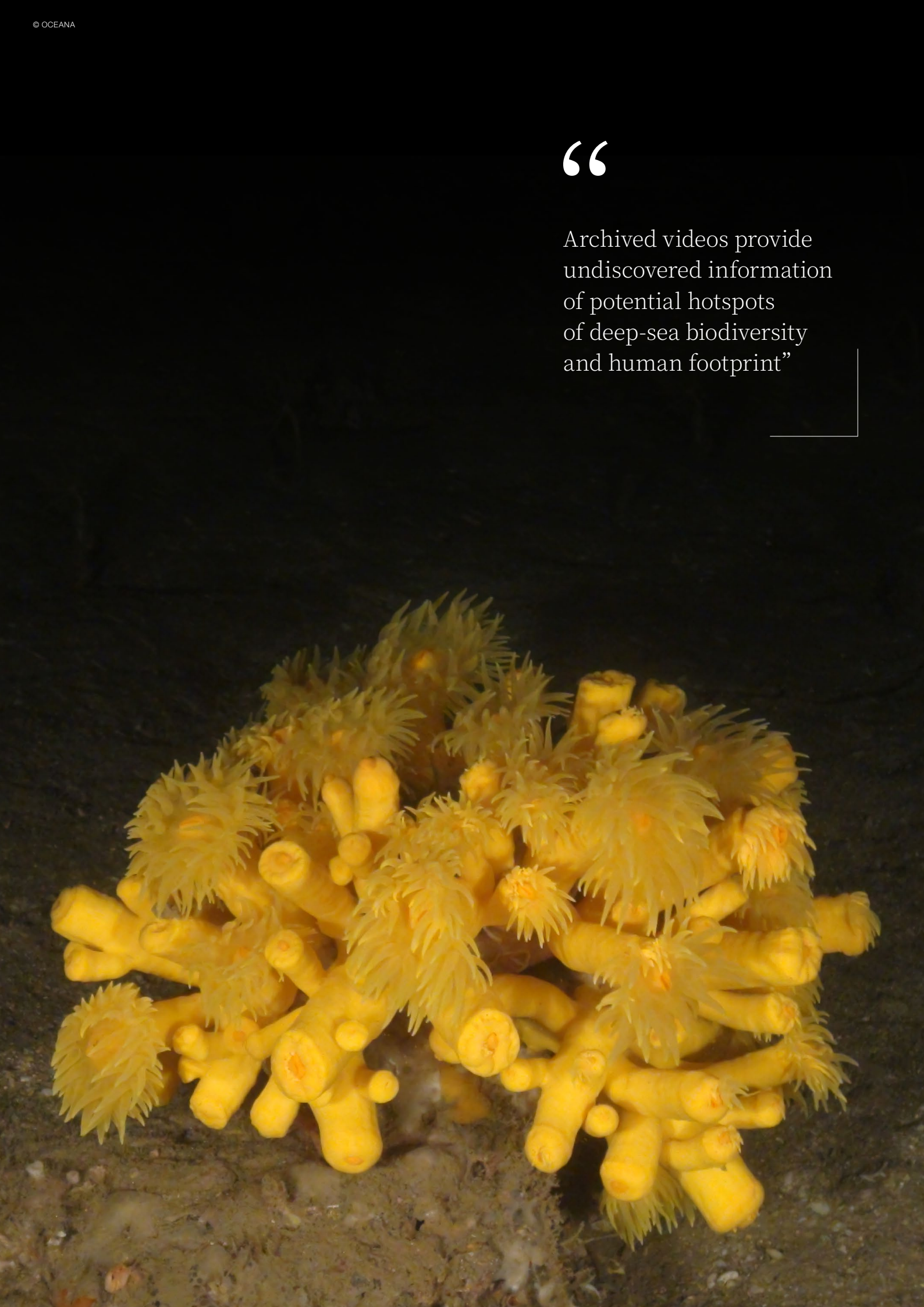


“

Archived videos provide undiscovered information of potential hotspots of deep-sea biodiversity and human footprint”

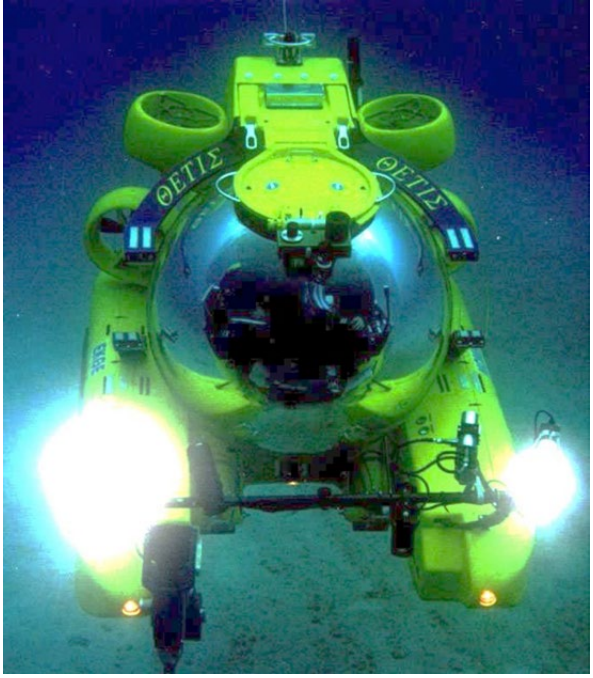
CHAPTER 4 /

Revisiting underwater surveys to uncover sites of conservation interest

Smith C.J., Gerovasileiou V., Mytilineou Ch., Jimenez C., Papadopoulou K., Salomidi M., Sakellariou D., Drakopoulou V., Otero M.

In contrast to the Western and Central Mediterranean Basin, data on deep-sea biodiversity are scarce in the Eastern Mediterranean (see Chapter 2). Visual observation has been extremely important for identification of deep-sea habitats and areas of conservation interest, directly from submersibles and indirectly from Remotely Operated Vehicles (ROVs) and other camera platforms. Where 40 years ago the availability to science of deep water imaging systems was restricted to only key institutions/organisations worldwide, there is today, much more common access to institutions' own, or shared resources. Imaging material has been produced from a variety of commercial and non-commercial sectors conducting offshore oil-and-gas explorations, geological-and-geophysical surveys, power cables and pipelines environmental impact assessments, wrecks and archaeological explorations, marine litter assessments as well as biological and oceanography campaigns. These surveys/works whilst not targeted to enhance biodiversity knowledge still have potential to deliver useful data.

By analysing existing repository data from these works, further knowledge can be acquired, and unknown spatial patterns uncovered, contributing to a more complete and comprehensive portrait of the deep ecosystem. Here, we present the results using this approach to catalogue and review video material, primarily acquired by HCMR over the last decades, from a variety of underwater mission types from different geographical areas in the Eastern Mediterranean. The aim was to further investigate areas of high interest (defined biological or geological features) previously identified (Chapters 2 & 3) and report the presence, association and distribution (geographical and depth range) of vulnerable marine fauna. Archived video material covering a 25-year period (1995-2017) was analysed to produce thematic maps for all sites observed in deep waters (> 200 m depth) with notification of sites of particular interest (biodiversity hotspots), particularly towards the presence of species already noted in Chapter 3, or other important conspicuous species (for example, some vent/seep related species).



One of the video data collection platforms, the HCMR submersible Thetis.

Video dive logs were examined, highlighting 36 distinct sites with over 250 hours of material for video analysis (Fig. 4.1 and Annex 4.1 with site metadata). The collection of information included area, date, depth range, number of dives and observation time, mission type, site description, vulnerable species (species, depths, number of observations and substrate), special features observed and anthropogenic traces[1]. Underwater video has been collected for a wide range of operations, from dedicated faunal surveys with prime usable video (constant slow speed, direction and low altitude) to target verification (on the seabed, searching and driving onto and around a target, targets being geological, archaeological, deployed equipment, lost structures) or manipulation (diving and working on a target). With different objectives, there were differences between missions in coverage and focus as well as different effort (from less than one hour to 37 hours, but 7 hours on average). Depths ranged from 200 m (the "deep sea" shallower limit) to 1,560 m (North Aegean). The usability of video was therefore highly variable and inconsistent, not allowing for the estimation of density or complete area comparisons.

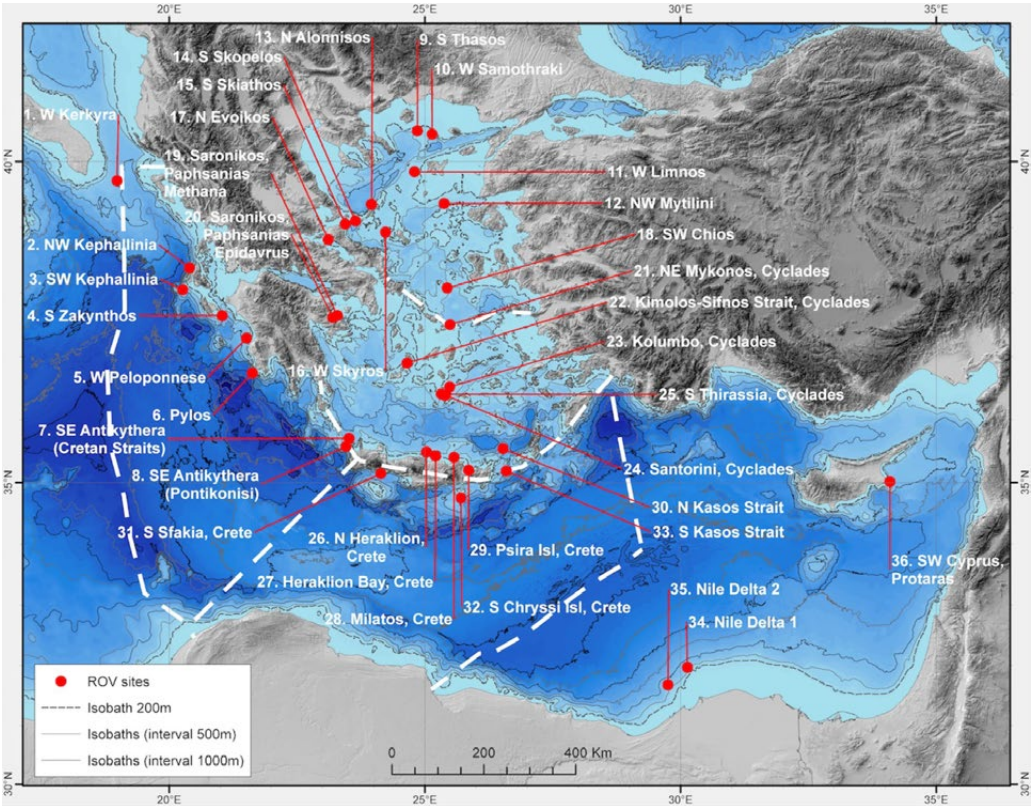


Fig. 4.1. Location of the sites examined within the different geographical areas of the Eastern Mediterranean.

