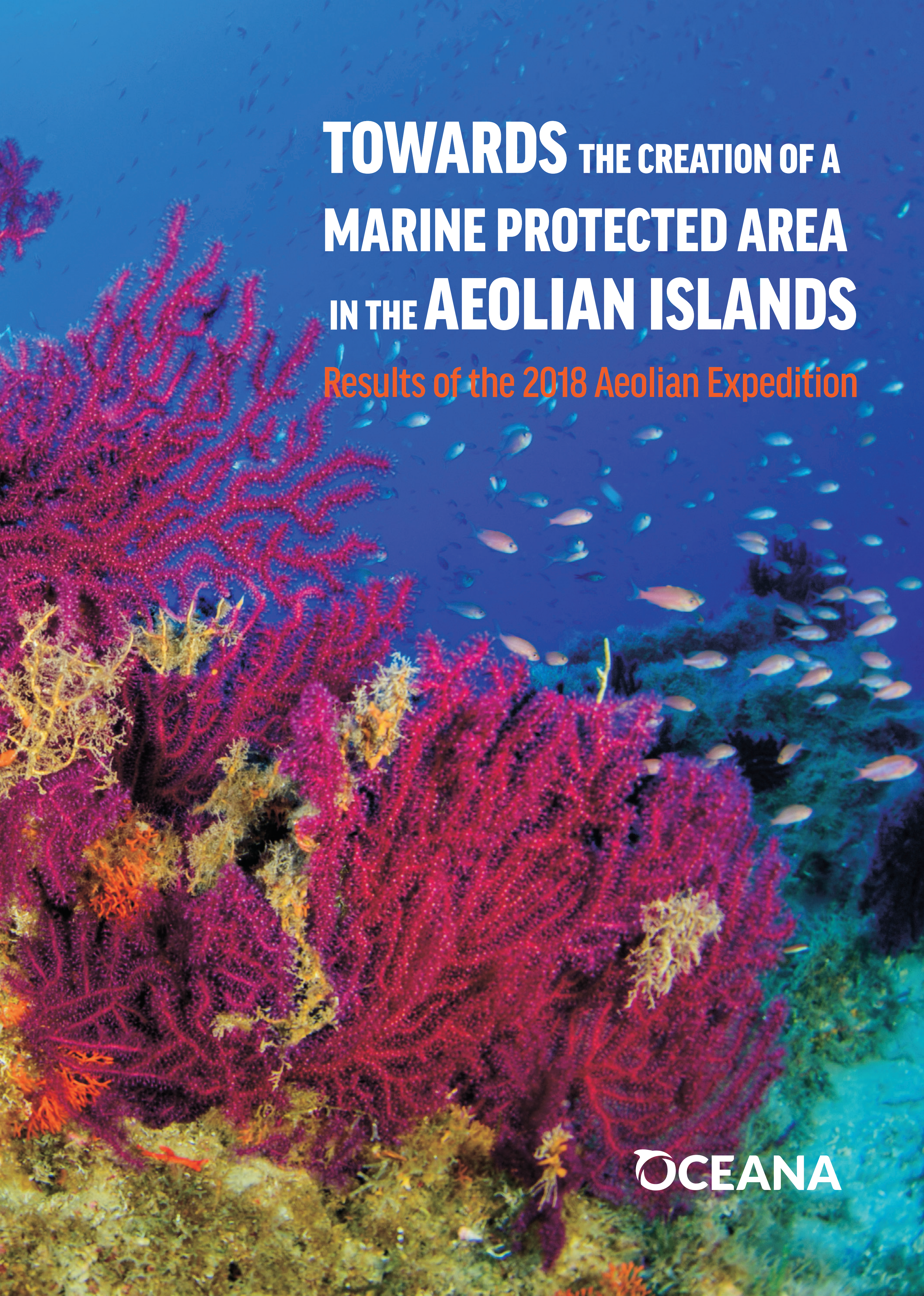
TOWARDS THE CREATION OF A MARINE PROTECTED AREA IN THE AEOLIAN ISLANDS

Results of the 2018 Aeolian Expedition



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Serranus scriba and *Chromis chromis* © OCEANA/ Juan Cuetos

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Red gorgonian (*Paramuricea clavata*)
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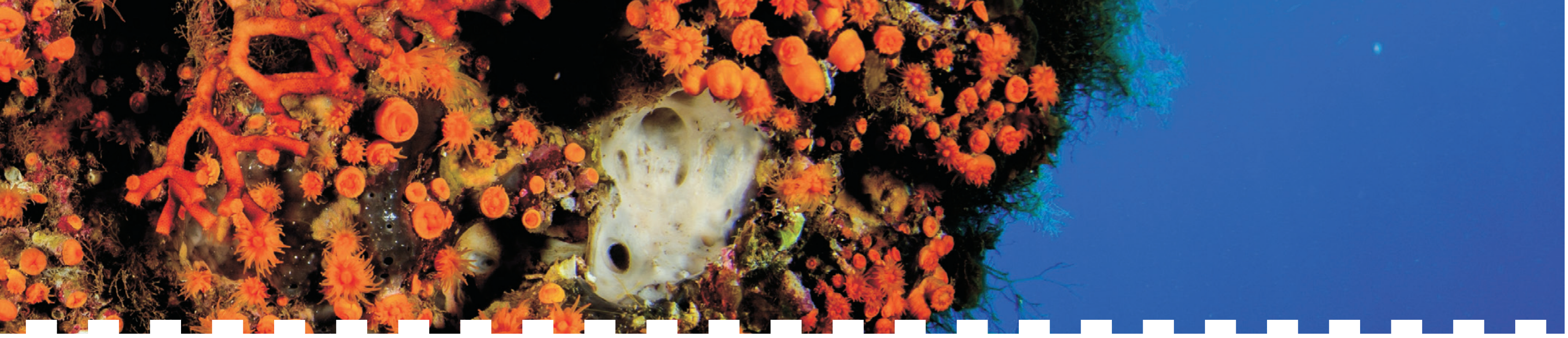

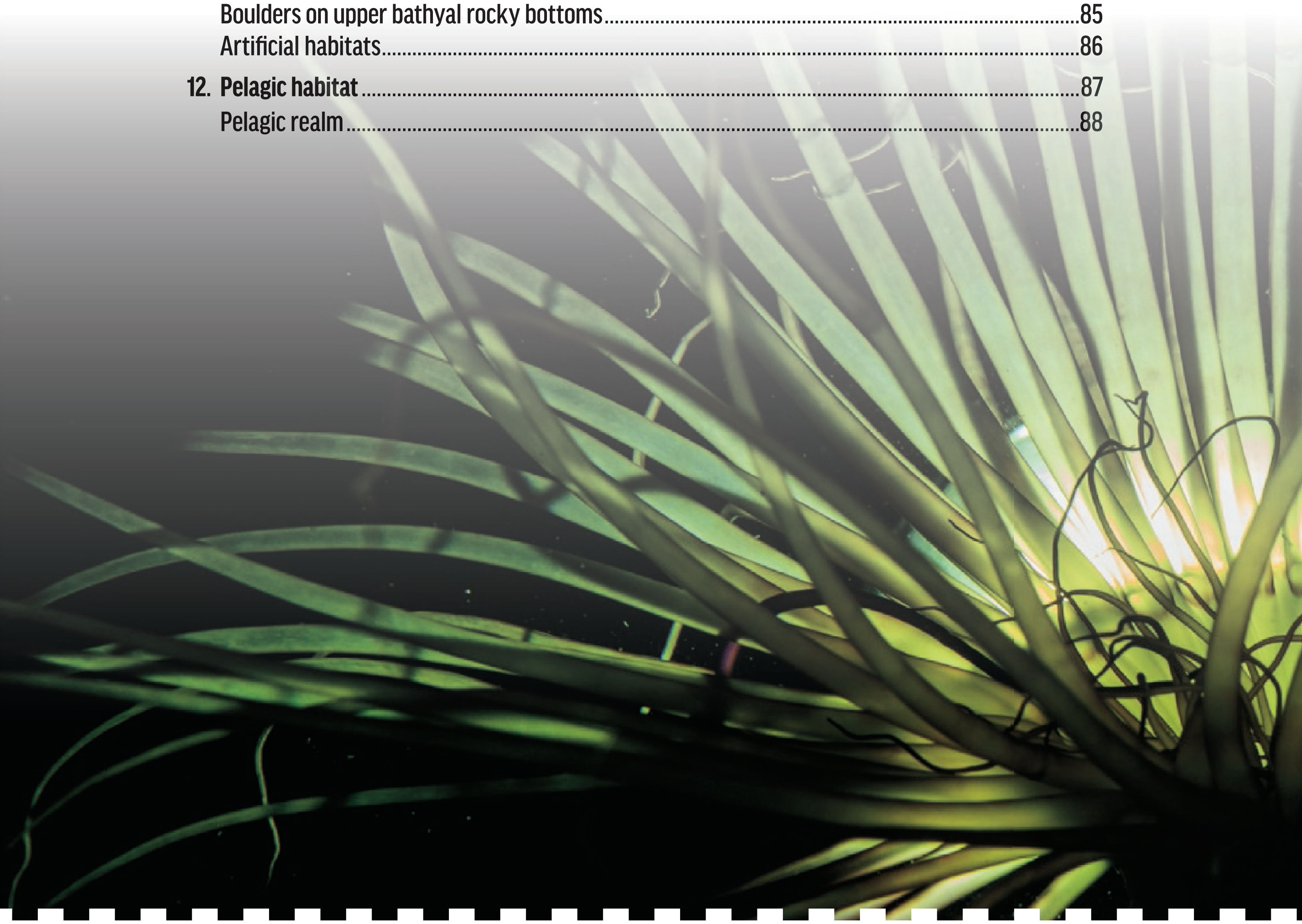

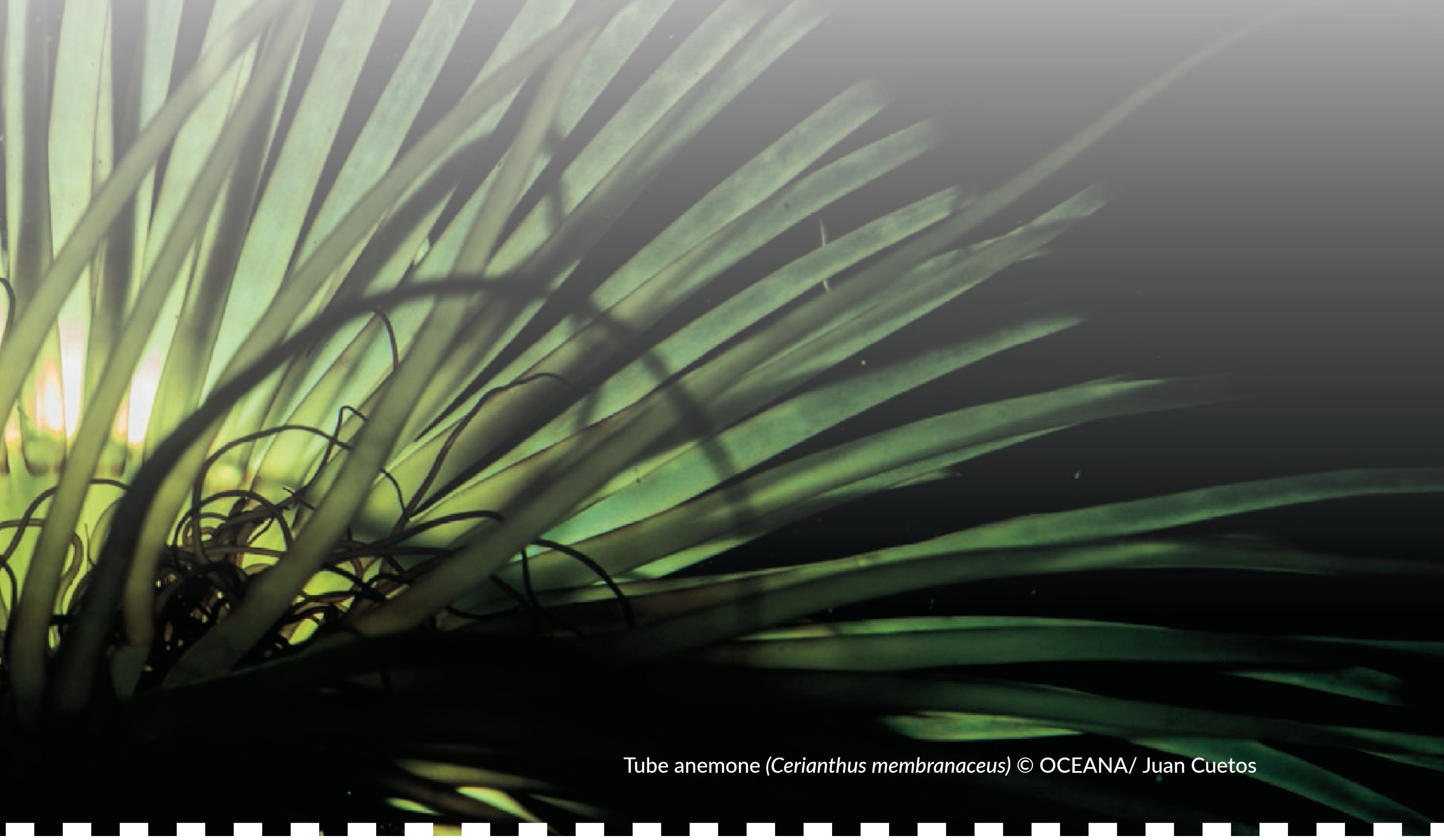

Tube anemone *(Cerianthus membranaceus)* © OCEANA/ Juan Cuetos

EXECUTIVE SUMMARY

The Aeolian archipelago, off the northern coast of Sicily, has long been recognised as a major area of importance for marine biodiversity. The waters surrounding these volcanic islands are characterised by steeply sloped bottoms that host a wide array of habitats – including seagrass meadows, seamounts, and hydrothermal vents – over a large depth range, and are home to iconic species such as loggerhead sea turtle, sperm whale, swordfish, and bluefin tuna.

In 1982, the Aeolian Islands were formally identified under Italian law as the site of a potential marine protected area (MPA). Years later, in 2016, the Italian government committed to establishing an Aeolian MPA and began the official process to create it. Critically, this process depends on in-depth knowledge about marine life in Aeolian waters. However, only limited research had been carried out on deep-sea ecosystems in the archipelago. While earlier studies by Oceana and others had suggested the presence of important deep-sea ecosystems in Aeolian waters, detailed information was lacking.

To address this data gap, Oceana carried out a one-month research expedition in 2018. Surveys were conducted across the Aeolian archipelago, using a combination of methods to study seabed habitats and species down to a depth of 989 m. The expedition documented a wide variety of ecosystems, ranging from meadows of seagrass (*Posidonia oceanica*) in the shallowest areas, to gardens of gorgonians (such as *Bebryce mollis*, *Swiftia dubia*, and *Villogorgia bebrycoides*) and forests and aggregations of black corals (such as *Antipathes dichotoma*, *Antipathella subpinnata* and *Leiopathes glaberrima*) at intermediate depths, and glass sponge aggregations (*Farrea bowerbanki*) on the deepest rocky bottoms surveyed.

In total, 902 taxa were identified, in association with 57 types of habitats and/or communities. Records included 34 species that are protected under European or international legal frameworks, 16 species that are threatened with extinction, and a variety of habitats that are protected or have been prioritised for conservation action in the Mediterranean. The most impressive discovery during the expedition was a spectacular forest of Critically Endangered bamboo coral (*Isidella elongata*), which was one of the densest and largest such forests found to date in the Mediterranean Sea.

Overall, the expedition findings underscored the clear need for a new MPA in the Aeolian Islands. Aeolian waters support an extensive variety of marine ecosystems, in shallow and deep areas throughout the archipelago. These ecosystems are home to a rich array of species, communities, and habitats – including those which by law must be protected. For Italy to comply with European and international laws and conventions, marine protection in the Aeolian Islands must be significantly increased, through the expansion of existing MPAs and/or the designation of new MPAs that will safeguard the remarkable biodiversity of this area.

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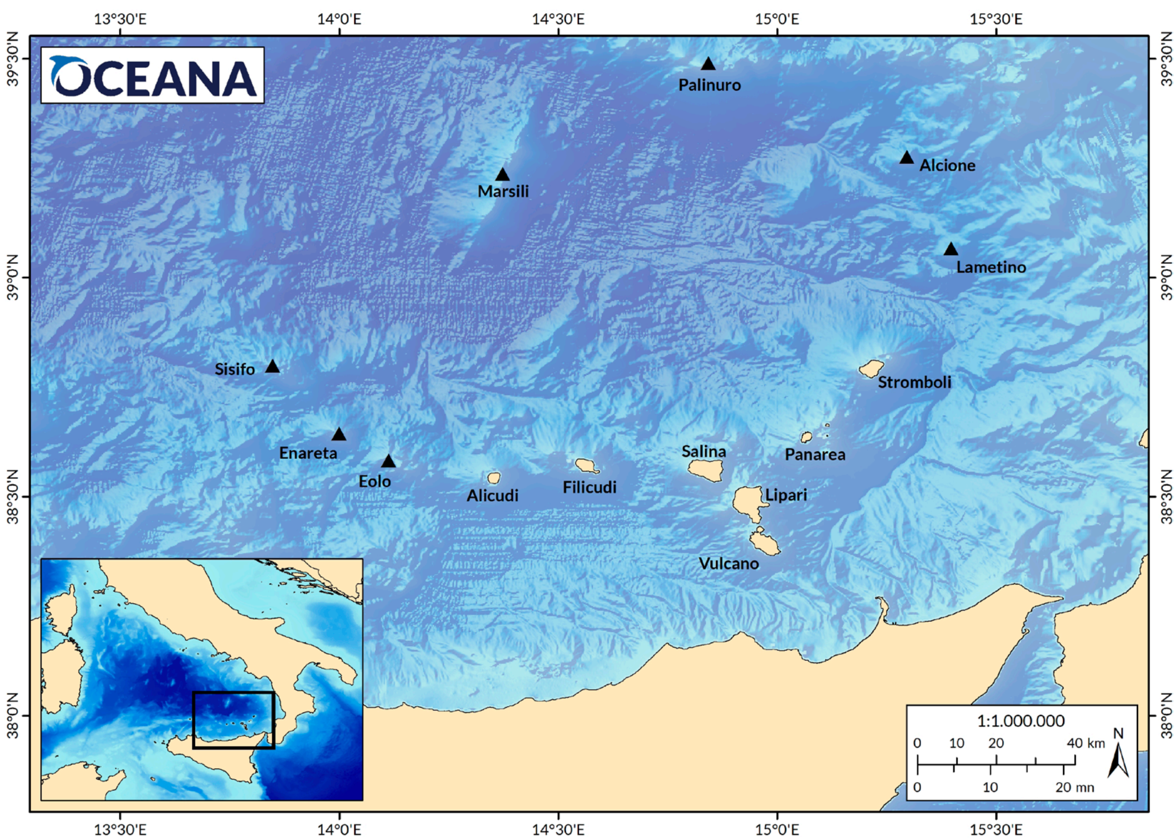
THE AEOLIAN ARCHIPELAGO

The Mediterranean Sea is the largest (2 969 000 km^2) and deepest (average 1460 m, maximum 5267 m) of the enclosed or semi-enclosed basins, and is considered one of the most important biodiversity hotspots of the planet, hosting around 17 000 recorded species.[1] The isolation of its waters from the surrounding oceans has resulted in a high number of endemic species,[1] and the convergence of the African-Eurasian tectonic plates has shaped the Mediterranean Sea bottom with a wide variety of geographical features such as archipelagos and seamounts.[2] Therefore, the location of the main Mediterranean islands – the Balearics, Corsica, Sardinia, Sicily, Malta, Crete and Cyprus – lie along the edges of these tectonic plates, in a zone strongly related to volcanic activity.[2]

The Aeolian Islands are an archipelago of seven main emerged volcanoes (Alicudi, Filicudi, Salina, Lipari, Vulcano, Panarea and Stromboli), and five smaller ones (Basiluzzo, Dattilo, Lisca Nera, Bottaro and Lisca Bianca). All of them are situated off the northern coast of Sicily, in the southeastern Tyrrhenian Sea. Together with several adjacent volcanic seamounts and banks (such as Lametino, Alcione, Palinuro, Marsili, Sisifo, Enareta and Eolo), they form a ring-like structure known as the Aeolian Arc (Figure 1). This volcanic system dates from 1.3 million years ago (Quaternary Period) and volcanic activity continues, on the islands of Vulcano and Stromboli.[3] As a result of volcanic activity in the area, hydrothermal vents are also present along the Aeolian arc (especially around the islands of Panarea and Vulcano), and play an important role in many processes occurring on the seabed.[4] This area, together with some Greek islands, is the only place where this type of gas seep is active in the Mediterranean.[4]

Figure 1. The Aeolian volcanic arc formed by islands and seamounts.



The Aeolian volcanic complex rises from between 1 km and more than 2 km above a seafloor crust that is 15 to 20 km thick.[5,6] The seamounts peak at depths of between 85 m (Palinuro) and 1073 m (Sisifo) and the heights of the islands range from 241 m above sea level (Panarea) to 964 m above sea level (Salina). In total, the islands cover an area of 121,6 km^2.

With heterogeneous morphologies dominated by hard bottoms and steep slopes, the marine environment of the Aeolian Islands represents a hotspot of biodiversity, hosting a wide variety of habitats and communities over a large depth range. In the shallowest areas (less than 90 m deep), rich seagrass (*Posidonia oceanica*) meadows occur, as well as dense coralligenous communities with black corals and gorgonian forests. The area is also known to be important for various cetaceans, some of which occur in high densities, such as the striped dolphin (*Stenella coeruleoalba*).[7]

In general, limited research has been carried out on deep-sea ecosystems of the Aeolian Islands. Scientific interest in the area has mainly been focused on the geology of hydrothermal vents, although there are some studies on the microbiological diversity of these environments[8,9,10], as well as their associated planktonic[11,12] and benthic[13,14,15] communities. Between 2014 and 2015, the Italian National Institute for Environmental Protection and Research (ISPRA by its Italian acronym), together with various national universities and research institutions, conducted two expeditions[16] in order to monitor hydrothermal vents close to the islet of Basiluzzo and their associated wildlife. This research documented the presence of various cylindrical and pyramidal structures with gas and fluid leakage, and the photophilous algal, bryozoan, and hydroid communities that colonise them. These findings suggested that the study area could be selected for protection under Annex I of the European Habitats Directive (EC Directive 92/43), under ‘Submarine structures made by leaking gases’ (habitat code 1180[17]).[a]

Beyond studies of these vent systems, other investigations have suggested the existence of rich ecosystems in the depths of Aeolian waters. In 2008, Oceana carried out a research expedition in the Mediterranean Sea doing exploratory sampling with a remotely operated vehicle (ROV) in Spain, Italy, Malta and Greece. As part of that expedition, three ROV dives were conducted in the Aeolian Islands: one in Secca del Capo (36-165 m deep) and two in Filicudi (28-443 m deep). That research documented the occurrence of deep-sea sponge aggregations, coral gardens and oysters. A full list of the habitats and communities identified during the 2008 expedition can be found in Annex I. Several other studies describe the presence of gardens formed by the black coral *Leiopathes glaberrima*, at ca. 300 m deep in the Aeolians and nearby areas.[18] This coral is a habitat-forming species that increases benthic diversity and serves as shelter, nursery and spawning grounds for many associated species; the gardens it forms are also considered vulnerable marine ecosystems (VMEs).[19] The bamboo coral *Isidella elongata* and tall sea pen *Funiculina quadrangularis* (both also considered VME indicator species) have been documented in muddy bottoms in the Giogia canyon, an area that is adjacent to the Aeolian archipelago.[20] More recently, in 2017, ISPRA carried out another expedition in the Aeolians, which included surveys of some areas down to several hundred metres depth. The findings of that research have not yet been published.

a “Submarine structures consist of sandstone slabs, pavements, and pillars up to 4 m high, formed by aggregation of carbonate cement resulting from microbial oxidation of gas emissions, mainly methane. The formations are interspersed with gas vents that intermittently release gas. The methane most likely originates from the microbial decomposition of fossil plant materials.” (European Commission. 2013. Interpretation Manual of European Union Habitats.)

Figure 2. A member of the crew of the 2018 Oceana Aeolian expedition, with Stromboli in the background. © OCEANA/ Enrique Talledo

The natural value of the Aeolian archipelago has long been recognised. At the international level, the area was designated as a UNESCO World Heritage site in 2001, on the basis of its volcanic and geochemical importance, as well as its natural outstanding landscape.[21] At the national level, the Italian government identified the Aeolians as a potential marine protected area (MPA) in 1982, due to its oceanographic and biological characteristics, (Ministerial Decree 979/82, Art. 31).[22] In August 2016, the government publicly committed to the designation of an MPA in the Aeolians, and the official process is currently underway. Critical to this process are data about the diversity of marine life in Aeolian waters, particularly the collection of new data to fill the gap in knowledge about deeper areas. To address this need, Oceana carried out a research expedition in 2018, thereby also contributing to an existing Aeolian Islands project being carried out by the Blue Marine Foundation in collaboration with the Aeolian Islands Preservation Fund. That project aims to secure the designation of an Aeolian MPA, alongside sustainable fisheries, development, and tourism.

The details and key findings of the 2018 Oceana Aeolian expedition are presented in the following sections.

The natural value of the Aeolians has long been recognised, and it was designated as a UNESCO World Heritage site in 2001.

THREATS TO AEOLIAN MARINE BIODIVERSITY

Hundreds of species are found in the rich Aeolian waters, some of which are officially listed as threatened or protected, such as sperm whale, loggerhead turtle, swordfish and grouper.[23] Invasive species such as the algae *Caulerpa* spp.[24] are also present in the area, constituting a threat to the balance of local ecosystems. The archipelago also faces other direct threats to marine life, such as overfishing, vessel anchoring, pollution and tourism.

Fishing is one of the two main activities upon which the Aeolian Islands depends economically.[25] Like many other places in the Mediterranean, a significant portion of fisheries in the Aeolian Islands is artisanal and small-scale (Figure 3). The artisanal fleet operates within the 12 nm limit and, traditionally has comprised over 400 fishermen (30% of the local population)[26]. 'Spadara' driftnets used for targeting swordfish once constituted the largest share of Aeolian fishing gear. These driftnets were considered a threat to biodiversity due to their low selectivity and the very high bycatch that this fishing gear produced, causing the death of countless non-targeted species,[27] including those regulated under protection measures, such as dolphins.[7] Because of these concerns, driftnets have gradually disappeared from the area since the implementation of EC Regulation 1239/98, which entered into force in 2002 and mandated a modification to the gear or a definitive end to its use.[28]

Nowadays, the Aeolian fleet is fairly diverse in terms of fishing gear; up to 15 different gear types are in regular use, with trammel nets and longlines (which have substituted 'spadara') among the most common.[28] Boat seines with FADs, 'lampada' nets and bottom traps are occasionally used, as well as the squid hand-jig line, a typical Aeolian fishing method aimed at European flying squid (*Todarodes sagittatus*), which represents an important revenue for artisanal fishermen.[28] Although there is no tradition of bottom trawling in the islands, a small area between Salina and Panarea is exploited by outside trawlers that fish for giant red shrimp (*Aristeomorpha foliacea*) and blue and red shrimp (*Aristeus antennatus*).[26] Outside the Aeolian archipelago, adjacent areas close to the Messina Strait-Giogia Canyon are also being trawled, with deleterious consequences to vulnerable species that inhabit deep, soft-bottoms.[20] Illegal fishing of greater amberjack with purse seine has also been reported from the Aeolians.[26]

Figure 3. Artisanal fishing boat near Salina. © OCEANA/ Enrique Talledo

Pelagic species have traditionally been of the greatest interest to local fishermen, including swordfish (*Xiphias gladius*), bluefin tuna (*Thunnus thynnus*), albacore (*Thunnus alalunga*) and spearfish (*Tetrapturus belone*), which are present year-round in the area.[26] The Aeolian habitats are especially important for the former two species, which have nursery and reproduction areas there.[28] Other important target species are dolphinfish (*Coryphaena hippurus*) and greater amberjack (*Seriola dumerili*), which are seasonally abundant in the area.[26,28] Benthic species such as scorpionfish (*Scorpaena scrofa*) and two-banded sea bream (*Diplodus vulgaris*) are also of high economic value.

Recreational fishing represents an additional challenge for Aeolian ecosystems, due to the 'soft' application of environmental legislation and a lack of scientific data about the scale of these fisheries. Such data are essential for the proper management of fisheries resources, to ameliorate the overfished state of Italian stocks.[26] Illegal activities that have been reported from recreational fisheries in the area include failing to respect minimum landing sizes, catches, and seasonal limits.[26]

The Aeolian archipelago has grown in popularity as a tourist area and, as a strict 'sun-and-sea' destination, is characterised by strong seasonal trends in tourist activity.[29] The annual number of visitor arrivals has risen from roughly 92 000 in the year 2000, to more than 132 000 in 2016,[30] with increases over time also documented in numbers of hotel beds and other lodging options (e.g., bed and breakfast, camping).[29] This growth has produced a series of social and economic changes in the islands, compromising their natural value. Although tourism has enhanced the local economy, environmental degradation has occurred, with increased exploitation of natural resources and perturbation of the highly fragile environment.[31]

Another growing environmental problem in the Aeolian Islands, and globally, is related to plastic pollution. Microplastics – those with a diameter of 1-5000 μm – represent the largest toxicological threat, as they are easily transmitted into the marine food web.[32] According to a study aimed at providing a baseline overview of the plastic situation in the Aeolian Islands, microplastics were the most documented type of plastic debris (>94%). The amount of microplastics found in the Aeolian area was relatively higher than in other parts of the world (e.g., Belgium, Germany, Singapore, and Slovenia), and was considered to be in the medium-to-high range. In contrast, levels of macroplastics (diameter >2.5 mm) were found to be notably lower than in other countries, such as Belgium, India, and Malta.[32]

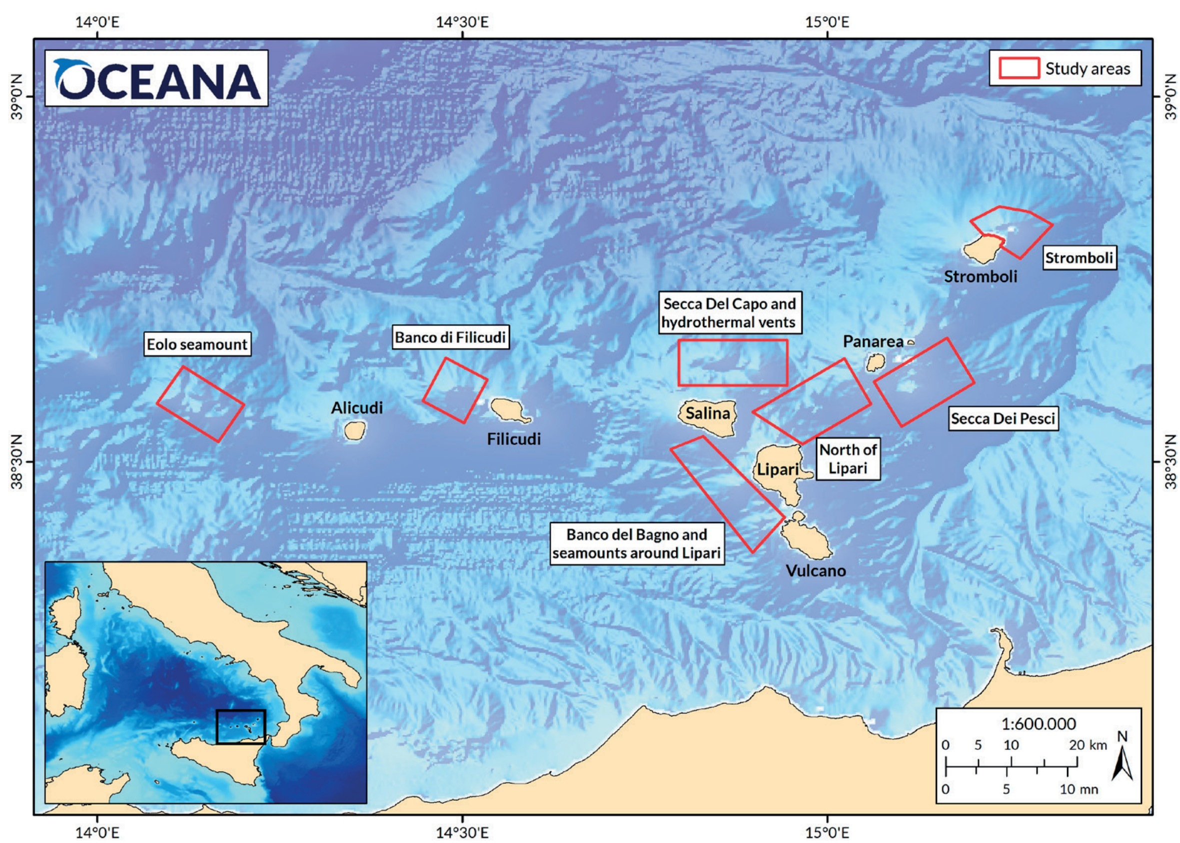
Figure 4. Fast ferry line connecting the Aeolian Islands and mainland Sicily. © OCEANA/ Enrique Talledo

THE 2018 AEOLIAN EXPEDITION

During May-June 2018, Oceana conducted a one-month expedition to document the habitats and species of the seabed surrounding the seven Aeolian Islands and the Eolo seamount (11 nm west of Alicudi, at ca. 800 m depth)[33]. The expedition was carried out using the Oceana research vessel *Ranger*, a ketch catamaran of 21 m overall length and 9 m extreme breadth (Figure 5). During the expedition, seven areas were surveyed (Figure 6), and information was obtained about the primary benthic habitats and communities of the circalittoral and bathyal zones, including coral forests, sponge aggregations and oyster beds, as well as about the occurrence, distribution and abundance of deep-sea species.

Figure 5. Oceana *Ranger* during the 2018 Aeolian expedition, with Lipari in the background. © OCEANA/ Enrique Talledo

Figure 6. Areas surveyed during the 2018 Aeolian expedition.



Surveys were carried out using a combination of sampling methodologies (Figure 7), primarily through visual, non-destructive surveys with a remotely operated vehicle (ROV), at depths down to 989 m. The Saab Seaeye Falcon DR ROV was equipped with a HD camera, compass, depth sensor and laser beams that provided a 10 cm scale for reference. In shallower coastal areas (down to 38 m depth), surveys were carried out by a team of professional underwater photographers and a videographer. In soft bottom areas, infauna was documented by means of a Van Veen grab, and sediment type was classified according to a colour chart.[34] Finally, oceanographic parameters such as temperature, salinity and chlorophyll were measured using a conductivity, temperature, and depth (CTD) device.

