong anchorage (approximately 11 $cm^2$). Pseudo-pinnules of various length (from 1 to 4 cm) are arranged irregularly in 1–4 rows around the ramification which bear them and are directed upwards with an angle of 30–45° (Figure 1G). Primary pseudo-pinnules show a density of 2–3 per cm (in all rows) and can reach the second order of ramifications. Subpinnules are shorter than primary pinnules (from 0.5 to 1.5 cm) and show the same density per cm. No anastomosis between ramifications are detectable.

The SEM analysis revealed typical 'Myriopathidae' spines. On the stem, there are long, thin, acute, smooth, cylindrical spines (apical portion 0.2 mm in

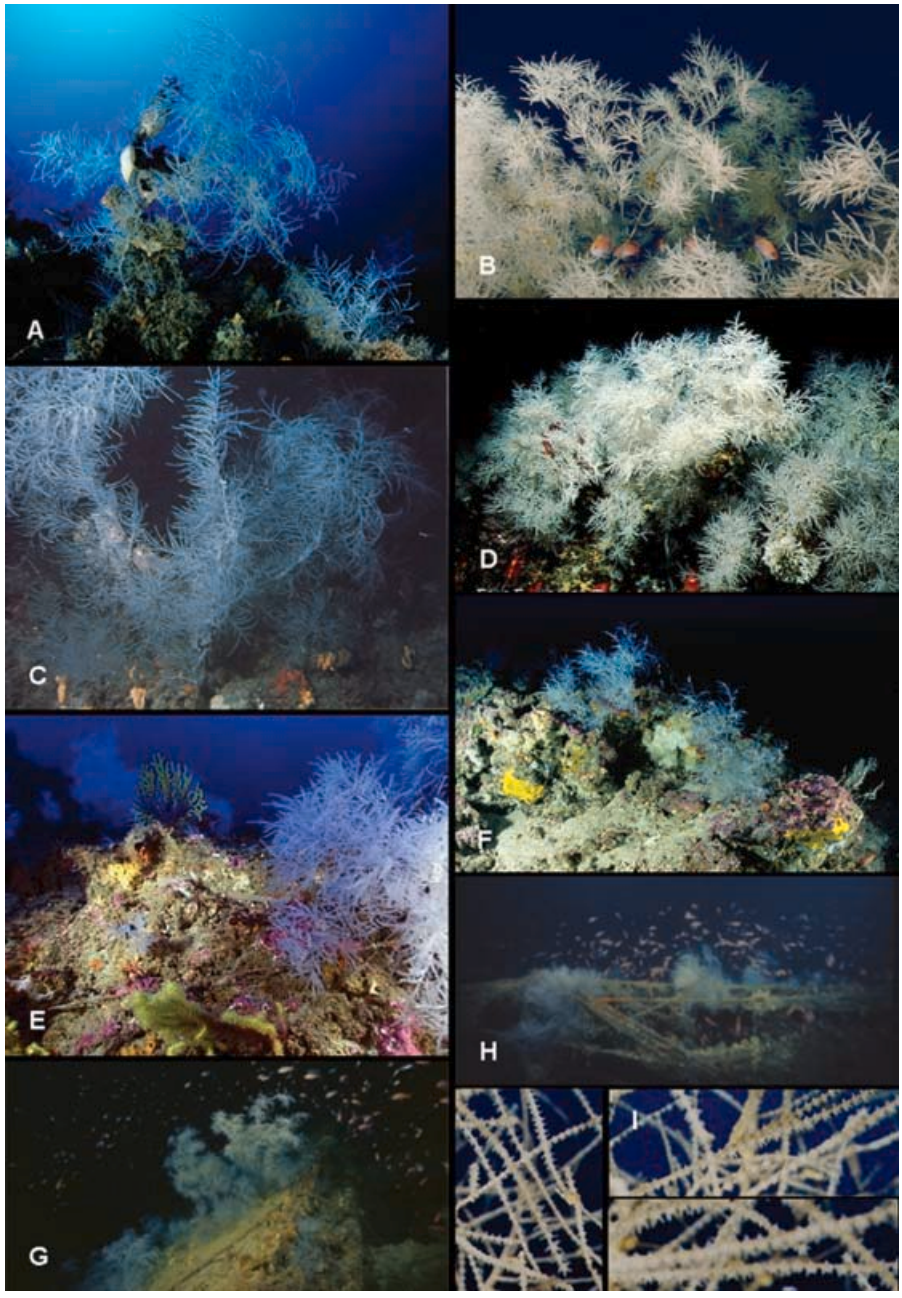


Figure 2. In situ photographs of *Antipathella subpinnata*. **A**, colony with shark's egg. Portofino. Photo Andrea Ghisotti. **B**, colonies offering refuge to some *Anthias anthias*. Messina Strait. Photo Gianni Neto. **C**, colonies photographed by ROV at 90 m depth in Portofino. Sponges *Axinellae* spp. present at the base of the coral. Courtesy of Prof. Riccardo Cattaneo-Vietti. **D**, big colonies of white *A. subpinnata*. Messina Strait. Photo Francesco Turano. **E**, colony on the rocky substrate of Favazzina, Messina Strait (62 m depth). Colonies of *Paramuricea clavata* in the background. Photo Gianmichele Iaria. **F**, Capraia Island. Photo Andrea Ghisotti. **G,H**, colonies on the wreck ''Ravenna'', Imperia (75–90 m depth). Photos Aldo Ferrucci, courtesy of Cristiano Aicardi. **I**, macro photos showing the expanded living polyps. ''Scoglio della Formica'', S. Flavia. Photos Santo Tirnetta.

diameter; Figure 1B) which become dendritic at the base of the stem (Figure 1C), and are irregularly arranged. On the branches, the spines are mainly simple (Figures 1D, E). The spines are inclined generally upwards without differences in height between the polypar and abpolypar side. They reach up