1 The methodological analyses that support the findings are available from the corresponding authors upon request.

Kephalonia (in Greek also known as Kefallonia or Kephallinia), Eastern Ionian Sea. © Skaisu, Dreamstime.

Table 4.1.
Areas where sampling observations were taken for video analysis.

Eastern Ionian Sea	South Aegean Sea
1. W. Kerkyra	19. Saronikos, Paphsanias Methana
2. NW. Kephallinia	20. Saronikos, Paphsanias Epidavrus
3. W. Kephallinia	21. NE. Mykonos, Cyclades
4. S. Zakynthos	22. Kimolos-Sifnos Strait, Cyclades
5. W. Peloponnese	23. Kolumbo, Cyclades
6. Pylos	24. Santorini, Cyclades
7. SE. Antikythera (Cretan Straits)	25. S. Thirassia, Cyclades
8. SE. Antikythera (Pontikonisi)	26. N. Heraklion, Crete
	27. Heraklion Bay, Crete
North Aegean Sea	28. Milatos, Crete
9. S. Thasos	29. Psira Island, Crete
10. W. Samothraki	30. N. Kasos Strait
11. W. Limnos	
12. NW. Mytilini	**Libyan Sea**
13. N. Alonnisos	31. S. Sfakia, Crete
14. S. Skopelos	32. S. Chryssi Island, Crete
15. S. Skiathos	33. S. Kasos Strait
16. W. Skyros	
17. N. Evoikos	**Levantine Sea**
18. SW. Chios	34. Nile Delta 1
	35. Nile Delta 2
	36. SW. Cyprus, Protaras

EASTERN IONIAN SEA

1

Of the 8 areas analysed with respect to underwater video, two areas of high biological interest were identified in the Eastern Ionian Sea due to numbers of vulnerable species and relative abundance, South West of the island of Kephallinia (**4.1 - 4.2**) and South East Antikythera (**4.3 - 4.6**).

The area South West of the island of Kephallinia, located on the Argostoli ridge within the Kephallinia seamount area (see Chapter 2, Fig 1.4) was characterised on sedimentary slopes by the presence of the bamboo coral *Isidella elongata* and the seapen *Funiculina quadrangularis* whilst interspersed bedrock outcrops, stones or exposed crusts had black corals *Antipathes dichotoma,* Plexauridae gorgonian spp. and the stone coral *Desmophyllum dianthus* as well as a few colonies of the long-lived black coral *Leiopathes glaberrima*.

Cape Apolytaras South of Antikythera Island © Charalambos Andronos, Dreamstime

These species were also recorded off SE Antikythera, but in richer concentrations and also included large numbers of the whip coral *Viminella flagellum*. Antikythera had a wide range of bottom types within a relatively small area across the straits and most likely had the richest concentration of vulnerable, and predominantly filter-feeding species, from the relatively richer waters funnelled through the straits from the Aegean Sea. Across all the Eastern Ionian Sea, sponges were only notable in the SE Antikythera straits area. *Isidella elongata, Pennatula* sp. and *Funiculina quadrangularis* were the most ubiquitous vulnerable species found at most of the studied areas. In terms of geology, the straits area was also of high interest due to its high variety of seabed types and very high topography including visible seismic evidence from faulted rocks.

Here, the richest dive sites were in the area of the Antikythera seamounts (see Chapter 2, Fig 1.6). A second area of high geological interest was noted in the steep slope off Pylos off the SW Peleponese, an area that drops off into the deepest part of the Mediterranean (Matapan Trench/Calypso Deep/Oinousses Deep, approximately 5,200 m depth), characterised by rock cliffs and seismic faulting.

Anthropogenic impacts were observed at most of the sites, this included ancient items including shipwrecks and amphoras and more modern items including a range of plastics, metal and glass/ceramics. Fishing traces were also evident from parts of lost fishing gears (nets and longlines) to scrapes from recovered gears on the seabed. Lost fishing gears were evident in some places of coral occurrence.

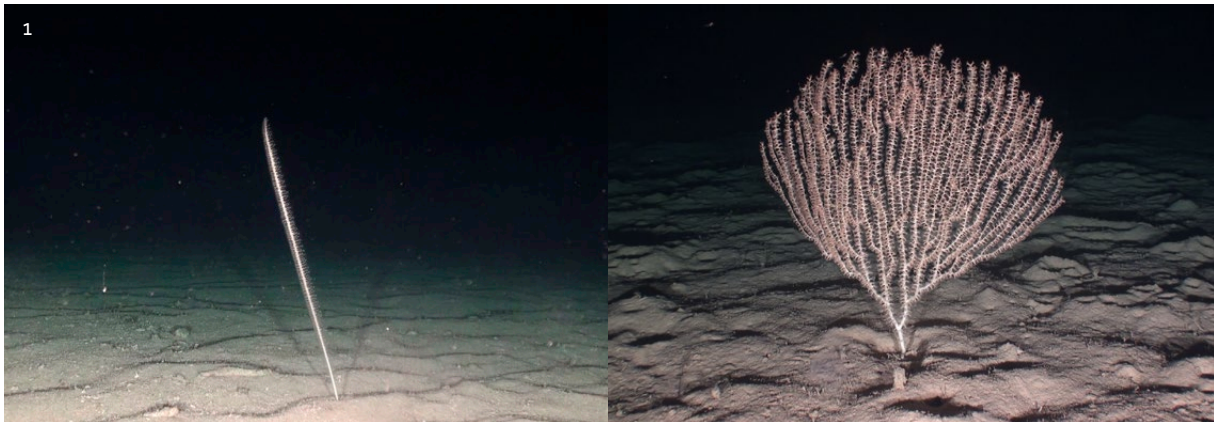


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Plate 4.1. *Funiculina quadrangularis* (left) and bamboo coral *Isidella elongata* (right) as those observed in SW Kephallinia.

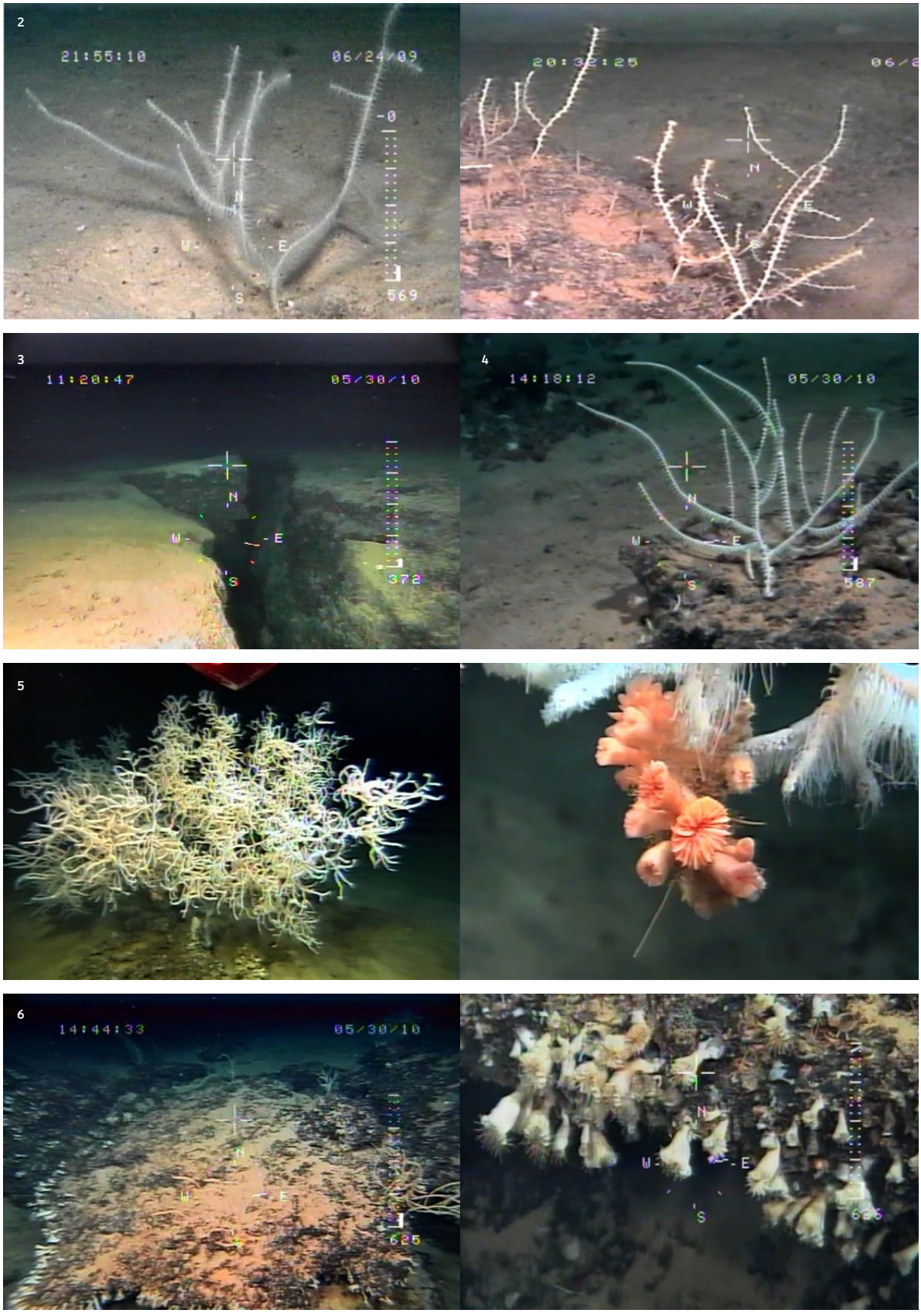


Plate 4.2. *Antipathes dichotoma* (left) and Plexauridae sp. (right) from SW Kephallinia.