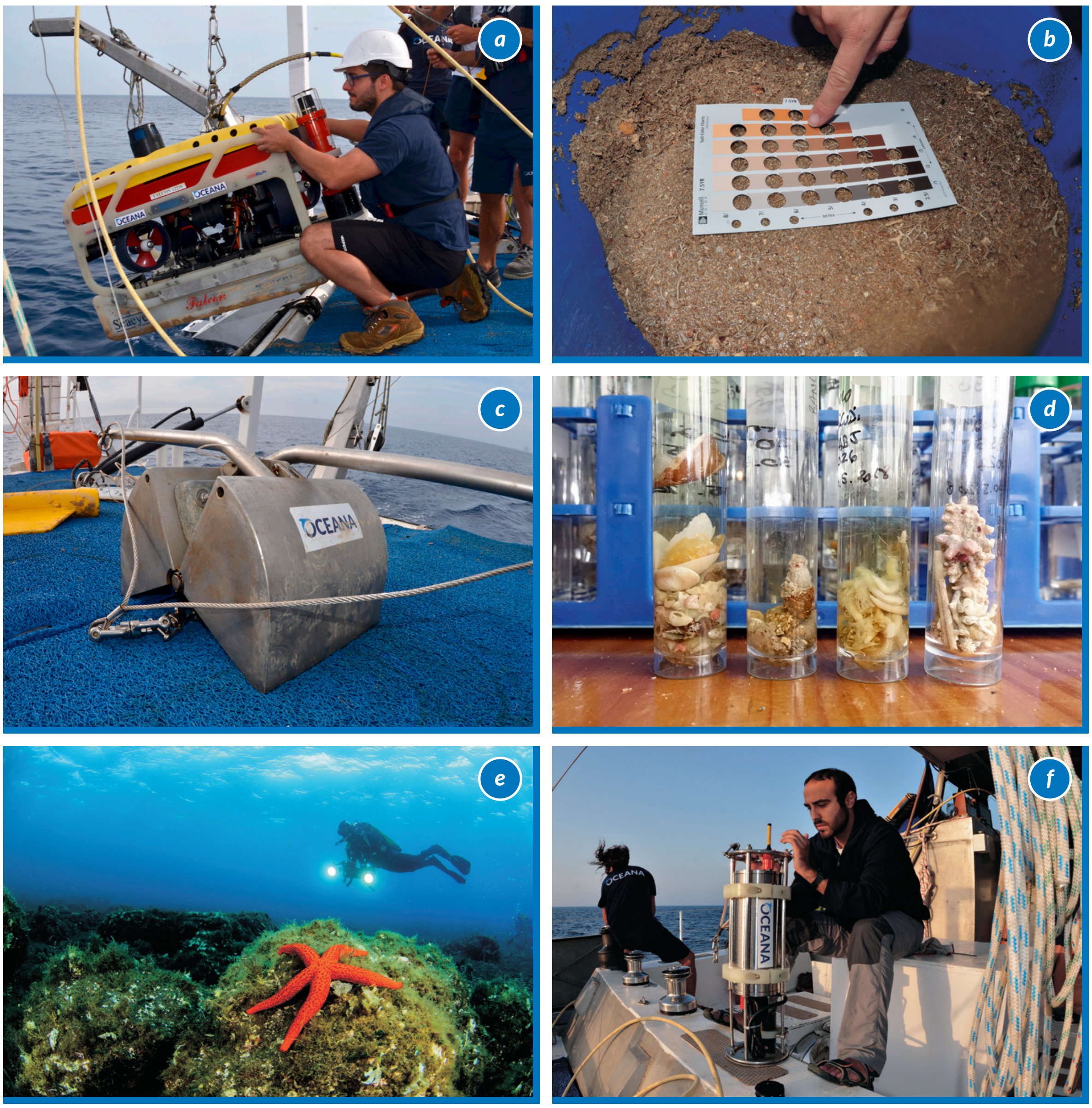


Figure 7. Sampling methods and tools © OCEANA/ Juan Cuetos / Enrique Talledo

a) **ROV pilot during launching manoeuvre;** ***b)*** **sediment colour chart;** ***c)*** **Van Veen grab;** ***d)*** **biological samples collected with the Van Veen grab;** ***e)*** **professional SCUBA videographer;** ***f)*** **CTD being prepared for extracting oceanographic data.**

Preliminary identification of observed species was carried out during the expedition. Most species could be identified visually based on the real-time video feed from the ROV; some specimens required more detailed taxonomic analysis and were collected with the robotic arm of the ROV for this purpose. Following the expedition, all the materials (e.g., videos, photos, and collected specimens) were carefully analysed, and all the species were identified to the finest taxonomic resolution possible.

In total, 902 taxa were identified, 688 of which to the species level. These organisms were documented in association with a total of 57 types of habitats and/or communities, which were classified in 12 broad categories according to similar features such as fauna, depth and substrate. A description of each of the documented habitat/community types, their most important features, and the main associated species is detailed in the next section.

© OCEANA/ Enrique Talledo

BENTHIC HABITATS AND COMMUNITIES IN THE AEOLIAN ISLANDS

Marine habitats are as variable as the conditions that influence them. Oceanography, geology, substrate, physico-chemical conditions, productivity, light, depth, water temperature, and anthropogenic impacts are among the countless factors that determine the dominant species in a given area. Therefore, in the heterogeneous context of the Aeolian Islands, a 'mosaic' of benthic habitats commonly occurs, in which dominant species can differ even at a scale of several metres.

As an example of this habitat mosaic, a rocky escarpment that is partially covered with soft sediment can host sponges and corals in the outcrops, sea pens on soft sediments, and oyster concretions on overhangs. Similarly, a garden of *Eunicella singularis* sea fans can occur between hard and soft substrates, and be mixed with an algal forest or seagrass meadow.

Thus, the task of describing specific, clearly isolated habitats, communities, facies, and assemblages is complicated in the Aeolian context, which is characterised by a marked complexity of marine ecosystems. In this section, the 57 main dominant habitats and communities that were recorded in the Aeolian Islands are outlined, grouped according to their shared features (i.e., species, substrate, and bathymetric range). The resulting 12 groups of habitats and communities are listed below:

1. Shallow bottoms with macroalgae and seagrasses
2. Maërl beds and coralligenous habitats
3. Soft bottoms with echinoderms and/or oyster aggregations
4. Gorgonian gardens on rocky and muddy bottoms
5. Sea bottoms with sea pens and hydrozoans
6. Rocky bottoms with black corals
7. Habitats formed by sponges
8. Stony coral and tube anemone dominated bottoms
9. Other habitats
10. Soft bottoms with bioturbations
11. Geogenic and artificial habitats
12. Pelagic habitat

Each of these groups is presented in turn, together with the detailed descriptions of the habitat and community types within that group. These descriptions include: the main associated species; whether the habitats or communities were observed in combination with others; how they varied to form different or transitional habitats; and any legal requirements or action plans for their protection.

A full list of the 57 documented habitats and communities is provided in Annex II, and a list of habitats and communities that are legally protected is in Annex III.

A 'mosaic' of benthic habitats occurs in the Aeolians – a total of 57 habitats and communities and more than 900 taxa were identified during the expedition.

1. Shallow bottoms with macroalgae and seagrasses

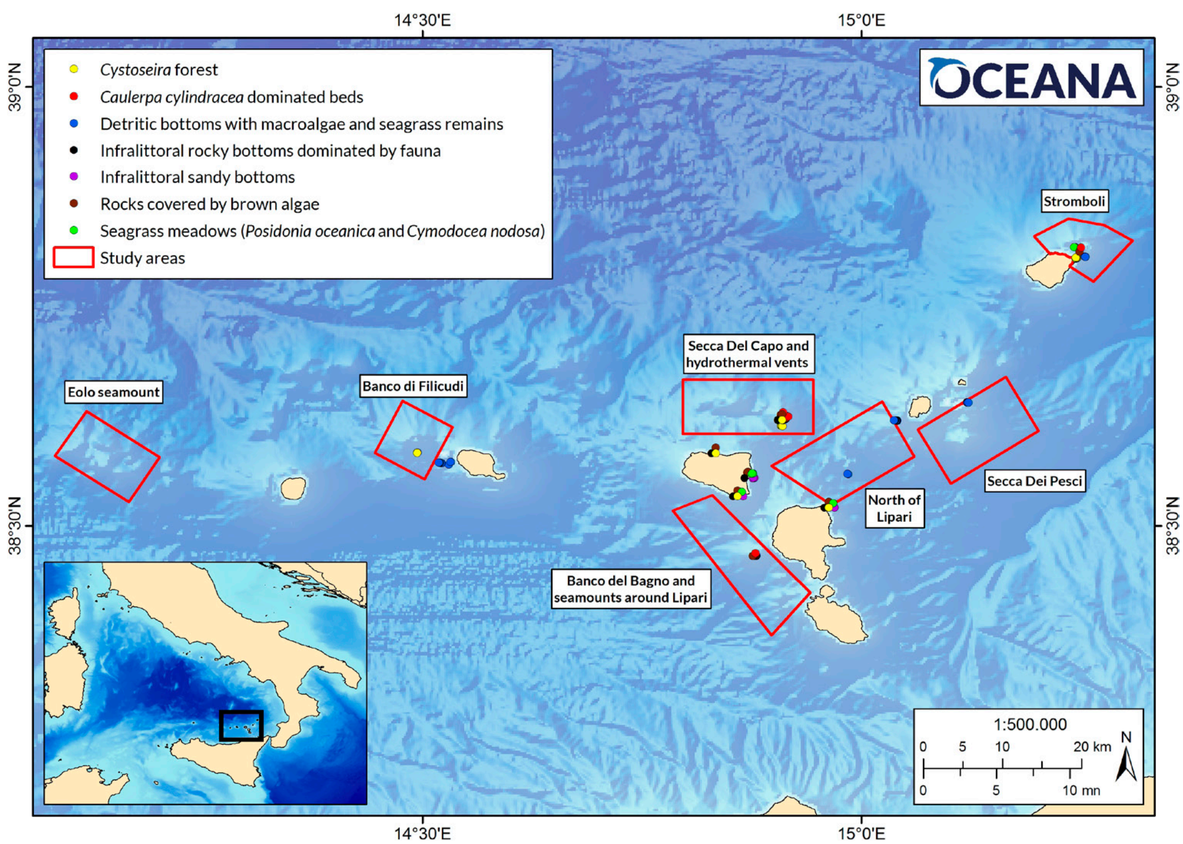
These habitats are formed by photosynthetic macroalgae and seagrasses. As shown in Figure 8, they were observed on shallower bottoms (5-60 m) in all the study areas (except for Eolo Seamount, where the minimum surveyed depth was below the photic zone). Algal and seagrass habitats occurred on hard and soft substrates, respectively. Brown macroalgae were the most common, specifically those belonging to the genus *Cystoseira*. The invasive species *Caulerpa cylindracea* was also found in abundance on these bottoms. The main species of seagrass that formed meadows were *Posidonia oceanica* and *Cymodocea nodosa*.

Algal forests and seagrass meadows play a significant ecological role as primary producers, and provide a variety of ecosystem services, acting against coastal erosion, filtering pollutants from the water, and enhancing local fisheries by supporting food webs and serving as nursery areas.[35] In fact, the seagrass *Posidonia oceanica* has been estimated to generate goods and benefits valued at between 25.3 and 45.9 million €/ha/year.[36]

These valuable ecosystems are disappearing globally due to anthropogenic pressures such as pollution and disturbance of the seabed, for example through fishing activities and anchoring.[37] As a result, some species like *P. oceanica* have been granted legal protection, in order to conserve them.

Faunal species that play a similar habitat-structuring role to seagrasses and macroalgae also co-occur in shallow-water areas. This is the case of various species of bryozoans and sponges, which proliferated over circalittoral rocky bottoms in some areas, forming a turf on the seabed.

Figure 8. Locations of shallow-water habitats with macroalgae and seagrasses.



Seagrass meadows (*Posidonia oceanica* and *Cymodocea nodosa*) on infralittoral bottoms

Depth range: 5 to 35 m

Distribution map: Figure 8

Main associated species:

- *Aptyxis syracusana*
- *Botryllus schlosseri*
- *Bunodeopsis strumosa*
- *Chromis chromis*
- *Coris julis*
- *Cymodocea nodosa*
- *Gibbula varia*
- *Halophila stipulacea*
- *Sarpa salpa*
- *Serranus scriba*
- *Symphodus tinca*

Posidonia oceanica and *Cymodocea nodosa* © OCEANA/ Juan Cuetos

Description

Posidonia oceanica was the most widely distributed spermatophyte, forming dense forests in shallow waters surrounding the Aeolian Islands.

Two other seagrass species were also found. The first of these species was *Cymodocea nodosa*, which in some places created mixed forests with *Posidonia oceanica*. However, while *P. oceanica* was distributed across both soft and hard bottoms, *C. nodosa* was only found on sandy bottoms. The other species, *Halophila stipulacea*, formed small patches on sandy bottoms close to the other phanerogams.

Among the species living on the leaves of seagrasses were the gastropods *Gibbula varia* and *Aptyxis syracusana*, the anemone *Bunodeopsis strumosa*, and the colonial tunicate *Botryllus schlosseri*.

As *P. oceanica* can grow on substrates of varying grain sizes, these meadows were mixed with communities on both rocks and sandy bottoms, adding a wider variety of associated species to the ecosystems that they form.

Protection status

Posidonia oceanica meadows are protected as a priority habitat for conservation under the EU Habitats Directive,[17] and, together with *Cymodocea nodosa*, are strictly protected under Annex II of the Protocol Concerning Specially Protected Areas and Biological Diversity (SPA/BD) of the Barcelona Convention.[38] Both species are protected under the EU *Regulation concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea*, which prohibits the use of towed bottom-contacting fishing gears in areas over seagrass beds.[39] They are also included in the United Nations Environment Programme/ Mediterranean Action Plan (UNEP-MAP) *Action Plan for the conservation of marine vegetation in the Mediterranean Sea*.[40]

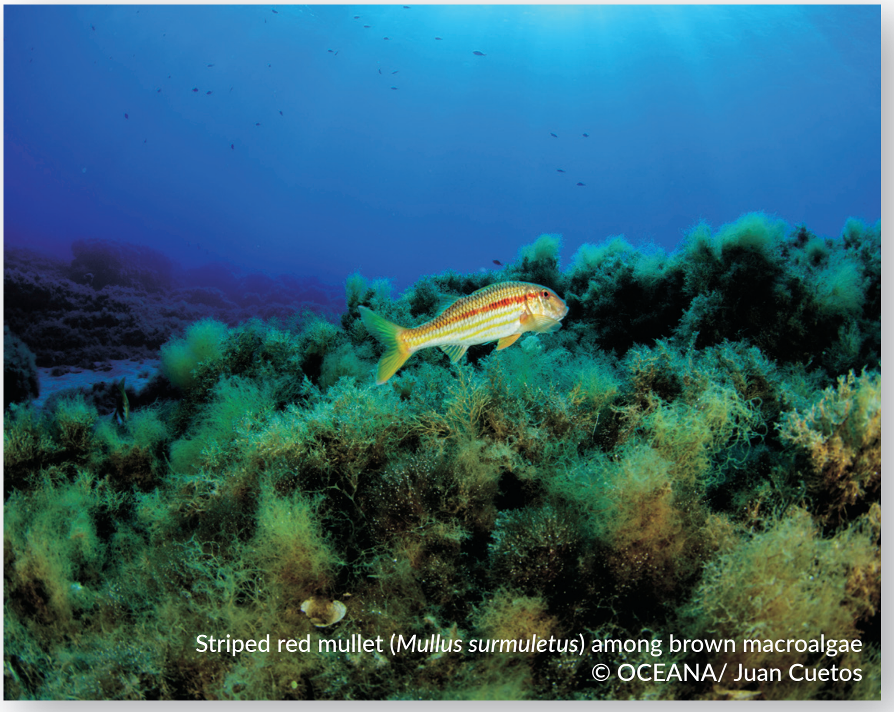
Rocks covered by brown macroalgae on infralittoral and circalittoral bottoms

Depth range: 27 to 59 m

Distribution map: Figure 8

Main associated species:

- *Acetabularia acetabulum*
- *Aglaophenia* spp.
- *Alcyonium acaule*
- *Antedon mediterranea*
- *Anthias anthias*
- *Caulerpa racemose*
- *Chromis chromis*
- *Cladophora* spp.
- *Clavellina delavallei*
- *Cliona celata*
- *Codium bursa*
- *Cystoseira* spp.
- *Dyctiota* spp.
- *Eunicella cavolini*
- *Eunicella singularis*
- *Mullus surmuletus*
- *Padina pavonica*
- *Pentapora fascialis*
- *Reteporella grimaldi*
- *Sabella spallanzanii*
- *Sargassum vulgare*


Striped red mullet (*Mullus surmuletus*) among brown macroalgae © OCEANA/ Juan Cuetos

Description

This habitat type was mainly dominated by brown macroalgae such as *Cystoseira* spp., *Dictyota dichotoma*, *D. fasciola*, *D.* cf. *mediterranea*, *Padina pavonica* and *Sargassum vulgare*, between 27 and 59 m. Some chlorophytes and rhodophytes also occurred, like *Acetabularia acetabulum*, *Cladophora* spp., *Codium bursa* and *Flabelia petiolata*.

These algal forests were commonly mixed with *Caulerpa cylindracea* and, in some areas, also with gorgonian forests of *Eunicella cavolini* and *E. singularis*. This habitat type was also sometimes mixed with the habitat 'Infralittoral rocky bottoms dominated by fauna' and shared some of the characteristic species of that habitat type.

Protection status

Some of the main species that form this habitat are included in the UNEP-MAP *Action Plan for the conservation of marine vegetation in the Mediterranean Sea*.[40]

Cystoseira forests (*C. spinosa* and *C. compressa*) on infralittoral and circalittoral rocky bottoms

Depth range: 21 to 60 m

Distribution map: Figure 8

Main associated species:

- *Aglaophenia pluma*
- *Antedon mediterraneus*
- *Anthias anthias*
- *Arthrocladia villosa*
- *Codium bursa*
- *Coris julis*
- *Dictyota dichotoma*
- *Flabellia petiolate*
- *Mesophyllum* sp.
- *Peyssonnelia* sp.
- *Pinna rudis*
- *Sabella spallanzanii*
- *Sporochnus pedunculatus*
- *Symphodus mediterraneus*
- *Thuridilla hopei*

Cystoseira forest © OCEANA/ Juan Cuetos

Description

Species of genus *Cystoseira*, although representing only part of the brown algae communities on rocky bottoms, are highlighted here, due to their considerable density and abundance, and role in providing habitat in shallow areas of the Aeolians.

They were distributed on rocky bottoms in the infralittoral and circalittoral zones, down to 60 m. This species was commonly found with other phaeophytes (like *Arthrocladia villosa*, *Dictyota dichotoma*, *Sporochnus pedunculatus*), chlorophytes (*Codium bursa*, *Flabellia petiolata*) and rhodophytes (*Mesophyllum* sp., *Peyssonnelia* sp.).

Protection status

Cystoseira spinosa is included in the UNEP-MAP *Action Plan for the conservation of marine vegetation in the Mediterranean Sea.*[40]

Infralittoral and circalittoral bottoms dominated by *Caulerpa cylindracea* beds

Depth range: 30 to 60 m

Distribution map: Figure 8

Main associated species:

- *Coris julis*
- *Echinaster sepositus*
- *Filograna implexa*
- *Halocynthia papillosa*
- *Holothuria poli*
- *Pinna rudis*

Caulerpa cylindracea among other algae and bryozoans © OCEANA

Description

Caulerpa cylindracea is an invasive species that has successfully established itself in many Mediterranean sites. Nowadays it represents one of the typical algal community types found on infralittoral and circalittoral bottoms.

This species was distributed on both hard and soft bottoms and was found either mixed with other macroalgae or as the dominant species, especially on sandy bottoms.

The fauna associated with this habitat type was similar to those listed for the previous habitats. However, a higher frequency of echinoderms (*Echinaster sepositus*, *Holothuria poli*), molluscs (*Pinna rudis*), tunicates (*Halocynthia papillosa*), annelids (*Filograna implexa*), and fish (*Coris julis*) was found in this habitat type.

The bathymetric distribution was predominantly between 30 and 60 m deep, although it also occasionally occurred in deeper waters.

Detritic circalittoral bottoms with macroalgal and seagrass remains and accumulations

Depth range: 41 to 831 m

Distribution map: Figure 8

Main associated species:

- *Arachnanthus sarsi*
- *Aulopus filamentosus*
- *Cerianthus membranceus*
- *Cidaris cidaris*
- *Mullus surmuletus*
- *Parastichopus regalis*
- *Serranus cabrilla*
- *Spatangus purpureus*
- *Raja montagui*

Spotted skate (*Raja montagui*) on sandy bottom with *Posidonia oceanica* leaves © OCEANA

Posidonia oceanica remains © OCEANA

Description

Dead leaves and rhizomes of the seagrass *Posidonia oceanica* and remains of macroalgae such as *Codium bursa* can accumulate on the seabed, forming dense aggregations both in areas where they grow and in deeper waters, reaching deep circalittoral areas. These aggregations were observed to be used as shelter by certain species, such as tube anemones (*Arachnanthus sarsi*, *Cerianthus membranceus*), echinoderms (*Cidaris cidaris*, *Parastichopus regalis*, *Spatangus purpureus*) and fishes (*Aulopus filamentosus*, *Mullus surmuletus*, *Serranus cabrilla*, *Raja montagui*).

Infralittoral sandy bottoms

Depth range: 6 to 38 m

Distribution map: Figure 8

Main associated species:

- *Acromegalomma vesiculosum*
- *Adamsia palliata*
- *Astropecten bispinosus*
- *Calliactis parasitica*
- *Centrostephanus longispinus*
- *Cerianthus membranaceus*
- *Cerithium vulgare*
- *Clibanarius erythropus*
- *Condylactis aurantiaca*
- *Dardanus calidus*
- *Gibbula pennanti*
- *Gobius geniporus*
- *Holothuria tubulosa*
- *Liocarcinus corrugatus*
- *Nereiphylla paretti*
- *Ophioderma longicauda*
- *Pachycerianthus solitarius*
- *Pagurus prideauxi*
- *Paradrepanophorus crassus*
- *Phoronis australis*
- *Pinna nobilis*
- *Sabella pavonina*
- *Synodus saurus*
- *Trachinus radiatus*
- *Venus verrucosa*
- *Xyrichthys novacula*

Pearly razorfish (*Xyrichthys novacula*) on a sandy bottom
© OCEANA/ Juan Cuetos

Description

Many of these sandy-bottom areas occurred close to seagrass meadows, and were commonly found mixed with scattered stones.

Species found associated with this habitat included the crustaceans *Dardanus calidus* and *Pagurus prideauxi* with the anemones *Calliactis parasitica*, and *Adamsia palliata*, respectively, and the cnidarian *Cerianthus membranaceus* with the phoronid *Phoronis australis.*

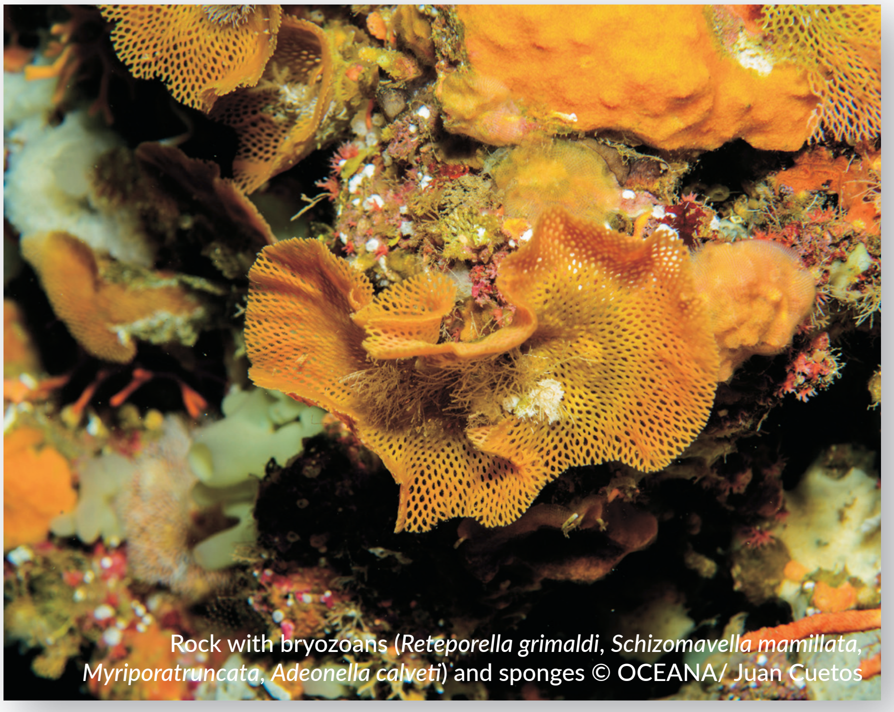
Infralittoral rocky bottoms dominated by fauna

Depth range: 6 to 38 m

Distribution map: Figure 8

Main associated species:

- *Anemonia viridis*
- *Anthopleura ballii*
- *Cellepora pumicosa*
- *Cereus pedunculatus*
- *Clavellina dellavallei*
- *Crambe crambe*
- *Epinephelus costae*
- *Leptofauchea coralligena*
- *Lissoclium perforatum*
- *Lithophyllum cabiochae*
- *Muraena helena*
- *Myriapora truncata*
- *Octopus vulgaris*
- *Peyssonnelia* spp.
- *Polysynchraton lacazei*
- *Protula tubularia*
- *Reptadeonella violacea*
- *Sarcotragus spinulosum*
- *Sepia elegans*
- *Serpulorbis arenarius*
- *Serranus cabrilla*
- *Spirastrella cunctatrix*
- *Spirorbis* sp.
- *Stylochus pilidium*
- *Umbraculum mediterraneum*



Rock with bryozoans (*Reteporella grimaldi*, *Schizomavella mamillata*, *Myriporatruncata*, *Adeonella calveti*) and sponges © OCEANA/ Juan Cuetos

Description

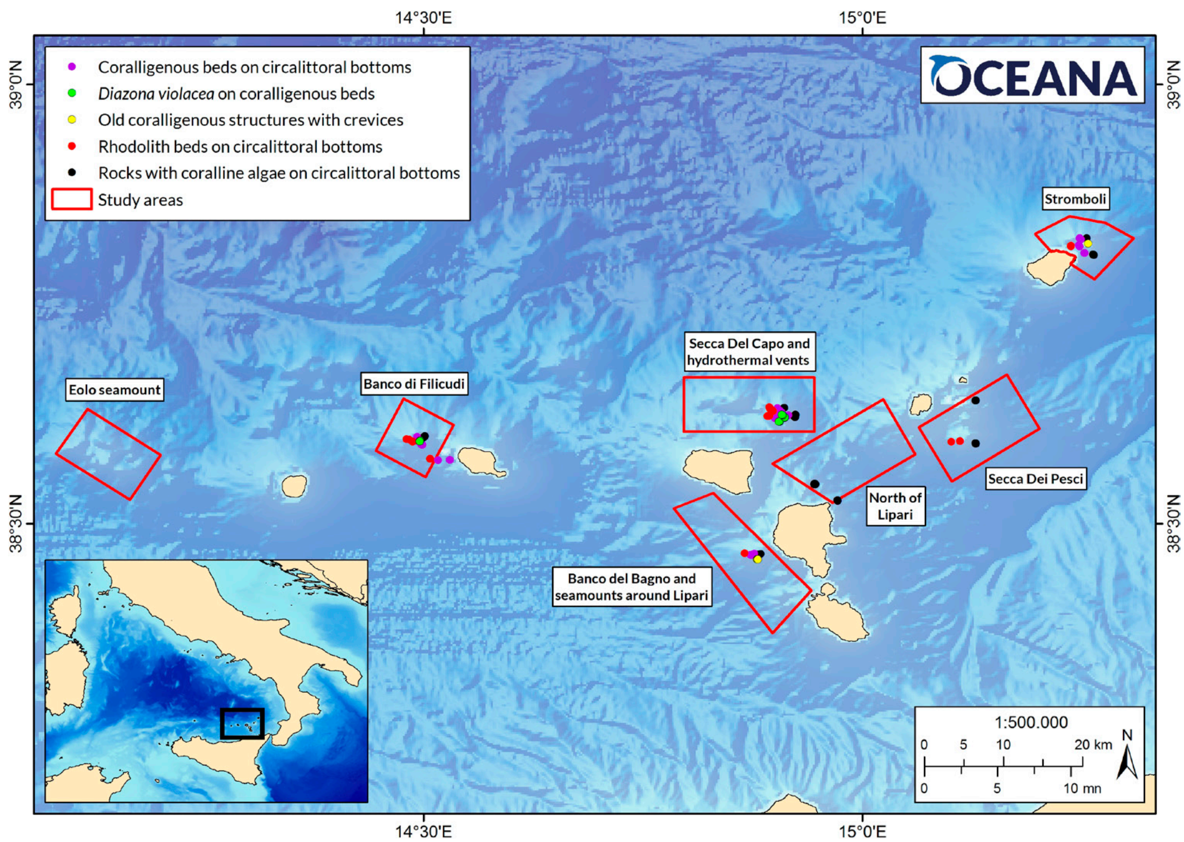
Although most of the infralittoral rocks were covered by macroalgal communities, some rocks were instead dominated by a variety of animal species, especially in steep slope areas. The dominant fauna was composed of a turf of bryozoans and sponges. Other benthic species present included tunicates, echinoderms, crustaceans, molluscs, annelids, cnidarians, platyhelminths, and foraminifera, as well as fishes.

2. Maërl beds and coralligenous habitats

Like the shallow bottoms with macroalgae and seagrasses, maërl beds and other coralline red algae were present in all of the sampling areas in which photosynthetic depths were surveyed (Figure 9). However, the main difference between these two groups of habitat types is that maërl and coralligenous species form calcareous structures and are therefore considered engineering species, which are colonised by other algae and/or invertebrates and sustain a large number of associated species.[41] In particular, rhodolith beds are formed by aggregations of live individuals that are several centimetres thick, spread over layers of dead rhodoliths and broken fragments.[42] These structures are regularly occupied by other invertebrates, and are used by a wide variety of infauna as shelter or nursery areas.[43] Likewise, coralline algae form thick crusts that host a high diversity of fauna in the same way – the thicker the crust, the higher the associated diversity.[44] Dead specimens continue to play a similar role to live ones as long as the structure is preserved, although they support lower levels of associated biodiversity.[45]

Maërl and coralline algae have skeletons composed of calcium carbonate, and actively participate in the carbonate cycle of coastal areas, serving as one of the primary biogenic sources. These species are highly affected by ocean warming and acidification, and very susceptible to mechanical destruction (e.g., through impacts from bottom-contacting fishing gear, which causes abrasion, burial and breakage).[43]

Figure 9. Locations of habitats with maërl beds and coralligenous habitats.



Coralligenous beds on circalittoral bottoms

Depth range: 54 to 137 m

Distribution map: Figure 9

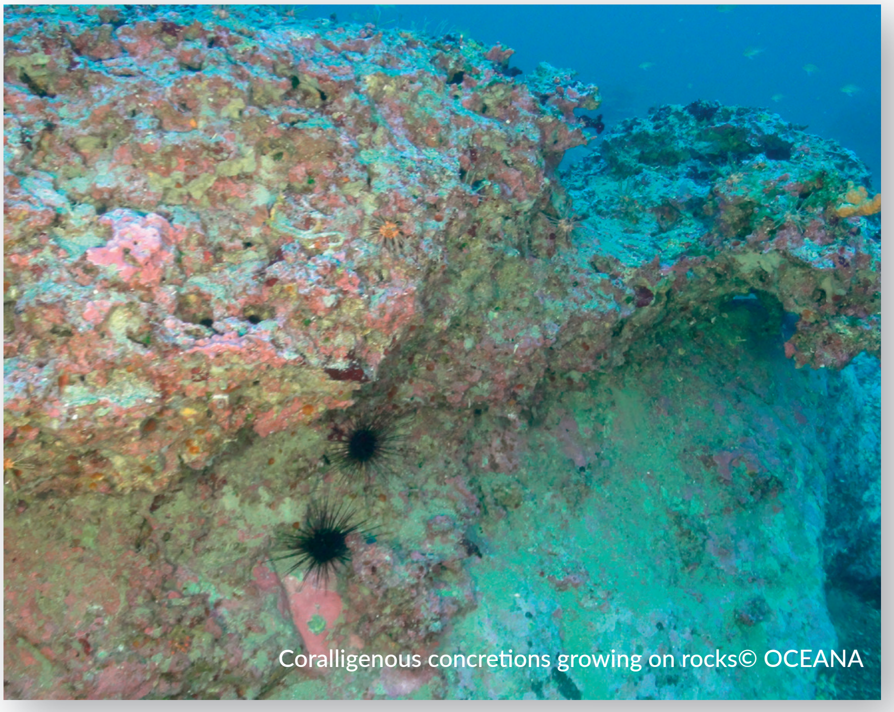
Main species associated with coralligenous beds:

- *Adeonella calveti*
- *Anthias anthias*
- *Caryophyllia smithii*
- *Centrostephanus longispinus*
- *Cidaris cidaris*
- *Clahrina coriacea*
- *Coris julis*
- *Crella pulvinar*
- *Drendrophyllia ramea*
- *Dentiporella sardonica*
- *Holothuria* spp.
- *Leptosamnia pruvoti*
- *Lithophyllum* spp.
- *Mesophyllum alternans*
- *Muraena helena*
- *Myriapora truncata*
- *Peyssonnelia* spp.
- *Pleraplysilla spinifera*
- *Polydora* sp.
- *Serpula vermicularis*
- *Tubularia* spp.