to 0.3 mm in height and 0.04 mm in width on the stem and major branches (range 0.2–0.3 mm), while decreasing to 0.2 mm on higher order branches. The number of rows is not countable on the stem, since the spines are extremely crowded, while there are 10–12 rows (from lateral view) on the major branches (6–7 spines per mm in one row, 0.16–0.21 mm apart). On the pseudo-pinnules the spines show a slightly

more triangular–subcylindrical shape (Figure 1F); they are 0.1–0.16 mm high on a pseudo-pinnule 0.1 mm in diameter; are distally inclined and arranged in 5–6 rows (decreasing to 4–5 on the subpinnules) with a density of 5–6 spines per mm in each row (meaning that they are 0.18 mm apart, on average).

The polyps are monoserial (Figure 3), with a slightly sagittally elongated outline, since the two lateral couples of tentacles are close to the oral cone and the sagittal tentacles are inserted at a lower level (Figures 1H–M). In vivo, polyps are at times so transparent that it is possible to observe the golden skeleton underneath (Figures 1H, I). Adult polyps have a transverse diameter of 0.7–0.9 mm and their tentacles in vivo are elongated (up to 0.7 mm long), cylindrical, with a rounded tip. The interpolypar distance is quite variable, ranging from 0.1 to 0.5 mm (up to 0.8–0.9 mm on certain pseudo-pinnules), the density ranges from 8 to 10 polyps per cm and small polyps (0.5 mm in transverse diameter) are irregularly distributed between the adult ones (Figures 1H, I). There is no distinct polypar side in the colony, since the zooids are not arranged on the same side of all ramifications. The oral cone is elevated (0.16 mm on average) and the mouth opening is usually oval in shape and surrounded by a thick oral margin (Figures 1L, M).

No sexually mature colonies were collected.

The cnidome of *A. subpinnata* is composed of microbasic p-mastigophores, basitrich isorhizas and spirocysts.