Plate 4.3. Fractures on the rocky seabed of SE Antikythera.

Plate 4.4. *Antipathes dichotoma* (right) observed on hard substrates covered with a thin sediment layer from SE Antikythera.

Plate 4.5. Large sized (> 1 m high) colony of the antipatharian *Leiopathes glaberrima* (left) and zoom photo of a scleractinian (possibly *Thalamophyllia gasti*) developing on its lower branch (right) from SE Antikythera.

Plate 4.6. Dense aggregations/facies of the scleractinian *Desmophyllum dianthus* developed on the sides or under-hanging surfaces of boulders and rocks from SE Antikythera.

Peristera island, Alonnisos. © Dreamstime.

2 NORTH AEGEAN SEA

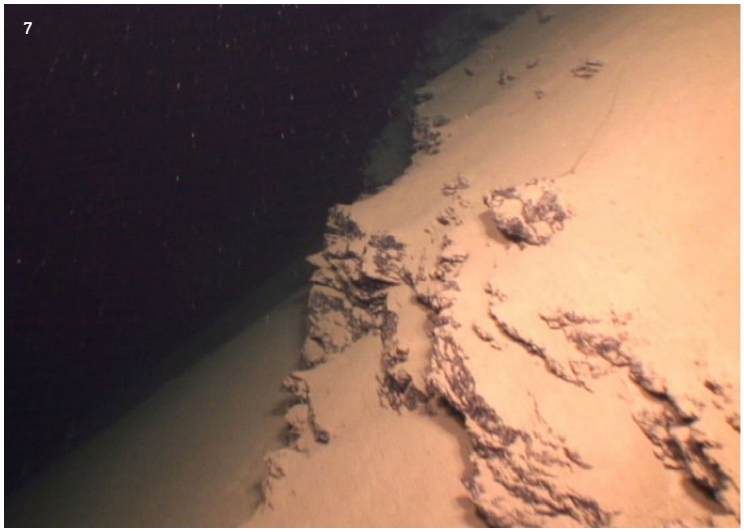
For the North Aegean, video observations have been reviewed in 10 different areas, mostly in the northern part and towards soft sedimentary areas (*Nephrops* grounds) with only few observations of hard substrates, notably in North Alonnisos and SW Chios (**4.7 - 4.9**). Of these, 2 were ROV missions, one with the submersible Jago and 7 with video sled. All the missions were science oriented with the exception of one search for airplane wreckage. Of the video sled observations 6 were during one early stock assessment survey for *Nephrops norvegicus* in Northern Aegean *Nephrops* fishing grounds during 1996. Most of the dives were therefore made on soft sedimentary grounds, and seapens were the most common group observed with *Funiculina quadrangularis* with high density at SW Chios Island and *Kophobelemnon stelliferum* with very high density (at field level) in the northern most site of South Thasos. The only observation of the critical endangered bamboo coral *Isidella elongata* was in the southern most site (SW Chios). Corals were represented in very low occurrences with exceptions of some scleractinians (*Desmophyllum dianthus* and Caryophyllidae sp.) in North Alonnisos and a few species (*Parantipathes larix*, *Callogorgia verticilata* and Caryophyllidae sp.) on low rock outcrops at SW Chios (**4.9**).

Sponges were mostly observed in the deep (950-1,500 m) Alonnisos dives, where there were significant areas of hard substrate from crusts to boulders and bedrock outcrops, a steep sedimentary slope with outcrops and evidence of landslides. Sponges observed included the glass sponge *Farrea* sp. (**4.8**), an unidentified lollipop sponge, *Phakellia* sp., *Haliclona* sp. with many encrustations of *Hamacantha falcula* and tetractinellids (e.g. *Geodia* sp. and *Pachastrella monilifera*). In addition, several individuals (> 30) of the rock sponge *Neophrissospongia* sp. were observed on rocks off SW Chios. On soft sediments, in South Skiathos a field of the sponge *Thenea muricata* was observed.

The crinoid *Leptometra phalangium* was recorded in two sites (West Limnos and North Evoikos) with very low numbers, whilst uncommonly high densities of the echiuran worm *Bonellia viridis* forming a field on soft sediments were recorded in North Evoikos Gulf. There were also high densities of the squat lobster *Munida* sp. in the same area on the sediment surface. The North Evoikos Gulf deep basin, from where the observations were made, is a relatively small basin (approximately 20 x 8 km), close to shore on the Evia Island side, with a number of steep submarine canyons leading into the basin. Two chondricthyans, the rabbitfish *Chimaera monstrosa* and the kitefin shark *Dalatias licha* were observed in the deep dives in North Alonnisos.

The most important sites were South Thasos due to the high seapen *Kophobelemnon stelliferum* abundance and SW Chios Island and the deep Alonissos site for overall abundance and diversity of corals and sponges. The deep Alonnisos dives had significant geological features ranging from hard substrate from crusts to boulders and bedrock outcrops, a steep sedimentary slope with outcrops and evidence of landslides. Two apparent broken thin "chimneys" were also observed at this site, isolated on soft sediments.

Litter including lost fishing gears were found in a number of sites, with only very low amounts recorded in the seven North Aegean sites observed by video sled from 1996. Trawl fishing marks were strongly present in some of these sites, which is unsurprising as they are commercial trawling grounds.



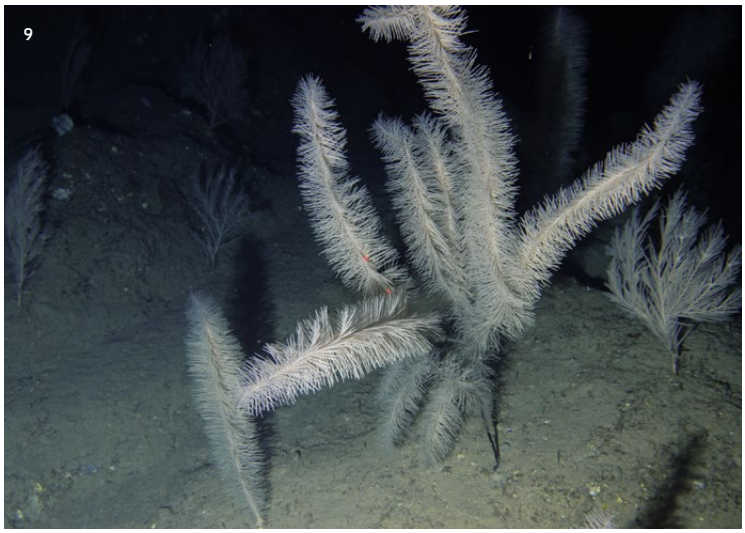


Plate 4.7. Steep sediment covered bedrock in North Alonissos.

Plate 4.8. Glass sponges *Farrea* sp. on hard substrate on outcrop reef (1560 m depth) in North Alonissos.

Plate 4.9. Rocky reef with *Callogorgia verticilata* and *Parantipathes larix* in SW Chios.

Palea Kameni island within the Santorini caldera, Cyclades Plateau, South Aegean Sea. © Maria Michelle.

3 SOUTH AEGEAN SEA

For the South Aegean, video observations have been reviewed in 12 major areas, 6 by ROV, 5 with the Jago manned submersible (from 1995) and one recently using a drop-camera system. All missions were part of scientific expeditions, either general survey concerning biology and geology or archaeological and litter searches. Three of the survey areas were related to underwater volcanoes including Paphsanias (Saronikos Gulf), Santorini and Kolumbo (Cyclades Plateau).

The volcanic areas of Paphsanias, Santorini and Kolumbo (**4.10, 4.11 - 4.12, 4.13 - 4.14** respectively), presented seemingly similar environments although they may be unique in terms of species composition. They all presented a range of different habitats, whether broken rock piles, rock faces, soft sediments, with abundant sponge communities; Paphsanias: *Haliclona* sp. (**4.10**), *Hamacantha falcula*, *Hexadella* sp., tetractinellid sponges; Kolumbo: lollipop sponges and *Hamacantha falcula*; Santorini: lollipop sponges and *Haliclona* sp (**4.12**).

What was also notable in these volcanic areas was the fact that the habitats were characterised by mono-specific assemblages: sponges on rock faces away from active seeps/vents in all areas, and in Kolumbo, Cerianthidae (tube anemones) fields on soft sediments adjacent to seeps/vents and mono-specific ascidian facies covering boulders or inactive chimneys.

One other area that may be identified as a sponge field was the shallower (250-300 m) area of NE Mykonos with many yellow/orange massive-tubular sponges (probably *Aplysina* sp. and *Agelas oroides*, (**4.15 - 4.16**). The shallower seabed in the same area (140-200 m) was covered by maerl gravel with very rich sponge gardens and bryozoan colonies. Two areas of high species numbers including corals were noted at: a) Kimolos-Sifnos Strait (**4.17 - 4.19**); particularly on rock terraces with high numbers of lollipop sponges and the sponge taxa *Phakellia* spp./*Poecillastra compressa*, as well as the corals *Callogorgia verticillata*, *Acanthogorgia hirsuta* and both living and rubble *Dendrophyllia cornigera*; and b) North Kasos Strait; including a variety of different kinds of hard substrate, with *Antipathes dichotoma*, *Parantipathes larix*, Plexauridae, *Leiopathes glaberrima* and Caryophyllidae sp. An additional area with high coral coverage was the cliff at Psira Island, Crete with many individuals of shallower water corals *Antipathella subpinnata* and *Eunicella cavolini* (**4.20**).