Moray eel (*Muraena helena*) in coralligenous crust © OCEANA

Main species associated with coralligenous concretions:

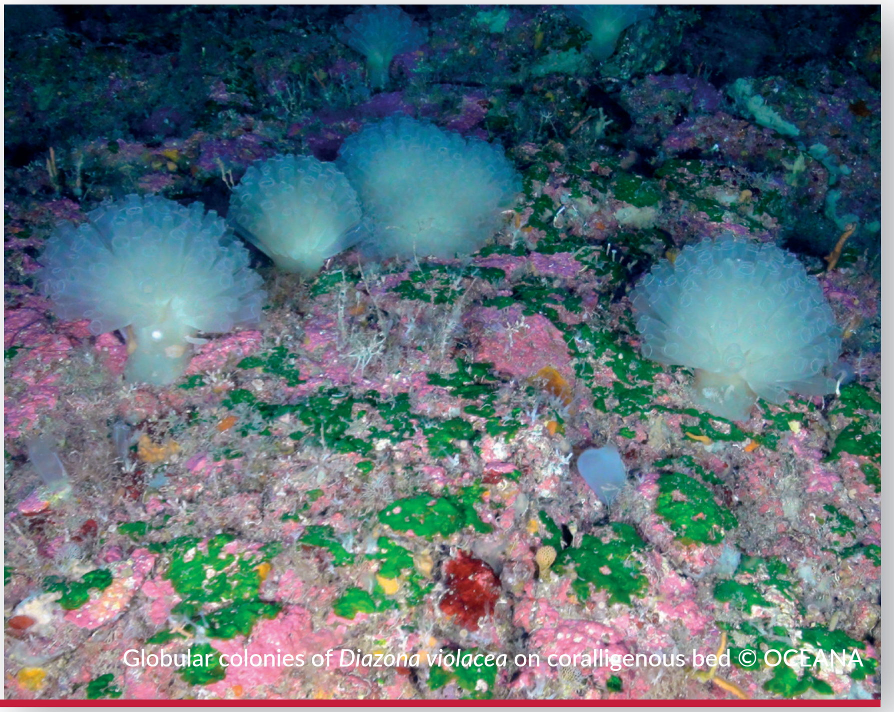
- *Anthias anthias*
- *Bonelia viridis*
- *Caryophyllia inornata*
- *Cidaris cidaris*
- *Crambe crambe*
- *Diazona violacea*
- *Eudendrium* sp.
- *Haliclona mucosa*
- *Muraena helena*
- *Nemertesia* spp.
- *Neopycnodonte cochlear*
- *Omalosecosa ramulosa*
- *Palinurus elephas*
- *Serranus cabrilla*
- *Schizomavella mamillata*
- *Serpula vermicularis*
- *Sphaerechinus granularis*
- *Spirastrella cunctatrix*,
- *Stylocidaris affinis*



Coralligenous concretions growing on rocks© OCEANA

Main species associated with *Diazona violacea* facies:

- *Anthias anthias*
- *Centrostephanus longispinus*
- *Cidaris cidaris*
- *Filograna implexa*
- *Guancha lacunosa*
- *Neopycnodonte cochlear*
- *Palinurus elephas*
- *Reptadeonella violacea*
- *Rhopalaea neapolitana*
- *Schizomavella mamillata*
- *Seranus cabrilla*
- *Serpula vermicularis*
- *Stylcidaris affinis*
- *Ute glabra*



Globular colonies of *Diazona violacea* on coralligenous bed © OCEANA

Description

Coralligenous beds were the richest habitat surveyed in terms of biodiversity, with over 200 associated species including bryozoans, sponges, echinoderms, cnidarians, annelids and fishes. Aggregations were densest between 55 and 115 m deep, but reached depths of around 140 m in some areas. The main coralligenous-forming species was *Mesophyllum alternans*, frequently mixed with other species of the genus *Mesophyllum*, *Lithophyllum* spp., *Peyssonnelia* spp. and *Palmophyllum crassum*.

In some areas, a slightly different coralligenous community was found. The main difference was that it was composed of rocks with some thick crustose coralligenous formations on top, in contrast to the calcareous red algae that formed the coralligenous beds. This habitat was observed to be a transitional one between the coralligenous beds and rocks from the lower circalittoral and upper bathyal (with or without coralline algae). It normally occurred below 80 m depth but was also observed in waters as shallow as 60 m, depending on the penetration of light and the slope of the sea bottom. The main habitat-forming species was again *Mesophyllum alternans*, together with other coralline algae, although the associated species varied.

In some cases, facies of the tunicate *Diazona violacea* had grown to reach such a density, and with such large colonies that they could be considered a separate habitat inside the coralligenous bed communities. Some calcareous sponges, like *Ute glabra* and *Guancha lacunosa* were common among these tunicate colonies.

Protection status

Coralligenous beds are included in the EU *Regulation concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea*, which prohibits the use of towed bottom-contacting fishing gears in areas over coralligenous beds.[39]

They are also covered under the UNEP-MAP *Action Plan for the conservation of the coralligenous and other calcareous bioconcretions in the Mediterranean Sea*.[46] Furthermore, they are encompassed under the definition of reefs (1170) in the EU Habitats Directive.[17]

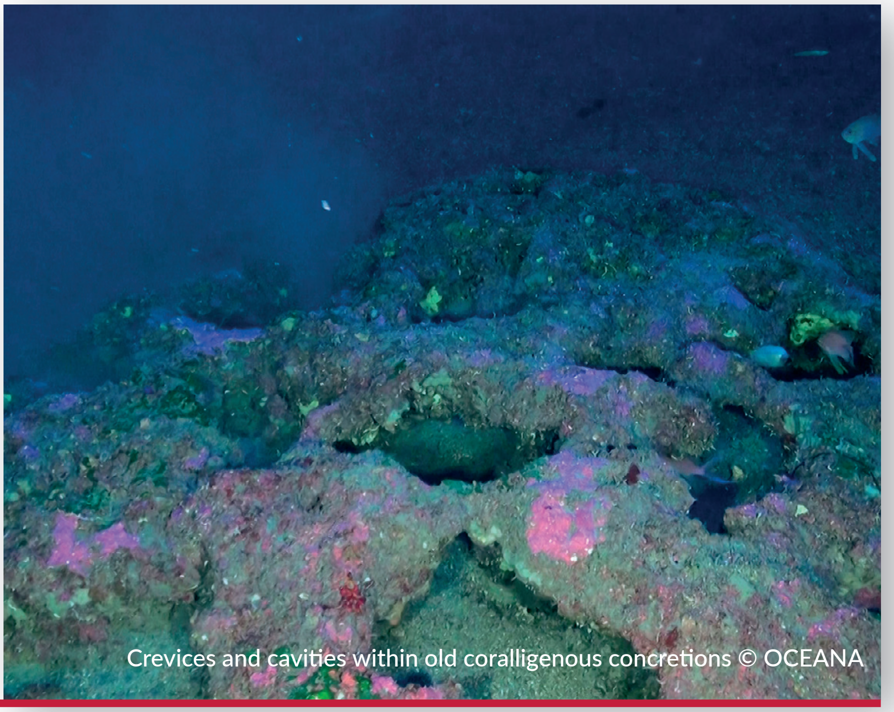
Old coralligenous structures with crevices, cavities and overhangs

Depth range: 101 to 112 m

Distribution map: Figure 9

Main associated species:

- *Anthias anthias*
- *Callanthias ruber*
- *Corallium rubrum*
- *Dendrophyllia ramea*
- *Eunicella verrucosa*
- *Exidmonea atlantica*
- *Hacelia attenuata*
- *Haliclona mucosa*
- *Peltaster placenta*
- *Reteporella* spp.
- *Scorpaena scrofa*



Crevices and cavities within old coralligenous concretions © OCEANA

Description

These structures retained the formations made by old coralligenous beds, with many nooks and crannies, and with few or no living algae. They were found at a depth of approximately 100 m, and extended several metres deeper. Species associated with this habitat type were similar to those found around rocks with coralline algae, with a high abundance of fish among the cavities, like *Anthias anthias*, *Callanthias ruber* and *Scorpaena scrofa*.

Protection status

This habitat is included under the UNEP-MAP *Action Plan for the conservation of the coralligenous and other calcareous bioconcretions in the Mediterranean Sea*.[46]

Rhodolith beds on circalittoral bottoms

Depth range: 55 to 125 m

Distribution map: Figure 9

Main associated species:

- *Acromegalomma vesiculosum*
- *Antedon mediterranea*
- *Anthopleura ballii*
- *Carpomitra costata*
- *Cereus pedunculatus*
- *Cerianthus membranaceus*
- *Charonia lampas*
- *Chelidonichthys lastoviza*
- *Cidaris cidaris*
- *Condylactis aurantiaca*
- *Coris julis*
- *Dictyota dichotoma*
- *Flabellia petiolate*
- *Haliclona fulva*
- *Marthasterias glacialis*
- *Mesophyllum* sp.
- *Lithothamnion* spp.
- *Lithophyllum racemus*
- *Luria lurida*
- *Pagurus* sp.
- *Palmophyllum crissum*
- *Phoronis australis*
- *Pleurobranchaea meckeli*
- *Pyura dura*
- *Sabella* sp.
- *Serpula vermicularis*
- *Spongites fruticosum*
- *Stylocidaris affinis*
- *Trachinus draco*


Rhodolith beds on circalittoral bottom © OCEANA

Description

Beds of these free-living red algae were predominantly composed of *Spongites fruticosum*, mixed with *Lithothamnion* spp., *Lithophyllum racemus*, *Mesophyllum* sp. and *Peyssonelia* sp. In some cases, they were also mixed with green macroalgae, like *Palmophyllum crassum* and *Flabellia petiolata*, or with brown macroalgae, such as *Carpomitra costata* and *Dictyota dichotoma*. Invertebrate species like the echinoid *Stylocidaris affinis* and tube anemone *Cerianthus membranaceus* were very commonly associated with this habitat.

Protection status

Rhodolith beds are included in the EU *Regulation concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea*, which prohibits the use of towed bottom-contacting fishing gears in areas over maërl beds.[39]

They are also included under the UNEP-MAP *Action Plan for the conservation of the coralligenous and other calcareous bioconcretions in the Mediterranean Sea*.[46]

Rocks with coralline algae on circalittoral bottoms

Depth range: 59 to 166 m

Distribution map: Figure 9

Main associated species:

- *Anthias anthias*
- *Alcyonium palmatum*
- *Astropartus mediterraneus*
- *Callanthias ruber*
- *Cellepora pumicosa*
- *Clavularia crassa*
- *Cliona intestinalis*
- *Diazona violacea*
- *Haliclona mucosa*
- *Holothuria forskali*
- *Homola barbata*
- *Lappanella fascialis*
- *Oceanapia* sp.
- *Omalosecosa ramulosa*
- *Palinurus elephas*
- *Paralcyonium spinulosum*
- *Peltaster placenta*
- *Poecillastra compressa*
- *Reteporella grimaldi*
- *Rhopalaea neapolitana*
- *Terebratulina retusa*

Crayfish (*Palinurus elephas*) on a rock with coralline algae and sponges (*Haliclona mucosa*) © OCEANA

Description

These habitats were formed by rocks covered by a thin layer of coralline algae that did not form thick structures as in the previous habitats. This habitat was observed at depths below 85-90 m, and reached as deep as 165 m. The presence of these calcareous algae suggests that the light still penetrated to those depths, but without enough strength to create massive formations.

This and other types of hard-bottom habitats (e.g., rocks with or without coralline algae and coralligenous outcrops) were used by common squid (*Loligo vulgaris*) as a substrate upon which to lay its eggs.

Protection status

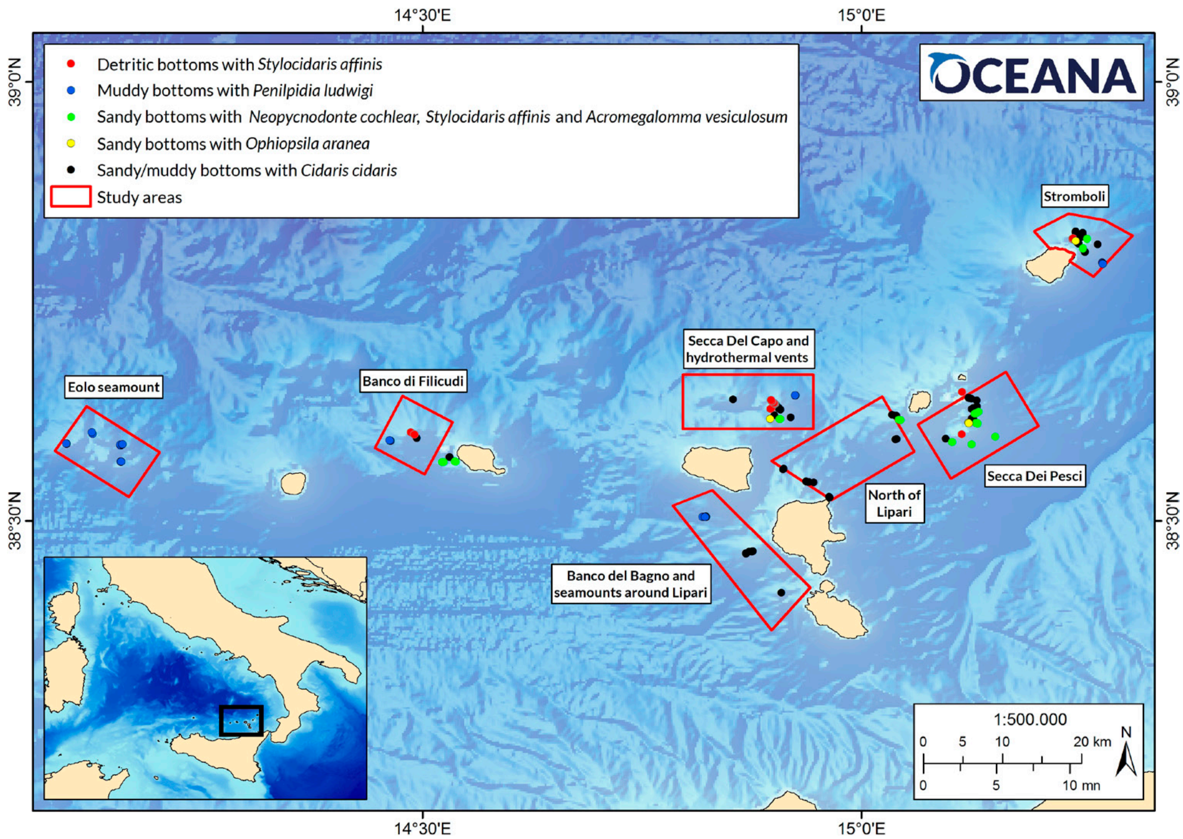
This habitat is included under the UNEP-MAP *Action Plan for the conservation of the coralligenous and other calcareous bioconcretions in the Mediterranean Sea*.[46]

3. Soft bottoms with echinoderms and/or oyster aggregations

Although habitat-forming species are generally sessile, various mobile fauna can also help to structure and add complexity to the sea bottom, thereby providing a very important ecological function. This is the case of some echinoderms that may concentrate in very high numbers to form feeding aggregations; this phenomenon occurs, for example, in some species of crinoids, holothurians and ophiuroids.[47] Sea urchins can also aggregate in large concentrations of individuals, creating mobile habitats and important feeding areas. Their three-dimensional shape allows them to host, on a small scale, other species such as hydroids, sponges, and barnacles.[47] Likewise, bivalves such as deep-sea oyster *Neopycnodonte cochlear* constitute another habitat-forming group of organisms that play an important role, by providing hard substrate on otherwise soft or mixed bottoms.

Mobile fauna such as echinoderms, crinoids, holothurians and ophiuroids can help to structure the sea bottom, providing an important ecological function.

Figure 10. Locations of soft-bottom habitats with echinoderms and/or oyster aggregations.



Detritic circalittoral and upper bathyal bottoms with ceriantharians and *Stylocidaris affinis*

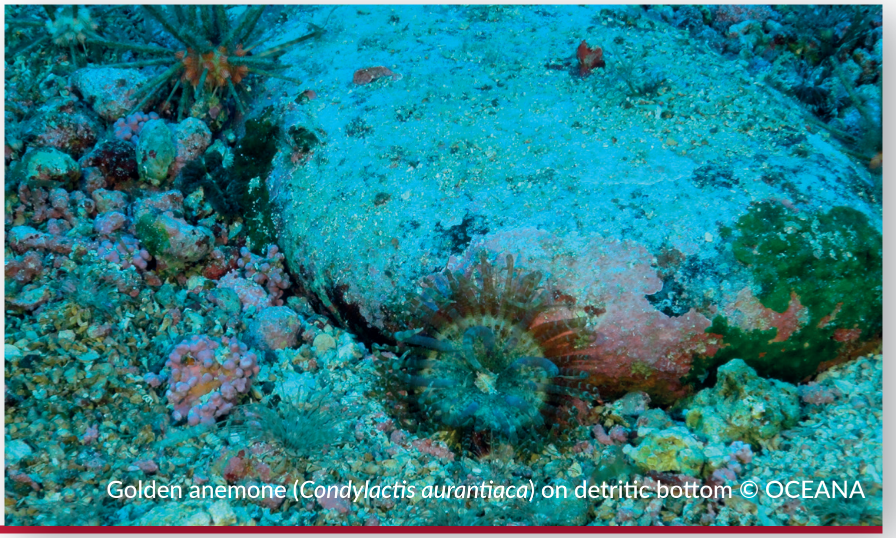
Depth range: 57 to 127 m

Distribution map: Figure 10

Main associated species:

- *Acromegalomma vesiculosum*
- *Ceriantharia* indet.
- *Cerianthus membranaceus*
- *Condylactis aurantiaca*
- *Holothuria forskali*
- *Spongites fruticulosa*

Red lance urchin (*Stylocidaris affinis*) on detritic sand © OCEANA



Golden anemone (*Condylactis aurantiaca*) on detritic bottom © OCEANA

Description

Large areas of detritic bottom, between 57 and 80 m depth (and in some cases down to 127 m), were covered with thousands of sea urchins (*Stylocidaris affinis*) and tube anemones (Ceriantharia indet.), which were clearly the two most common species in this habitat. As on other types of soft bottoms with coarse sediments (e.g., rhodolith beds), other commonly associated species were tube anemone (*Cerianthus membranaceus*), golden anemone (*Condylactis aurantiaca*), sea cucumbers (*Holothuria forskali*), the annelid *Acromegalomma vesiculosum*, and scattered rhodoliths (mainly *Spongites fruticulosa*).

Bathyal muddy bottoms with *Penilpidia ludwigi*

Depth range: 812 to 946 m

Distribution map: Figure 10

Main associated species:

- *Cladorhiza abyssicola*
- *Gadella maraldi*
- *Hymenocephalus italicus*
- *Pelosina arborescens*

Elasipodid sea cucumber (*Penilpidia ludwigi*) © OCEANA

Elasipodid sea cucumbers (*Penilpidia ludwigi*) © OCEANA

Description

These deep-sea holothurians were only found on muddy bottoms deeper than 800 m. This species has also been recorded from other sites in western and eastern Mediterranean waters.[48,49,50,51] Although it had gone unnoticed for many years, it plays a fundamental role for deep bathyal muddy bottoms; *P. ludwigi* aggregations have been associated with increased flow of organic matter, related to seasonal high primary production.[49]

Sandy circalittoral and upper bathyal bottoms with *Neopycnodonte cochlear*, *Stylocidaris affinis* and *Acromegalomma vesiculosum*

Depth range: 65 to 482 m

Distribution map: Figure 10

Main associated species:

- Astrorhizida
- *Adamsia carciniopados*
- *Cerianthus membranaceus*
- *Chelidonichthys cuculus*
- *Cidaris cidaris*
- *Gobius gasteveni*
- *Hyalinoecia tubicola*
- *Luidia ciliaris*
- *Mitrella* sp.
- *Ophiura ophiura*
- *Pagurus prideauxi*
- *Pennatula rubra*
- *Pleurobranchaea meckeli*
- *Pseudamussium clavatum*
- *Pteroeides griseum*
- *Scorpaena porcus*
- *Serpula vermicularis*

Black scorpionfish (*Scorpaena porcus*) among oysters, sea urchins and tube worms © OCEANA

Description

Some areas of sandy/detritic bottoms, occasionally with seagrass remains, were characterised by a mixed community of primarily echinoderms, annelids, and molluscs. Three of the most common species in these communities were the deep-sea oyster (*Neopycnodonte cochlear*), which formed aggregations with scattered but abundant tube worms (*Acromegalomma vesiculosum*) and highly abundant sea urchins (*Stylocidaris affinis*).

The sea urchin *Cidaris cidaris* was also observed, mixed with *Stylocidaris affinis* in shallower areas and then becoming predominant on deeper bottoms. *Neopycnodonte cochlear* was also highly abundant in coralligenous beds.

Circalittoral sandy bottoms with *Ophiopsila aranea*

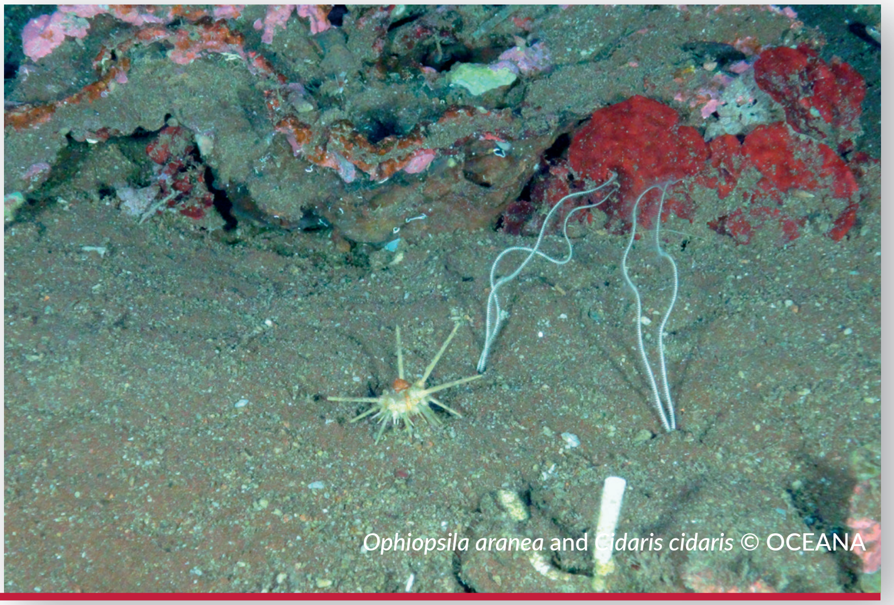
Depth range: 95 to 112 m

Distribution map: Figure 10

Main associated species:

- *Arachnanthus* sp.
- *Bonellia viris*
- *Clavularia crasa*
- *Hyalinoecia tubicola*
- *Pagurus prideauxi*
- *Protula* sp.
- *Serpula vermicularis*

Ophiopsila aranea on sandy bottom beside coralligenous outcrops © OCEANA



Ophiopsila aranea and *Cidaris cidaris* © OCEANA

Description

This community type, which is typical of circalittoral sandy bottoms, was found in a few areas at roughly 100 m depth. It also formed facies in the aforementioned sandy/muddy bottoms with oysters, tube worms and sea urchins, and close to coralligenous outcrops. Therefore, the species associated with this community type are the same as for those two habitat types.

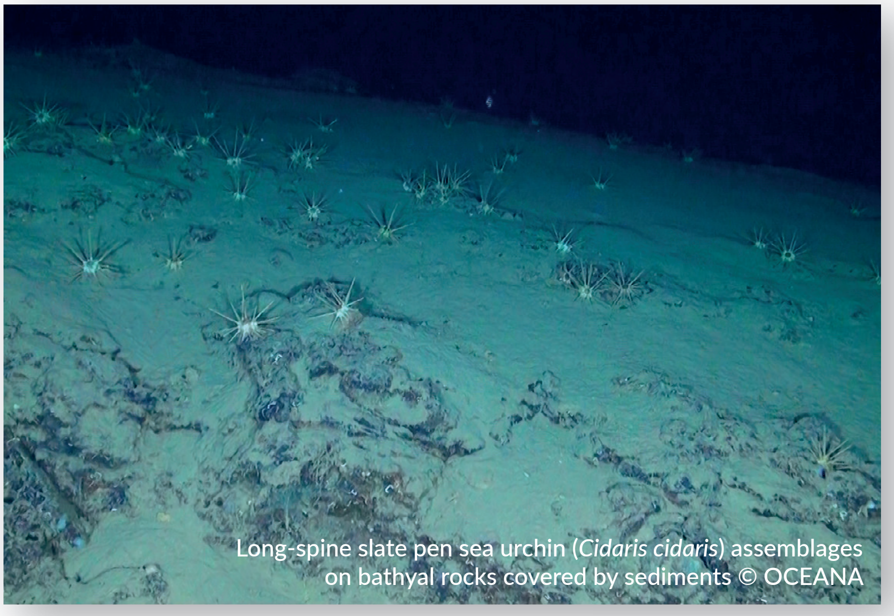
Circalittoral and bathyal bottoms with aggregations of *Cidaris cidaris*

Depth range: 21 to 60 m

Distribution map: Figure 8

Main associated species:

- *Acromegalomma vesiculosum*
- *Aphia minuta*
- Astrorhizida
- *Bebryce mollis*
- *Bonellia viridis*
- *Capros aper*
- *Cerianthus membranaceus*
- *Chelidonochthys* spp.
- *Chlorophthalmus agassizi*
- *Gobius gasteveni*
- *Gryphus vitreus*
- *Helicolenus dactylopterus*
- *Hyalinoecia tubicola*
- Lepadomorpha indet.
- *Macroramphosus scolopax*
- *Neopycnodonte cochlear*
- *Pachastrella monilifera*
- *Serpula vermicularis*
- Zoanthidae indet.



Long-spine slate pen sea urchin (*Cidaris cidaris*) assemblages on bathyal rocks covered by sediments © OCEANA

Tube worms and cirripeds growing on sea urchin spines © OCEANA

Description

Some echinoderms can structure the communities on the seabed, both due to their abundance and the fact that they provide substrate for other species. *Cidaris cidaris* was one of the most common species on the Aeolian seabed, both in rocky and sandy/muddy areas, with a wide bathymetric distribution. It was found between 59 and 427 m depth, although it was more abundant in the transition area between the circalittoral and the bathyal zones.

C. cidaris has been described to form large aggregations and act as a 'mobile habitat', as its long spines can serve as substrate and shelter for other species such as hydroids, crustaceans and zoanthids.[47]

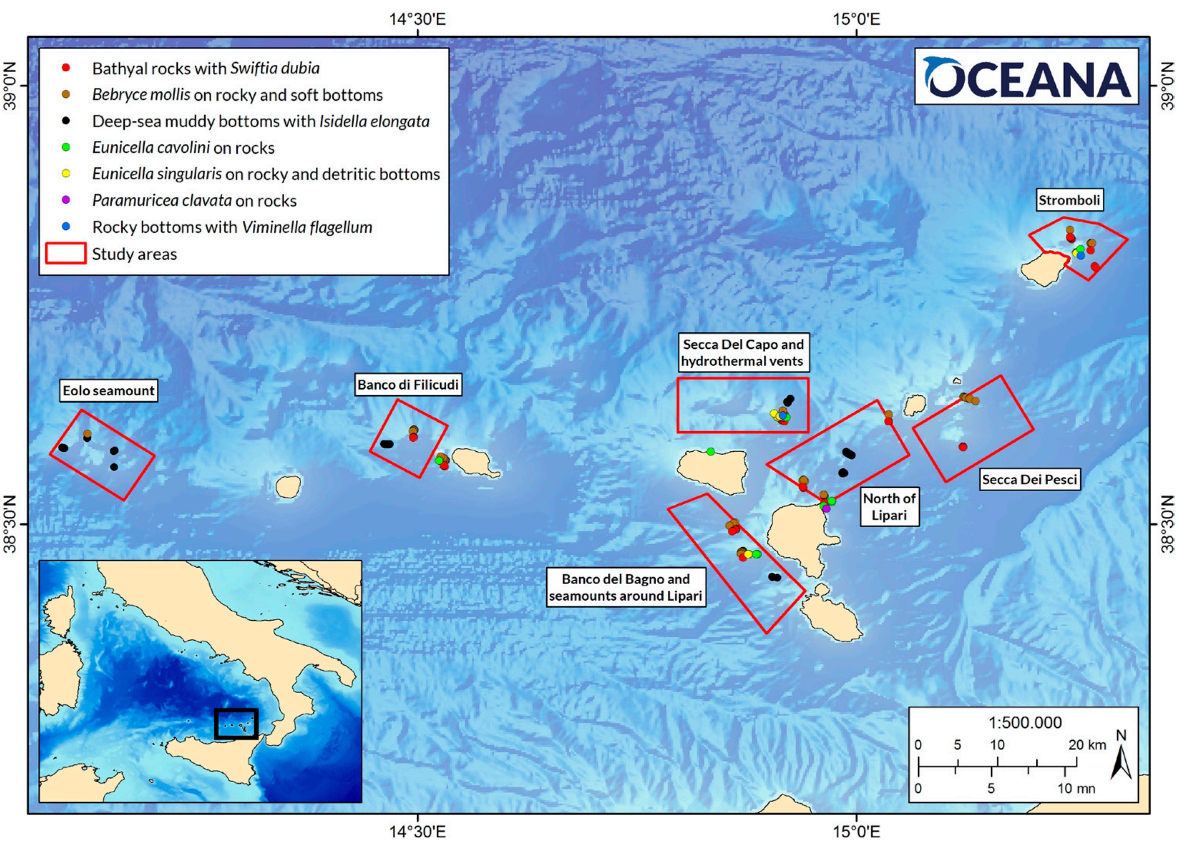
4. Gorgonian gardens on rocky and muddy bottoms

Gorgonians gardens are widely distributed across the Mediterranean, dominated by different species according to multiple physical and oceanic factors such as bathymetric range and bottom type.[52] In the Aeolians, various species were found to predominate and create gardens, ranging from gorgonians belonging to the genus *Eunicella* on the shallower, rocky bottoms of Banco di Filicudi, Banco del Bagno, Secca del Capo, North of Lipari and Stromboli, to the Critically Endangered bamboo coral *Isidella elongata*,[53] which formed dense aggregations on soft, bathyal bottoms to the north of Lipari.

With increasing depth and light attenuation, in some areas gorgonian gardens replace macroalgal or seagrass aggregations and become the main three-dimensional features that rise from the seabed, and therefore play an important ecological role.[54] As with macroalgae and seagrasses, gorgonians support high levels of biodiversity because they form complex structures that provide suitable habitat and substrate for other organisms, as well as shelter and nursery areas.[54]

Gorgonian exoskeletons are composed of calcium carbonate, and so they are very fragile. Anthropogenic activities such as trawling and longline fishing represent significant threats to gorgonians, as does climate change.[54]

Figure 11. Locations of habitats formed by gorgonian gardens on rocky and muddy bottoms.



Bathyal rocks with *Swiftia dubia*

Depth range: 120 to 786 m

Distribution map: Figure 11

Main associated species:

- *Aaptos aaptos*
- *Bebryce mollis*
- *Callanthias ruber*
- *Corella parallelogramma*
- *Dendrophyllia cornigera*
- *Nidalia studeri*
- *Peltaster placenta*
- *Plesionika gigliolii*
- *Reteporella* sp.
- *Stenocyathus vermiformis*

Sea fans (*Swiftia dubia*) on a rock covered by sediments © OCEANA

Description

Swiftia dubia occupied a similar niche to *Bebryce mollis*, but unlike that sea fan species, *S. dubia* is not adapted to high levels of sedimentation. It occurred mainly between 120 and 250 m deep, but was also found in much deeper waters, with some colonies below depths of 700 m.

The habitat formed by *S. dubia* was sometimes combined with *Dendrophyllia cornigera* and *Bebryce mollis*, and with other cnidarians, like *Nidalia studeri* and *Stenocyathus vermiformis*.

Protection status

Swiftia dubia forests are included within the scope of the UNEP-MAP *Action Plan for the conservation of habitats and species associated with seamounts, underwater caves and canyons, aphotic hard beds and chemo-synthetic phenomena in the Mediterranean Sea* (*Dark Habitats Action Plan*).[55]

Bebryce mollis on rocky and soft circalittoral and bathyal bottoms

Depth range: 137 to 793 m

Distribution map: Figure 11

Main associated species:

- *Amphianthus dohrnii*
- *Anthias anthias*
- *Callanthias ruber*
- *Chironephthya mediterranea*
- *Dendrophyllia cornigera*
- *Muriceides lepida*
- *Nidalia studeri*
- *Peltaster placenta*
- *Swiftia dubia*
- *Villogorgia bebrycoides*


Tritoniidae nudibrach among *Bebryce mollis* colonies © OCEANA

Description

This small gorgonian created dense facies on the vertical parts of rocks or on bathyal coarse sediments. Large numbers of the small anemone *Amphianthus dohrnii* were usually associated with this species. *Bebryce mollis* was found in association with other corals and gorgonians that share hard sediment preferences and sometimes proliferate and create their own specific communities, like *Dendrophyllia cornigera* or *Swiftia dubia*. Other cnidarians also comprised part of this habitat and sometimes created patches (although never proliferating enough to be considered a habitat themselves). These species were *Chironephthya mediterranea*, *Muriceides lepida*, *Nidalia studeri* and *Villogorgia bebrycoides*.

Communities of *B. mollis* were also found on soft sediments, normally on coarse beds and rocks that were highly affected by sedimentation on circalittoral and bathyal bottoms. This observation suggested that the species exhibited some tolerance of sedimentation. In such cases, the habitat that it formed was slightly different to the one on rocks, with lower associated biodiversity, as is common in more extreme environments.

Other common species found among these colonies were the sea star *Peltaster placenta* and the fishes *Anthias anthias* and *Callanthias ruber*. Although those two species could co-occur, *A. anthias* was more common in the circalittoral zone, and *C. ruber* in the bathyal zone.

Protection status

Bebryce mollis forests are included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

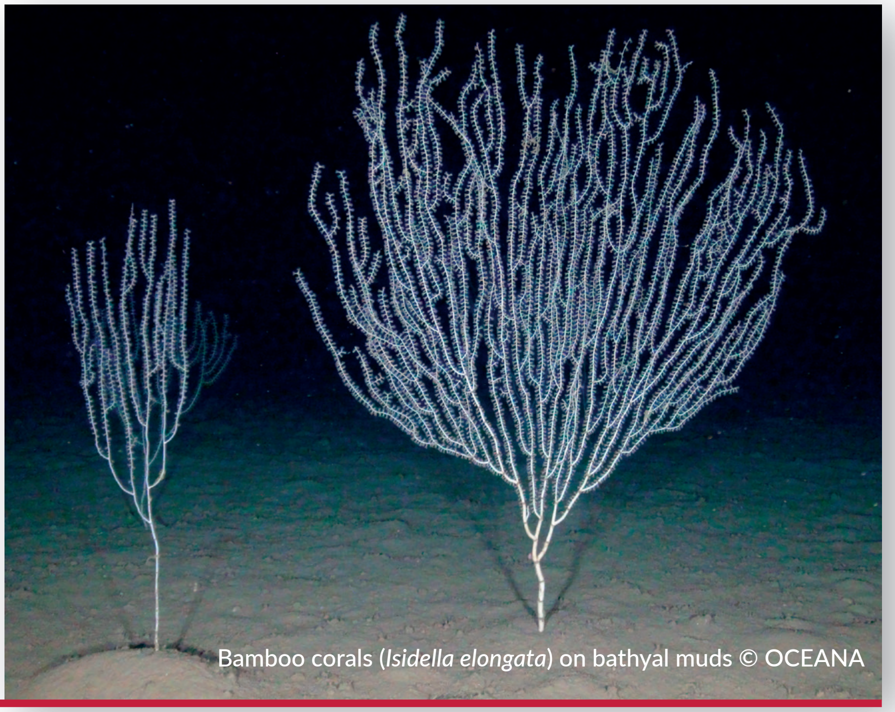
Deep-sea bathyal muddy bottoms with *Isidella elongata*

Depth range: 280 to 921 m

Distribution map: Figure 11

Main associated species:

- *Anamathia rissoana*
- *Boreomysis arcticus*
- *Nezumia sclerorhynchus*
- *Periclimenes* sp.
- *Polyacanthonotus rissoanus*



Bamboo corals (*Isidella elongata*) on bathyal muds © OCEANA

Description

Isidella elongata was found in different deep-sea muddy-bottom areas of the Aeolian Islands. The densest communities were found in a flat area approximately 800 to 850 m deep, to the northeast of Lipari. There, bamboo corals created a dense forest of more than 2000 colonies per hectare. This estimate suggests a very high density, close to that of the densest bamboo coral forest ever found in the Mediterranean Sea, in the Balearic Islands.[50]

These habitats were strongly associated with crustaceans and benthic fishes. The most common species found among these forests were the crustaceans *Anamathia rissoana*, *Boreomysis arcticus*, and *Periclimenes* sp.; an unidentified crinoid, some small anemones and several fishes, like *Conger conger*, *Nezumia sclerorhynchus* and *Polyacanthonotus rissoanus*.