1. Microbasic p-mastigophores can be separated in two categories based of the size and the shape of the capsules. The first consists of drop-like nematocysts, $29 \times 6\,\mu m$ (shaft 10 μm long), with a distinct V-notch on the undischarged shaft (Figure 1N); the second consists of nematocysts $22 \times 5\,\mu m$ (shaft 8 μm long) characterized by a capsule of more uniform width (Figure 1O). Both categories of mastigophores are found in tentacles and coenenchyme, but a few of the first type are present also around the mouth.
2. Spirocysts ($16-22 \times 2\,\mu m$) are the most abundant cnidocysts in this species and are present in all the considered portions of the polyps, but are densely packed in batteries only in the tentacular epidermis (Figure 1P).
3. Basitrich isorhizas are recorded in two sizes, $20 \times 3\,\mu m$ (Figures 1Q, R) and $9 \times 2\,\mu m$ (Figure 1S), respectively. The first isorhiza is present around the mouth, in the coenenchyme and tentacles, where it is more abundant. The second type is present in tentacles and mainly in the coenenchyme.

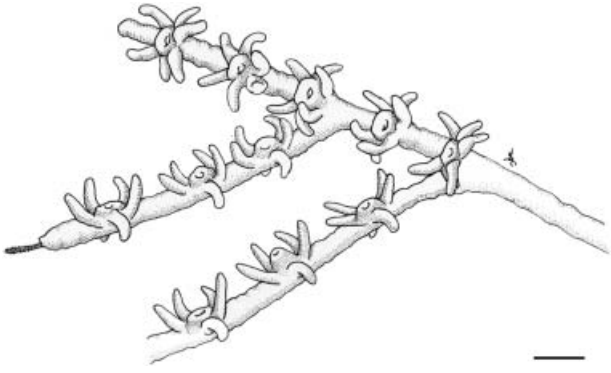

Figure 3. Arrangement of polyps in *A. subpinnata*. Drawing by Dr Cristina Gioia di Camillo. Scale bar: 0.7 mm.

*Remarks*

Opresko (2001) gave a detailed description of *A. subpinnata* based on a small, alcohol-fixed colony. The analysis of our samples immediately after collection, has added new information about the morphology, the cnidome and the colour of living polyps (Figure 2I). In the past Lacaze-Duthiers (1865) described red-grey polyps, Gravier (1918) yellow-white polyps, and von Koch (1889) reported a colour toning from white-grey to reddish after contraction, which was then lost after alcohol preservation.

The possibility of studying large colonies allowed us to check the morphological variability of the spines within the entire set of ramifications. Particularly, the SEM analysis of the basal part of the stem verified the presence of dendritic spines, which was previously only hypothesised. The data concerning the height of spines were in accordance with what was reported by Opresko (2001) and most other authors, but not with Gili (1987), who reported, probably erroneously, that the spines of his specimen were 0.6–1.7 mm high.

Moreover, our specimens, which were bigger than any ever reported in literature, had a more dense system of ramification made up of more numerous or thicker branches and pseudo-pinnules. The study of the living polyps revealed a more sagittally elongated outline than that reported before and a different colour pattern than what was known for fixed samples. While the transverse diameter of zooids was smaller than the 0.1 mm reported by Opresko (2001), the sagittal tentacles were slightly more elongated (0.7 mm rather than 0.6 mm) and more cylindrical when extended. Data concerning the oral cone, the mouth and the cnidome were for the first time included in the description.

*Distribution*

A map of the geographic distribution of *A. subpinnata* in the Mediterranean basin (Figure 4) has been created summarising the data present in the literature (Table I) and those obtained from diving centres (Table II). For some historical records it has not been possible to verify the species determination, because it was lacking a systematical description, therefore some may be considered doubtful.