In two areas on the north of Crete, important beds of the fragile sediment dwelling, filter feeding crinoid *Leptometra phalangium* were observed (**4.21**). Although the bed in Heraklion Bay was first observed in 1995, further observations have been made in the same area[1,2]. This site is adjacent to a commercial trawl lane, but protected from trawling by the local topography (slope) and extends into waters shallower than 200 m. The single observations of seapens *Funiculina quadrangularis* and *Kophobelemnon stelliferum* were near the southeast-

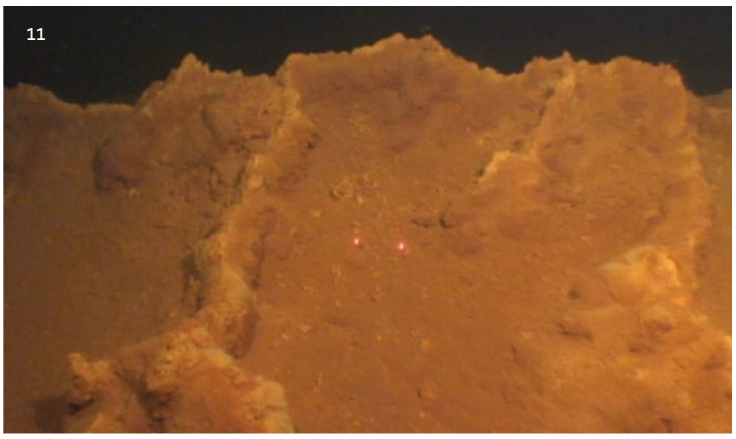
ern-most area studied, the North Kasos Strait. This was also the only site in the region where *Isidella elongata* was observed (4.22).

As noted, most of the observed areas were characterised by prominent geological features, whether volcanos or areas with faults. The 3 volcanos (Paphsanias in Saronikos Gulf, Santorini and Kolumbo) had many different habitats/formations within close proximity including active venting/seeping chimneys or flowing bottom seeps across soft sedimentary seabeds, inactive chimneys, fractured rock slopes or boulder slopes and cliffs. The volcanic areas have been well described[3]. The faults were found in North Heraklion and North Kasos and were characterised by open troughs a few metres deep with rock faces and sediments in the bottom in otherwise sedimentary bottoms, and in the case of Kasos with other broken rock faces and crusts.

> “The volcanic sites of Paphsanias and Kolumbo and the Kimolos Strait had rich sponge field grounds adjacent to the seeps and vent formations, tube anemones, corals, bryozoans and occasional maerl beds”

The crinoid *Leptometra phalangium* a suspension-feeding species confined in the Mediterranean to the continental shelf-break area.

View of Santorini Caldera. © Dreamstime.



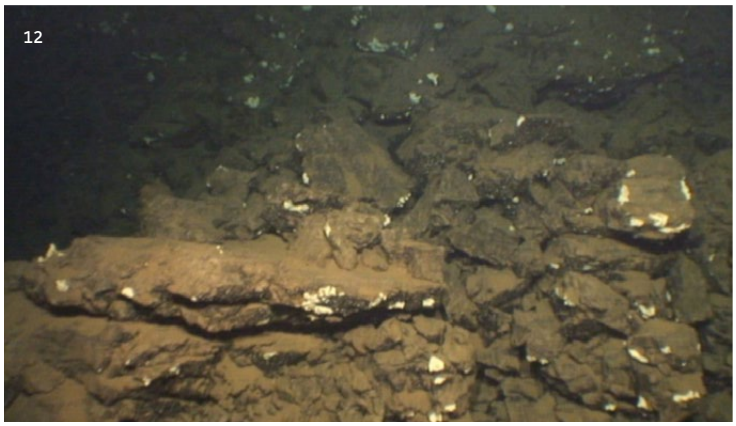


Plate 4.10. Sponges (probably *Haliclona* sp.) and the decapod *Munida* sp. were found in high numbers on rocks in the Paphsanias volcano.

Plate 4.11. Soft sediment with cemented-looking crests, possibly covered with bacteria from Santorini caldera.

Plate 4.12. Mono-specific sponge assemblages, possibly belonging to the genus *Haliclona*, on boulders and outcrops (200-295 m depth) from Santorini caldera.

Plate 4.13. Active rocky chimney with hot water seeps and gas vents, covered with bacteria from the Kolumbo volcano.

Mykonos Greece. © Fokke Baarssen, Dreamstime.

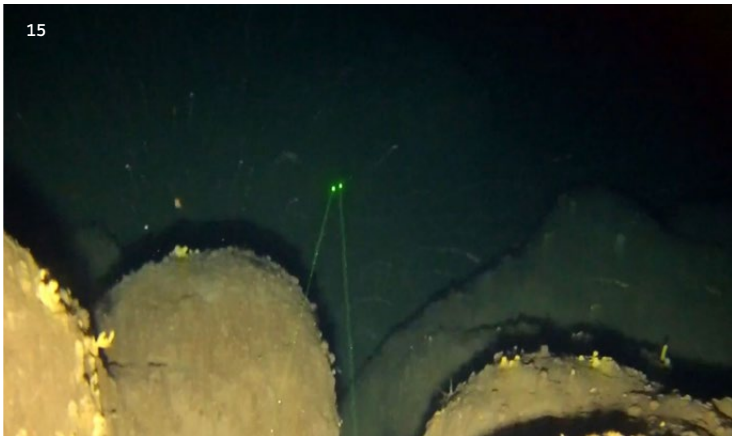
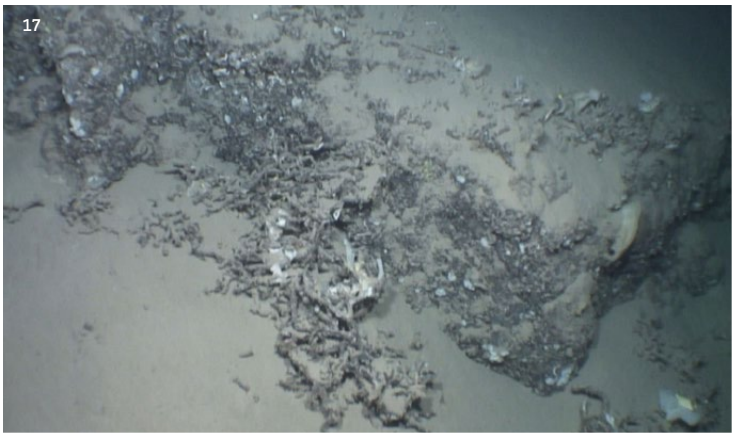


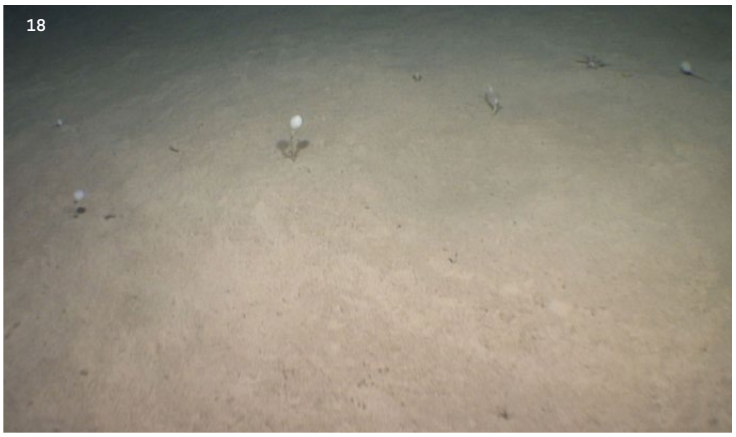
Plate 4.14. Active chimney covered with bacteria and microbial mats forming “white rivers” from the Kolumbo volcano.

Plate 4.15. Yellow and orange massive/tubular sponges (possibly *Aplysina* sp. and/or *Agelas oroides*) (approx. 250-300 m depth) on edge of rock steps and boulders from NE Mykonas.

Plate 4.16. Maerl bed with rich sponge gardens and bryozoan colonies (140-200 m depth) from NE Mykonas.

Aerial view of the south Kimolos-Sifnos Strait, Cyclades. © Jan Hamadak, Dreamstime.





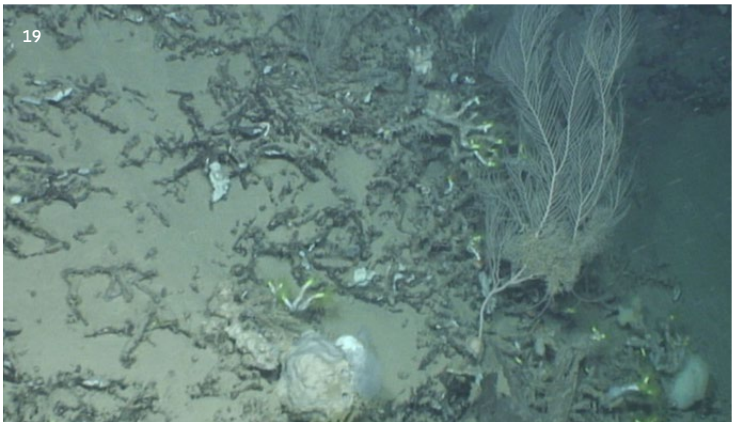


Plate 4.17. Upslope with sediment covered short (< 1 m) rough-faced bedrock terraces, partially comprised of *Dendrophyllia* coral rubble from Kimolos-Sifnos Strait.

Plate 4.18. Lollipop sponges (540-600 m depth) patch/field on soft sediment from Kimolos-Sifnos Strait.

Plate 4.19. Massive tetractinellid sponges, *Phakellia* spp./*Poecillastra compressa* individuals and the corals *Callogorgia verticillata* on *Dendrophyllia cornigera* reef terraces from Kimolos-Sifnos Strait.

Psira island, Greece. © Nerijus Juras. Dreamstime.

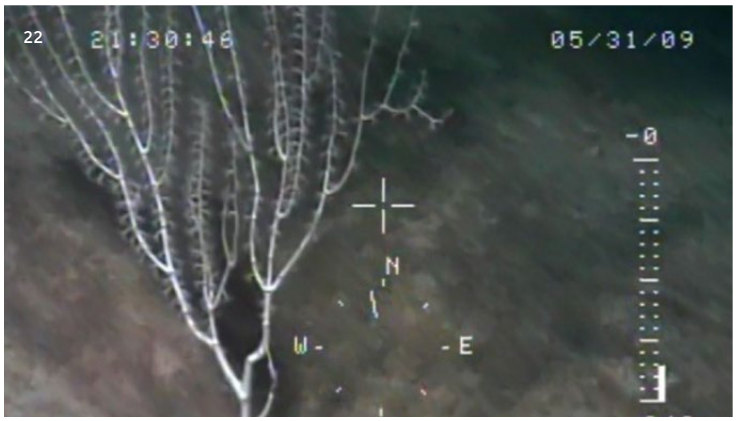


Plate 4.20. *Antipathella subpinnata* on the rock wall of Psira Island, Crete.