Protection status

Bamboo coral is strictly protected under Annex II of the Protocol Concerning Specially Protected Areas and Biological Diversity (SPA/BD) of the Barcelona Convention.[38]

It is considered to represent a VME indicator species[56] and provides essential fish habitat (EFH) for some commercial crustaceans, like *Nephrops norvegicus*[57]. This species is Red Listed by IUCN as Critically Endangered,[53] and is particularly threatened by bottom fishing activities, pollution, and increased sedimentation from land-based activities.[53]

It is also included under the UNEP-MAP *Dark Habitats Action Plan*,[58] and encompassed under the definition of reefs (1170) in the EU Habitats Directive.[17]

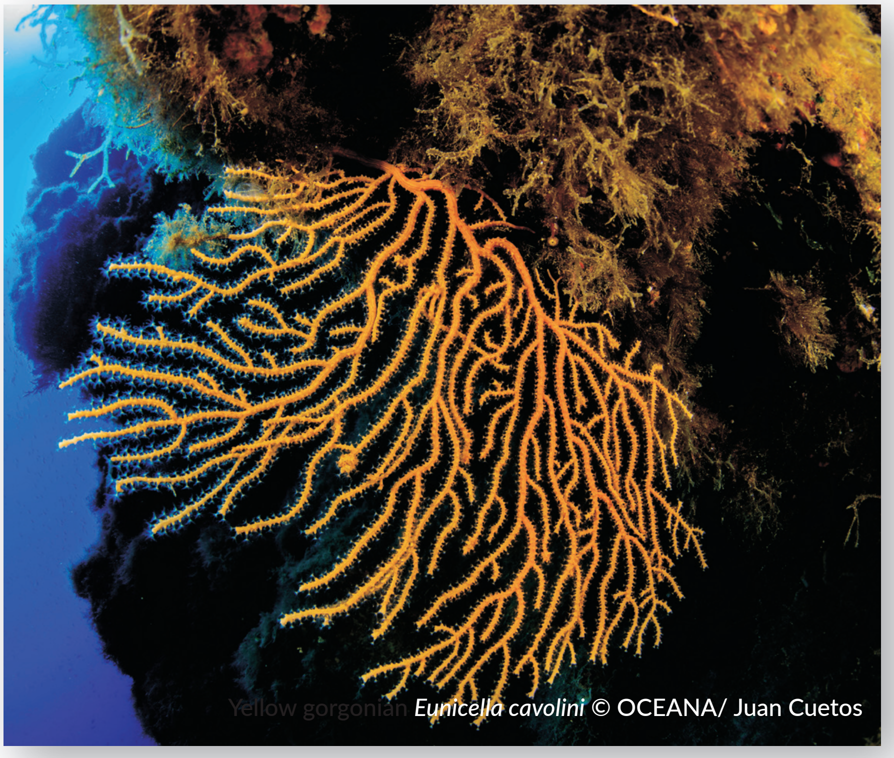
Eunicella cavolini on rocky infralittoral and circalittoral bottoms

Depth range: 31 to 96 m

Distribution map: Figure 11

Main associated species:

- *Agelas oroides*
- *Alcyonium coralloides*
- *Clavellina dellavallei*
- *Echinaster sepositus*
- *Dictyota* spp.
- *Flabellia petiolata*
- *Hacelia attenuata*
- *Holothuria forskali*
- *Holothuria poli*
- *Leptosamnia pruvoti*
- *Padina pavonica*
- *Pentapora fascialis*
- *Peyssonnelia rubra*
- *Polysynchraton* sp.
- *Reteporella grimaldi*



Yellow gorgonian *Eunicella cavolini* © OCEANA/ Juan Cuetos

Eunicella cavolini garden © OCEANA

Description

Communities with this gorgonian were found on rocky bottoms and on vertical rocks of the lower infralittoral and circalittoral zones.

Eunicella cavolini was observed in mixed communities with *E. singularis* on flat rocky bottoms in the deep infralittoral and circalittoral zones, and also in combination with some rocky bottom communities.

Eunicella singularis on rocky and detritic infralittoral and circalittoral bottoms

Depth range: 38 to 75 m

Distribution map: Figure 11

Main associated species:

- *Anthedon mediterranea*
- *Anthias anthias*
- *Caulerpa cylindracea*
- *Cliona viridis*
- *Dyctiota dichotoma*
- *Filograna implexa*
- *Flabellina petiolata*
- *Halopteris filicina*
- *Mesophyllum alternatus*
- *Sabella* spp.
- *Serranus cabrilla*
- *Spicara flexuosa*

White gorgonian (*Eunicella singularis*) © OCEANA

White gorgonian (*Eunicella singularis*) © OCEANA

Description

Communities characterised by this gorgonian were recorded on rocky and detritic bottoms in the lower infralittoral and upper circalittoral zones. As noted above, this species formed mixed forests together with *Eunicella cavolini*. It was also observed to occur in combination with brown macroalgal forests, and with typical communities from both sandy and rocky bottoms.

Protection status

Eunicella singularis forests are encompassed under the definition of reefs (1170) in the EU Habitats Directive.[17]

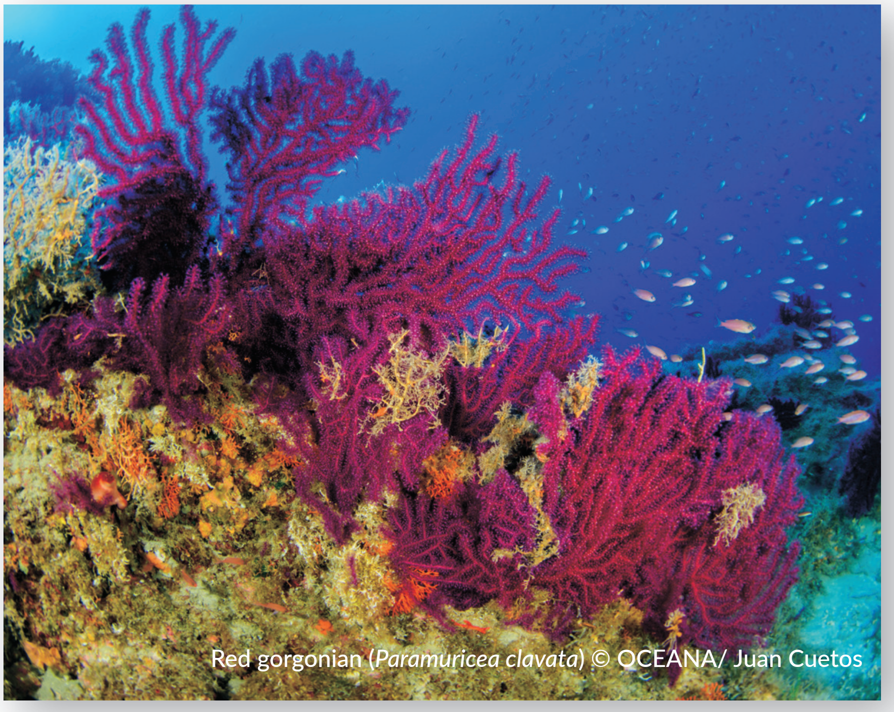
Paramuricea clavata on rocky infralittoral and circalittoral bottoms

Depth range: 31 to 38 m

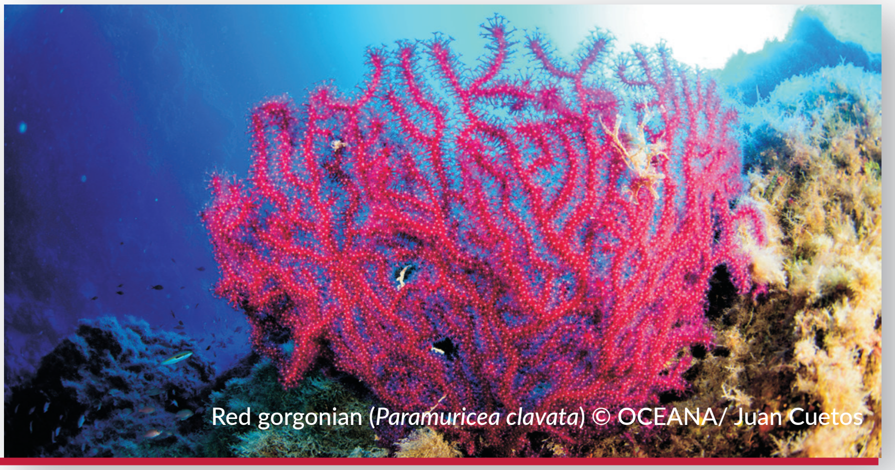
Distribution map: Figure 11

Main associated species:

- *Adeonella calveti*
- *Anthias anthias*
- *Chromis chromis*
- *Dentiporella sardonica*
- *Didemnum commune*
- *Dyctiota* sp.
- *Leptosamnia pruvoti*
- *Filograna implexa*
- *Halocynthia papillosa*
- *Schizomavela mamillata*
- *Smittina cervicornis*
- *Reteporella grimaldi*



Red gorgonian (*Paramuricea clavata*) © OCEANA/ Juan Cuetos



Red gorgonian (*Paramuricea clavata*) © OCEANA/ Juan Cuetos

Description

Habitats formed by this gorgonian were documented from deep infralittoral waters in one location in the North of Lipari survey area. Some isolated colonies were also recorded in the circalittoral zone, normally associated with coralligenous beds.

In some cases, *P. clavata* was found to be mixed with *Eunicella cavolini*. Like communities formed by that species, *P. clavata* only colonises rocky bottoms, and therefore could only mix with communities associated with that substrate.

Protection status

Paramuricea clavata forests are encompassed under the definition of reefs (1170) in the EU Habitats Directive.[17]

Deep circalittoral and upper bathyal rocky bottoms with *Viminella flagellum*

Depth range: 117 to 148 m

Distribution map: Figure 11

Main associated species:

- *Anthias anthias*
- *Aulopus filamentosus*
- *Caryophyllia* sp.
- *Filograna implexa*
- *Haliclona mucosa*

Whip-like gorgonian (*Viminella flagellum*) © OCEANA

Description

Dense forests of this whip coral were found at the edge of rocky-bottom areas in the deep circalittoral zone. Reflecting their transitional position, they were sometimes observed to be mixed with shallower circalittoral species, like *Eunicella* sp., or with other more bathyal gorgonian species, like *Callogorgia verticillata*.

Protection status

Viminella flagellum forests are encompassed under the definition of reefs (1170) in the EU Habitats Directive[17] and included under the UNEP-MAP *Dark Habitats Action Plan*.[59]

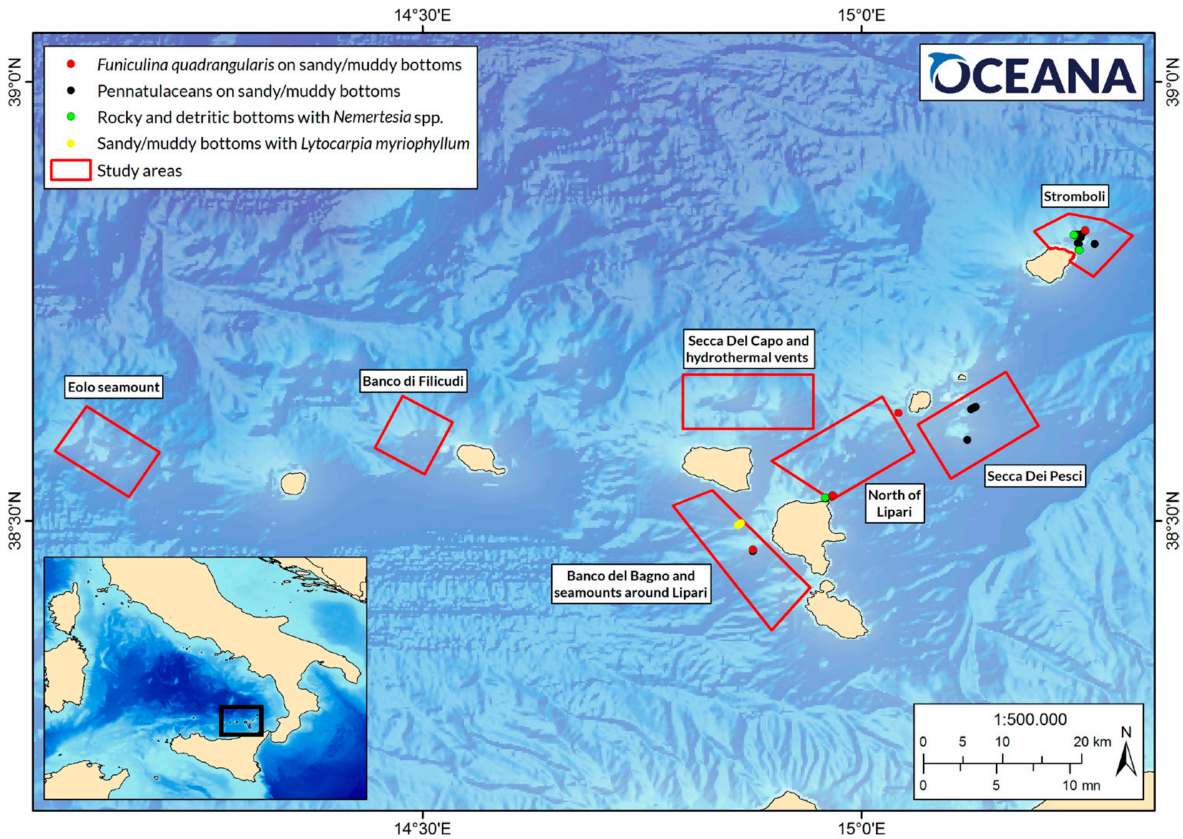
5. Sea bottoms with sea pens and hydrozoans

Sea pens and hydrozoans were found in four of the study areas (Banco del Bagno, North of Lipari, Secca dei Pesci and Stromboli) (Figure 12).

Sea pens belong to the order Pennatulacea and, by definition, are considered to be cold-water corals.[59] They are generally found on soft bottoms[60] and can form dense meadows, reaching 0.1 m - 2 m above the surface of the sediment. As such, sea pens create important habitats for other organisms, including commercial fishes, and serve as a nursery habitat.[60,61] Species associated with sea pen communities include various shrimp and ophiuroids.[60] These corals are extremely vulnerable to bottom-contacting fishing gear, which can damage or completely remove colonies from the seabed.

Hydrozoans also create three-dimensional gardens – comparable to those formed by gorgonians – that enhance habitat complexity and thereby increase biodiversity;[61] they are also considered to serve as essential fish habitat.[62] They are fragile organisms that are subject to direct and indirect anthropogenic impacts, such as from bottom fishing activities and climate change, respectively.[62]

Figure 12. Locations of habitats formed by sea pens and hydrozoans.



Funiculina quadrangularis on deep circalittoral and upper bathyal sandy/muddy bottoms

Depth range: 55 to 159 m

Distribution map: Figure 12

Main species associated with *Funiculina quadrangularis* communities:

- *Aphia minuta*
- *Chelidonichthys cuculus*
- *Cidaris cidaris*
- *Lesueurigobius* sp.
- *Neopycnodonte cochlear*
- *Trachurus picturatus*

Main species associated with other pennatulacean communities:

- *Anomoura* indet.
- *Ceriantharia* indet.
- *Cidaris cidaris*
- *Chelidonichthys cuculus*
- *Funiculina quadrangularis*
- *Pennatula rubra*
- *Pteroeides* spp.
- *Serranus hepatus*
- *Stylocidaris affinis*
- *Trachinus draco*
- *Veretillum cynomorium*
- *Virgularia mirabilis*

Tall sea pens (*Funiculina quadrangularis*) © OCEANA

Red sea pen (*Pennatula rubra*) with oysters and tube worms © OCEANA

Description

Communities with tall sea pen (*Funiculina quadrangularis*) were found on soft bottoms, typically either with sand or a mixture of sand and mud. Tall sea pens found in the Aeolians were in the sandy/muddy deep circalittoral bottoms close to rocks.

Other common sea pen species found on similar bottoms were *Virgularia mirabilis*, *Pennatula rubra*, *Pteroeides* spp. and *Veretillum cynomorium*; they were recorded from sandy and detritic bottoms at depths of between 100 and 159 m.

These species occurred in areas where they were mixed with bottoms with bioturbations and with bottoms dominated by oysters, polychaetes and sea urchins, or with those of free-living scleractinians or ceriantharians and hermit crabs.

Protection status

Sea pen beds are included under the UNEP-MAP *Dark Habitats Action Plan*.[59]

Deep circalittoral and upper bathyal rocky and detritic bottoms with *Nemertesia* spp.

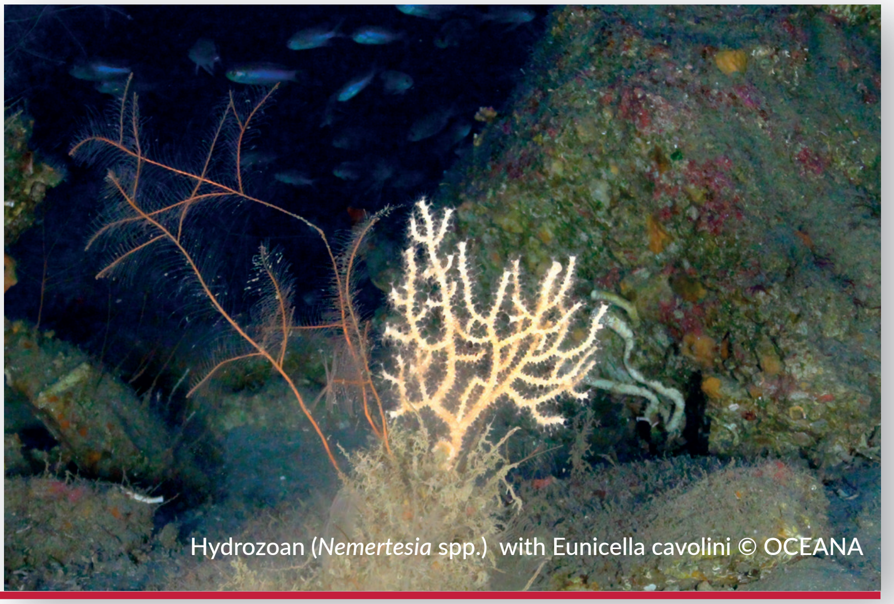
Depth range: 52 to 137 m

Distribution map: Figure 12

Main associated species:

- *Bonellia viridis*
- *Eunicella cavolini*
- *Holothuria tubulosa*
- *Hornera frondiculata*
- *Serranus cabrilla*

Hydrozoan (*Nemertesia* spp.) between hard and soft bottoms © OCEANA



Hydrozoan (*Nemertesia* spp.) with Eunicella cavolini © OCEANA

Description

Several species belonging to the genus *Nemertesia* were found in abundant numbers on rocky and soft bottoms. *N. ramosa* was observed to form very large colonies on soft bottoms and to create dense forests on circalittoral bottoms, as has been previously documented in the Columbretes Islands (Spain) [63] and from some Atlantic locations.[63]

Bathyal sandy/muddy bottoms with *Lytocarpia myriophyllum*

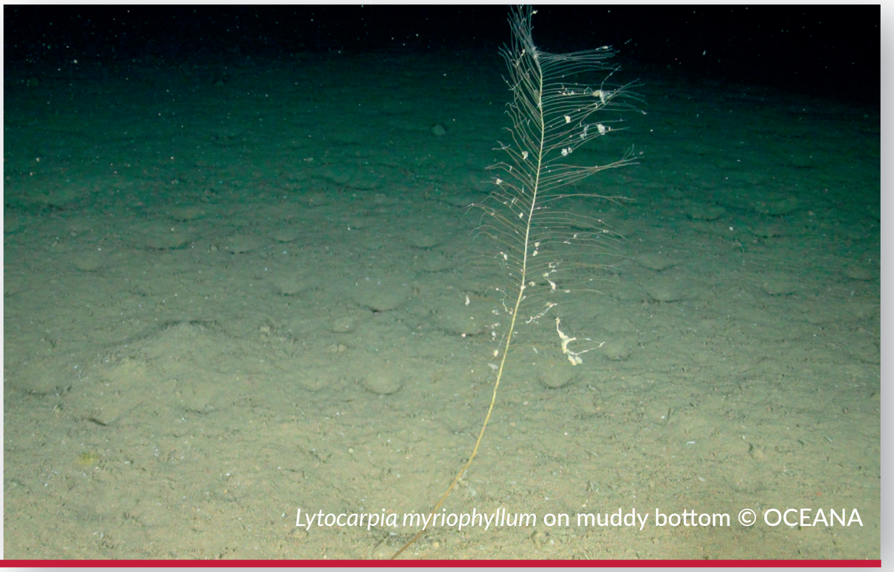
Depth range: 196 to 212 m

Distribution map: Figure 12

Main associated species:

- *Arnoglossus rueppelii*
- *Capros aper*
- *Latreillia elegans*
- *Myxicola infundibulum*
- *Parastichopus regalis*
- *Pelosina arborescens*
- *Ranella olearium*

Elegant spider crab (*Latreillia elegans*) on the hydrozoan *Lytocarpia myriophyllum* © OCEANA



Lytocarpia myriophyllum on muddy bottom © OCEANA

Description

This community type was only found in one location, at approximately 200 m deep.

The small crustacean *Latreillia elegans* was observed climbing on branches of the hydrozoan *Lytocarpia myriophyllum*. This community has been found in other Mediterranean sites, and has been proposed for conservation strategies,[64] because *L. myriophyllum* is considered to be an engineering species.

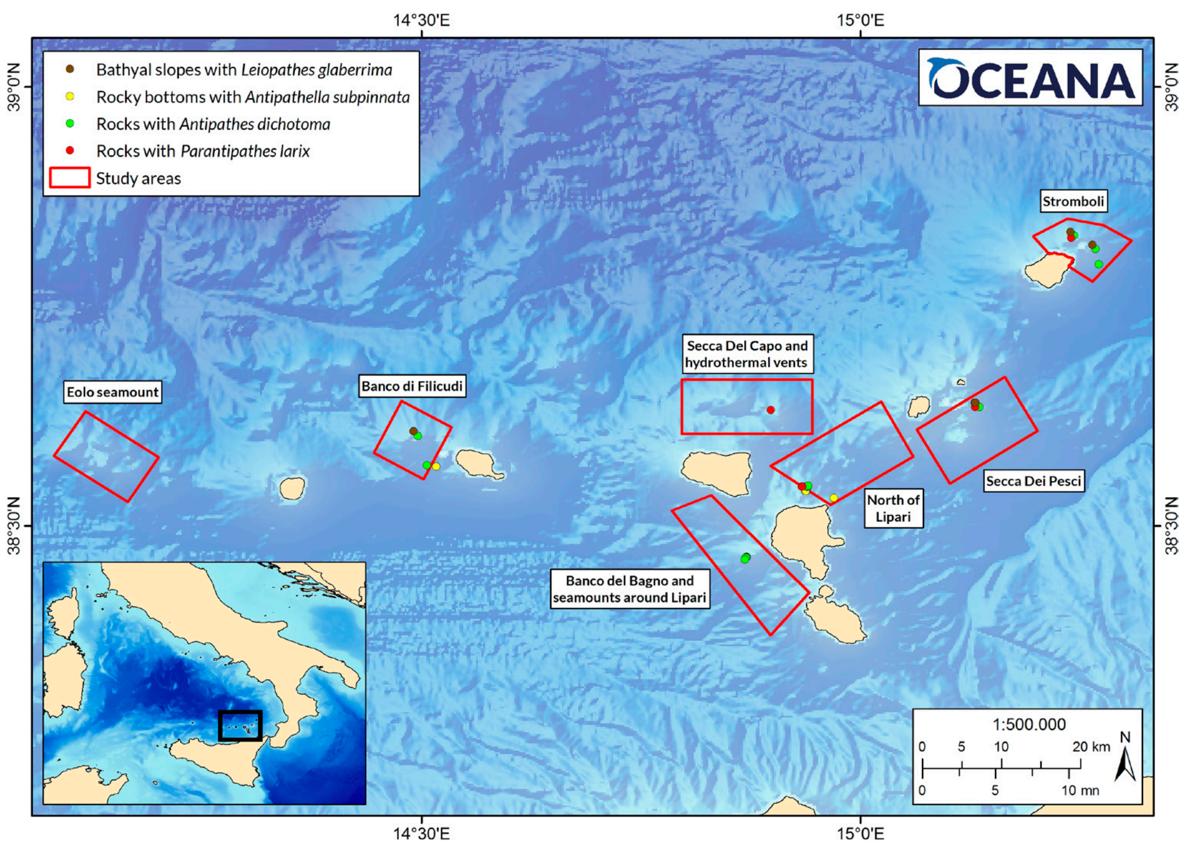
6. Rocky bottoms with black corals

Black corals were found in all of the survey areas, with the exception of the Eolo seamount (Figure 13). They are considered engineering species, and form forest-like aggregations across a wide depth range; during this expedition they were recorded from 74 m to 696 m depth, although they have been reported from down to 8500 m depth.[65] They are long-lived, fragile organisms that are commonly present in coral and gorgonian gardens, and create complex three-dimensional habitats hosting a multitude of organisms. They are considered to be VMEs;[66] black corals, and therefore the habitats that they help create, are slow-growing and considered to be vulnerable to the impacts of fishing, such as from bottom longlining.[53]

Six species of black corals have been described from the Mediterranean, belonging to four genera (i.e., *Antipathella*, *Antipathes*, *Leiopathes* and *Parantipathes*). All four species known to be more widespread in the Mediterranean were documented during the Aeolian expedition, some of them seriously impacted by lost fishing lines.

Black corals are long-lived and fragile, and create complex three-dimensional habitats, hosting a multitude of organisms.

Figure 13. Locations of habitats formed by black corals on rocky bottoms.



Deep circalittoral and upper bathyal rocky bottoms with *Antipathella subpinnata*

Depth range: 74 to 612 m

Distribution map: Figure 13

Main associated species:

- *Aglaophenia* sp.
- *Anthias anthias*
- *Astropartus mediterraneus*
- *Axinella* sp.
- *Cidaris cidaris*
- *Clavularia crassa*
- *Corallium rubrum*
- *Filograna implexa*
- *Hacelia attenuata*
- *Haliclona mediterranea*
- *Haliclona mucosa*
- *Lappanella fasciata*
- *Myriapora truncata*
- *Omalosecosa ramulosa*
- *Palmophyllum crassum*
- *Pteria hirundo*
- *Schizomavella mamillata*
- *Serranus cabrilla*
- *Zeus faber*

John Dory (*Zeus faber*), shark eggcases, and epibionts in black coral (*Antipathella subpinnata*) forest © OCEANA

Description

This black coral was found in lower circalittoral areas, where it created dense forests between rocks with coralline algae and rocky bottoms without algae. Only one colony was found in the bathyal zone, at more than 600 metres depth.

This habitat type was found mixed with communities of sponges (*Haliclona mucosa*) and coralline algae on rocks.

Forests of *A. subpinnata* serve as essential fish habitat for sharks such as *Scyliorhinus canicula*, which lays its eggs in the branches of this coral. Those parts of the coral that are damaged or without polyps are rapidly colonised by other organisms; such species observed included the polychaete *Filograna implexa*, hydrozoans, and the oyster *Pteria hirundo*.

Protection status

This species is strictly protected under Annex II of the SPA/BD Protocol of the Barcelona Convention,[38] and is particularly threatened by bottom fishing activities, pollution, and increased sedimentation from land-based activities. It is also included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

Bathyal rocks with *Parantipathes larix*

Depth range: 129 to 349 m

Distribution map: Figure 13

Main associated species:

- *Anthias anthias*
- *Antipathes dichotoma*
- *Aulopus filamentosus*
- *Bebryce mollis*
- *Callathias ruber*
- *Caryophyllia* sp.
- *Chironephthya mediterranea*
- *Cidaris cidaris*
- *Clavularia crassa*
- *Cornuspiramia adherens*
- *Diazona violacea*
- *Haliclona mucosa*
- *Hexadella detritifera*
- *Poecillastra compressa*
- Polychaeta indet.
- *Reteporella* sp.
- *Sclerasterias richardi*

Black coral (*Parantipathes larix*) © OCEANA

Description

Habitats characterised by this species were found in the upper bathyal zone, on rocks with moderate-to-high sedimentation. Although most of the colonies were found isolated or in small groups, this species is known to create large forests, either on its own[67] or in combination with other black corals, dead coral framework, or sponge aggregations.[68,69]

Protection status

This species is strictly protected under Annex II of the SPA/BD Protocol of the Barcelona Convention,[38] and is particularly threatened by bottom fishing activities, pollution, and increased sedimentation from land-based activities. It is also included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

Bathyal rocks with *Antipathes dichotoma*

Depth range: 146 to 696 m

Distribution map: Figure 13

Main associated species:

- *Anthias anthias*
- *Bebryce mollis*
- *Benthocometes robustus*
- *Callanthias ruber*
- *Cidaris cidaris*
- *Corallium rubrum*
- *Dendrophyllia cornigera*
- *Haliclona mucosa*
- *Lappanella fasciata*
- *Leiopathes glaberrima*
- *Parantipathes larix*
- *Peltaster placenta*
- *Phakellia robusta*
- *Poecillastra compressa*

Black coral (*Antipathes dichotoma*) and yellow tree coral (*Dendrophyllia cornigera*) © OCEANA

Description

Habitats characterised by this species of black coral typically occurred on top of bathyal rocks or steep slopes with low levels of sedimentation. In some cases, *A. dichotoma* was found mixed with other antipatharians, like *Parantipathes larix* or *Leiopathes glaberrima*.

Large colonies were associated, in particular, with the fish *Benthocometes robustus*.

Protection status

This species is strictly protected under Annex II of the SPA/BD Protocol of the Barcelona Convention,[38] and is particularly threatened by bottom fishing activities, pollution, and increased sedimentation from land-based activities. It is also included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

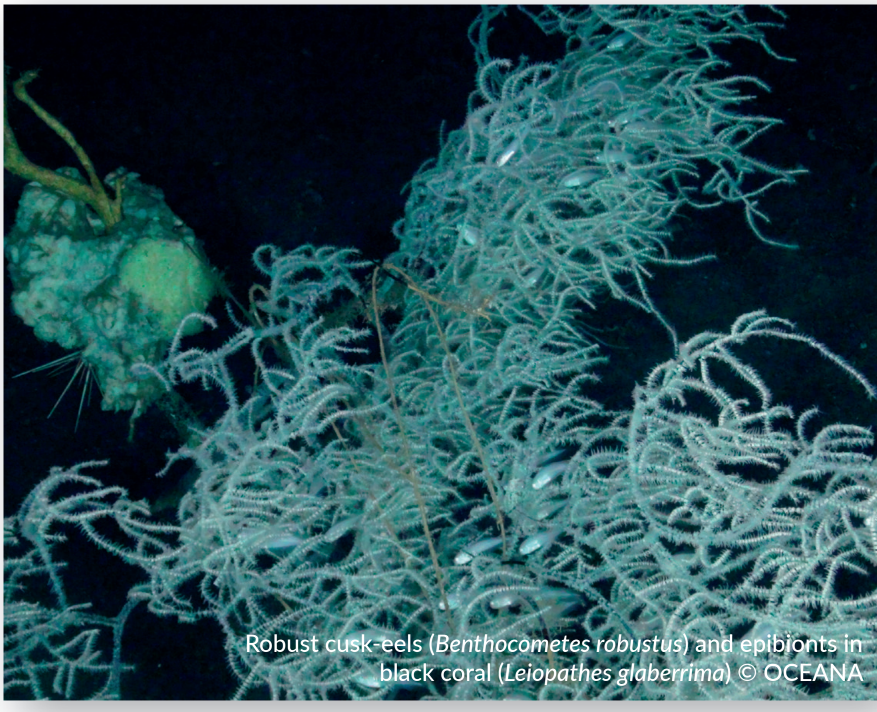
Deep-sea bathyal rocky slopes with *Leiopathes glaberrima*

Depth range: 223 to 344 m

Distribution map: Figure 13

Main associated species:

- *Anamathia rissoana*
- *Benthocometes robustus*
- *Callanthias ruber*
- *Capros aper*
- Ceriantharia indet.
- *Cidaris cidaris*
- *Dendrophyllia cornigera*
- *Epigonus constanciae*
- *Hexadella detritifera*
- *Neopycnodonte zibrowii*
- *Plesionika edwardsii*
- *Savalia savaglia*



Robust cusk-eels (*Benthocometes robustus*) and epibionts in black coral (*Leiopathes glaberrima*) © OCEANA

Description

Areas with large colonies of this long-lived black coral species were found on rocky slopes and walls in the bathyal zone, between 223 and 344 m depth.

The fish *Benthocometes robustus* was recorded among these colonies in large numbers. The false black coral *Savalia savaglia*, sponges, hydrozoans, and other epibionts were also documented in association with *L. glaberrima*, having settled on the black coral structure in places where the branches were damaged.