Eight records of *A. subpinnata* in the Mediterranean Sea have been reported in the literature since the species was first described from near Gibraltar by Ellis and Solander in 1786. The records available for the western basin are more numerous than for the eastern one, probably due to a different number of studies conducted in the two regions (Vafidis & Koukouras 1998). For the Western Mediterranean, the species has been reported from off the Spanish (Gili 1987), French (Riedl 1983; Rossi 1971), and North African coasts (Vafidis & Koukouras 1998); and from the Ligurian sea (Riedl 1983; Rossi 1971), Gulf of Naples (Lacaze-Duthiers 1865; Brook 1889; von Koch 1889; Gravier 1918; Dantan 1920; Opresko 2001), and Adriatic sea (Heller 1868; Pax & Müller 1955). For the Eastern Mediterranean, the species has only been recorded from the Greek archipelago, situated in the North Aegean Sea (Vafidis & Koukouras 1998) (Figure 4).

Outside the Mediterranean basin there are four records for the Eastern Atlantic Ocean: Great Meteor and Josephine Seamounts (Grasshoff 1985), west coast of Portugal (Nobre 1931; Grasshoff 1985), west coast of France (Roule 1896; Grasshoff 1985) and Brest, English Channel (Dantan 1920) (Figure 4). For the non-Mediterranean records the confusion may rise with the Atlantic species *Antipathella wollastoni*. The two species have a similar arborescent morphology, but in *A. wollastoni* the pinnules are frequently arranged in four rows with a total of 14–20 pinnules per cm (Opresko 2001).

Grasshoff (1988) referred to *Antipathes* cf. *subpinnata*, a collection of several fragments and colonies up to 2 m tall, collected in a depth range between 80 and 220 m, around the islands of St. Paul and Amsterdam, in the southern Indian Ocean. The description of these specimens does not agree with the characteristics of the species and therefore we considered this attribution as doubtful.

Our investigation along the Italian coasts added twelve new records. The majority of these were from