Plate 4.21. *Eunicella cavolini* on the rock wall of Psira Island, Crete.

Plate 4.22. *Isidella elongata* on soft substrate (right) from N. Kasos Strait.

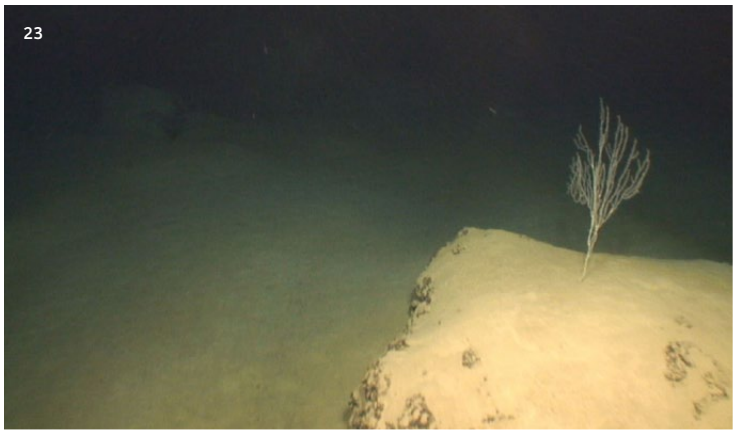
Kasos island. © Dimitris Tzortzakis, Dreamstime.

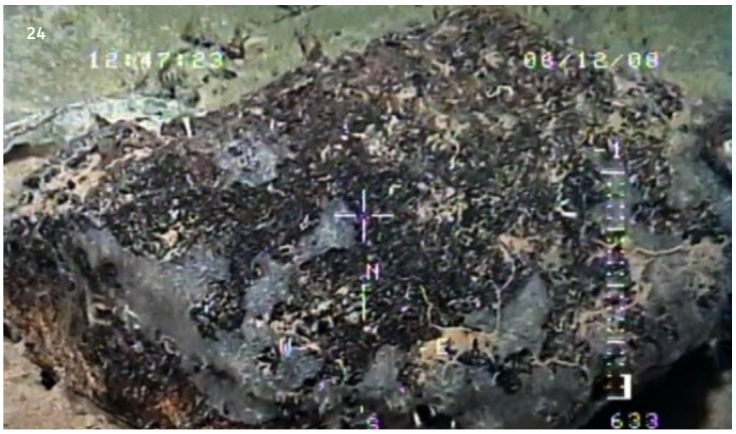
4 LIBYAN SEA

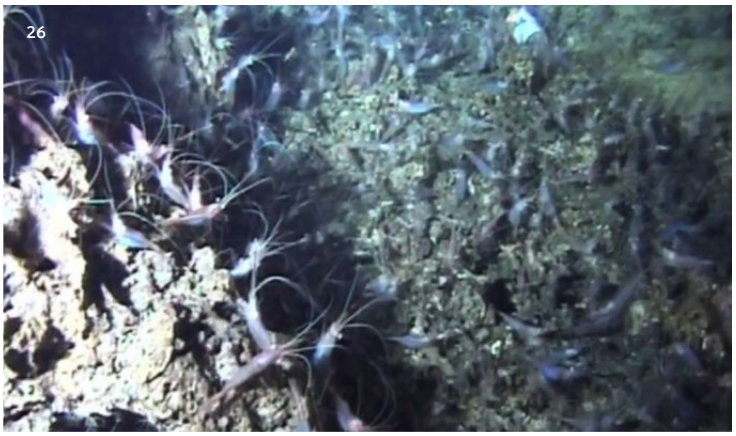
The three observation areas in the Libyan Sea were all in the area of the Hellenic Trench, off the South coast of Crete or the Crete-Kasos strait. The two easterly areas were investigated as part of archaeological expedition, whilst the westerly area was a search mission for a recent airplane wreck. All three areas were characterised by predominantly flat soft sediments, with some small patches of crusts, a few stones or small areas of low outcropping rocks (**4.23 - 4.28**). Commonly present were the corals *Funiculina quadrangularis* and *Isidella elongata* and, in the Kasos Strait, one observation on soft sediments of the seapen *Kophobelemnon stelliferum*.

There were rarer hard substrates, exposed crusts and rocks, and these were colonised by low numbers of mostly small vulnerable coral species including black corals of *Antipathes dichotoma* and *Parantipathes larix* as well as the scleractinians Caryophyllidae spp. and *Dendrophyllia cornigera,* both living and rubble, observed on the edge of hard substrates. The richest area with the highest number of species was the area South of Chyrssi Island (**4.24 - 4.26**), the main Chryssi Seamount with a total of 14 vulnerable species and notably high numbers of the seapen *Funiculina quadrangularis,* the black coral *Antipathes dichotoma,* Caryophyllidae sp., Zoantharia sp.*,* the uncommon Corallimorpharia *Sideractis glacialis* and the brachiopod *Gryphus vitreus*. Dense aggregations of deep-shrimps *Plesionika* sp. were also observed on the occasional crusts and small outcrops in this area (**4.26**). Observations of small corals were also made on ancient litter in the form of terracotta amphora. More observations of the filter feeding vulnerable species were made in the Kasos Straits area, another important site, particularly *Funiculina quadrangularis* and *Isidella elongata* on soft sediments, which may have been due to higher water flows. However, the number of sponge observations was very low. The most striking sponge record was that of the rarely reported rock sponge *Leiodermatium* sp., which was found on fine substrate, at 450-617 m in the Kasos Strait (**4.27**). Bioturbation levels were mostly low, although large densities of wide echinoid feeding trails bulldozed on the sediment surface were observed particularly in the South Crete areas from an irregular heart urchin (probably *Spantangus purpureus*). Another monospecific hotspot was evidenced by large number of the sea urchin *Cidaris cidaris* feeding on a mammal skeleton.

A mixture of small litter items (e.g. plastic bags, bottles and cans) were observed in all sites and lost longlines were observed at the shallower two sites off South Chryssi Island and the Kasos Strait (500-600 m) (**4.27 - 4.28**) with none at the deeper South Sfakia site (950 m), with the exception of the modern airplane wreckage (metal allows and plastics). Overall the sites represented an important area for the Libyan Sea in terms of vulnerable species.







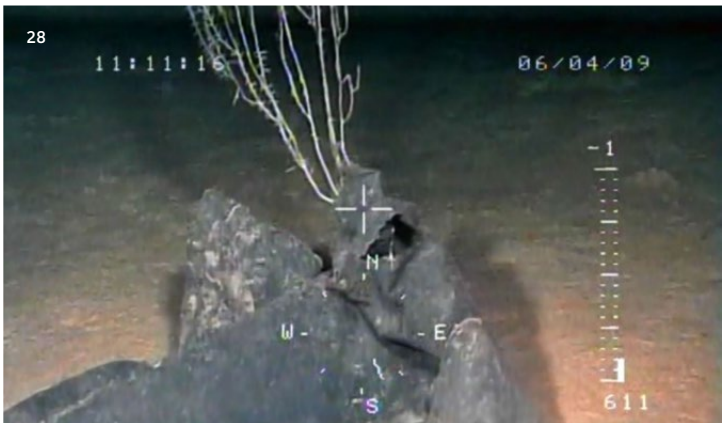


Plate 4.23. *Isidella elongata* on rock boulder covered with sediment, S. Sfakia, Crete.

Plate 4.24. Stones covered with the sponge *Hamacantha falcula*, S. Chryssi Island, Crete.

Plate 4.25. *Leiopathes glaberrima* colonies on amphora (different specimens), S. Chryssi Island, Crete.

Plate 4.26. Aggregations of shrimps *Plesionika* sp. on crust outcrops, S. Chryssi Island, Crete.

Plate 4.27. Rock sponges *Leiodermatium* sp. on fine substrate observed from the submersible, S. Kasos Strait, Crete.

Plate 4.28. Degraded *Isidella elongata* covered by plastic litter, S. Kasos Strait, Crete.

***Dendrophyllia ramea* is considered a rare coral in the Mediterranean Sea and with a patchy distribution.**

5 LEVANTINE SEA

ROV dives were available for examination in only three areas in the Levantine Sea and it is not possible to draw any broad conclusions about biological or geological areas of interest or distribution maps from video with such limited material available. From two close dive sites in the Nile Delta and one of the South West Coast of Cyprus, the most important biological feature from the material observed was the presence of patches and tube matrices of the siboglinid annelid *Lamellibrachia* sp. (most probably *L. anaximandri*) (**4.29**). This species has been reported before in the Levantine Sea related to seeps and vents (it is named after the Anaximander seamount), and it is highly probable that its presence is related to the geological formation on the sediments in the Nile Delta. There were no biological features of interest observed in the deeper waters of the Cyprus dive, although the coral *Dendrophyllia ramea* was observed in shallower waters (125-175 m) during the same dive transect[4].

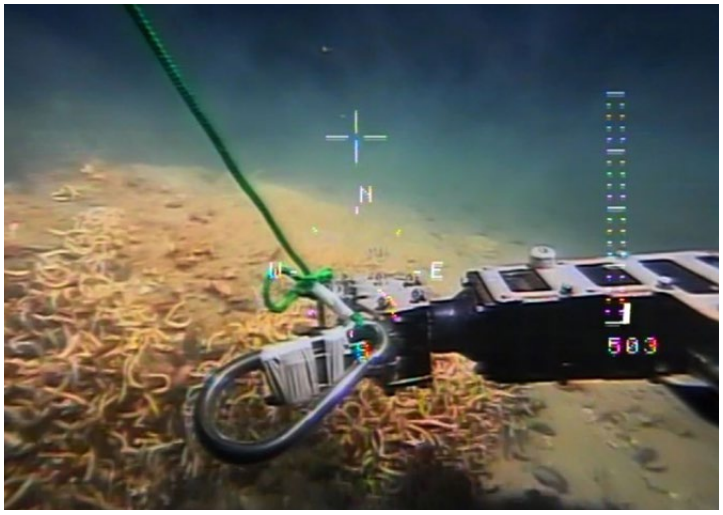


Plate 4.29.
Patches of the Siboglinidae annelid *Lamellibrachia* sp. associated with crusts or low sediment covered outcrops from the Nile Delta.