Some isolated individuals of giant oyster *Neopycnodonte zibrowii* were recorded close to the large colonies, but without forming the typical concretions made by this species in other areas.[70]

Protection status

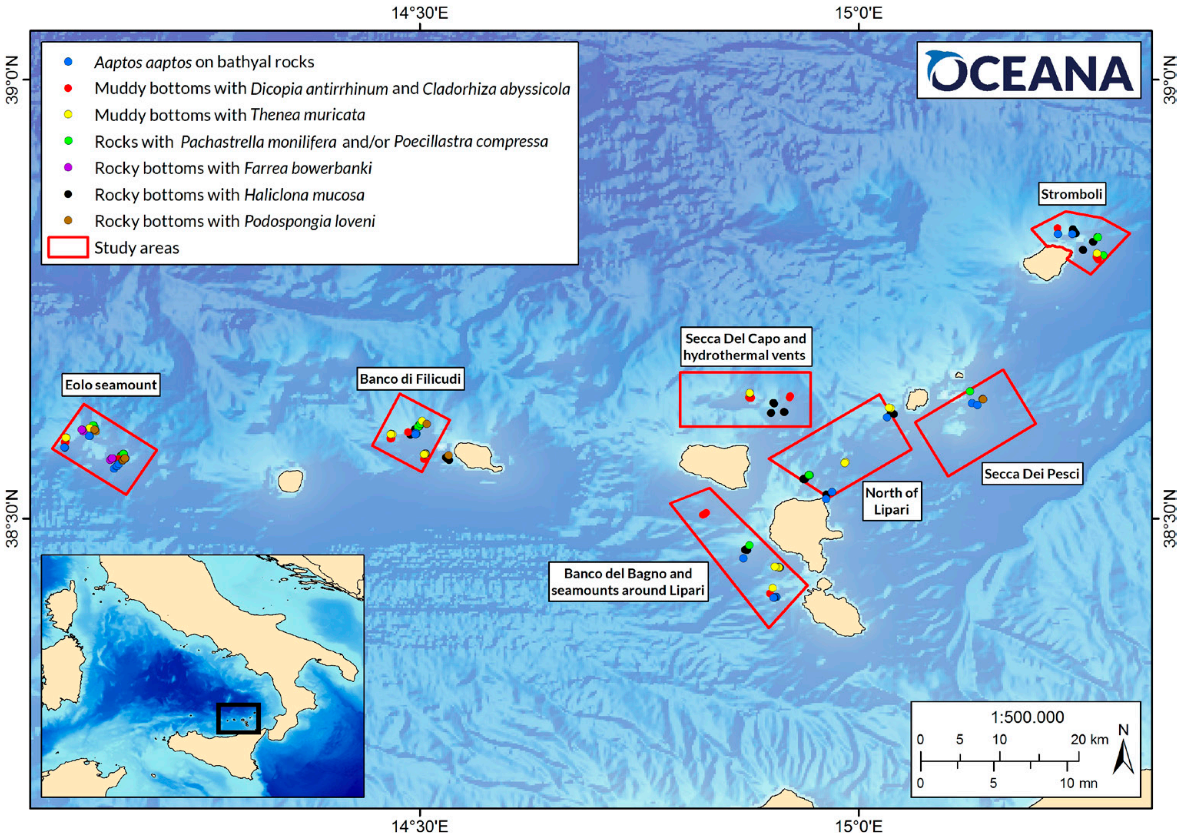
This species is strictly protected under Annex II of the SPA/BD Protocol of the Barcelona Convention,[38] and is particularly threatened by bottom fishing activities, pollution, and increased sedimentation from land based activities. It is also included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

7. Habitats formed by sponges

Sponges exhibit a diverse array of morphologies and inhabit a wide range of bottom types and depths.[71] When they proliferate, sponges can create enormous monospecific or multispecific aggregations, also becoming key elements in habitats in which they are mixed with other biota (e.g., coral reefs). These aggregations can extend over hundreds of square kilometres and increase both habitat complexity and associated biodiversity. They also play an essential role in the cycling of important nutrients such as carbon and nitrogen, and in the transfer of matter and energy between the water column and the benthos.[72]

Sponges are vulnerable to mechanical damage, habitat destruction, and pollution. Anchoring and bottom-contacting fishing gears are the primary sources of mechanical damage, specifically bottom trawls and longlines, depending on the type of sponge.[73] These fishing gears also pose an indirect threat, in that they cause resuspension of bottom sediments, leading to smothering of sponges. Underwater industrial activities such as dredging, deep-sea mining, and oil and gas exploitation also represent anthropogenic threats to this phylum. Damage to sponges caused by lost fishing lines was documented during this expedition.

Figure 14. Locations of habitats formed by sponges.



Sponges exhibit a diverse array of morphologies and create enormous aggregations that can extend over hundreds of square kilometres.

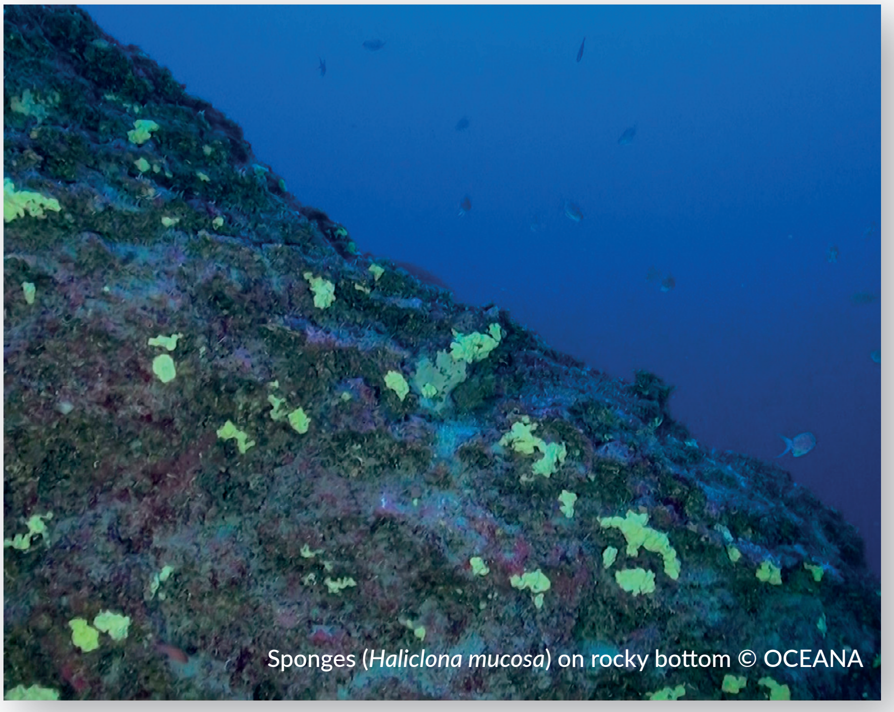
Deep circalittoral and upper bathyal rocky bottoms with *Haliclona mucosa*

Depth range: 84 to 234 m

Distribution map: Figure 14

Main associated species:

- *Acanthogorgia hirsuta*
- *Bebryce mollis*
- *Caberea* sp.
- *Callanthias ruber*
- *Cidaris cidaris*
- *Clavularia crassa*
- *Dendrophyllia cornigera*
- *Diazona violacea*
- *Hacelia attenuata*
- *Halocynthia papillosa*
- *Helicolenus dactylopterus*
- *Holothuria* spp.
- *Peltaster placenta*
- *Plesionika edwardsii*
- *Reteporella* sp.
- *Scorpaena elongata*
- *Swiftia dubia*


Sponges (*Haliclona mucosa*) on rocky bottom © OCEANA

Description

Haliclona mucosa was the most common species on rocky bottoms between the lower circalittoral and upper bathyal zones. It occurred in large numbers on rocks with or without coralline algae, creating monospecific facies, although it was also commonly mixed with polychaetes and other sponges. *Haliclona* habitat was observed to coexist with many other communities and facies present in this bathymetric range, such as gorgonians (e.g., *Acanthogorgia hirsuta*, *Bebryce mollis*, *Swiftia dubia*). Such mixed habitat was only recorded from areas that were not heavily overgrown by macroalgae, since this sponge is unable to compete with them.

H. mucosa was also found as part of the sponge fauna associated with coralligenous communities.

Bathyal muddy bottoms with *Thenea muricata*

Depth range: 250 to 837 m

Distribution map: Figure 14

Main associated species:

- *Aristeus antennatus*
- *Chlorophthalmus agassizi*
- *Gryphus vitreus*
- *Helicolenus dactylopterus*
- *Hymenocephalus italicus*
- *Pelosina arborescens*
- *Plesionika acanthonotus*

Sponges (*Thenea muricata*) on bathyal muddy bottom © OCEANA

Description

This sponge was abundant on muddy bottoms of the upper bathyal zone, sometimes epiphytised by zoantharians. In some muddy bottom areas, it represented the sole visible epifaunal species, while in others it occurred together with other communities such as bamboo coral gardens and sea pens.

Protection status

Thenea muricata aggregations are included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

Aaptos aaptos on bathyal rocks heavily affected by sedimentation

Depth range: 252 to 983 m

Distribution map: Figure 14

Main associated species:

- *Pachastrella monilifera*
- *Podospongia loveni*

Sponges (*Aaptos aaptos*) on rocks fully covered by mud © OCEANA

Aaptos aaptos in sedimented rocky bottom © OCEANA

Description

This sponge occurred on bathyal rocks with medium-to-high levels of sedimentation. In deeper areas it was also found mixed with other sponges, such as *Podospongenia poveni* and *Pachastrella monilifera.*

Protection status

Aaptos aaptos aggregations are included within the scope of the UNEP-MAP *Dark Habitats Action Plan.*[55]

Deep-sea oligotrophic bathyal muddy bottoms with *Cladorhiza abyssicola* and *Dicopia antirrhinum*

Depth range: 280 to 967 m

Distribution map: Figure 14

Main associated species:

- *Gryphus vitreus*
- *Helicolenus dactylopterus*
- *Nezumia sclerorhynchus*
- *Pelosina arborescens*

Carnivorous sea squirt (*Dicopia antirrhinum*) © OCEANA

Description

Both carnivorous species, the sponge *Cladorhiza abyssicola* and the sea squirt *Dicopia antirrhinum* occurred on deep muddy bottoms around the Aeolian Islands, normally below 600 metres depth.

In some areas these species were locally abundant, as was the case of *D. antirrhinum* in Secca del Capo. However, they were typically more dispersed, forming part of the scarce epifauna on the deep-sea muddy slopes of the islands.

Associated species that were found on these oligotrophic muddy bottoms were the giant foraminifer *Pelosina arborescens*, the brachiopod *Gryphus vitreus*, ceriantharians, mysids, and fish species like *Helicolenus dactylopterus* and *Nezumia sclerorhynchus.*

Protection status

Cladorhiza abyssicola aggregations are included within the scope of the UNEP-MAP *Dark Habitats Action Plan.*[55]

Bathyal rocks with *Pachastrella monilifera* and/or *Poecillastra compressa*

Depth range: 113 to 986 m

Distribution map: Figure 14

Main associated species:

- *Aaptos aaptos*
- *Bebryce mollis*
- *Callanthias ruber*
- *Cidaris cidaris*
- *Farrea bowerbanki*
- *Helicolenus dactylopterus*
- *Hexadella detritifera*
- *Munidopsis* sp.
- *Peltaster placenta*
- *Podospongia loveni*
- *Swiftia dubia*

Sponge (*Poecillastra compressa*) on deep circalittoral rocks with other sponges and black coral © OCEANA

Description

These sponges were widely distributed on deep circalittoral and bathyal rocks and appeared to be adapted to a certain level of sedimentation. Although in other Mediterranean sites these two species can create mixed assemblages,[73,73] in the Aeolians they were commonly found distributed within distinct bathymetric ranges. *Pachastrella monilifera* showed a wider bathymetric and substrate-based distribution, from around 170 m to close to 1000 m depth; *Poecillastra compressa* was observed to be more concentrated on rocky bottoms in the deep-circalittoral and upper bathyal zones.

Due to its wide bathymetric range, *P. monilifera* was found mixed with a variety of other sponge species, like *Aaptos aaptos*, *Farrea bowerbanki*, *Hexadella detritifera* and *Podospongia loveni*, as well as with other fauna.

Protection status

Pachastrella monilifera and Poecillastra compressa aggregations are included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

Deep-sea bathyal rocky bottoms with *Farrea bowerbanki*

Depth range: 855 to 986 m

Distribution map: Figure 14

Main associated species:

- *Munidopsis* sp.
- *Notacanthus bonapartei*
- *Pachastrella monilifera*
- *Podospongia loveni*
- Polychaeta indet.

Glass sponges (*Farrea bowerbanki*) growing on an old fossil reef © OCEANA

Glass sponges (*Farrea bowerbanki*)© OCEANA

Description

Communities characterised by this species were only recorded from the deepest areas surveyed, down to 1000 m depth. This hexactinellid was sometimes mixed with the stalked demosponge *Podospongia loveni* and other sponges. In all cases, it was observed to occur on vertical hard substrates, such as rocky walls.

Deep-sea bathyal rocky bottoms with *Podospongia loveni*

Depth range: 283 to 986 m

Distribution map: Figure 14

Main associated species:

- *Aaptos aaptos*
- *Caryophyllia calveri*
- *Farrea bowerbanki*
- *Hexadella detritifera*
- *Kadophellia bathyalis*
- *Munidopsis* sp.
- *Pachastrella monilifera*
- *Peltaster placenta*
- Polychaeta indet.
- Stolonifera indet.

'Lollipop' sponges (*Podospongia loveni*) on bathyal rocks © OCEANA

Description

Communities characterised by these 'lollipop' sponges occurred mainly on vertical walls but also on top of rocky formations. *P. loveni* formed aggregations of hundreds of sponges on deep bathyal rocks, at depths below 700 m.

In some cases, this species was observed to occur in combination with *Farrea bowerbanki* and other sponges, like *Aaptos aaptos*, *Hexadella detritifera* and *Pachastrella monilifera*, among others.

8. Stony coral and tube anemone dominated bottoms

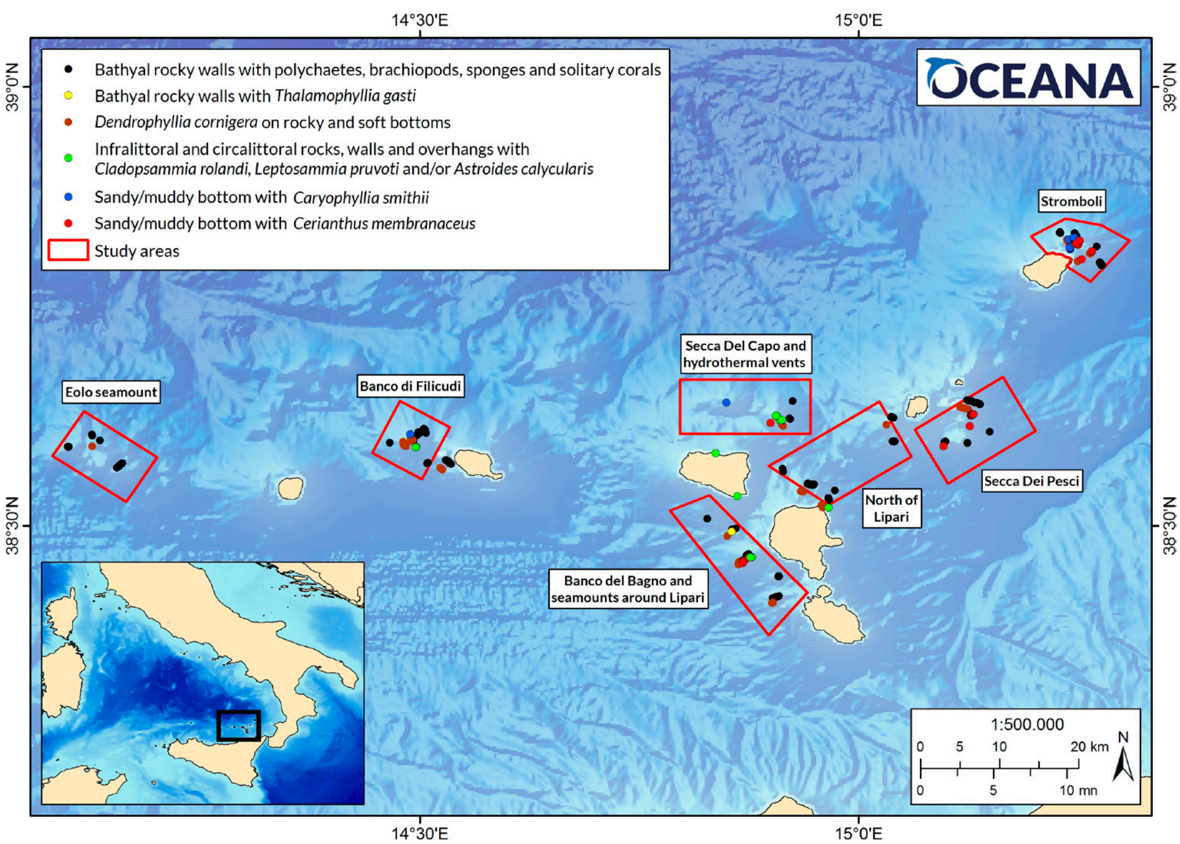
Stony corals and tube anemones display a wide variety of morphologies, occur as solitary individuals and in colonies, and are common members of benthic communities at many different depths and on a variety of substrates. These communities were documented in all the surveyed areas in the Aeolian Islands (Figure 15).

Branching corals such as *Dendrophyllia cornigera* resemble the shape of a tree, as indicated by its common name (yellow tree coral). These species form forests in the ocean depths, providing structure or substrate for other species to shelter, camouflage, etc., as well as creating a wide variety of ecological niches in relation to the complex habitat architecture they create.[74] Other colonial corals such as *Cladopsammia rolandi*, *Leptosammia pruvoti* and *Astroides calycularis* formed dense encrustations of individual corals on hard substrates.

Solitary corals and tube anemones provide similar ecosystem services, on a smaller scale. Some of them, such as *Caryophyllia smithii* var. *clavus* and the tube anemone *Cerianthus membranaceus* grew on soft bottoms, enhancing habitat complexity with their structures.

Branching corals resemble the shape of a tree, and form forests that provide structure and create a wide variety of ecological niches.

Figure 15. Locations of habitats formed by stony coral and tube anemone dominated bottoms.



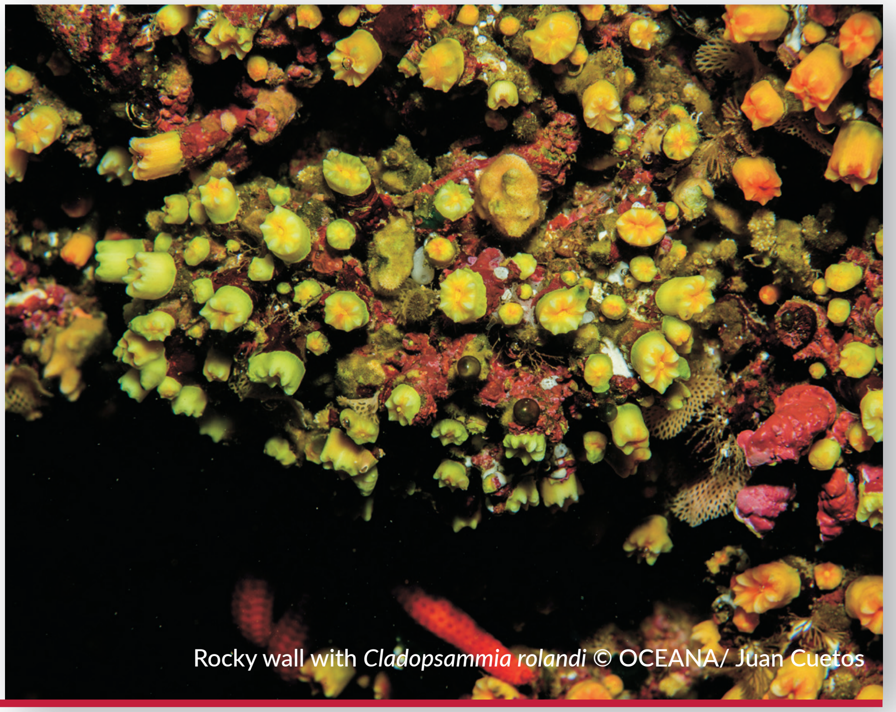
Infralittoral and circalittoral rocks, walls and overhangs with *Cladopsammia rolandi*, Leptosammia pruvoti and/or *Astroides calycularis*

Depth range: 21 to 62 m

Distribution map: Figure 15

Main associated species:

- *Hoplangia durotrix*
- *Madracis pharensis*
- *Polycyathus muellerae*



Rocky wall with *Cladopsammia rolandi* © OCEANA/ Juan Cuetos

Description

Communities of these three species of scleractinians formed dense colonies on rocky bottoms and coralligenous habitat, mainly on steep walls in the infralittoral and shallow circalittoral zones. *Leptosammia pruvoti* was more widely distributed in general and across a broader range of depths, while the densest communities were formed by *Cladopsammia rolandi* and *Astroides calycularis*.

In deeper areas, some facies of *Madracis pharensis* were observed, although it also dominated infralittoral walls of Punta Castagna (northwest of Lipari). The colonial corals *Hoplangia durotrix* and *Polycyathus muellerae* were also found on some infralittoral and circalittoral rocks.

Species associated with these communities of scleractinians included some that were also found on rocky bottoms in the infralittoral and circalittoral zones.

Protection status

Astroides calycularis facies are strictly protected under Annex II of the SPA/BD Protocol of the Barcelona Convention,[38] are encompassed under the definition of reefs (1170) in the EU Habitats Directive,[17] and included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

Bathyal rocky walls/steep rocks with polychaetes, brachiopods, sponges and solitary corals

Depth range: 101 to 979 m

Distribution map: Figure 15

Main associated species:

- *Callanthias ruber*
- *Caryophyllia* spp.
- *Desmophyllum dianthus*
- *Epigonus constanciae*
- *Filograna implexa*
- *Haliclona mucosa*
- *Hexadella detritifera*
- *Megerlia truncata*
- *Munida* sp.
- *Myxicola aesthetica*
- *Myxicola infundibulum*
- *Neocrania anomala*
- *Octopus salutii*
- *Peltaster placenta*
- *Plesionika edwardsii*
- *Plesionika giglioli*
- *Polydora* sp.
- *Reteporella* sp.
- *Sabella discifera*
- *Sabella pavonina*
- *Sabella spallanzanii*
- *Scorpaena elongata*
- *Serpula* spp.
- *Stenocyathus vermiformis*
- *Terebratulina retusa*
- *Tubularia* spp.
- *Vermiliopsis monodiscus*

Vermiliopsis monodiscus among other polychaetes, corals, zoanthids and anemones (*Kadophellia bathyalis*) © OCEANA

Description

On rocky bathyal bottoms, observed communities comprised various sessile organisms, including scleractinians, other anthozoans, worms, brachiopods, and sponges. The dominant taxa varied depending on the particular area.

Regarding corals, *Caryophyllia calveri* was the most abundant solitary scleractinian on rocky bottoms. *Desmophyllum dianthus*, *Stenocyathus vermiformis*, other *Caryophyllia* spp., Stolonifera, anemones, and zoanthids also occasionally occupied the same rock beds. Other isolated scleractinians, like *Caryophyllia smithii* and *C. inornata* were documented from infralittoral and circalittoral rocks.

Bathyal rocky walls/steep rocks with polychaetes, brachiopods, sponges and solitary corals (continued)

Sessile polychaetes were widely distributed on all the bathyal rocks. However, only a few of them could be identified, such as *Serpula* spp., *Tubularia* spp., and *Vermiliopsis monodiscus*. The latter species was recorded only from rocks below 250-300 m. These annelids were commonly mixed with brachiopods (like *Neocrania anomala*, *Megerlia truncata* and *Terebratulina retusa*, among others), solitary corals (like *Caryophyllia* spp. and *Desmophyllum dianthus*), bryozoans (like *Tervia irregularis* and *Reteporella* sp.) and sponges (like *Hexadella detritifera*). In the upper bathyal zone this community type was mixed with the sponge *Haliclona mucosa*.

Polychaetes were also very common in shallower areas in the Aeolian Islands, forming different communities with other associated species. For example, the annelids *Sabella discifera*, *Myxicola aesthetica* and *Polydora* sp. were only found in coralligenous beds. *Sabella spallanzanii* occupied infralittoral sandy and rocky bottoms, *Myxicola infundibulum* occurred in muddy bottoms; and *Sabella pavonina* was common in circalittoral sandy bottoms. Other polychaetes such as *Filograna implexa* were widely distributed, but did not form large communities.

Some of the species associated with these mixed communities included the shrimps *Plesionika edwardsii* and *P. giglioli*, squat lobster *Munida* sp., the sponge *Hexadella detritifera*, the sea star *Peltaster placenta*, scorpionfish *Scorpaena elongata*, and the octopus *Octopus salutii*. The most common fish species around these bathyal rocks were the deep-water cardinalfish (*Epigonus constanciae*) and the parrot sea perch (*Callanthias ruber*).

Protection status

The species *Caryophyllia calveri* and *Desmophyllum dianthus* are included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

Bathyal rocky walls and overhangs with *Thalamophyllia gasti*

Depth range: 282 m

Distribution map: Figure 15

Main associated species:

- *Acanthogorgia hirsuta*
- *Bebryce mollis*
- *Bonellia viridis*
- *Caryophyllia* sp.
- *Dendrophyllia cornigera*
- *Munida rugosa*
- *Plesionika giglioli*
- *Plesionika narval*

Colonial coral (*Thalamophyllia gasti*) on a rocky overhang © OCEANA

Description

Thalamophyllia gasti aggregations were found on the most sheltered and steep areas of bathyal rocks, only in one location in Banco del Bagno.

These facies were associated with other corals (*Caryophyllia* sp.), polychaetes, brachiopods, and soldier shrimps (*Plesionika narval* and *P. giglioli*).

Dendrophyllia cornigera on rocky and soft bottoms

Depth range: 96 to 615 m

Distribution map: Figure 15

Main associated species:

- *Bebryce mollis*
- *Benthocometes robustus*
- *Callanthias ruber*
- *Capros aper*
- *Cidaris cidaris*
- *Haliclona mucosa*
- *Helicolenus dactylopterus*
- *Hexadella detritifera*
- *Lappanella fasciata*
- *Megerlia truncata*
- *Nidalia studeri*
- *Octopus salutii*
- *Phycis blennoides*
- *Plesionika giglioli*
- *Reteporella* sp.
- *Stenocyathus vermiformis*
- *Swiftia dubia*

Robust cusk-eel (*Benthocometes robustus*) among yellow tree coral (*Dendrophyllia cornigera*) © OCEANA

Description

Dendrophyllia cornigera is an important habitat-forming coral species that was commonly found on hard substrates, particularly bathyal rocks. It was typically found deeper than 250 m. Both live and dead colonies act together as a three-dimensional structure that provides shelter to various species; those species were in some cases mixed with other cnidarian communities, like black corals, gorgonians and soft corals.

D. cornigera also created a different community type on soft bottoms, though with a similar function to those on hard substrates. It formed scattered small 'forests' of live and dead, unfixed corals on muddy bottoms. These structures were used by other species to shelter, settle, and lay their eggs.

The fish *Benthocometes robustus* was commonly associated with this coral, together with other species that seek shelter among its structures, like fishes (*Capros aper*, *Helicolenus dactylopterus*, *Phycis blennoides*), molluscs (*Octopus salutii*) and crustaceans (*Plesionika antigai*).

The dead coral framework of *D. cornigera*, both on hard and soft bottoms can still provide habitat for many species. Due to the absence of live polyps, other species can colonise the skeletons; this is the case of anthozoans such as the Zoanthidae, hydrozoans, *Desmophyllum dianthus*, and *Caryophyllia calveri*. The tube anemone *Cerianthus membranaceus* was commonly found more abundantly next to the structures.

Similar communities of tree corals (*D. ramea*) living on muddy bottoms have been discovered in recent years in Cyprus[75] and Lebanon. [51]

Protection status

Dendrophyllia cornigera is strictly protected under Annex II of the SPA/BD Protocol of the Barcelona Convention.[38] It is also listed as Endangered on the IUCN Red List of Anthozoans in the Mediterranean[53], and encompassed under the definition of reefs (1170) in the EU Habitats Directive.[17] *Dendrophyllia cornigera* forests are included under the UNEP-MAP *Dark Habitats Action Plan*.[59]

Sandy/muddy circalittoral and upper bathyal bottoms with *Caryophyllia smithii*

Depth range: 85 to 350 m

Distribution map: Figure 15

Main associated species:

- *Cerianthus membranaceus*
- *Cidaris cidaris*
- *Parastichopus regalis*

Solitary scleractinian coral (*Caryophyllia smithii* var. *clavus*) on soft bottom © OCEANA

Description

The scleractinian variety of *Caryophyllia smithii* var. *clavus* is well known to create large communities of solitary individuals on soft sediments. Similar communities have been found on the transitional slope between the circalittoral and bathyal zones in other Mediterranean areas, such as in Chella Bank (Spain)[76]. These aggregations are similar to those formed by other solitary corals in the Atlantic, like *Flabellum* spp. and *Deltocyathus* spp.[77,78,79] In the Aeolians, these communities were observed in Banco di Filicudi, Secca del Capo, and Stromboli.

In some locations, this community type was also mixed with other soft bottom communities, like the ones created by bioturbations of *Lesueurigobius* sp. and *Goneplax rhomboides* (see *Soft bottoms with bioturbations*), tube anemone (*Cerianthus membranaceus*) fields, sandy bottoms with *Neopycnodonte cochlear*, *Stylocidaris affinis* and *Acromegalomma vesiculosum*, or giant foraminifera.

Protection status

The species *Caryophyllia smithii* is included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

Sandy/muddy circalittoral and upper bathyal bottoms with *Cerianthus membranaceus*

Depth range: 90 to 323 m

Distribution map: Figure 15

Main associated species:

- *Acromegalomma vesiculosum*
- *Aphia minuta*
- *Charonia lampas*
- *Chelidonichthys cuculus*
- *Cidaris cidaris*
- *Dardanus arrosor*
- *Neopycnodonte cochlear*
- *Octopus vulgaris*
- *Parastichopus regalis*
- *Pyrosoma atlanticum*
- *Raja montagui*
- *Stylocidaris affinis*
- *Tethyaster subinermis*
- *Virgularia mirabilis*
- *Zeus faber*

Tube anemones (*Cerianthus membranaceus*) on sandy/muddy bottom © OCEANA

Description

Hundreds of individuals of *Cerianthus membranaceus* formed scattered but large communities on sandy/muddy bottoms. In some areas, this tube anemone was the dominant and nearly sole epifaunal species. In other areas, it occurred together with typical facies and communities of sandy bottoms, like the oyster *Neopycnodonte cochlear*, the polychaete *Acromegalomma vesiculosum*, sea urchins *Cidaris cidaris* and *Stylocidaris affinis*, and also with sea pen communities and with macroalgal and seagrass remains.

Protection status

The species *Cerianthus membranaceus* is included within the scope of the UNEP-MAP *Dark Habitats Action Plan*.[55]

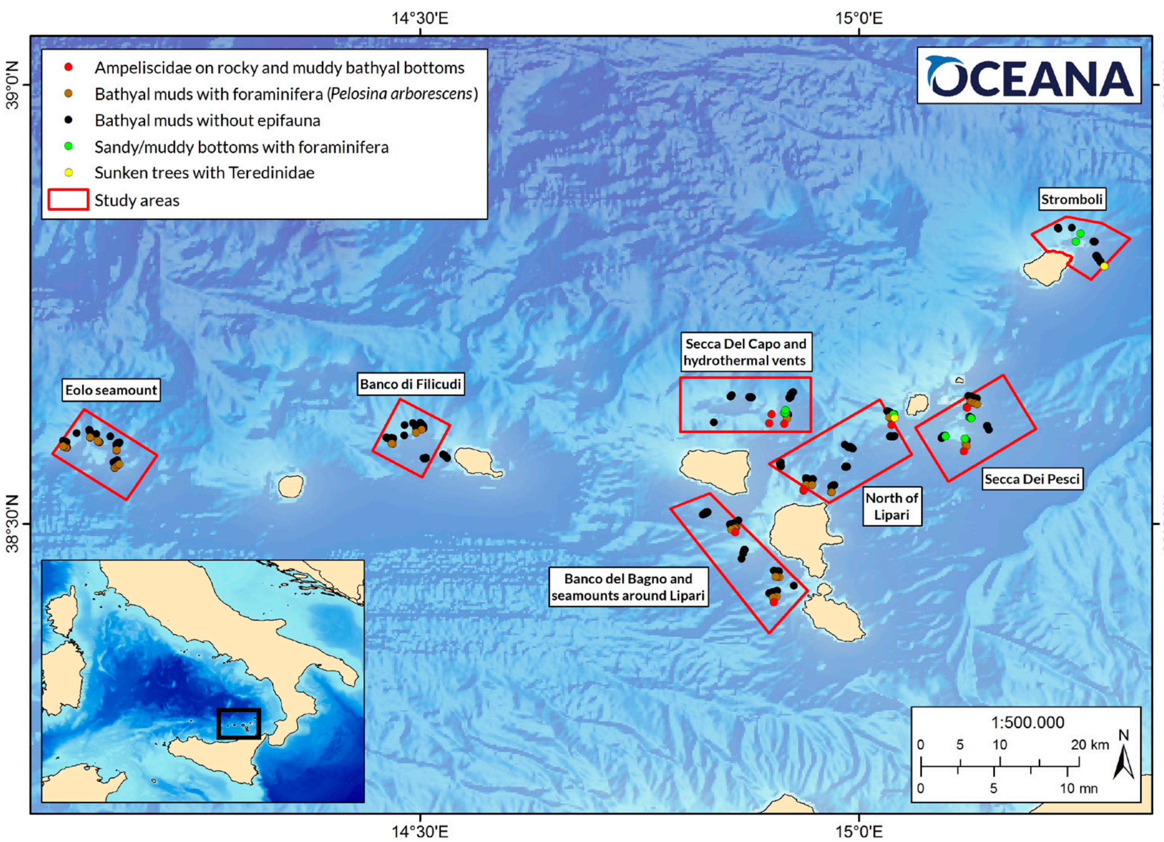
9. Other habitats

This group comprises various organisms, such as foraminifera and tube-dwelling amphipods, that add complexity to the soft bottoms that they inhabit. On a smaller scale than the aforementioned corals and sponges, these species create structures of varying forms that aggregate fauna.

Tube-dwelling amphipods like the Ampeliscidae collect sediments around them and build tube-like structures in which they live. They create aggregations of up to several thousand tubes per square metre.[80] The habitats that they form support species that are exclusively associated with this engineered system. They are widely distributed, including around hydrothermal vents.

Foraminifera such as *Pelosina arborescens* form tree-like, calcareous structures. Apart from being used by other fauna, these structures are considered to be indicators of good environmental status, as they have a short life cycle and rapid turnover, a fast response to environmental changes, and are well preserved as fossil records.[81]

Figure 16. Locations of habitats formed by different organisms such as Ampeliscidae, Foraminifera and Teredinidae.



Foraminifera such as Pelosina arborescens form tree-like, calcareous structures and are considered to be indicators of good environmental status.

Bathyal muds without epifauna

Depth range: 201 to 945 m

Distribution map: Figure 16

Main associated species:

- *Aristaeomorpha foliacea*
- *Gryphus vitreus*
- *Scyliorhinus canicula*
- *Squalus blainvillei*
- *Symphurus ligulatus*

Giant red shrimp (*Aristaeomorpha foliacea*) © OCEANA

Description

This habitat was found in all the sampling areas. Crustaceans can create bioturbations in this habitat type. Fish species like *Symphurus ligulatus*, *Squalus blainvillei*, *Scyliorhinus canicula* and giant red shrimp (*Aristaeomorpha foliacea*), were common among the fauna found in this environment.

Another species typically found on this type of bottom, as well as on bathyal rocks, was the brachiopod *Gryphus vitreus*. Although this species was documented, it was not observed to have formed aggregations.