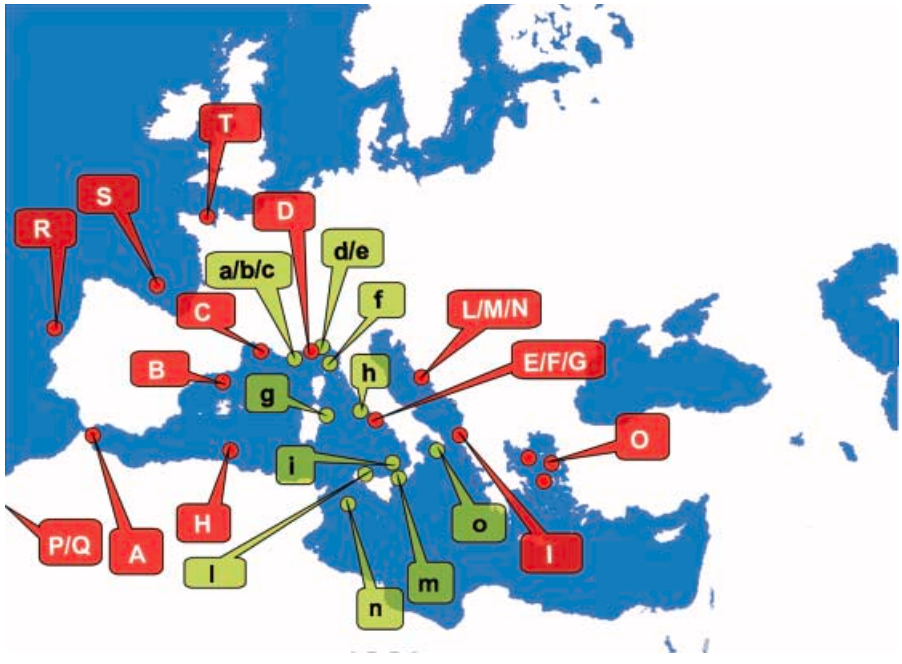


Figure 4. Distribution map of *Antipathella subpinnata* in the Atlantic-Mediterranean region. Legend of colours: Dark grey/red: historical record sites; light grey/green: current record sites. A, Near Gibraltar. B, Spanish coast. C, French coast. D, Ligurian Sea. Gulf of Naples, Tyrrhenian Sea: E, Bay of Naples; F, Capri Island; G, Nisida Island. H, Tunisian and Algerian coasts. Adriatic Sea: I, Albanian coasts of Otranto Strait, Croatian islands of L, Lastovo; M, Lissa and N, Lagosta. O, North Aegean Sea. Eastern Atlantic (not shown in the map): P, Josephine Seamount; Q, Great Meteor Seamount. R, West Coast of Portugal. S, West Coast of France: Biskaya Bay and Gascogne Gulf. T, Brest, Atlantic France, English Channel. Gulf of Genoa, Genoa, Ligurian Sea: a, Bordighera; b, Wreck 'Ravenna', Imperia; c, Capo Mele. Portofino Promontory, Genoa, Ligurian Sea: d, Secca dell'Isuela; e, Punta di Portofino. f, Secca fonda della Civitata, Capraia. G, Capo Comino, Sardinia. h, Ponza, Latina. i, Dorsale della Sciara del Fuoco, Stromboli, Sicily. l, Scoglio della Formica, S. Flavia, Palermo, Sicily. m, Secche di Favazzina, Bagnara, Strait of Messina, RC, Sicily. n, Pantelleria Island, Sicily. o, Gallipoli, Lecce.

Table I. Summary table of the literature data concerning the distribution of *A. subpinnata* in the Mediterranean Sea.

| Author, Year | Locality | Depth (m) | Ecological remarks | Notes |
|---|---|---|---|---|
| | | ***Western Mediterranean*** | | |
| Ellis & Solander, 1786 | Near Gibraltar | | | Holotype lost |
| Lamouroux, 1821 | Mediterranean | | | |
| Gili, 1987 | Catalan Coast | 500 | Rare in the considered area (continental platform, rocky substrate covered by mud); colony 20–35 cm high | 2 colonies collected in Blanes and Roses (Costa Brava) |
| Riedl, 1983 | Near Marsiglia | 10?–300 | | Depth range includes also other two sites (Adriatic Sea and Genoa). Identification of the species not verified for Marsiglia |
| Rossi, 1971 | Monaco | 60–200 | Coralligenous substrate; 50–60 cm height; includes also Napoli, Lagosta and Otranto | |
| Lacaze-Duthiers, 1865 | Gulf of Naples | | | Kept alive in aquarium for several days |
| LoBianco, 1895 | Nisida Island | approx. 100 | Many big specimens collected by 'Ingegno' (for *Corallium rubrum*) on coralligenous bottoms | Manuscript notes, quoted by Gravier, 1918 |
| Brook, 1889 | Gulf of Naples | 243 | | Sample originally in the collection of the Zoological Station of Naples |
| von Koch, 1889 | Capri Island and Gulf of Naples | 70 | One fragment from Capri collected at 70 m depth, for the others no precise indication | 2 fragments, collected separately in Capri, others from the Gulf of Naples |
| Gravier, 1918 | Gulf of Naples | | | Non classified dry preserved fragments in the collection of the Zoological Station of Naples, studied in 1917 |
| Dantan, 1920 | Gulf of Naples | 80–100 | | Collected by fish line |
| Opresko, 2001 | Gulf of Naples | | | Neotype |
| Vafidis and Koukouras, 1998 | Tunisian and Algerian coasts | | | |
| | | ***Adriatic Sea*** | | |
| Heller, 1868 | Lastovo Island, Croatia | | | 1st record for the Adriatic Sea. Fragments of a colony, preserved in Innsbruck, became lost with the exception of one piece in the Natural History Museum of Trieste which was analysed in Breslavia by Pax F., but then lost during WWII in 1945. |
| Pax, 1952 and Pax & Müller, 1962 | Albanian coasts of Otranto Strait 40°8,5′ N–19°32,5′ E and Boka Kotorska, Dalmatia | 236–256 | Otranto: Possibly a colony of *Antipathes dichotoma*. Muddy bottom, together with *Isidella elongata* | Otranto: Fragment collected by fishing trawl during the Hvar Expedition in 1948 (Stn 167); in the collection of the Oceanographic Institute in Split. Dalmatia: in the collection of the Dubrovnik Museum |
| Pax & Müller, 1955 | Dalmatia | | | 2 fragments of a colony; labelled 'Dalmatia'; conserved in the Natural History Museum of Trieste |