Species diversity

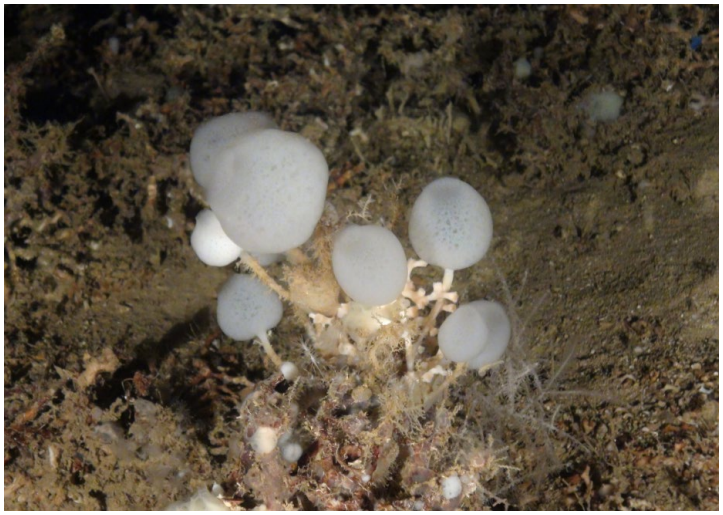
A total of 46 vulnerable invertebrate taxa were identified in the examined video material from 6 different phyla.

SPONGES (PORIFERA)

Sponges were recorded extending from the Eastern Ionian to the Aegean and Libyan Seas (Fig. 4.2). The bathymetric range of these occurrences was 200-1,650 m, with most taxa being found at 200-1,200 m (Fig. 4.3). Most recorded taxa of sponges belonged to the demosponge order Tetractinellida, namely *Geodia* sp., *Leiodermatium* sp., *Neophrissospongia* sp., *Poecillastra compressa*, *Thenea muricata*, tetractinellid sponges (unidentified) and probably several of the unidentified white massive sponges. The latter two taxa were the most widely distributed ones, along with lollipop sponges and the encrusting species *Hamacantha falcula* (found in 7-8 sites, each). Only two hexactinellid taxa (glass sponges) were observed, *Farrea* sp. and *Tretodictyum reiswigi*, but it is possible that the categories "white-blue sponges" and "lollipop sponges" also included some glass sponges (e.g. *Sympagella* sp.).

Demosponge (*Geodia* sp.).

Poecillastra compressa.



Glass sponges pedunculated (*Sympagella delauzei*).

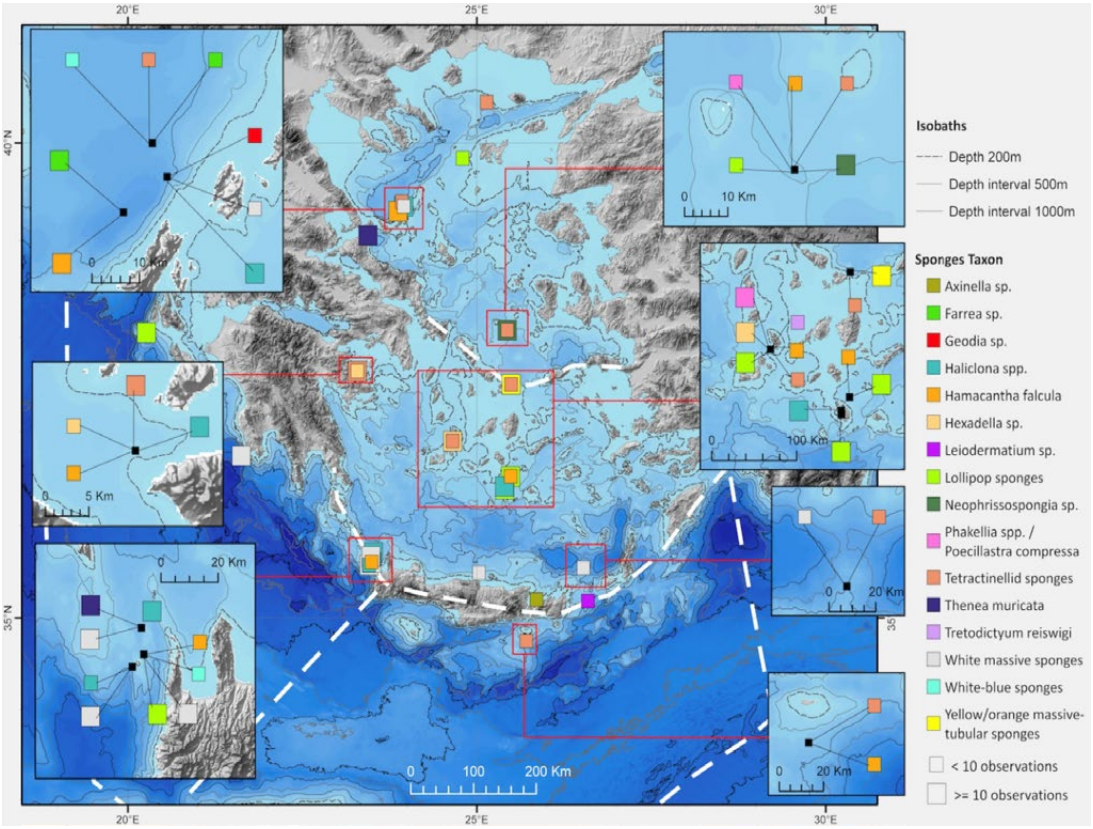


Fig. 4.2. Geographic distribution of the recorded sponge fauna. Site points are identified in Fig. 4.1.

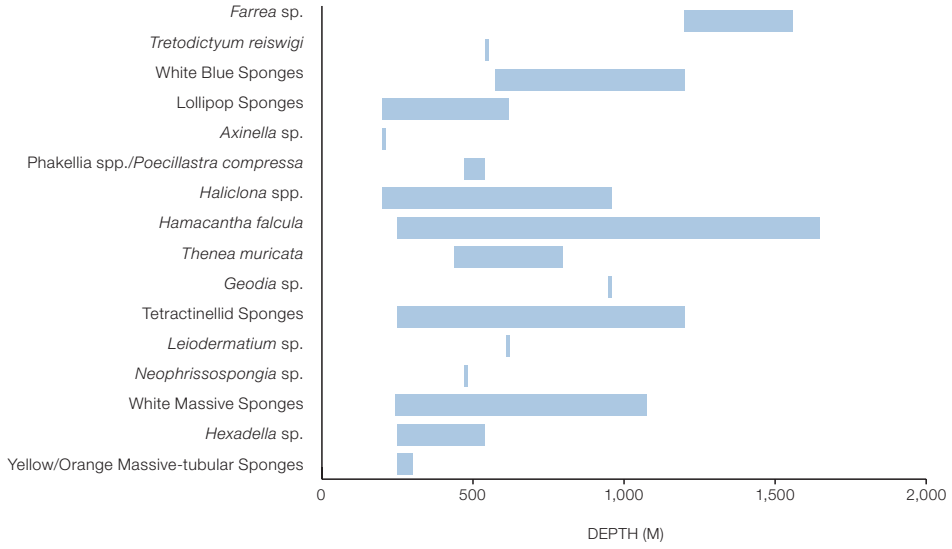


Fig. 4.3. Bathymetric distribution of the recorded sponge fauna.

ANTHOZOANS

Most recorded vulnerable taxa were anthozoans which were further categorized as “cold water corals” (CWC), which developed on both hard substrates (mostly) and fine sediments, and sea pens and anemones (7 taxa), mostly on soft substrates. Cold-water corals extend from the Eastern Ionian to the Aegean and Libyan Seas (Fig. 4.4) and were observed at a depth range of 300-500 m with Caryophyllidae reaching a maximum depth of 1,150 m (Fig. 4.5). The most widely distributed were the bamboo coral *Isidella elongata*, black corals *Antipathes dichotoma* and Plexauridae gorgonians.

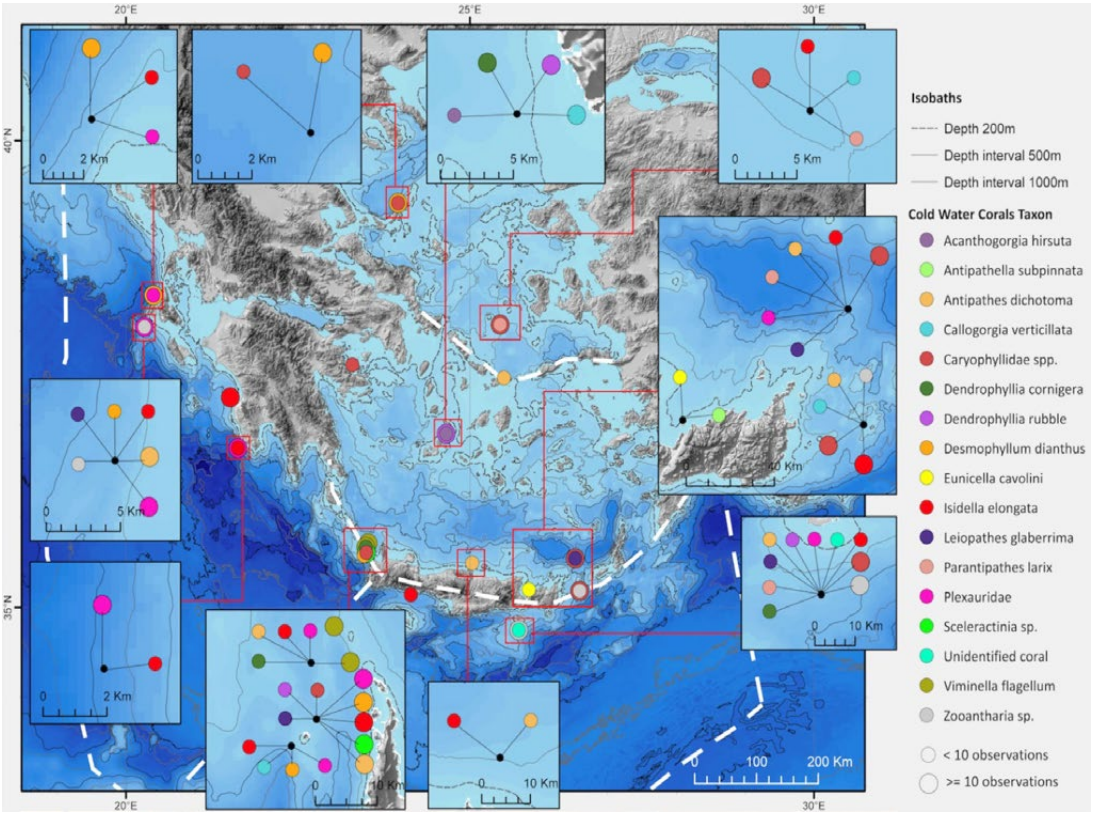


Fig. 4.4. Geographic distribution of the recorded cold water corals. Site points are identified in Fig. 4.1.