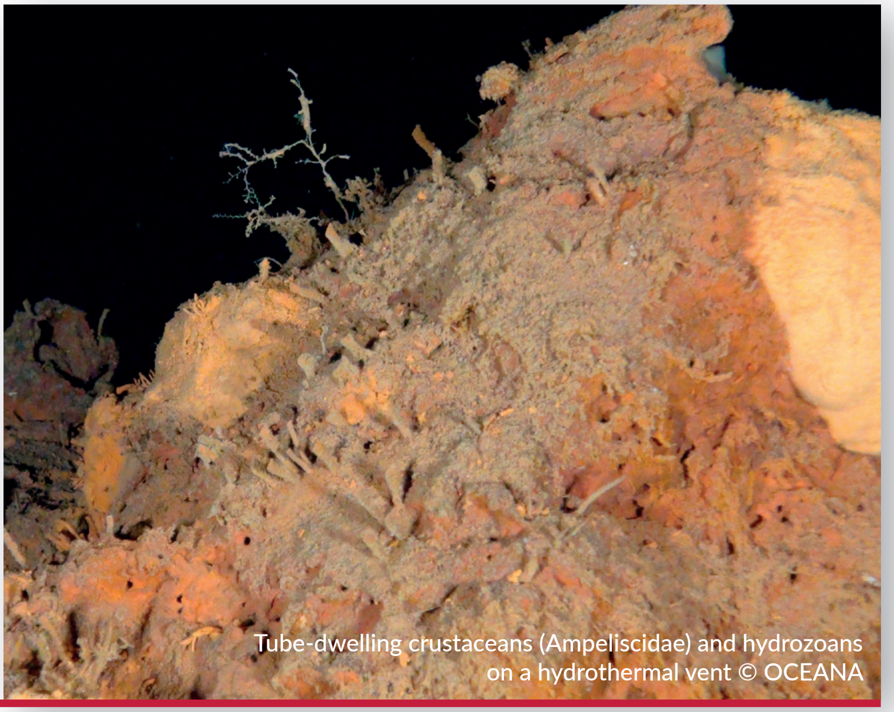
Ampeliscidae on rocky and muddy bathyal bottoms

Depth range: 101 to 269 m

Distribution map: Figure 16

Main associated species:

- *Bebryce mollis*
- *Capros aper*
- *Caryophyllia calveri*
- *Cidaris cidaris*
- *Galeodea echinopora*
- *Gryphus vitreus*
- *Hexadella detritifera*
- Hydrozoa indet.
- *Pelosina arborescens*
- *Plesionika giglioli*
- Polychaeta indet.
- *Scrupocellaria* sp.
- *Sertularella* sp.
- *Swiftia dubia*



Tube-dwelling crustaceans (Ampeliscidae) and hydrozoans on a hydrothermal vent © OCEANA

Description

Although Ampeliscidae tubes are usually found on soft bottoms, most of the aggregations of these crustaceans in the Aeolian Islands were found close to or on rocks. They created dense communities, providing shelter and food for other species.

Previous studies in the area have associated the species *Ampelisca ledoyeri* with hydrothermal activity[82]. Some of the Ampeliscidae found during these surveys were next to or on crustose structures on the seabed that have been formed as a result of gas seepage and bacterial activity (see *Geogenic and artificial habitats*). However, many other crustaceans from this family were observed in areas without crustose structures, although there may still have been hydrothermal activity in those locations.

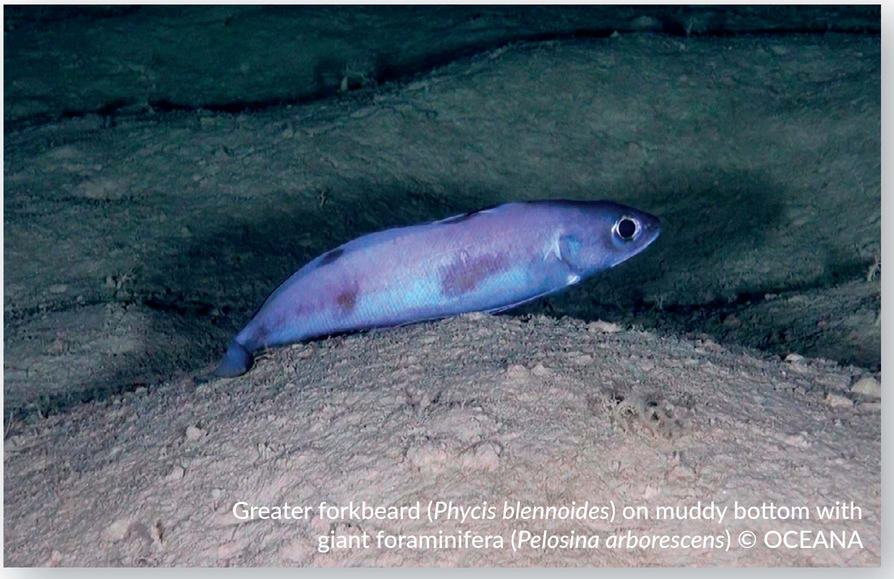
Circalittoral and bathyal soft bottoms with foraminifera

Depth range: 81 to 958 m

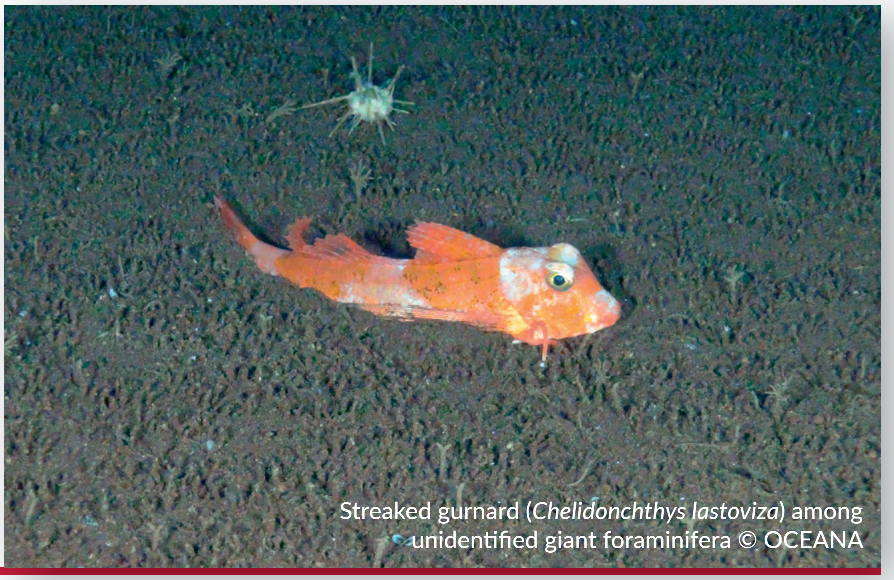
Distribution map: Figure 16

Main associated species:

- *Acromegalomma vesiculosum*
- *Aulopus filamentosus*
- *Arachnanthus* sp.
- *Chelidonchthys lastoviza*
- *Gryphus vitreus*
- *Helicolenus dactylopterus*
- *Lampanyctus crocodilus*
- *Neopcynodonte cochlear*
- *Nezumia aequalis*
- *Penilpidia ludwigi*
- *Peristedion cataphractum*
- *Phycis blennoides*
- *Stylocidaris affinis*
- *Thenea muricata*



Greater forkbeard (*Phycis blennoides*) on muddy bottom with giant foraminifera (*Pelosina arborescens*) © OCEANA



Streaked gurnard (*Chelidonchthys lastoviza*) among unidentified giant foraminifera © OCEANA

Description

Pelosina arborescens is a giant foraminifer, which was the most common Astrorhizida species on bathyal mud (148 to 958 m depth), and was abundant in some areas. It was also documented growing on rocks with sediments, and mixed with various species of brachiopods, sponges, cerianthids, holothurians and fishes.

P. arborescens was also found among other communities on bathyal muds, such as the aforementioned *Isidella elongata* gardens, aggregations of the sea squirt *Dicopia antirrhinum*, and close to Ampeliscidae and hydrothermal vents.

Another, unidentified species of giant foraminifer was also highly abundant in sandy/muddy bottoms in the upper bathyal. These individuals were found in shallower depths than *P. arborescens* (81 to 187 m). In several areas, they were mixed with the typical soft-bottom community of the oyster *Neopycnodonte cochlear*, the polychaete *Acromegalomma vesiculosum* and the echinoid *Stylocidaris affinis*.

Sunken trees with Teredinidae (bathyal)

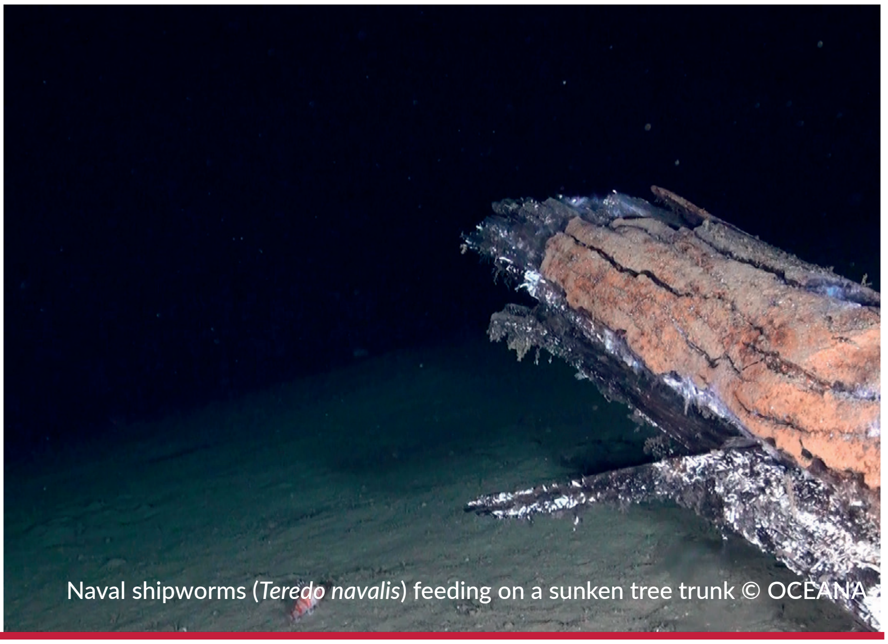
Depth range: 216 to 912 m

Distribution map: Figure 16

Main associated species:

- *Acantholabrus palloni*
- *Helicolenus dactylopterus*

Naval shipworms (*Teredo navalis*) feeding on a sunken tree trunk © OCEANA



Naval shipworms (*Teredo navalis*) feeding on a sunken tree trunk © OCEANA

Description

During surveys, two tree trunk remains were recorded, both with the Teredinidae species *Teredo navalis*. One was located at 216 m depth, and the other at 912 m.

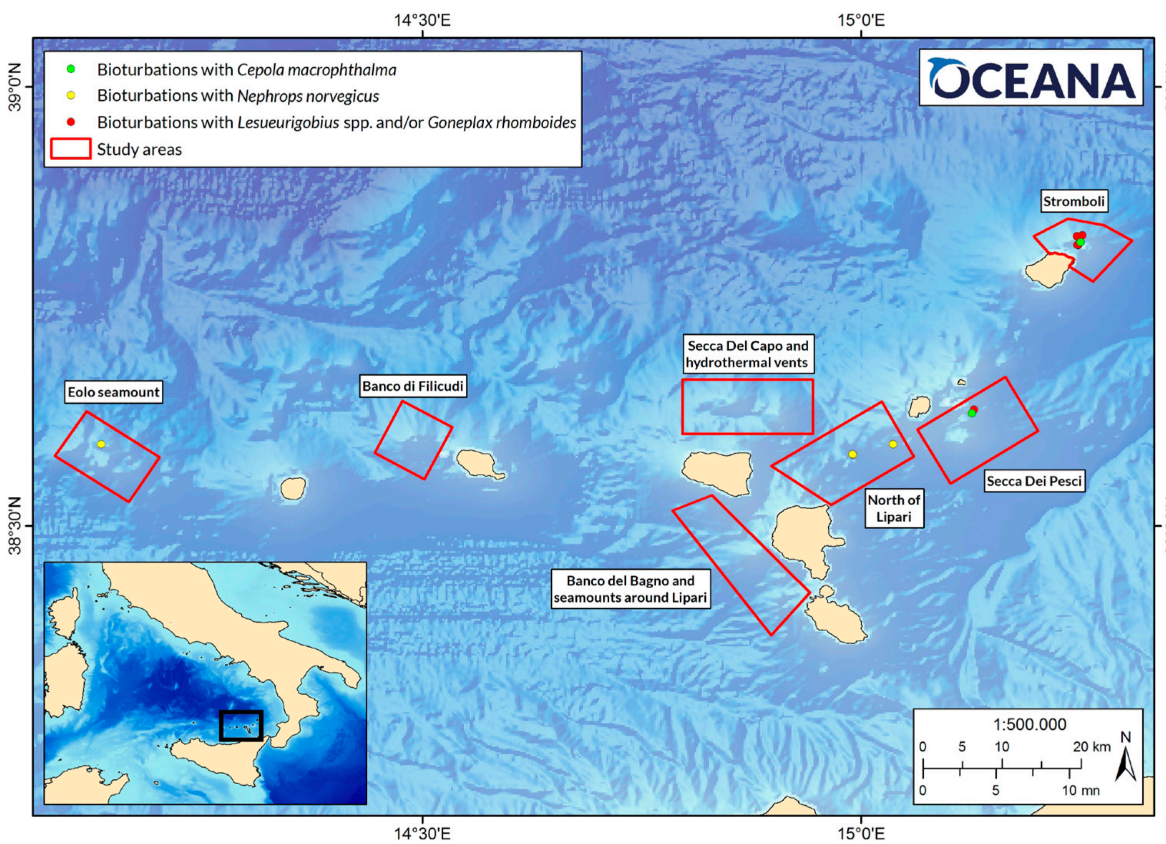
10. Soft bottoms with bioturbations

Benthic macrofaunal organisms are considered to exert a significant influence on the seabed where they live, especially in soft substrate environments. Some of these organisms, such as crustaceans and fishes generate holes in the sediment as part of a strategy for finding shelter, mating, or laying eggs. These bioturbations may greatly affect biochemical processes, ecosystem functioning, and microbial activities in such sediments, due to modifications in the exchange rates of oxygen, carbon dioxide, and nutrients between the sediment and the overlying water.[83]

Bioturbations generated by different species may greatly affect biochemical processes, ecosystem functioning, and microbial activities.

During this research, habitats characterised by the presence of bioturbations were documented in four of the seven surveyed areas: Eolo seamount, North of Lipari, Secca dei Piesci and Stromboli. The species observed to form these bioturbations were *Cepola macrophthalma*, *Goneplax rhomboides*, *Lesueurigobius* spp. and *Nephrops norvegicus*.

Figure 17. Locations of soft bottoms with bioturbations.



Bioturbations created by *Lesueurigobius suerii* and/or *Goneplax rhomboides* in bathyal sandy/muddy bottoms

Depth range: 95 to 158 m

Distribution map: Figure 17

Main associated species:

- *Caryophyllia smithii* var. *clavus*

Lesuer's goby (*Lesueurigobius suerii*) and burrows © OCEANA

Description

The crab *Goneplax rhomboides* and fish of the genus *Lesueurigobius* create galleries and hollows in soft bottoms, which can sometimes be shared between them. In the Aeolian Islands, these habitats were found in Secca dei Piesci and Stromboli, in sandy/muddy bottoms of the upper bathyal zone. They have also been documented in other areas such as the Alboran Sea and Gulf of Cadiz in the western Mediterranean[84], and in the eastern Mediterranean, in Lebanese submarine canyons.[51]

This community type was found mixed with other soft-bottom communities, like the aforementioned sea pen communities, or with communities of solitary stony coral *Caryophyllia smithii* var. *clavus*.

Bioturbations created by *Cepola macrophthalma* in bathyal sandy/muddy bottoms

Depth range: 108 to 126 m

Distribution map: Figure 17

Main associated species:

- *Cidaris cidaris*
- *Pennatula rubra*
- *Raja montagui*

Red bandfish (*Cepola macrophthalma*) © OCEANA

Description

Like *Lesueurigobius* and *Goneplax*, bioturbations of *Cepola macrophthalma* were found in sandy/muddy bottoms in the circalittoral zone in Secca dei Piesci and Stromboli areas. However, their hollows were bigger, and could extend over several square metres.

In previous studies conducted in southern Italy, in the Ionian Sea[85], the presence of this habitat was related to *Pennatula rubra* fields. Similar *C. macrophthalma* bioturbations have also been documented in other Mediterranean sites, such as in Cabrera National Park, Spain.[86]

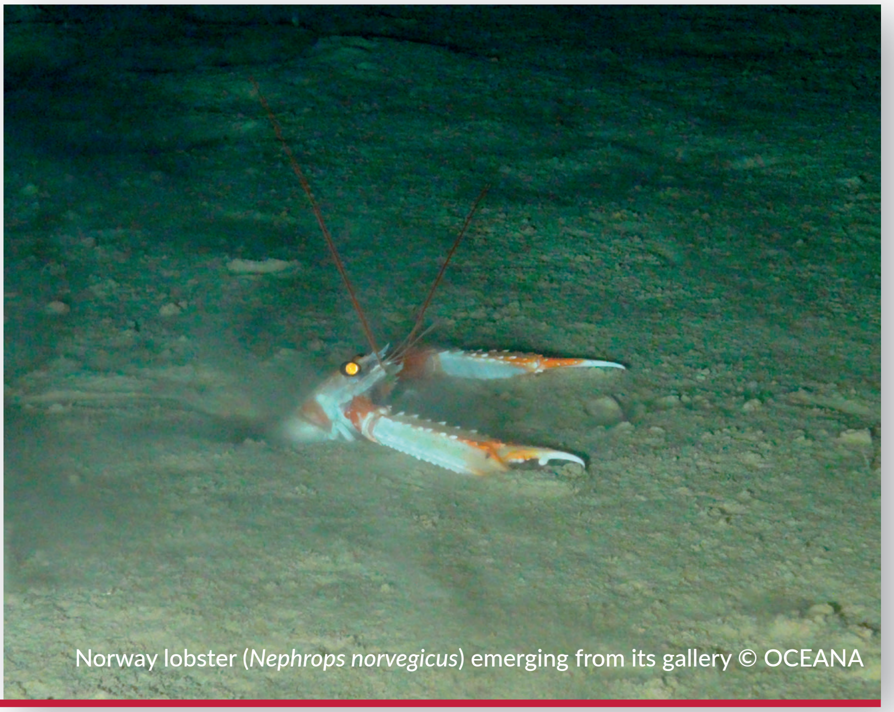
Bioturbations created by *Nephrops norvegicus* in bathyal muddy bottoms

Depth range: 444 to 790 m

Distribution map: Figure 17

Main associated species:

- *Cerianthus membranaceus*
- *Chlorophthalmus agassizi*
- *Cidaris cidaris*
- *Hymenocephalus italicus*
- *Nezumia aequalis*
- *Phycis blennoides*
- *Rossia macrosoma*



Norway lobster (*Nephrops norvegicus*) emerging from its gallery © OCEANA

Description

Norway lobster (*Nephrops norvegicus*) communities were recorded from two survey areas (Eolo seamount, and north of Lipari), where the species made its burrows in bathyal muddy bottoms. Occasionally it also occurred within facies of *Isidella elongata* and other species that are commonly associated with muddy bottoms, like *Pelosina arborescens*. This association has also been documented from the Balearic Islands, Spain.[50]

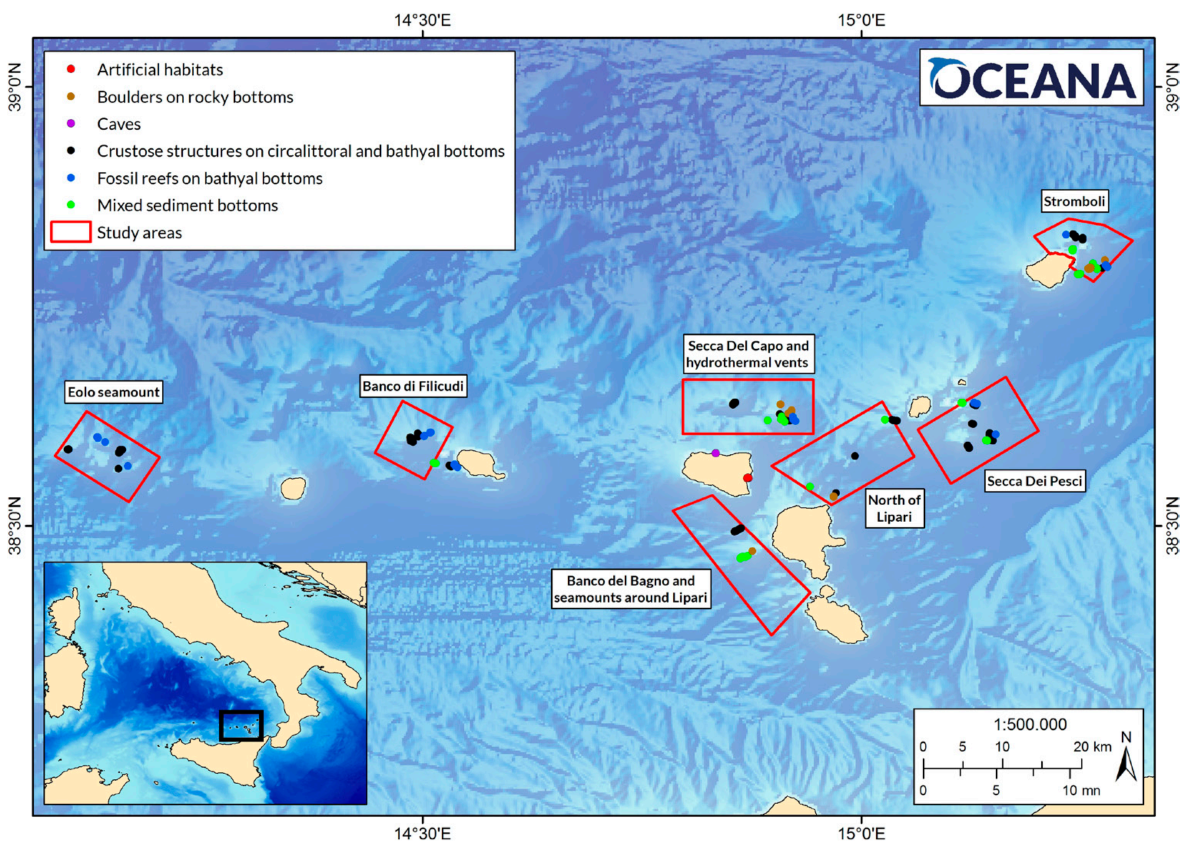
Species that were recorded in association with this community type, in both of the survey areas where it was documented, included the fishes *Chlorophthalmus agassizi*, *Hymenocephalus italicus*, *Nettastoma melanurum*, *Nezumia aequalis* and *Phycis blennoides*, the tube anemone *Cerianthus membranaceus*, the cephalopod *Rossia macrosoma*, and the echinoid *Cidaris cidaris*.

Artificial habitat in Salina port © OCEANA/ Enrique Talledo

11. Geogenic and artificial habitats

Hard substrates provide a surface for a variety of algal and animal species to settle, which in turn form benthic communities. In the Aeolian Islands, these surfaces were either natural in origin (e.g., rocks and boulders, fossil reefs, and caves) or artificial (e.g., harbours, artificial reefs). These habitats were found in all of the survey areas, especially the crustose structures on circalittoral and bathyal bottoms, which were present in all seven areas surveyed.

Figure 18. Locations of geogenic and artificial habitats.



Caves

Depth range: 33 m

Distribution map: Figure 18

Main associated species:

- *Agelas oroides*
- *Apogon imberbis*
- *Arbacia lixula*
- *Argyrotheca cuneata*
- *Astroides calycularis*
- *Cabera boryi*
- *Cladopsammia rolandi*
- *Dendroxea lenis*
- *Didemnum* sp.
- *Eupolymnia nebulosa*
- *Flabellina pedata*
- *Hacelia attenuata*
- *Halcynthia papillosa*
- *Halopteris filicina*
- *Hermodice carunculata*
- *Leptosamia pruvoyi*
- *Lissoclinum perforatum*
- *Lithophyllum cabiochae*
- *Mesophyllum* spp.
- *Myriapora truncata*
- *Octopus vulgaris*
- *Ophidiaster ophidianus*
- *Palinurus elephas*
- *Palmophyllum crissum*
- *Peltodoris atromaculata*
- *Peyssonnelia* spp.
- *Phycis phycis*
- *Pleraplysilla spinifera*
- *Plesionika narval*
- *Reteporella grimladii*
- *Sabella spallanzanii*
- *Serranus scriba*
- *Spirastrella cunctatrix*
- *Symphodus ocellatus*


Cave turf © OCEANA

Description

Caves and overhangs are common along the coasts of the Aeolian Islands. During the expedition, one cave was documented in the infralittoral zone in Malfa, north of Salina. The benthic community was characterised by the sponges *Agelas oroides*, the bryozoan *Myriapora truncata* and *Reteporella grimaldii*, various species of macroalgae (*Halopteris filicina*, *Palmophyllum crissum*, *Peyssonnelia rubra*) and fish such as *Serranus scriba*.

Protection status

Caves are included under the UNEP-MAP *Dark Habitats Action Plan*.[59]

Crustose structures on circalittoral and bathyal bottoms

Depth range: 55 to 925 m

Distribution map: Figure 18

Main associated species:

- *Cerianthus mediterraneus*
- *Cidaris cidaris*
- *Coelorinchus caelorhincus*
- *Dendrophyllia cornigera*
- *Desmophyllum dianthus*
- *Echinus melo*
- *Eledone cirrhosa*
- *Hexadella detritifera*
- *Hoplostethus mediterraneus*
- *Hymenocephalus italicus*
- *Munidopsis* sp.
- *Pelosina arborescens*
- *Peltaster placenta*
- *Penilpidia ludwigi*
- *Pteroctopus tetracirrhus*
- *Sepia orbignyana*
- *Sideractis glacialis*


Crustose structures associated with hydrothermal vents © OCEANA

Description

Crustose structures are the result of hydrothermal activity in the Aeolian area,[87] which has created chimneys, sulphide deposits, iron-rich crusts, and other hard and foam-like structures, as well as bacterial activity. The crustose structures were found on both rocky and muddy bottoms in all of the survey areas.

Many crustose structures had no epifauna. The larger (and presumably older) structures, where bacterial activity appeared to be reduced and substrates were harder, were the ones that hosted some cnidarians, like hydroids, corals (*Desmophyllum dianthus*), and anemones such as corallimorpharians (*Sideractis glacialis*). Some organisms, such as sponges (e.g., *Hexadella detritifera*) and stony corals (*Dendrophyllia cornigera*), were settled on the upper parts of rocky formations, in places where the crustose structures did not cover the apical surface.

In several places, hydrothermal vents were close to or associated with thanatocoenoses where remains of dead corals were abundant, although some live colonies of *Dendrophyllia cornigera* were also found.

Fossil reefs on bathyal bottoms

Depth range: 134 to 976 m

Distribution map: Figure 18

Main associated species:

- *Bathynectes maravigna*
- *Caryophyllia* spp.
- *Exidmonea atlantica*
- *Farrea bowerbanki*
- *Hexadella detritifera*
- *Munida* sp.
- *Munidopsis* sp.
- *Plesionika* spp.
- *Podospongia loveni*
- *Stenocyathus vermiformis*
- Zoanthidae indet.

Sponges and bryozoans growing on an old fossil reef © OCEANA

Description

Old fossilised coral reefs covered a wide depth range, although they were mostly found below 600 m depth.

Many species observed inhabiting this habitat type were similar to those on bathyal rocks (especially on vertical walls). However, a large number of crustacean species, like *Munidopsis* sp., *Bathynectes maravigna*, *Munida* sp. and *Plesionika* spp., were also found on these reefs.

Deep circalittoral and upper bathyal bottoms with mixed sediments

Depth range: 44 to 928 m

Distribution map: Figure 18

Main associated species:

- *Alcyonium palmatum*
- *Aulopus filamentosus*
- *Cerianthus membranceus*
- *Bebryce mollis*
- *Cidaris cidaris*
- *Coris julis*
- *Exidmonea atlantica*
- *Galeodea echinopora*
- *Pachastrella monilifera*
- *Reteporella grimaldi*
- *Serranus cabrilla*
- *Serpula vermicularis*
- *Stylocidaris affinis*
- *Tarantinaea lignaria*


Sea snail (*Tarantinaea lignaria*) among rhodoliths, cobbles and sand © OCEANA

Description

In the Mediterranean Sea, a transition area is commonly found between the circalittoral and bathyal zones. Here, dead remains of structuring biota such as rhodoliths, corals, shells, bryozoans and algae accumulate and mix with coarse sediment, sand and mud. These bottoms, known by various names in different languages (e.g., gravel, rubble, gravas, cascajo, pietrisco, gravir), can host high levels of biodiversity[88] over a bathymetric range of between 30 and 200 m depth.

In the Aeolians, this habitat was present across a much wider depth range (44 to 928 m), although it was more common in the lower circalittoral and upper bathyal zones. It supported a diverse variety of associated species, such as soft corals, tube anemones, bryozoans, polychaetes, gastropods, echinoderms, and fishes. Some species that are typical of hard bottoms were also documented, such as the gorgonian *Bebryce mollis* and the sponge *Pachastrella monilifera*, which can colonise these types of sediments.

Boulders on upper bathyal rocky bottoms

Depth range: 37 to 779 m

Distribution map: Figure 18

Main associated species:

- *Acanthogorgia hirsuta*
- *Anthias anthias*
- *Axinella* sp.
- *Bonellia viridis*
- *Callanthias ruber*
- *Callogorgia verticillata*
- *Cidaris cidaris*
- *Eximonea atlantica*
- *Haliclona mucosa*
- *Hexadella detritifera*
- *Octopus vulgaris*
- *Peltaster placenta*
- *Serranus cabrilla*
- *Swiftia dubia*

Slender rockfish (*Scorpaena elongata*), sea fans (*Callogorgia verticillata*), snails, and polychaetes on boulder © OCEANA

Description

Boulders created specific areas full of cavities and refuges that were utilised by different species as shelter, and also as substrate upon which various species could settle, such as the gorgonians *Callogorgia verticillata* and *Swiftia dubia*, as well as polychaetes, sponges and soft and stony corals. Several species of crustaceans and fishes used the crevices and hollows to hide and escape from predators.

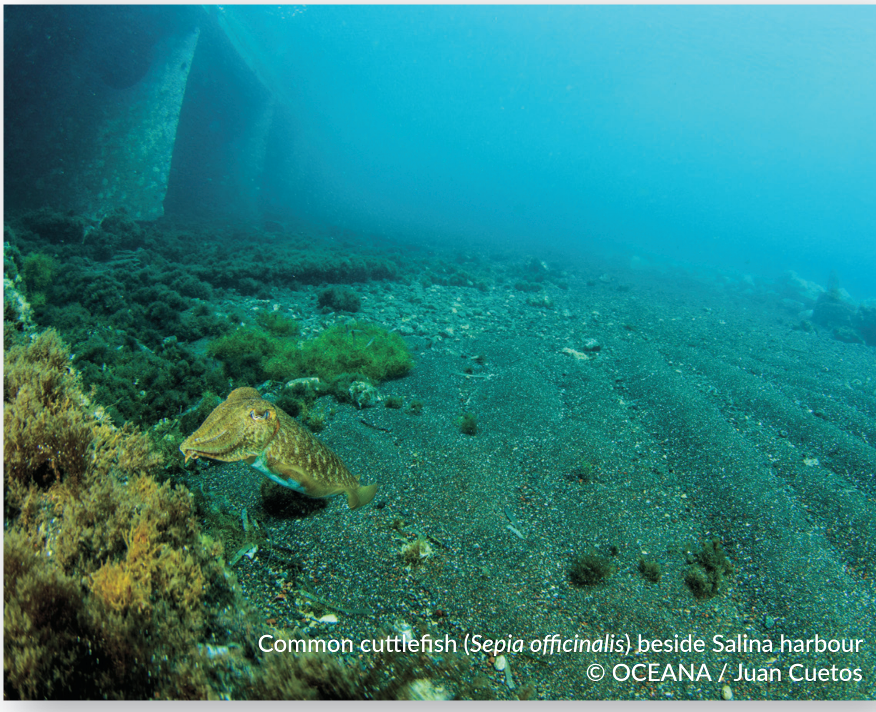
Artificial habitats

Depth range: 6 to 16 m

Distribution map: Figure 18

Main associated species:

- *Acetabularia acetabulum*
- *Astropecten bispinosus*
- *Cystoseira* sp.
- *Dictyota* spp.
- *Echinaster sepositus*
- *Holothuria tubulosa*
- *Hypselodoris picta*
- *Ilia nucleus*
- *Liocarcinus corrugatus*
- *Maja squinado*
- *Mullus surmuletus*
- *Octopus vulgaris*
- *Posidonia oceanica*
- *Sepia officinalis*
- *Serranus scriba*
- *Symphodus tinca*


Common cuttlefish (*Sepia officinalis*) beside Salina harbour
© OCEANA / Juan Cuetos

Description

Harbours and coastal development have changed the morphology of the Aeolian coasts, providing new and different substrates upon which marine species can settle. Even domestic waste – a known threat to marine life – can sometimes increase the complexity of a certain area, and create new artificial habitats. Discarded tyres, fishing gears, plastic waste, metallic waste, etc., were observed to have been colonised by sessile species. In some cases, such materials act as artificial reefs, concentrating fauna and flora on and around them.

As an example, the marina on Salina hosted a relatively high level of marine biodiversity, including seagrass patches of *Posidonia oceanica*, algal-dominated communities, a wide variety of crustaceans, molluscs, echinoderms and fishes.

12. Pelagic habitat

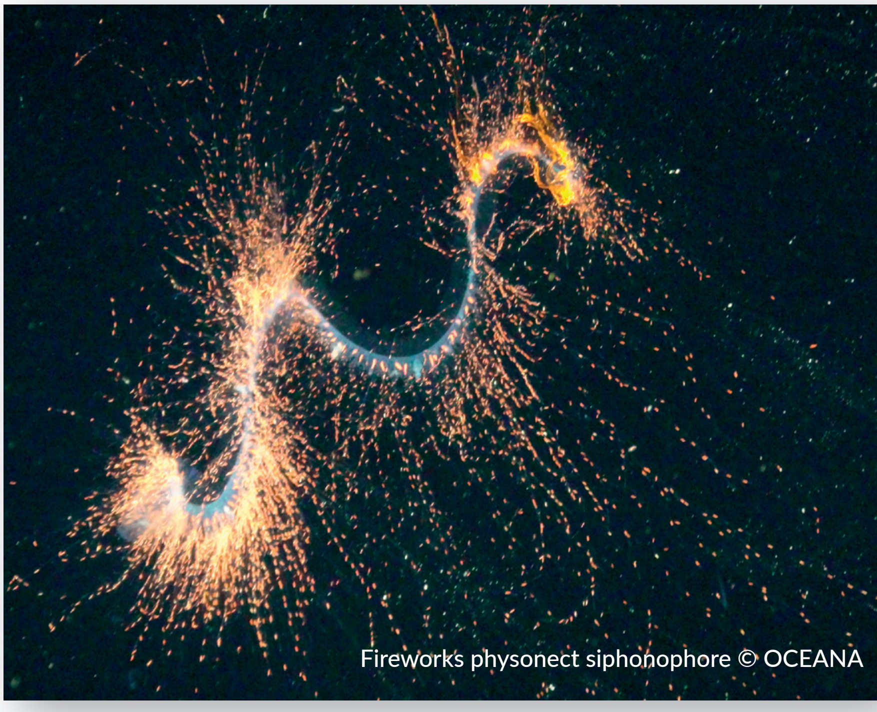
In addition to the exploration of benthic communities and ecosystems, surveys documented a series of species that inhabit the water column. Physicochemical factors such as temperature, light penetration, and dissolved organic matter are, like on the sea bottom, critical determinants of the distributions of species that swim or float in this zone. In the Aeolian Islands, a wide variety of species were documented in the water column, including gelatinous organisms in particular, as well as fishes and arthropods, among others.