Table I. Continued.

| Author, Year | Locality | Depth (m) | Ecological remarks | Notes |
|---|---|---|---|---|
| | | ***Eastern Mediterranean*** | | |
| Vafidis and Koukouras, 1998 | Greek Archipelago, North Aegean Sea | 80–120 | 9 colonies on rocks, presence of *Pteria hirundo*, height of colonies 273–563 mm | 1st records for the eastern Mediterranean; Stn 138, 175, 200b (by fishing trawl) |
| *Atlantic Ocean* | | | | |
| Grasshoff, 1985 | Josephine Seamount | 229–241 | Sandy surface and sparse rocky substrates, together with gorgonians (*Bebryce mollis* and *Nicella granifera*) | 1 fragment collected by cutter trawl; Expedition 9c (1967) with the *R/V METEOR*; Stn 120 KD 41 |
| Grasshoff, 1985 | Great Meteor Seamount | 292 | Together with the gorgonian *Ellisella flagellum* | 1 fragment by Agassiz Trawl; Expedition 19 (1970) with the *R/V METEOR*; Stn 129 AT 96 |
| Nobre, 1931 | West coast of Portugal | | | |
| Grasshoff, 1985 | Gorringe Ridge and Gettysburg Seamount, Portugal | 250 | | |
| Roule, 1896 | Gascogne Gulf | 400–500 | Coralline and muddy bottoms | Several specimens collected in two stations; Stn 24 (6° 55′ O 46°40′ N) and Stn 28 (9°30′ O 46°40′ N) |
| Grasshoff, 1985 | Biskaya Bay | 250 | | |
| Dantan, 1920 | North of Aberwrac'h, Brest, English Channel, Atlantic France | 54 | | Determined by M. Hérouard in Roscoff Laboratory; 1st record for the English Channel; northern known limit of distribution |

the Tyrrhenian and Ligurian Seas, in particular Bordighera, Imperia, Capo Mele, Portofino Promontory, Capraia Island, Capo Comino on the eastern coasts of Sardinia, and Ponza Island. Other new records were from Sicily and the surrounding islands (Stromboli Island, Palermo, Messina Strait, Pantelleria Island). The most eastern record of *A. subpinnata* in Italy is that for Gallipoli, situated on the Ionian Sea (Figure 4).

### *Bathymetric range*

The bathymetric distribution of the species, as reported by the divers, ranges from 54 m to 92 m (Table II). The shallower records are for Sardinia, the deepest for the wreck ''Ravenna'' in the Ligurian Sea. Specimens described in literature were collected mainly at depths greater than 100 m, sometimes over 200 m, and reaching a maximum of 500 m.

### *Substrate*

Generally *A. subpinnata* was found on hard substrata (Table II). In the majority of the sites the species was found growing on rock, even if covered by fine muddy sediments (as for example in Stromboli island). *A. subpinnata* is also able to colonise artificial substrates as observed on the wreck ''Ravenna'' in the Ligurian Sea where numerous large colonies are anchored on the iron skeleton of the ship.