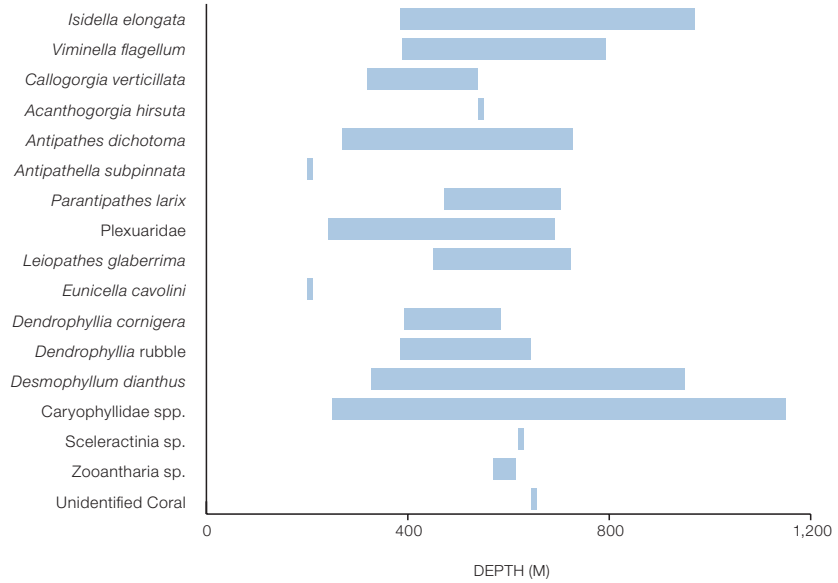


Fig. 4.5. Bathymetric distribution of the recorded cold water corals.

Most taxa of sea pens and anemones were found at 400-800 m depth, with their maximum bathymetric range being 970 m (Fig. 4.6; Fig. 4.7). The most widely distributed species was the tall vulnerable sea pen *Funiculina quadrangularis*.

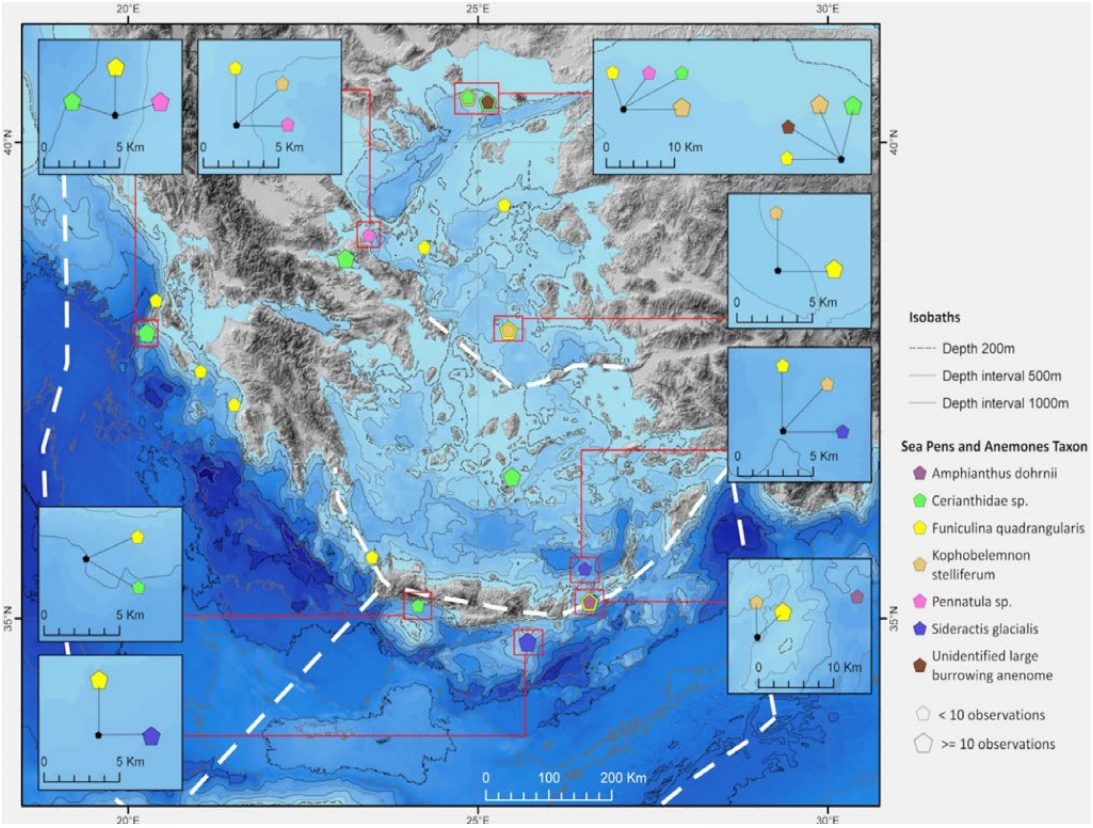


Fig. 4.6. Geographic distribution of the recorded sea pens and anemones. Site points are identified in Fig. 4.1.

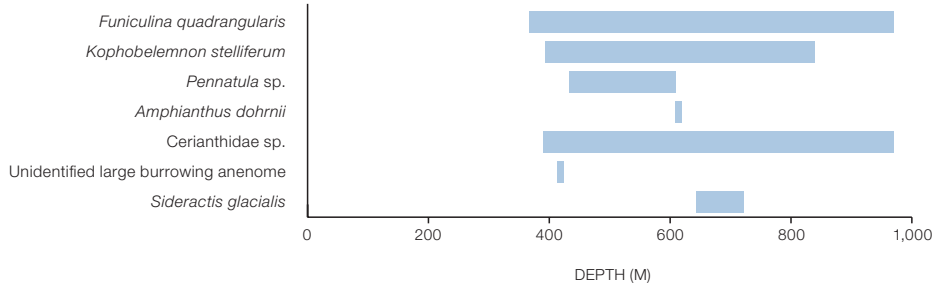
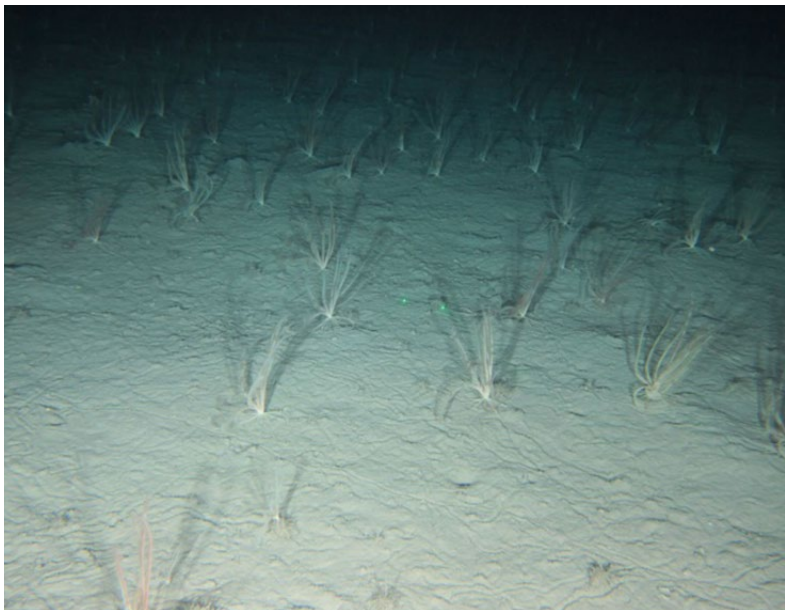


Fig. 4.7. Bathymetric distribution of the recorded sea pens and anemones.

OTHER FAUNA

Other vulnerable invertebrate taxa were found with a small number of occurrence records and limited spatial distribution (Fig. 4.8) and bathymetric range of 220-690 m (Fig. 4.9).



Leptometra phalangium.

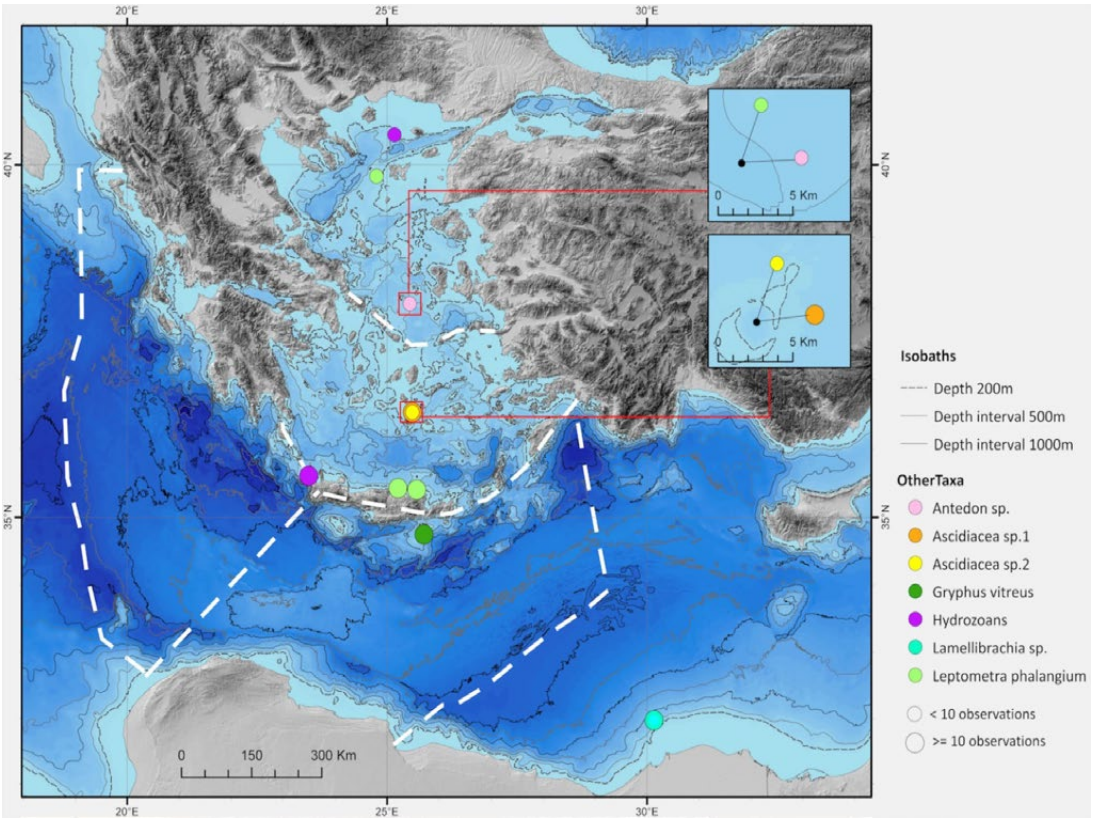


Fig. 4.8. Geographic distribution of other recorded taxa. Site points are identified in Fig. 4.1.