Pelagia noctiluca © OCEANA/ Enrique Talledo

Pelagic realm

Main associated species:

- *Apolemia uvaria*
- *Argonauta argo*
- *Beroe* spp.
- *Bolinopsis infundibulum*
- *Chauliodus sloani*
- *Cyclothone braueri*
- *Eusergestes arcticus*
- *Electrona risso*
- *Forskalia edwardsii*
- *Janthina* spp.
- *Pasiphaea multidentata*
- *Pasiphaea sivado*
- *Pleurobrachia pileus*
- *Solmissus albescens*
- *Stomias boa*
- *Sudis hyaline*



Fireworks physonect siphonophore © OCEANA

Description

The most commonly observed species in the water column were gelatinous ones, including ctenophores (*Beroe* spp., *Bolinopsis infundibulum*, *Pleurobrachia pileus*), siphonophores (*Forskalia edwardsii*, *Apolemia uvaria*) and jellyfishes, both Scyphozoa and Hydrozoa, particularly the narcomedusa *Solmissus albescens*.

Fishes recorded from the water column included: various myctophiform and stomiiform species, such as *Electrona risso*, *Cyclothone braueri*, *Stomias boa* and *Chauliodus sloani*; aulopiform fishes, such as *Sudis hyalina*; crustaceans, such as *Eusergestes arcticus*, *Pasiphaea sivado* and *P. multidentata*; and various species of krill, mysids, and arrow worms (chaetognaths).

Further insights into the composition of the pelagic community were provided through the observation of many shells of pelagic molluscs on the seabed. These species included *Argonauta argo*, *Janthina* spp., and pteropods.

THREATENED, RARE AND OTHER KEY SPECIES

The Aeolian archipelago has long been recognised as an important area for marine biodiversity, and the 2018 Oceana expedition confirmed the value of Aeolian waters – both shallow and deep – for a wide array of threatened, rare, and other key species of interest. Among the species documented, some are protected under European or international legal frameworks, and/or are considered threatened and listed as such. Other documented species represent findings of particular scientific interest, because they constitute new records or are considered rare. The distributions of those species are either not well known or have been little reported in scientific records for the region or the Mediterranean in general. Finally, the occurrence of other species is worth noting because they are non-indigenous and/or considered invasive, and may be harmful to local native marine ecosystems.

Threatened and/or protected species

Of the 902 taxa identified during the 2018 Aeolian expedition, 16 species are considered threatened and are included on national, regional, or global IUCN Red Lists, which assess the state of conservation of species, categorising them according to their level of extinction risk (Annex V). Among these organisms, those listed at the highest levels of threat were red corals, black corals, and other cold-water coral species that are variously threatened by overexploitation, fishing impacts, and other anthropogenic activities.[53]

The most remarkable discovery was a spectacular forest of bamboo coral, which was one of the densest and largest found in the Mediterranean.

A total of 34 recorded species from the Aeolians are legally protected under different international frameworks (see Annex V). Twenty-eight species are granted relatively stronger protection, under: the Habitats Directive (Annex II & IV), which requires the creation of protected areas and management plans to ensure the protection of listed species; the Bern Convention (Appendices I & II), which grants strict protection to species and the conservation of their habitats; and the Barcelona Convention (Annex II of the SPA/BD Protocol), which requires Mediterranean countries to ensure the maximum possible protection and recovery of listed species, and to prohibit destruction of and damage to their habitats. Most of these protected species were cnidarians (n=11), followed by molluscs (n=6), in part reflecting the higher relative coverage of these groups under the Barcelona Convention. An additional six species are protected to a lesser extent, under legal frameworks that allow their exploitation but require it to be managed: the Habitats Directive (Annex V); the Bern Convention (Appendix III); and the Barcelona Convention (Annex III of the SPA/BD Protocol).

Selected highlights of the most important findings for conservation are presented below:

- The most remarkable discovery was a spectacular forest of bamboo coral (*Isidella elongata*), which was one of the densest and largest forests found to date in the Mediterranean Sea. This species – and therefore the forests that it forms – is strictly protected in the Mediterranean Sea, under Annex II of the SPA/BD Protocol of the Barcelona Convention. It is considered Critically Endangered by IUCN and is a key forming-habitat species on muddy bottoms; it also provides important habitat for several commercial species.

- Another significant finding was of forests formed by the black coral *Antipathella subpinnata*, protected under Annex II of the Barcelona Convention.[38] This habitat seems to play an important role for oviparous sharks, which lay their eggs on the *A. subpinnata* branches. As in the Aeolians, similar shark behaviour has been documented with other black coral species, such as *Leiopathes glaberrima*, in other Mediterranean locations including southwest Sardinia[89] and offshore from Morocco (R. Aguilar, pers. obs.).
- Although *L. glaberrima* was not documented as forming forests, the discovery of large colonies of this black coral was nevertheless noteworthy, as this species can live more than 4000 years[90]; it may be the colonial organism with longest life-span worldwide. The ages of colonies found in Italy have been estimated at 2000 years old[91]. This species is protected under Annex II of the Barcelona Convention[38], and is categorised as Endangered on both the Mediterranean and Italian Red Lists.
- The hatpin urchin (*Centrostephanus longispinus*), which is strictly protected under both the Habitats Directive and the Barcelona Convention, was also recorded in Aeolian waters. It is considered a relic species in the Mediterranean, as it is the only representative member of the order Diadematoida.
- The loggerhead turtle *Caretta caretta* and *Posidonia oceanica* seagrass were documented on multiple occasions during this expedition. Both are considered priority features of community interest in the European Union, protected under the Habitats Directive in Annex I in the case of *P. oceanica* and Annex II and IV in the case of *C. caretta*.[17] Both are also protected unther the Annex II of the Barcelona Convention at the scale of the Mediterranean.[38]


Detail of fire worm (*Hermodice carunculata*)
© OCEANA/ Juan Cuetos

Species of scientific interest

Other findings of particular relevance for science included species for which the expedition provided the first-ever records from the Aeolians or the Mediterranean, or the first recent records after many years. Some of these uncommon species may have always been present in the Aeolian Islands, but had gone unnoticed due to the general lack of deep-sea research in the area. This is the case of the deep-sea holothurian *Penilpidia ludwigi*, the carnivorous sea squirt *Dicopia antirrhinum*, and several molluscs.

Another example is the goby *Gobius kolombatovici*, which had not been reported from the Aeolians, despite being a common species in shallow waters of the archipelago. This species had been considered endemic to the northern Adriatic Sea where it was first discovered[92]. More recently, it was found in several western Mediterranean sites[93] and has now been documented in the Aeolians.

Other documented species of scientific interest include:

- The first record of the sea star *Zoroaster fulgens* from the Mediterranean, despite extensive studies having been previously carried out in other Mediterranean sites.
- The Messina rockfish (*Scorpaenodes arenai*) was originally thought to be endemic to the Strait of Messina, until it was recently found in other western Mediterranean locations, and even in the Atlantic Ocean[94]. These surveys have provided the first record of *S. arenai* from the Aeolians.
- The habitat-forming species *Neopycnodonte zibrowii* (giant oyster) has only been recently discovered and is extremely vulnerable, as its lifespan may be more than 500 years[95]. Despite the fact that aggregations of this mollusc were not observed in the Aeolians, as are typically seen in other Mediterranean and Atlantic sites[71], its presence may nevertheless indicate the existence of that important biogenic habitat in other, non-surveyed areas in Aeolian waters.
- Other species recently discovered or rediscovered in the Mediterranean Sea and now recorded in the Aeolian Islands were the soft corals *Nidalia studeri*[96] and *Chironephthya mediterranea*[97], as well as the hexactinellid sponge *Farrea bowerbanki*[98].
- The non-indigenous green macroalgae *Caulerpa cylindracea*, widely distributed in the Mediterranean Sea, was also documented during the expedition, and was found to cover extensive areas. Other cryptogenic species recorded here were the molluscs *Naria turdus* and *Teredo navalis.* [99]

Naria turdus © OCEANA

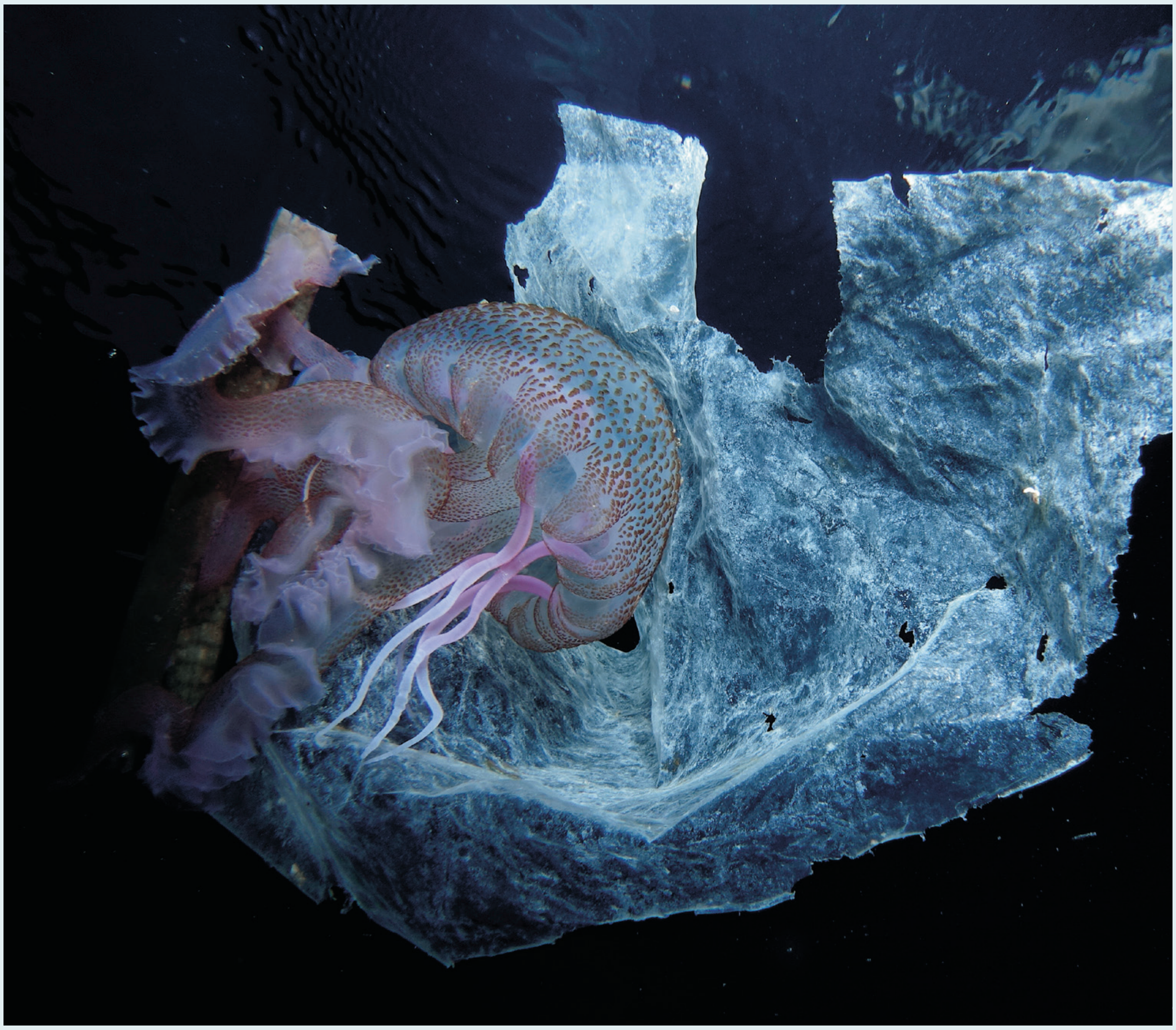
HUMAN IMPACTS DOCUMENTED DURING THE 2018 EXPEDITION

As well as revealing the diversity of marine ecosystems and species in Aeolian waters, the 2018 expedition also recorded a variety of human impacts on marine life, both on the sea bottom and in the water column.

Although direct fisheries impacts on the seabed were less apparent than in some other parts of the Mediterranean, discarded or lost fishing gear or fishing-related objects nevertheless represented the most obvious threat observed. These objects included fishing lines, nets, and ropes, and they were widespread throughout the archipelago, recorded from all seven of the survey areas. In some cases, protected and threatened species were found entangled in fishing lines, which had visibly affected their growth and development, or appeared to have directly caused their death. This was the case of black and stony corals and sponges, as well as a dead loggerhead turtle (*Caretta caretta*) that was found floating in the water column, its mouth hooked on a fishing line.

Caretta caretta **hooked on a ghost fishing line © OCEANA/ Juan Cuetos**

Multiple types of plastics (e.g., bags, boxes, and sheets) and household garbage also represented a significant part of the impacts observed in the Aeolians, recorded from both benthic and pelagic ecosystems. In particular, a small valley on the seabed of the Banco del Bagno survey area was filled with domestic garbage, such as drink cans, glass bottles, and plastic cutlery.



***Pelagia noctiluca* wrapped in floating plastic © OCEANA/ Enrique Talledo**

Finally, other anthropogenic impacts were also documented during the research work, including the presence of large pieces of metal, tyres, and pipelines on the seafloor.

Abandoned balloon © OCEANA/ Enrique Talledo

Different sorts of garbage accumulated on the seabed in Banco del Bagno © OCEANA/ Enrique Talledo

CONCLUSIONS

There is no doubt about the richness hidden below the waters of the Aeolian archipelago. The combination of its geographic location, wide variety of substrates, broad depth range, and the occurrence of exceptional marine underwater features such seamounts and hydrothermal vents makes this area a perfect enclave for marine life – both the organisms that inhabit the area, and the many migratory species that regularly visit it.

The marine biodiversity value of the Aeolian Islands was formally recognised more than 35 years ago, when the Italian government identified the area as a potential MPA.[22] Yet, until now, information about benthic ecosystems has been lacking, particularly from deeper waters, which represent most of the marine area of the archipelago. With the official process to propose and designate an Aeolian Islands MPA underway, it is critical that such data be collected and used to inform the design and management of the protected area.

The 2018 Aeolians expedition sought to address this clear data need. Over the course of one month, Oceana surveys revealed the occurrence of more than 900 taxa, from a wide variety of diverse marine ecosystems, ranging from biologically rich meadows of seagrass (*Posidonia oceanica*) in the shallowest areas, to gardens of gorgonians (such as *Bebryce mollis*, *Swiftia dubia*, and *Villogorgia bebrycoides*) and forests and aggregations of black corals (such as *Antipathes dichotoma*, *Antipathella subpinnata* and *Leiopathes glaberrima*) at intermediate depths, and to glass sponge aggregations (*Farrea bowerbanki*) on the deepest rocky bottoms surveyed. Dense maërl beds were found on the continental shelf, while flat, soft-sediment bottoms were covered by bamboo coral gardens (*Isidella elongata*), carnivorous sea squirts (*Dicopia antirrhinum*), and carnivorous sponges (*Cladorhiza abyssicola*).

These ecosystems were located throughout the archipelago, further emphasising the high biodiversity value of Aeolian waters in general, and the need for their broad-scale protection, rather than only isolated areas.

The findings of the expedition also made clear that the creation of one of more MPAs in the Aeolian Islands is not optional; marine ecosystems in the area are home to a wide array of species, communities, and habitat types which must be protected, under European and/or international laws and conventions to which Italy is signatory (see Annexes III and V). These frameworks and their implications for the Aeolian Islands are outlined below:

1) EU Habitats Directive
   Current Natura 2000 sites in the Aeolian Islands are mainly terrestrial, but include some limited areas of marine habitats, specifically *Posidonia* beds, coastal lagoons, reefs, and submerged or partially submerged caves.[100] They do not, however, encompass two other priority habitats for protection that occur in the Aeolians: sandbanks and submarine structures made by leaking gases.

2) Barcelona Convention
   The Barcelona Convention comprises seven protocols concerning various aspects of the conservation and protection of the Mediterranean Sea. Two of these protocols relate specifically to marine biodiversity protection; the Protocol on Integrated Coastal Zone Management (ICZM) promotes marine habitat protection and specifically refers to the special environmental protection measures needed for islands, while the Protocol Concerning Specially Protected Areas and Biological Diversity (SPA/BD) covers the protection of biodiversity, including the designation of specially protected areas. Such MPAs may be established for various reasons, including the conservation of threatened habitat and species.

This expedition documented the occurrence of 24 species that are strictly protected under Annex II of the SPA/BD Protocol (see Annex V). For these species, Italy is required to ensure the maximum possible protection and recovery, and to prohibit destruction of and damage to their habitats. A further six species were recorded that are listed under Annex III of the same protocol, and so must be managed to maintain a favourable conservation status.

In addition to listed species, the SPA/BD Protocol also relates to a series of nine Action Plans for the conservation of Mediterranean species and habitats, eight of which apply to the Aeolian Islands.[a] These Action Plans concern both priority species in the archipelago (e.g., turtles, cetaceans, and seabirds), and key habitat and community types. The expedition documented many habitat types covered within the Action Plans, particularly those related to marine vegetation, coralligenous and maërl/rhodolith beds, and 'dark habitats' (see Annex III). In particular, the *Dark Habitats Action Plan* covers many of the assemblages and communities found during this expedition, including habitats formed by stony corals, black corals, sea pens, gorgonians, and sponges. In addition, in the case of the *Action Plan on Cartilaginous Fishes*, one of the stated objectives is the "protection and restoration of critical habitats, such as mating, spawning and nursery grounds"[101], which is clearly relevant to areas such as the black coral forest found to the north of Lipari.

a Action Plan for the Conservation of Mediterranean Marine Turtles; Action Plan for the Conservation of Cetaceans in the Mediterranean Sea; Action Plan for the Conservation of Bird Species Listed in Annex II of the SPA/BD Protocol; Action Plan for the Conservation of Marine Vegetation in the Mediterranean Sea; Action Plan on Cartilaginous Fishes in the Mediterranean Sea; Action Plan on Introduction of Species and Invasive Species in the Mediterranean Sea; Action Plan on for the Conservation of the Coralligenous and other Calcareous Bio-concretions in the Mediterranean; and Action Plan for the Conservation of Habitats and Species associated with Seamounts, Underwater Caves and Canyons, Aphotic Hard Beds and Chemo-synthetic Phenomena in the Mediterranean Sea (Dark Habitats Action Plan).

In addition to the above requirements, other legislative instruments, such as those related to fisheries management, are also relevant to the conservation of benthic marine ecosystems in the Aeolian Islands. For example, the EU *Regulation concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea* prohibits the use of towed bottom-contacting fishing gears over seagrasses, maërl beds, and coralligenous habitat.[39] At the broader scale of the Mediterranean, the FAO General Fisheries Commission for the Mediterranean is in the process of developing measures for the protection of vulnerable marine ecosystems (VMEs), which will be relevant for many of the deep-sea communities and habitats documented here.

Overall, it is clear that for Italy to comply with EU and international laws and conventions, spatial protection of marine ecosystems in the Aeolian Islands must be significantly increased, through the expansion of existing MPAs and/or the designation of new marine areas as protected. Currently, the MPAs in place under the Natura 2000 network in the Aeolian Islands are relatively limited and do not cover the diverse and valuable offshore habitats described here. Critically, newly protected areas must include the wide array of ecosystems, habitats, and communities present in the Aeolian Islands, with a special focus on those that: require legal protection; are threatened (e.g., bamboo corals) or are important for other threatened species; are vulnerable marine ecosystems; act as essential fish habitats (e.g., black corals); or are absent from the current network of MPAs in the area (e.g., hydrothermal vents). It should also be noted that while the Oceana 2018 Aeolian expedition revealed a wealth of information about Aeolian marine ecosystems and priorities for conservation, this research was not exhaustive. Further study may reveal additional areas that also merit protection in this exceptional archipelago.

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Oceana warmly acknowledges the Ranger crew for their hard work and assistance during the expedition.

Couple of painted comber (*Serranus scriba*) in courting and group of damselfishes (*Chromis chromis*)
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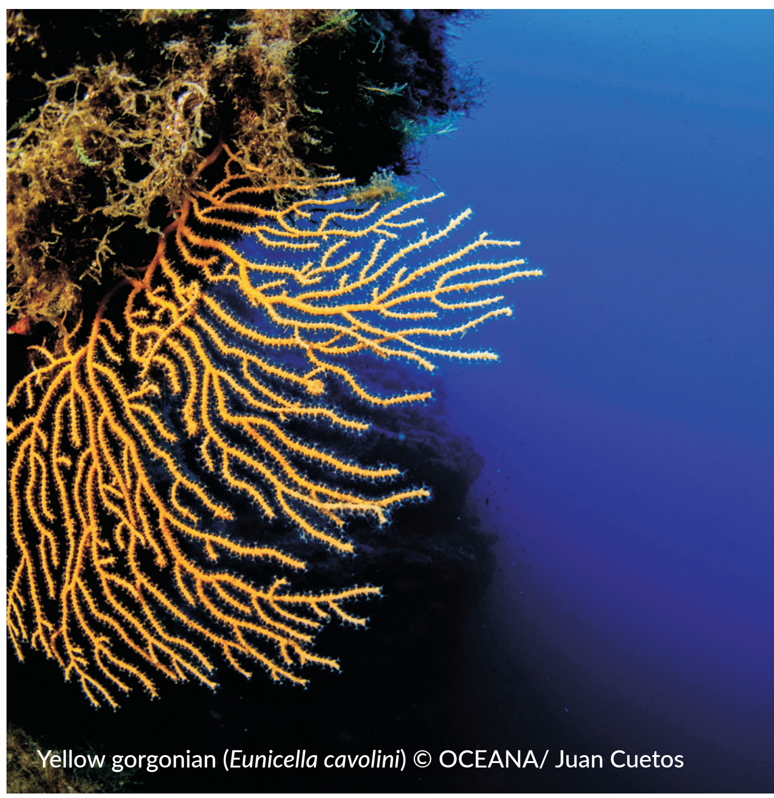
ANNEX

Annex I. List of habitats/communities found in Aeolian waters during the 2008 Oceana Mediterranean expedition

- Rocks covered by brown macroalgae on infralittoral and circalittoral bottoms
- *Eunicella cavolini* on rocky infralittoral and circalittoral bottoms
- *Eunicella singularis* on rocky and detritic infralittoral circalittoral bottoms
- Coralligenous beds on circalittoral bottoms
- Rocks with coralline algae on circalittoral bottoms
- Rhodolith beds on circalittoral bottoms
- Detritic bottoms with algal and seagrass remains and accumulations on circalittoral bottoms
- Sandy circalittoral and upper bathyal bottoms with *Neopycnodonte cochlear, Stylocidaris affinis* and *Acromegalomma vesiculosum*
- *Dendrophyllia cornigera* on rocky and soft bottoms
- Crustose structures on circalittoral and bathyal bottoms
- Deep circalittoral and upper bathyal rocky bottoms with *Haliclona mucosa*
- Deep circalittoral and upper bathyal rocky bottoms with *Antipathella subpinnata*
- Bathyal rocks with *Antipathes dichotoma*
- Pennatulaceans on deep circalittoral and upper bathyal sandy/muddy bottoms
- Deep-sea bathyal rocky slopes with *Leiopathes glaberrima* and *Neopycnodonte zibrowii*
- Deep circalittoral and upper bathyal rocky bottoms with *Viminella flagellum*
- Bathyal rocks with *Pachastrella monilifera* and/or *Poecillastra compressa*
- Bathyal sandy/muddy bottoms with *Cidaris cidaris*
- Bathyal rocky walls/steep rocks with polychaetes, brachiopods, sponges and corals
- Bathyal muds without epifauna
- Fossil reefs on bathyal bottoms
- Deep circalittoral and upper bathyal bottoms with mixed sediments
- Boulders on upper bathyal rocky bottoms
- Assemblages of *Ophiura ophiura* on circalittoral mixed sediments and sandy bottoms
- Pelagic realm



Yellow gorgonian (*Eunicella cavolini*) © OCEANA/ Juan Cuetos

Annex II. List of habitats/communities found during the 2018 Oceana Aeolian expedition

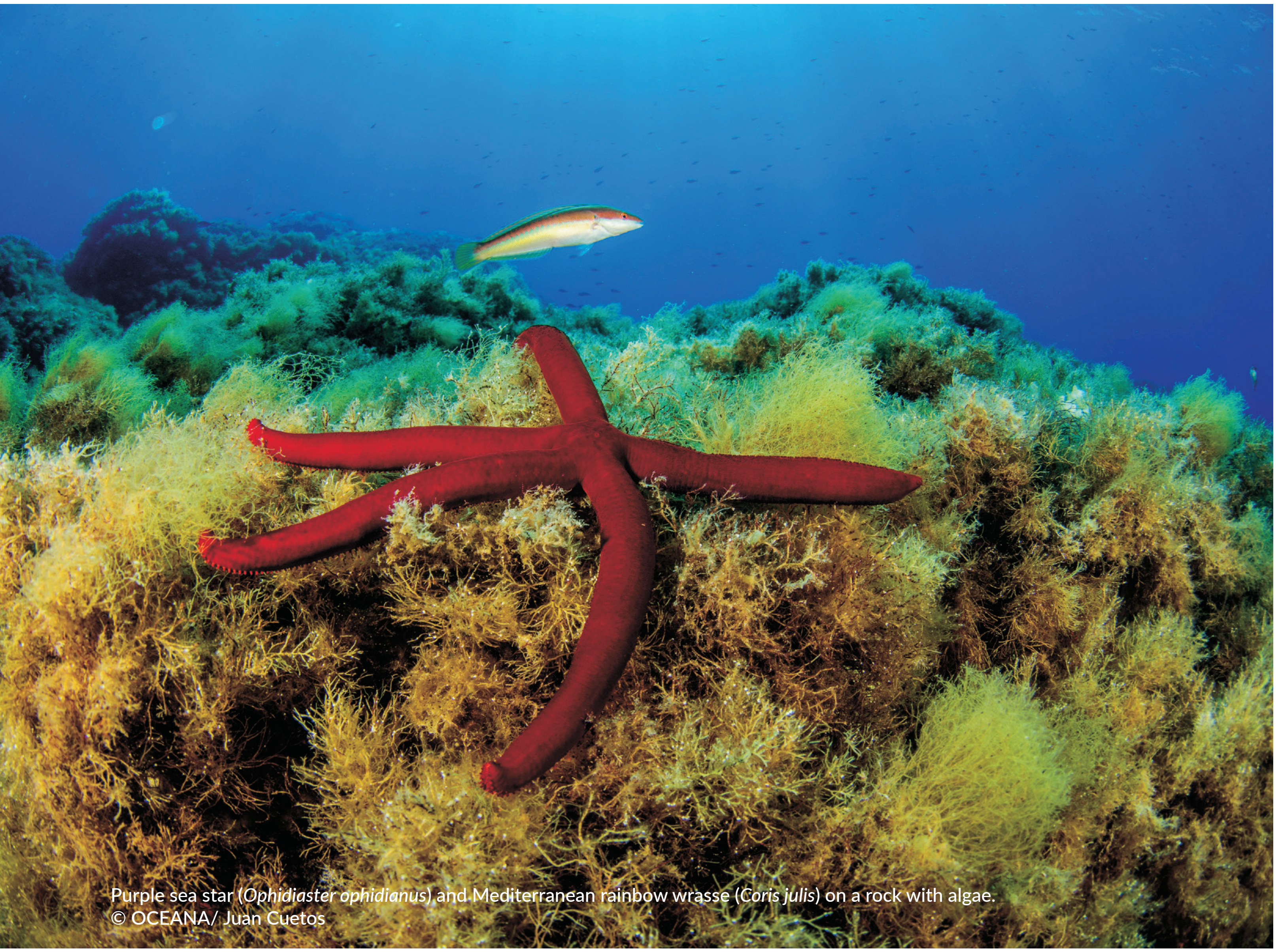
1. Shallow bottoms with macroalgae and seagrasses
   - Seagrass meadows (*Posidonia oceanica* and *Cymodocea nodosa*) on infralittoral bottoms
   - Rocks covered by brown macroalgae on infralittoral and circalittoral bottoms
   - *Cystoseira* forest (*C. spinosa* and *C. compressa*) on infralittoral and circalittoral rocky bottoms
   - Infralittoral and circalittoral bottoms dominated by *Caulerpa cylindracea* beds
   - Detritic circalittoral bottoms with macroalgal and seagrass remains and accumulations
   - Infralittoral sandy bottoms
   - Infralittoral rocky bottoms dominated by fauna
2. Maërl beds and coralligenous habitats
   - Coralligenous beds on circalittoral bottoms
   - Old coralligenous structures with crevices, cavities and overhangs
   - Rhodolith beds on circalittoral bottoms
   - Rocks with coralline algae on circalittoral bottoms
3. Soft bottoms with echinoderms and/or oyster aggregations
   - Detritic circalittoral and upper bathyal bottoms with ceriantharians and *Stylocidaris affinis*
   - Bathyal muddy bottoms with *Penilpidia ludwigi*
   - Sandy circalittoral and upper bathyal bottoms with *Neopycnodonte cochlear, Stylocidaris affinis and Acromegalomma vesiculosum*
   - Circalittoral sandy bottoms with *Ophiopsila aranea*
   - Circalittoral and bathyal bottoms with aggregations of *Cidaris cidaris*
4. Gorgonian gardens on rocky and muddy bottoms
   - Bathyal rocks with *Swiftia dubia*
   - *Bebryce mollis* on rocky and soft circalittoral and bathyal bottoms
   - Deep-sea bathyal muddy bottoms with *Isidella elongata*
   - *Eunicella cavolini* on rocky infralittoral and circalittoral bottoms
   - *Eunicella singularis* on rocky and detritic infralittoral and circalittoral bottoms
   - *Paramuricea clavata* on rocky infralittoral and circalittoral bottoms
   - Deep circalittoral and upper bathyal rocky bottoms with *Viminella flagellum*
5. Sea bottoms with sea pens and hydrozoans
   - *Funiculina quadrangularis* on deep circalittoral and upper bathyal sandy/muddy bottoms
   - Deep circalittoral and upper bathyal rocky and detritic bottoms with *Nemertesia* spp.
   - Bathyal sandy/muddy bottoms with *Lytocarpia myriophyllum*
6. Rocky bottoms with black corals
   - Deep circalittoral and upper bathyal rocky bottoms with *Antipathella subpinnata*
   - Bathyal rocks with *Parantipathes larix*
   - Bathyal rocks with *Antipathes dichotoma*
   - Deep-sea bathyal rocky slopes with *Leiopathes glaberrima*

Branchial plume of sea slug (*Felimare picta*)
© OCEANA/ Juan Cuetos

7. Habitats formed by sponges
   - Deep circalittoral and upper bathyal rocky bottoms with *Haliclona mucosa*
   - Bathyal muddy bottoms with *Thenea muricata*
   - *Aaptos aaptos* on bathyal rocks heavily affected by sedimentation
   - Deep-sea oligotrophic bathyal muddy bottoms with *Cladorhiza abyssicola* and *Dicopia antirrhinum*
   - Bathyal rocks with *Pachastrella monilifera* and/or *Poecillastra compressa*
   - Deep-sea bathyal rocky bottoms with *Farrea bowerbanki*
   - Deep-sea bathyal rocky bottoms with *Podospongia loveni*
8. Stony coral and tube anemone dominated bottoms
   - Infralittoral and circalittoral rocks, walls and overhangs with *Cladopsammia rolandi*, *Leptosammia pruvoti* and/or *Astroides calycularis*
   - Bathyal rocky walls/steep rocks with polychaetes, brachiopods, sponges and solitary corals
   - Bathyal rocky walls and overhangs with *Thalamophyllia gasti*
   - *Dendrophyllia cornigera* on rocky and soft bottoms
   - Sandy/muddy circalittoral and upper bathyal bottoms with *Caryophyllia smithii*
   - Sandy/muddy circalittoral and upper bathyal bottoms with *Cerianthus membranaceus*
9. Other habitats
   - Bathyal muds without epifauna
   - Ampeliscidae on rocky and muddy bathyal bottoms
   - Circalittoral and bathyal soft bottoms with foraminifera
   - Sunken trees with Teredinidae (Bathyal)
10. Soft bottoms with bioturbations
   - Bioturbations created by *Lesueurigobius* spp. and/or *Goneplax rhomboides* in bathyal sandy/muddy bottoms
   - Bioturbations created by *Cepola macrophthalma* in bathyal sandy/muddy bottoms
   - Bioturbations created by *Nephrops norvegicus* in bathyal muddy bottoms
11. Geogenic and artificial habitats
   - Caves
   - Crustose structures on circalittoral and bathyal bottoms
   - Fossil reefs on bathyal bottoms
   - Deep circalittoral and upper bathyal bottoms with mixed sediments
   - Bulders on upper bathyal rocky bottoms
   - Artificial habitats
12. Pelagic habitat
   - Pelagic realm

Annex III. List of protected habitats and communities found during the 2018 Oceana Aeolian expedition

Habitats and communities listed are either included on Annex I or II of the EU Habitats Directive,[17] Annex II[38] of the SPA/BD Protocol of the Barcelona Convention, are protected from bottom-contacting fishing gears under the EC regulation (1967/2006) concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea[39] and/or are included in one of the following UNEP-MAP Action Plans: the Action Plan for the conservation of marine vegetation in the Mediterranean Sea;[40] the Action Plan for the conservation of the coralligenous and other calcareous bioconcretions in the Mediterranean Sea;[46] or the Conservation of Habitats and Species Associated with Seamounts, Underwater Caves and Canyons, Aphotic Hard Beds and Chemo-synthetic Phenomena in the Mediterranean Sea (Dark Habitats Action Plan)[59] or its accompanying guidelines.[55]



Purple sea star (*Ophidiaster ophidianus*) and Mediterranean rainbow wrasse (*Coris julis*) on a rock with algae.
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Habitat/Community	EU Habitats Directive	Barcelona Convention (SPA/BD Protocol)	EC Regulation 1967/2006	UNEP-MAP Action Plans
Tracheophyta				
Posidonia oceanica meadows	Annex I (1120)	Annex II	✓	Marine Vegetation
Cymodocea nodosa meadows		Annex II	✓	Marine Vegetation
Ochrophyta				
Cystoseira belts				Marine Vegetation
Rhodophyta				
Coralligenous beds	Annex I (1170)		✓	Coralligenous and calcareous bioconcretions
Maërl beds			✓	Coralligenous and calcareous bioconcretions
Cnidaria				
Astroides calycularis facies	Annex I (1170)	Annex II		Dark habitats
Antipathella subpinnata forests		Annex II		Dark habitats
Antipathes dichotoma		Annex II		Dark habitats
Bebryce mollis forests				Dark habitats
Bottoms with *Caryophyllia calveri/ smithii*				Dark habitats
Cerianthus membranaceus				Dark habitats
Dendrophyllia cornigera forests	Annex I (1170)	Annex II		Dark habitats
Bottoms with *Desmophyllum dianthus*				Dark habitats
Eunicella singularis forests	Annex I (1170)			
Isidella elongata forests	Annex I (1170)	Annex II		Dark habitats
Leipathes glaberrima forests		Annex II		Dark habitats
Paramuricea clavata forests	Annex I (1170)			
Parantipathes larix forests		Annex II		Dark habitats
Pennatula spp.				Dark habitats
Swiftia dubia forests				Dark habitats
Bottoms with *Stenocyathus vermiformis*				Dark habitats
Viminella flagellum forests	Annex I (1170)			
Porifera				
Aaptos aaptos aggregations				Dark habitats
Bottoms with *Cladorhiza abyssicola*				Dark habitats
Bottoms with *Pachastrella moilifera*				Dark habitats
Bottoms with *Poecillastra compressa*				Dark habitats
Bottoms with *Thenea muricata*				Dark habitats
Others				
Caves				Dark habitats

Annex IV. List of species identified from the 2018 Oceana Aeolian expedition, according to survey methodology.