### *Colony size*

Recorded colonies ranged in height from a minimum of 40 cm to a maximum of 1.2 m (Table II) without evident relation to the described environmental factors, like substrate (rock or artificial), population density (dense population or sparse colonies) and current (moderate or strong).

Concerning the literature data, only a few authors gave precise measures of the colony size: for example Gili (1987) referred to some of the smallest colonies ever reported (20–35 cm high) and Vafidis and Koukouras (1998) found colonies 27–56 cm high in the Eastern Mediterranean.

### *Population density*

In some sites, *A. subpinnata* reaches high densities (Table II). The most dense and most extensive populations are those of Palermo with about 100 colonies covering 40 $m^2$ and Portofino with 10 colonies for 100 $m^2$. There are, however, sites in which the colonies are more spread out, as in the

Table II. Summary table of new data concerning the distribution of *A. subpinnata* in Italian Seas.

| Record site | Locality | Depth (m) | Ecological remarks |
|---|---|---|---|
| Bordighera, Western Ligurian Sea | Fossata of Bordighera | 64–75 | Isolated rock along a muddy slope; numerous colonies up to 1.2 m high, colonised by *Pterya hirundo*, and several young smaller colonies; together with *Paramuricea clavata*; strong currents |
| Imperia, Western Ligurian Sea | Wreck "Ravenna" | 80–92 | Artificial substrate (iron); numerous colonies on the prow of the wreck, together with *Paramuricea clavata*; strong currents always present; colonies minimum 50 cm high |
| Capo Mele, Western Ligurian Sea | | 80 | Rocky substrate |
| Portofino Promontory, Eastern Ligurian Sea | Secca dell'Isuela | 56–60 | 10 colonies on a rocky bottom (about 100 $m^2$); colonies 40–70 cm high; at times sharks' eggs |
| Portofino Promontory, Eastern Ligurian Sea | Punta di Portofino | 100 | Sparse colonies on a rocky substrate (ROV images) |
| Capraia Island, Tuscan Archipelago, Tyrrhenian Sea | Secca fonda della Civitata | 75–90 | 6–7 colonies 40–70 cm high |
| Capo Comino, Eastern Sardinia, Tyrrhenian Sea | | 54 | |
| Ponza Island, Pontin Archipelago, Tyrrhenian Sea | | | One colony on a rock |
| Stromboli Island, Aeolian Archipelago, Tyrrhenian Sea | Dorsale della Sciara del Fuoco | 52–58 | Few isolated colonies; volcanic rock covered by fine muddy sediment; moderate currents |
| S. Flavia, Northern Sicily, Tyrrhenian Sea | Scoglio della Formica | 55–65 | About 100 colonies on a rocky surface (about 40 $m^2$); site exposed to N-NW currents; colonies reach 1 m height |
| Bagnara Calabra, Messina Strait | Secche di Favazzina ("Secca dei Francesi") | 55–70 | Dense population on a rocky substrate mixed with *Paramuricea clavata*, a rich fish community, some *Pteria hirundo* and sharks' eggs; just on one side of the shoal; colonies 40–60 cm high; at times strong current |
| Pantelleria Island, Ionian Sea | | >70 | |
| Gallipoli, Apulian coast, Ionian Sea | | >50 | Rocky substrate |

case of Capraia island, Capo Comino, Stromboli island, and Gallipoli.

### *Associated fauna*

Our data confirm that *A. subpinnata* colonies are frequently mixed with gorgonias (Lütken 1872; Grasshoff 1985); in particular, we have recorded this black coral within dense meadows of *Paramuricea clavata* and *Eunicella cavolinii* together also with sponges (for example *Axinellae* spp.; Table II and Figure 2C). These coral assemblages host a rich fish community (Figure 2B). The colonies generally do not harbour epibionts, with the exception of the bivalve *Pteria hirundo* (reported also by Vafidis & Koukouras 1998) or *Scyliorhinus* sp. eggs hanging from the ramifications of the coral (Figure 2A).