Species	ROV	Scuba	Grab
Annelida			
Acromegalomma vesiculosum	X		
Annelida indet.	X		X
Bispira volutacornis	X		
Bonellia viridis	X	X	
Ditrupa arietina	X		
Errantia indet.	X		
Eupolymnia nebulosa	X	X	
Filograna implexa	X	X	X
Hermodice carunculata	X	X	
Hyalinoecia tubicola	X		
Mesochaetopterus rogeri	X		
Myxicola aesthetica	X	X	
Myxicola infundibulum	X		
Nereiphylla paretti			X
Polychaeta indet.	X	X	X
Polydora sp.	X		
Protula intestinum	X	X	
Protula sp.		X	
Protula tubularia	X	X	
Sabella discifera	X		
Sabella pavonina	X	X	X
Sabella sp.	X		
Sabella spallanzanii	X	X	
Sabellidae indet.	X		
Serpula sp.	X		
Serpula vermicularis	X	X	
Serpulidae indet.	X		
Spirobranchus sp.			X
Spirobranchus triqueter			X
Spirorbis sp.		X	
Terebellidae indet.	X		
Vermiliopsis monodiscus	X		

Species	ROV	Scuba	Grab
Arthropoda			
cf. *Achelia echinata*	X		
Adna anglica		X	
Ampelisca sp.			X
Ampelisca spinipes			X
Ampeliscidae indet.	X		
Amphipoda indet.	X		
Anamathia rissoana	X		
Anilocra sp.		X	
Anomura indet.	X		
Aristaeomorpha foliacea	X		
Aristeus antennatus	X		
Balanus sp.	X		
Bathynectes maravigna	X		
Boreomysis arctica	X		
Boreomysis indet.	X		
Brachyura indet.	X		
Calappa granulata	X		
Calcinus tubularis	X	X	
Caridea indet.	X		
Cestopagurus timidus		X	
Clibanarius erythropus		X	
Copepoda indet.	X		
Dardanus arrosor	X		
Dardanus calidus	X	X	
Distolambrus maltzami	X		
Dromia personata		X	
Ebalia cranchii			X
Ebalia nux			X
Ebalia tuberosa			X
Epimeria (Epimeria) cornigera	X		
Eualus sp.	X		
Euphausiacea indet.	X		

Species	ROV	Scuba	Grab
Eurynome aspera			X
Eusergestes arcticus	X		
Galathea strigosa	X	X	
Gnathia sp.		X	
Gnathophyllum elegans		X	
Goneplax rhomboides	X		
Homola barbata	X		
Ilia nucleus		X	
Inachus dorsettensis	X		
Inachus phalangium		X	
Inachus sp.	X		
Latreillia elegans	X		
Lepadomorpha indet.	X		
Lepas (Anatifa) pectinata			X
Ligur ensiferus	X		
Liocarcinus corrugatus		X	
Maja squinado	X	X	
Meganyctiphanes norvegica	X		
Munida rugosa	X		
Munida sp.	X		
Munidopsis sp.	X		
Mysida indet.	X		
Neomaja goltziana	X		
Nephrops norvegicus	X		
Ostracoda indet.	X		
Pagurus anachoretus	X		X
Pagurus prideaux	X		X
Pagurus sp.	X		
Palinurus elephas	X		X
Pasiphaea multidentata	X		
Pasiphaea sivado	X		
Periclimenes sp.	X		
Phronima sedentaria	X		
Plesionika acanthonotus	X		
Plesionika antigai	X		

Species	ROV	Scuba	Grab
Plesionika edwardsii	X		
Plesionika gigliolii	X		
Plesionika martia	X		
Plesionika narval	X		
Plesionika sp.	X		
Polycheles typhlops	X		
Pycnogonida		X	
Scyllarus arctus	X		
Spinolambrus macrochelos	X		
Stenopus spinosus	X		
Brachiopoda			
Argyrotheca cuneata		X	X
Brachiopoda indet.	X		
Gryphus vitreus	X		
Megerlia truncata	X		X
Novocrania anomala	X	X	
Terebratulina retusa	X		
Bryozoa			
Adeonella calveti	X	X	X
Bicellariella ciliata	X		
Bryozoa indet.	X	X	X
Bugulina calathus		X	
Caberea boryi	X	X	X
Caberea ellisii	X		
Caberea sp.	X		
Candidae indet.	X		
Cellaria fistulosa	X	X	
Cellaria sp.	X		
Cellepora pumicosa	X	X	X
Celleporina caminata			X
Celleporina sp.	X		X
Cradoscrupocellaria reptans	X	X	X
Crisia sp.	X	X	X
Dentiporella sardonica	X	X	
Diplosolen obelium			X

Species	ROV	Scuba	Grab
Diplosolen sp.			X
Diporula verrucosa	X		
Electra posidoniae		X	
Exidmonea atlantica	X	X	
Exidmonea sp.			X
Frondipora verrucosa	X		
Hornera frondiculata	X		
Margaretta cereoides	X	X	
Myriapora truncata	X	X	X
Omalosecosa ramulosa	X	X	
Patinella radiata	X	X	
Pentapora fascialis	X		X
Pentapora foliacea		X	
Platonea stoechas	X	X	
Reptadeonella violacea	X	X	
Reteporella elegans	X	X	
Reteporella grimaldii	X	X	X
Reteporella mediterranea	X	X	
Reteporella sp.	X	X	
Rhynchozoon neapolitanum	X	X	
Savignyella lafontii	X	X	
Schizobrachiella sanguinea	X	X	
Schizomavella (Schizomavella) linearis	X	X	
Schizomavella (Schizomavella) mamillata	X	X	
Schizomavella sp.		X	
Schizoporella sp.		X	
Scrupocellaria scrupea	X	X	
Scrupocellaria scruposa	X	X	
Scrupocellaria sp.	X	X	
Smittina cervicornis	X		X
Smittoidea reticulata		X	
Tervia irregularis	X		X
Turbicellepora avicularis	X		
Turbicellepora magnicostata	X		X
Chaetognatha			
Chaetognatha indet.	X		

Species	ROV	Scuba	Grab
Chlorophyta			
Acetabularia acetabulum	X	X	
Bryopsis plumosa		X	
Caulerpa cylindracea	X	X	
Chlorophyceae indet.	X		
Chlorophyta indet.	X		
Cladophora sp.	X	X	
Codium bursa	X	X	
Dasycladus vermicularis	X	X	
Flabellia petiolata	X	X	
Halimeda tuna	X	X	
Palmophyllum crassum	X		X
Valonia macrophysa	X	X	
Valonia utricularis	X	X	
Chordata			
Acantholabrus palloni	X		
Actinopterygii indet.	X		
Anthias anthias	X	X	
Aphia minuta	X		
Apogon imberbis	X	X	
Argentina sphyraena	X		
Arnoglossus laterna	X		
Arnoglossus rueppelii	X		
Arnoglossus thori	X		
Ascidia conchilega	X		
Ascidia mentula	X	X	
Ascidiacea indet.	X	X	
Atherina presbyter		X	
Aulopus filamentosus	X		
Benthocometes robustus	X		
Blennius ocellaris	X		
Boops boops	X		
Bothus podas	X	X	
Botryllus schlosseri		X	
Callanthias ruber	X		
Capros aper	X		

Species	ROV	Scuba	Grab
Caretta caretta	X	X	
Cepola macrophthalma	X		
Chauliodus sloani	X		
Chelidonichthys cuculus	X		
Chelidonichthys lastoviza	X		
Chlopsis bicolor	X		
Chlorophthalmus agassizi	X		
Chromis chromis	X	X	
Ciona intestinalis	X		
Clavelina dellavallei	X	X	
Coelorinchus caelorhincus	X		
Conger conger	X		
Corella parallelogramma	X		
Coris julis	X	X	
Cyclothone braueri	X		
Cyclothone sp.	X		
Deltentosteus quadrimaculatus	X		
Diazona violacea	X		
Dicopia antirrhinum	X		
Didemnum sp.	X	X	
Diplodus annularis		X	
Diplodus vulgaris	X	X	
Distomus variolosus		X	
Dysomma brevirostre	X		
Elasmobranchii indet.	X		
cf. *Electrona risso*	X		
Epigonus constanciae	X		
Epinephelus costae	X	X	
Gadella maraldi	X		
Gadiculus argenteus	X		
Galeus melastomus	X		
Glossanodon leioglossus	X		
Gobius cruentatus		X	
Gobius gasteveni	X	X	
Gobius geniporus	X	X	
Gobius kolombatovici	X		

Species	ROV	Scuba	Grab
Gobius paganellus		X	
Gobius vittatus	X		
Halocynthia papillosa	X	X	
Helicolenus dactylopterus	X		
Hoplostethus mediterraneus	X		
Hymenocephalus italicus	X		
Labrus merula		X	
Lampanyctus crocodilus	X		
Lappanella fasciata	X		
Lepadogaster candolii		X	
Lepidopus caudatus	X		
Lepidorhombus whiffiagonis	X		
Lepidotrigla cavillone	X		
Lesueurigobius friesii	X		
Lesueurigobius sp.	X		
Lesueurigobius suerii	X		
Lissoclinum perforatum	X	X	
Macroramphosus scolopax	X		
Macrouridae indet.	X		
Merluccius merluccius	X		
Microcosmus nudistigma		X	
Mullus surmuletus	X	X	
Muraena helena	X	X	
Myctophidae indet.	X		
Nettastoma melanurum	X		
Nezumia aequalis	X		
Nezumia sclerorhynchus	X		
Nezumia sp.	X		
Notacanthus bonaparte	X		
Peristedion cataphractum	X		
Phycis blennoides	X		
Phycis phycis	X	X	
Polyacanthonotus rissoanus	X		
Polysyncraton bilobatum	X		
Polysyncraton lacazei	X	X	
Polysyncraton sp.	X		

Species	ROV	Scuba	Grab
Pyrosoma atlanticum	X		
Pyura dura	X		
Raja montagui	X		
Rhopalaea neapolitana	X		
Rhopalaea sp.	X		
Sarpa salpa	X	X	
Scorpaena elongata	X		
Scorpaena loppei	X		
Scorpaena maderensis	X	X	
Scorpaena notata	X	X	
Scorpaena porcus	X	X	
Scorpaena scrofa	X	X	
Scorpaena sp.	X		
Scorpaeniformes indet.	X		
Scorpaenodes arenai	X		
Scyliorhinus canicula	X		
Serranus cabrilla	X	X	
Serranus hepatus	X		
Serranus scriba	X	X	
Sparisoma cretense		X	
Sphyraena viridensis		X	
Spicara flexuosa	X		
Spicara maena		X	
Spicara smaris	X	X	
Squalus blainville	X		
Stomias boa boa	X		
Sudis hyalina	X		
Symphodus mediterraneus	X		
Symphodus ocellatus	X	X	
Symphodus roissali		X	
Symphodus rostratus	X		
Symphodus sp.	X		
Symphodus tinca	X	X	
Symphurus ligulatus	X		
Synchiropus phaeton	X		
Synodus saurus	X		

Species	ROV	Scuba	Grab
Thalassoma pavo	X	X	
Thorogobius ephippiatus	X		
Torpedo marmorata		X	
Trachinus draco	X		
Trachinus radiatus		X	
Trachurus picturatus	X		
Trachurus sp.	X		
Tripterygion delaisi		X	
Tripterygion tripteronotum	X		
Xyrichtys novacula	X	X	
Zeus faber	X		
Cnidaria			
Abietinaria abietina	X	X	
Acanthogorgia armata	X		
Acanthogorgia hirsuta	X		
Actinauge richardi	X		
Actiniaria indet.	X		
Actinostolidae indet.	X		
Adamsia palliata	X	X	
Aglaophenia octodonta	X		
Aglaophenia pluma	X		
Aglaophenia sp.	X	X	
Aiptasia diaphana		X	
Aiptasia mutabilis	X	X	
Alcyonium acaule	X		
Alcyonium coralloides	X		
Alcyonium palmatum	X		
Alicia mirabilis	X	X	
Amphianthus dohrnii	X		
Anemonia indet.	X		
Antennella secundaria	X		
Anthopleura ballii	X		
Anthozoa indet.	X		
Antipatharia indet.	X		
Antipathella subpinnata	X		
Antipathes dichotoma	X		

Species	ROV	Scuba	Grab
Aphanipathidae indet.			X
Apolemia uvaria	X		
Arachnanthus oligopodus	X		
Arachnanthus sarsi	X		
Arachnanthus sp.	X		
Astroides calycularis	X	X	
Balanophyllia (Balanophyllia) europaea	X	X	
Balanophyllia sp.	X		
Bebryce mollis	X		
Bunodeopsis strumosa		X	
Calliactis parasitica	X	X	
Callogorgia verticillata	X		
Caryophyllia (Caryophyllia) ambrosia	X		X
Caryophyllia (Caryophyllia) calveri	X		
Caryophyllia (Caryophyllia) cyathus	X		
Caryophyllia (Caryophyllia) inornata	X	X	
Caryophyllia (Caryophyllia) smithii	X	X	X
Caryophyllia sp.	X	X	X
Caryophylliidae indet.			X
Ceratotrochus magnaghii			X
Cereus pedunculatus	X	X	
Ceriantharia indet.	X		X
Cerianthus membranaceus	X	X	
Cerianthus sp.	X		
Chironephthya mediterranea	X		
Cladopsammia rolandi	X	X	
Clavularia crassa	X		
Condylactis aurantiaca	X	X	
Corallium rubrum	X		X
Cornularia cornucopiae	X		
Corynactis viridis	X	X	
Dendrophyllia cornigera	X		
Dendrophyllia ramea	X		
Desmophyllum dianthus	X		
Desmophyllum sp.	X		
Edwardsia sp.	X		

Species	ROV	Scuba	Grab
Epizoanthus sp.	X		
Eudendrium sp.	X		
Eunicella cavolini	X	X	
Eunicella singularis	X		
Eunicella verrucosa	X	X	
Forskalia edwardsii	X		
Funiculina quadrangularis	X		
Halecium halecinum	X		
Halopteris sp.		X	
Holaxonia indet.	X		
Hoplangia durotrix			X
Hormathia coronata	X		
Hydractinia aculeata		X	
Hydromedusa indet.	X		
Hydrozoa indet.	X		
Isidella elongata	X		
Isozoanthus sulcatus	X		
Kadophellia bathyalis	X		
cf. *Kirchenpaueria pinnata*	X		
Leiopathes glaberrima	X		
Leptopsammia pruvoti	X	X	
Lytocarpia myriophyllum	X		
Maasella edwardsi	X		
Madracis pharensis	X	X	
Monomyces pygmaea	X		
Muriceides lepida	X		
Nausithoe punctata		X	
Nausithoe sp.			X
Nemertesia antennina	X		
Nemertesia ramosa	X		
Nemertesia sp.	X		
Nidalia studeri	X		
Pachycerianthus solitarius	X		X
Paracyathus pulchellus	X		
Paralcyonium spinulosum	X		
Paramuricea clavata	X		X

Species	ROV	Scuba	Grab
Parantipathes larix	X		
Parazoanthus anguicomus	X		
Parazoanthus axinellae	X		X
Pelagia noctiluca	X		X
Pennatula rubra	X		
Phyllangia americana mouchezii		X	
Phymanthus pulcher	X		
Polycyathus muellerae		X	X
Pteroeides griseum	X		
Pteroeides spinosum	X		
Savalia savaglia	X		
Scleractinia indet.	X		
cf. *Scleranthelia rugosa*	X		
Sertularella gayi	X		
Sertularella sp.	X	X	
Sideractis glacialis	X		
Siphonophorae indet.	X		
Solmissus albescens	X		
Stenocyathus vermiformis	X		X
Stolonifera indet.	X		
Swiftia dubia	X		
cf. *Telmatactis forskalii*	X		
Thalamophyllia gasti	X		
Veretillum cynomorium	X		
Villogorgia bebrycoides	X		
Viminella flagellum	X		
Virgularia mirabilis	X		
Zoantharia indet.	X		
Zoanthidae indet.	X		
Ctenophora			
Beroe forskalii		X	
Beroe sp.	X		
Bolinopsis infundibulum	X		
Ctenophora indet.	X		
Pleurobrachia pileus	X		

Species	ROV	Scuba	Grab
Echinodermata			
Antedon mediterranea	X		
Arbacia lixula	X	X	
Asteroidea indet.	X		
Astropecten bispinosus	X	X	
Astrospartus mediterraneus	X		
Centrostephanus longispinus	X	X	
Ceramaster sp.	X		
Chaetaster longipes	X		
Cidaris cidaris	X		
Crinoidea indet.	X		
Echinaster (Echinaster) sepositus	X	X	
Echinocyamus pusillus	X		X
Echinoidea indet.	X		X
Echinus melo	X		
Hacelia attenuata	X	X	
Holothuria (Holothuria) tubulosa	X	X	
Holothuria (Panningothuria) forskali	X	X	
Holothuria (Platyperona) sanctori		X	
Holothuria (Roweothuria) poli	X		
Holothuria sp.	X		
Luidia ciliaris	X		
Luidia sarsii	X		
Marthasterias glacialis	X	X	
Mesothuria intestinalis	X		
Ophidiaster ophidianus	X		X
Ophioderma longicauda	X		X
Ophiopsila aranea	X		
Ophiothrix fragilis	X		
Ophiura ophiura	X		
Ophiuroidea indet.	X		
Paracentrotus lividus			X
Parastichopus regalis	X		
Peltaster placenta	X		X
Penilpidia ludwigi	X		

Species	ROV	Scuba	Grab
Sclerasterias richardi	X		
Spatangoidea indet.	X		
Spatangus purpureus	X		
Sphaerechinus granularis	X	X	
Stylocidaris affinis	X	X	X
Tethyaster subinermis	X		
Zoroaster fulgens	X		
Foraminifera			
Ammodiscus anguillae			X
Ammolagena clavata			X
Ammonia beccarii			X
Ammonia sp.			X
Astrorhizida indet.			X
Cornuspiramia trinidadensis	X		X
Foraminifera indet.	X		
Komokioidea indet.	X		
Lenticulina inornata			X
Lenticulina orbicularis			X
Lenticulina rotulata			X
Lenticulina sp.			X
Melonis barleeanus			X
Miniacina miniacea	X	X	
Orbulina universa		X	
Pelosina arborescens	X		
Pyramidulina raphanistrum			X
Pyrgo inornata			X
Pyrgo sp.			X
Triloculina tricarinata			X
Mollusca			
Abra alba			X
Abra longicallus			X
Abra prismatica			X
Abralia (Asteroteuthis) veranyi	X		
Acanthocardia aculeata	X		
Acanthocardia paucicostata			X
Acanthocardia sp.	X		

Species	ROV	Scuba	Grab
Acar clathrata			X
Aclis ascaris	X		X
Acteon monterosatoi			X
Addisonia excentrica	X		
Aequipecten opercularis			X
Aglaja tricolorata	X		
Alvania aeoliae			X
Alvania cimicoides			X
Alvania testae			X
Amphissa acutecostata			X
Anomiidae indet.	X		X
Antalis dentalis			X
Antalis entalis			X
Antalis inaequicostata			X
Antalis panorma			X
Antalis sp.			X
Antalis vulgaris			X
Aplysia depilans		X	
Aptyxis syracusana		X	
Arca tetragona	X		X
Argonauta argo	X		
Armina tigrina		X	
Asbjornsenia pygmaea			X
Asperarca nodulosa			X
Astarte montagui	X		X
Astarte sp.	X		X
Atlanta brunnea			X
Atlanta peronii			X
Barleeia unifasciata			X
Basterotia angulata			X
Bathyarca philippiana			X
Bittium latreillii	X	X	X
Bittium sp.	X	X	X
Bivalvia indet.	X	X	X
Bolinus brandaris	X	X	
Bolma rugosa	X		

Species	ROV	Scuba	Grab
Buccinoidea indet.		X	
Bursidae indet.		X	
Cadulus jeffreysi			X
Calliostoma gualterianum	X		
Calliostoma laugieri	X		
Calliostoma sp.	X		
Callostracon tyrrhenicum			X
Cardiidae indet.	X		X
Cardiomya costellata			X
Cassidae indet.	X		
Cavolinia inflexa	X		X
Cavolinia sp.			X
Cavolinia tridentata			X
Centrocardita aculeata			X
Cephalaspidea indet.	X		X
Cephalopoda indet.	X		
Cerithidea indet.	X		X
Cerithiopsidae indet.			X
Cerithium scabridum			X
Cerithium sp.	X	X	
Cerithium vulgatum	X	X	
Chama circinata		X	X
Charonia lampas	X		
Chauvetia brunnea			X
Chiroteuthis veranii	X		
Chiton olivaceus	X	X	
Clanculus corallinus	X		
Clausinella fasciata			X
Clio pyramidata	X		X
Columbellidae indet.			X
Conus ventricosus		X	
cf. *Coralliophila* sp.	X		
Corbula gibba			X
Crassopleura maravignae			X
Cuspidaria cuspidata			X
Cuspidaria obesa			X

Species	ROV	Scuba	Grab
Cuspidaria rostrata			X
Dikoleps depressa			X
Dondice banyulensis	X		
Dosinia exoleta			X
Dosinia lupinus			X
Drilliola emendata			X
Eatonina cossurae			X
Edmundsella pedata		X	
Eledone cirrhosa	X		
Eledone moschata	X		
Emarginula adriatica			X
Emarginula fissura			X
Emarginula multistriata	X		
Emarginula octaviana			X
Entalina tetragona			X
Epitonioidea indet.		X	
Epitonium cf. *clathrus*	X		
Erato voluta			X
Eulimella cf. *profunda*	X		
Euspira nitida	X		X
Facelina bostoniensis	X		
Felimare fontandraui	X		
Felimare picta		X	
Flabellina sp.	X		
Flexopecten flexuosus			X
Fusinus pulchellus	X		
Fusiturris similis	X		
Galeodea echinophora	X		
Galeodea sp.	X		
Gari costulata			X
Gastropoda indet.	X	X	X
Gibberula philippii			X
Gibbula sp.	X		
Glans trapezia		X	X
Gleba cordata			X
Glycymeris sp.			X

Species	ROV	Scuba	Grab
Gonilia calliglypta			X
Goodallia macandrewi			X
Gouldia minima	X		X
Heliconoides inflatus			X
Hemilepton nitidum			X
Hexaplex trunculus		X	
Hiatella arctica			X
Homalopoma sanguineum	X		X
Hyalocylis striata			X
Illex coindetii	X		
Irus irus			X
Isara cornea			X
Janthina exigua	X		
Janthina pallida	X		
Janthina sp.	X		
Jujubinus exasperatus	X		X
Jujubinus montagui	X		X
Jujubinus sp.	X		X
Kelliella miliaris			X
Laevicardium oblongum			X
Lasaeidae indet.			X
Lepetella espinosae			X
Lima lima	X		X
Limaria hians		X	
Limaria loscombi			X
Limatula gwyni	X		X
Limatula subauriculata			X
Limea crassa			X
Lithophaga lithophaga		X	
Loligo vulgaris	X		
Luria lurida	X	X	
Macomangulus tenuis			X
Mangelia tenuicosta			X
Mimachlamys varia			X
Mitrella minor			X
Mitrella scripta			X

Species	ROV	Scuba	Grab
Mitrella sp.	X		X
Moerella donacina			X
Mollusca indet.	X	X	
Monoplex parthenopeus		X	
Naria turdus	X		
Nassariidae indet.		X	X
Naticarius stercusmuscarum	X	X	
Naticidae indet.	X		
Neopycnodonte cochlear	X	X	
Neopycnodonte zibrowii	X		
Nudibranchia indet.	X		
Ocenebra erinaceus	X		
Octopus salutii	X		
Octopus vulgaris	X		X
Ommastrephes bartramii	X		
Ostreidae indet.	X		
Pagodula echinata		X	
Palliolum incomparabile		X	
Palliolum sp.	X		
Palliolum striatum		X	
Parvamussium fenestratum		X	
Parvicardium minimum		X	
Parvicardium scriptum		X	
Parvicardium sp.		X	
Pecten jacobaeus	X	X	
Pectinidae indet.	X	X	
Peltodoris atromaculata	X		X
Philine catena			X
Philine sp.			X
Philinopsis depicta		X	
Phorcus articulatus	X		
Phyllidia flava		X	
Pinna nobilis	X	X	
Pinna rudis	X		
Pinna sp.		X	
Platydoris argo	X	X	

Species	ROV	Scuba	Grab
Pleurobranchaea meckeli	X	X	
Pleurobranchus testudinarius	X	X	
Polycera quadrilineata	X		
Pruvotfolia pselliotes	X		
Pseudamussium clavatum	X		
Pteria hirundo	X		
Pteroctopus tetracirrhus	X		
Pteropoda indet.	X		
Pusia ebenus	X		X
Ranella olearium	X		
Rissoa turricula			X
Rossia macrosoma	X		
Rostanga rubra		X	
Saccella commutata			X
Scaphopoda indet.	X		
Seguenzia indet.			X
Semelidae indet.			X
Semicassis granulata		X	
Sepia elegans	X		
Sepia officinalis	X		
Sepia orbignyana	X		
Sepia sp.	X		
Similipecten similis			X
Skeneopsis sp.			X
Solatisonax alleryi	X		
Spondylus gussonii	X		
Steromphala adriatica		X	
Steromphala pennanti		X	
Steromphala sp.		X	
Steromphala varia		X	
Styliola subula			X
Tarantinaea lignaria	X		
Tectura virginea	X		
Teredo navalis	X		
Thracia villosiuscula			X
Thuridilla hopei	X	X	

Species	ROV	Scuba	Grab
Thylacodes arenarius		X	
Tiberia minuscula			X
Timoclea ovata	X		X
Tricolia speciosa		X	
Tritia lima	X		X
Tritia sp.	X		
Tritoniidae indet.	X		
Trivia sp.			X
Trochidae indet.	X	X	X
Tropidomya abbreviata			X
Turritella communis	X		
Umbraculum umbraculum	X	X	
Vanikoroidea indet.	X		
Veneridae indet.			X
Venus verrucosa	X	X	X
Vexillum sp.	X		
Volvarina mitrella	X		X
Yoldiella philippiana			X
Nemertea			
Paradrepanophorus crassus			X
Ochrophyta			
Arthrocladia villosa	X		
Carpomitra costata	X		
Cystoseira compressa	X	X	
Cystoseira sp.	X	X	
Cystoseira spinosa		X	
Dictyopteris polypodioides	X	X	
Dictyota dichotoma	X	X	
Dictyota fasciola	X	X	
Dictyota implexa	X	X	
Dictyota sp.	X	X	
Halopteris filicina	X	X	
Halopteris scoparia	X		
Lobophora variegata	X	X	
Padina pavonica	X		X
Phaeophyceae indet.	X	X	

Species	ROV	Scuba	Grab
Sargassum vulgare	X	X	
Sporochnus pedunculatus	X		
Zanardinia typus	X	X	
Phoronida			
Phoronis australis	X		
Platyhelminthes			
Stylochus pillidum		X	
Porifera			
Aaptos aaptos	X		
Acanthella acuta		X	
Agelas oroides	X	X	
Amphilectus fucorum		X	
Aplysilla sulfurea	X		
Aplysina cavernicola	X		
Asbestopluma sp.			X
Axinella rugosa	X		
Axinella sp.	X	X	
Chondrosia reniformis	X	X	
Cinachyrella sp.	X		
Cladorhiza abyssicola	X		
Cladorhiza sp.	X		
Cladorhizidae indet.	X		
Clathrina clathrus		X	
Clathrina coriacea	X		
Clathrina lacunosa	X		
Clathrina rubra	X		
Clathrina sp.		X	
Cliona viridis	X	X	
Corticium candelabrum	X		
Crambe crambe	X	X	
Crella (Grayella) pulvinar	X	X	
Demospongiae indet.			X
Dendroxea lenis		X	
Diplastrella bistellata	X	X	
Dysidea fragilis	X		
Farrea bowerbanki	X		

Species	ROV	Scuba	Grab
Fasciospongia cavernosa	X		
Halichondria (Halichondria) panicea	X		
Haliclona (Halichoclona) fulva	X		
Haliclona (Haliclona) cf. *oculata*	X		
Haliclona (Haliclona) simulans	X		
Haliclona (Haliclona) urceolus	X		
Haliclona (Reniera) cinerea	X		
Haliclona (Reniera) mediterranea	X		
Haliclona (Soestella) mucosa	X		
Haliclona sp.	X		
Hemimycale columella		X	
Hexactinellida indet.	X		
Hexadella dedritifera	X		
Hexadella pruvoti		X	
Higginsia ciccaresei	X		
Merlia normani	X		
Mycale (Aegogropila) rotalis		X	
Mycale (Carmia) macilenta		X	
Mycale (Carmia) micracanthoxea		X	
Mycale sp.	X		
cf. *Myxilla (Myxilla) rosacea*	X		
Nethea amygdaloides	X		
Oceanapia sp.	X		
Oscarella balibaloi	X		
Oscarella lobularis	X		X
Pachastrella monilifera	X		
Petrobiona massiliana	X		X
Petrosia (Petrosia) ficiformis	X		
Phakellia robusta	X		
Phorbas fictitius		X	
cf. *Phorbas* sp.	X		
Phorbas tenacior	X		
Plakina monolopha	X		
Plakina trilopha	X		
Pleraplysilla spinifera	X	X	
Podospongia lovenii	X		

Species	ROV	Scuba	Grab
Poecillastra compressa	X		
Porifera indet.	X	X	
Raspaciona aculeata	X	X	
Rhabderemia sp.	X		
Sarcotragus foetidus	X		
Sarcotragus spinosulus	X	X	
Spirastrella cunctatrix	X	X	
Spongia (Spongia) officinalis	X		
cf. *Spongosorites flavens*	X		
Sycon raphanus	X		
Terpios gelatinosus	X	X	
Thenea muricata	X		
Thenea sp.	X		
Topsentia pachastrelloides	X		
Topsentia vaceleti	X		
Ute glabra	X		
Rhodophyta			
Alga indet.	X	X	
Amphiroa cryptarthrodia		X	
Amphiroa rigida		X	
Amphiroa sp.		X	
Chrysymenia ventricosa		X	
Corallinales indet.	X		
Erythroglossum cf. *balearicum*	X		
Eupogodon planus	X		
Leptofauchea coralligena		X	
Liagora sp.		X	
Liagora viscida	X		
Lithophyllum cabiochiae	X	X	
Lithophyllum racemus	X		
Lithophyllum sp.	X	X	
Lithophyllum stictiforme	X		
Lithothamnion sp.	X		
Lithothamnion valens	X		

Species	ROV	Scuba	Grab
Mesophyllum alternans	X	X	
Mesophyllum lichenoides	X	X	
Mesophyllum sp.	X	X	
Neogoniolithon brassica-florida	X		
Neogoniolithon mamillosum			X
Neogoniolithon sp.	X		
Neurocaulon foliosum	X		
Osmundaria volubilis	X		
Peyssonnelia rosa-marina	X		
Peyssonnelia rubra	X	X	
Peyssonnelia sp.	X	X	
Peyssonnelia spp.	X		
Peyssonnelia squamaria	X	X	
Phymatolithon lenormandii		X	
Rhodophyta indet.	X		
Spongites fruticulosa	X		
Tricleocarpa fragilis		X	
Sipuncula			
Apionsoma (Apionsoma) murinae			X
Phascolion (Phascolion) strombus strombus			X
Tracheophyta			
Cymodocea nodosa	X	X	
Halophila stipulacea	X	X	
Posidonia oceanica	X	X	

Annex V. Table of threatened and protected species found during the 2018 Oceana Aeolian expedition

Species listed are either included in Annex II, IV or V of the Habitats Directive,[17] Annex II[38] or III[102] of the SPA/BD Protocol of the Barcelona Convention, Appendix I, II, or III of the Bern Convention[103] and/or have been assessed by IUCN as threatened (i.e., Vulnerable (VU), Endangered (EN), or Critically Endangered (CR)) in the Italian[104,105], Mediterranean[53], and/or global Red Lists of threatened species.[106]

Species	Habitats Directive	Barcelona Convention SPA/BD Protocol	Bern Convention	Global Red List	Mediterranean Red List	Italian Red List
Arthropoda						
Maja squinado		Annex III	Appendix III			
Palinurus elephas		Annex III	Appendix III	VU		
Scyllarus arctus		Annex III	Appendix III			
Chordata						
Caretta caretta	Annexes II & IV	Annex II	Appendix II	VU		
Epinephelus costae						VU
Merluccius merluccius					VU	
Cnidaria						
Antipathella subpinnata		Annex II				
Antipathes dichotoma		Annex II	Appendix III			
Astroides calycularis		Annex II	Appendix II			
Callogorgia verticillata		Annex II				
Corallium rubrum	Annex V	Annex III	Appendix III		EN	EN
Dendrophyllia cornigera		Annex II			EN	VU
Dendrophyllia ramea		Annex II			VU	
Desmophyllum dianthus		Annex II			EN	VU
Eunicella singularis						VU
Funiculina quadrangularis					VU	CR
Isidella elongata		Annex II			CR	CR
Leiopathes glaberrima		Annex II			EN	EN
Paramuricea clavata					VU	
Parantipathes larix		Annex II				
Pennatula rubra					VU	
Pteroeides spinosum					VU	
Savalia savaglia		Annex II	Appendix II			
Virgularia mirabilis						VU

Species	Habitats Directive	Barcelona Convention SPA/BD Protocol	Bern Convention	Global Red List	Mediterranean Red List	Italian Red List
Echinodermata						
Centrostephanus longispinus	Annex IV	Annex II	Appendix II			
Ophidiaster ophidianus		Annex II	Appendix II			
Paracentrotus lividus		Annex III	Appendix III			
Mollusca						
Charonia lampas		Annex II	Appendix II			
Lithophaga lithophaga	Annex IV	Annex II	Appendix II			
Luria lurida		Annex II	Appendix II			
Pinna nobilis	Annex IV	Annex II				
Pinna rudis		Annex II				
Ranella olearium			Appendix II			
Ochrophyta						
Cystoseira spinosa			Appendix I			
Laminaria rodriguezii		Annex II	Appendix I			
Porifera						
Aplysina cavernicola			Appendix II			
Petrobiona massiliana		Annex II	Appendix II			
Sarcotragus foetidus		Annex II				
Spongia (Spongia) officinalis		Annex III	Appendix III			
Rhodophyta						
Mesophyllum lichenoides			Appendix I			
Tracheophyta						
Cymodocea nodosa		Annex II	Appendix I			
Posidonia oceanica		Annex II	Appendix I			

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