## Discussion

Our study expands the known distribution of *Antipathella subpinnata* in the seas surrounding Italy and clearly indicates that this species is a common component of the lower fringe of the circalittoral twilight environment, below 50 m depth, where hard substrata are available. The large data set obtained in this study shows that in the Mediterranean Sea this black coral never lives at depths shallower than 50 m. It is very probable that the record of *A. subpinnata* from 10 m depth reported by Riedl (1983) is erroneous, since there is no actual evidence of its presence at such shallow depths.

The bathymetric pattern highlighted in this study suggests that temperature is the main environmental factor involved in determining the bathymetric distribution of *A. subpinnata*. The data indicate that it is a stenothermal species not able to survive at water temperatures greater than 15°C. For this reason, *A. subpinnata* must be viewed as a characteristic species of a coral assemblage composed also of some species of gorgonians, mainly *Paramuricea clavata* and *Eunicella cavolinii*. Moreover, the optimum temperature range for this species agrees with that of the other species belonging to the genus *Antipathella*, for example *A. aperta* and *A. fiordensis* which live in the fiords of New Zealand.

In the Mediterranean Sea research on deep coral assemblages was until now limited to the white coral banks mainly composed of madrepores of the genus

*Lophelia* Milne-Edwards & Haime, 1849 and *Madrepora* Linnaeus, 1758 (Tursi et al. 2003), while the populations of flexible corals (black corals, gorgonians) are almost unknown. Moreover, these important assemblages are now endangered by trawling activity and the situation is particularly problematic in some areas where the coral assemblages host populations of important target species for commercial fisheries. This is, for example, the case of the middle slope horizon of the western Mediterranean, whose assemblage is characterised by meadows of the gorgonian *Isidella elongata* and by the shrimps *Aristeus antennatus* and *Aristeomorpha foliacea*. This assemblage, described at the beginning of the twentieth century (Issel 1930) has been heavily exploited and the gorgonian has now almost completely disappeared from the trawled bottoms of most of the Mediterranean areas (Sardà et al. 2004).

Coral assemblages characterised by *A. subpinnata* are found on hard substrata, the type of bottom that is not trawled by commercial fisherman; therefore, direct damage by trawling activities is minimal. On the other hand, in some places the boats, trawling very close to the base of the cliff, can produce a strong resuspension of the sediment that increases the water turbidity and may thereby damage the *Antipathella* assemblages. For all these reasons we strongly suggest the institution of Marine Protected Areas in places where hard substrata are present deeper than 50 m.

The genus *Antipathella* is comprised of five species living in temperate waters; three occur off New Zealand (*A. aperta*, *A. strigosa*, *A. fiordensis*), one in the northeastern Atlantic (*A. wollastoni*), and the third mainly in Mediterranean Sea (*A. subpinnata*) (Opresko 2001). The scarcity of taxonomic studies and the uncertainty of several old determinations about antipatharians, in general, have, until now, prevented biogeographic studies on black corals. Concerning the genus *Antipathella*, for example, the distinction between *A. wollastoni* and *A. subpinnata* has just been recently clarified (Opresko 2001), but some old identifications could be doubtful. Nevertheless, the world distribution of the entire genus strongly suggests the status of Thetyan relict (Figure 5), a distribution pattern known for many genera, like the popular examples of the precious coral (*Corallium rubrum*, distributed with other species from the Atlantic to the Pacific Ocean passing through the Mediterranean basin) (Bayer 1964), and the sea grass *Posidonia* (with the only Mediterranean species *Posidonia oceanica* and a group of eight species around the Australian coast) (Kuo & McComb 1989).

Figure 5. World distribution map of the species belonging to the genus *Antipathella*. **X**, *Antipathella subpinnata*; •, *Antipathella strigosa*; ★, *Antipathella aperta*; ▲, *Antipathella fiordensis*; ■, *Antipathella wollastoni*.

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