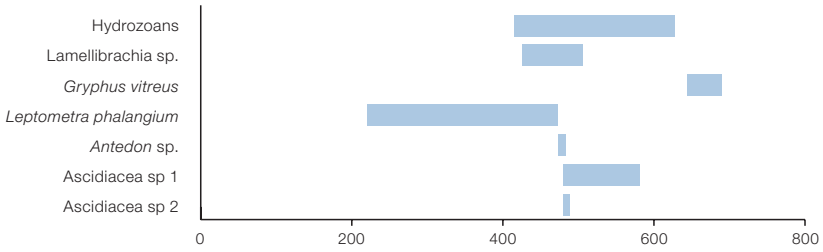


Fig. 4.9. Bathymetric distribution of other recorded taxa.

General Remarks

NEW AND RARE RECORDS

The whip-like gorgonian *Viminella flagellum*, the gorgonian *Acanthogorgia hirsuta* and the sponge *Phakellia* spp. are reported for the first time in the Eastern Mediterranean Sea and Greek waters. The glass sponges *Farrea* sp. and *Tretodictyum reiswigi* and the rock sponge *Leiodermatium* sp. are reported for the second time in the Eastern Mediterranean. The former was only recently found off Lebanon in the framework of Deep-sea Lebanon Expedition[5] while the latter two species were collected by dredging, at 207 m depth, off Epidaurus in 1968[6]. Other rare records are the rock sponge *Neophrissospongia* sp., which has been recently reported only from shallow marine caves and deep-waters of the Aegean Sea[7,8] and several anthozoan species with a restricted number of records in the Eastern Mediterranean: the actiniarians *Amphianthus dohrnii*, the corallimorpharian *Sideractis glacialis*, the black corals *Antipathella subpinnata*, *Leiopathes glaberrima* and *Parantipathes larix*, the gorgonian *Callogorgia verticillata* and the seapen *Kophobelemnon stelliferum*[5,9,10]. Other interesting records include the siboglinid annelid *Lamellibrachia* sp. (most probably *L. anaximandri*) associated to seeps and vents off Nile Delta.

In addition to the new/rare distribution records, interesting ecological habits were recorded for several taxa: *Dendrophyllia cornigera* was found to be capable to construct extensive terraced reefs, comprised mainly of coral rubble and some living colonies (540 m depth, Kimolos-Sifnos Strait, South Aegean Sea); *Desmophyllum dianthus* was found to form dense aggregations on the sides or under-hanging boulders and rocks (573-632 m, SE Antikythera, Eastern Ionian Sea); a deep record of the yellow gorgonian *Eunicella cavolini* was observed at 200 m, off Crete (Psira Island, South Aegean Sea), close to its deepest known bathymetric edge (220 m); abundant sponge assemblages, Cerianthidae fields and facies of ascidians, often mono-specific, were observed in different volcanic areas (Paphsanias, Kolumbo and Santorini volcanos, South Aegean); dense observations of the annelid *Bonellia viridis* (up to 1 m^{-2}) and numerous *Munida* sp. decapods were made in North Evoikos Gulf (442-445 m, North Aegean Sea), man-made structures (e.g. ancient and modern litter and wrecks) often provided hard substrate for the development of several taxa (e.g. sponges and corals).

These findings provide a baseline for future surveys tailored specifically towards samplings for accurate spatial and taxonomic characterization of deep water fauna at present.

Biodiversity Hotspots

There are two levels of hotspots in the Eastern Mediterranean, large-scale of geographical importance with higher levels of biodiversity or abundance potentially on a kilometre scale and those at the local level, small-scale, often oases, at the metre scale.

LARGE-SCALE HOTSPOTS

At the large area scale certain hotspots could be identified. These areas of higher species number and abundance of vulnerable species included, **two areas on either side of Crete, the SE Antikythera sites to the northwest of Crete in the Eastern Ionian Sea, the Chryssi Island and the Straits of Kasos to the SE of Crete, in the Libyan Sea, as well as the SW Kephallinia area in the Eastern Ionian Sea. In the southern part of the North Aegean Sea, there was an important site south west of the island of Chios, but also potentially in S. Thasos if the sea pen field is still present. In the South Aegean, the volcanic sites of Paphsanias and Kolumbo and the Kimolos Strait were also sites of interest.**

At this scale both geological and oceanographic phenomena are the primary reasons for higher biodiversity or abundance. The sites associated with straits on either side of Crete (bordering south eastern Ionian and south western Aegean on the one side and south eastern Aegean and north western Libyan Sea on the other) are firstly areas of higher water movement with exchange between the Aegean Sea and other surrounding seas. The Antikythera area on the western side will be more associated with nutrient richer water from the Aegean Sea (Black Sea origins), having better feeding conditions for vulnerable filter feeders. For both straits a net export of nutrients from the Cretan Sea towards the open waters of the Eastern Mediterranean through deep water outflow have

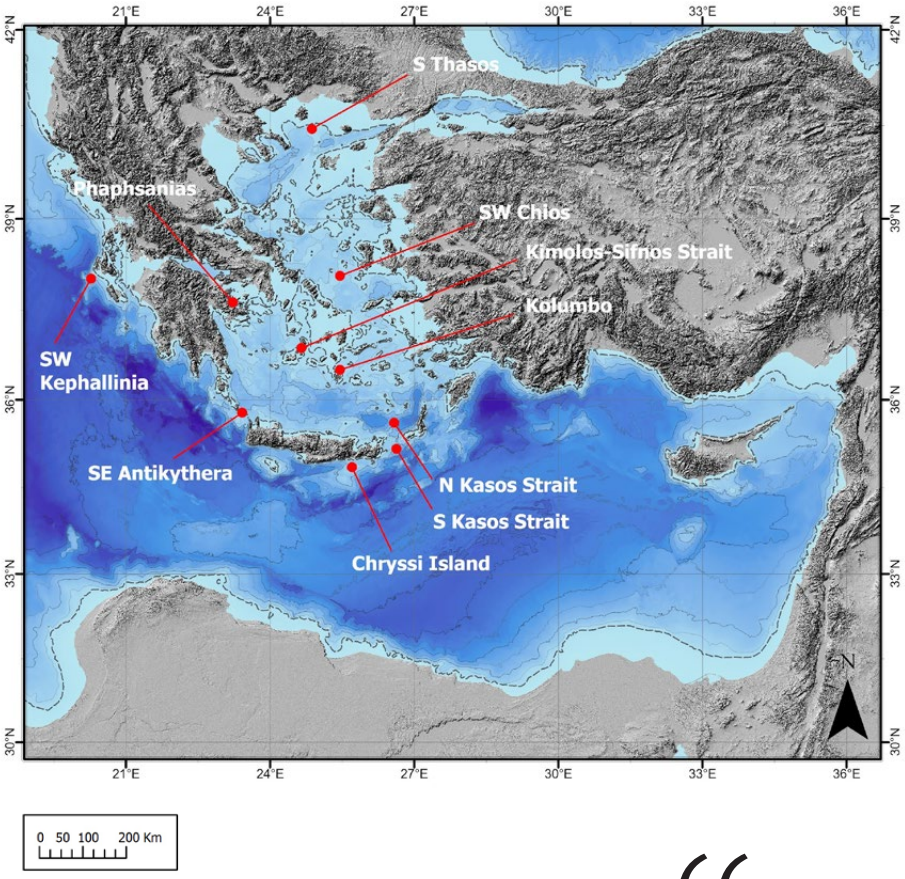


Fig. 4.10. Deep-sea hotspots of benthic biodiversity identified.

“Hotspots of biodiversity were found at several areas on either side of Crete (SE Antikythera sites, the Chryssi Island and the Straits of Kasos), the SW Kephallinia area in the Eastern Ionian Sea, south west of the island of Chios and S. Thasos in North Aegean Sea. In the South Aegean, the volcanic sites of Paphsanias and Kolumbo and the Kimolos Strait”

been recorded[11]. Secondly these are areas of variable seabed morphology providing substrates for both soft sediment fauna (sea pens and *Isidella elongata*) and hard substrate fauna (corals and sponges). The Antikythera and areas to the south west of Crete were also associated with seamounts, which are seabed geomorphologies that are known to have high biodiversity levels[12]. The Antikythera area had the largest number of species and abundance from all the sites investigated. The Eastern Ionian Sea site investigated off SW Kephallinia is also located on a seamount and was noted for high diversity and abundance. The area also had a mix of substrates with sea pens and *Isidella* bamboo corals on soft sediments and the corals *Antipathes dichotoma,* Plexauridae spp. and *Desmophyllum dianthus* as well as a few large individuals of the longeveous black coral *Leiopathes glaberrima.* This area is approximately 130 nm south west of the highly biodiverse cold water coral province of Santa Maria di Leuca, characterised by the reef building scleractinian corals *Madrepora oculata* and *Lophelia pertusa*[13]. No living analogues to these reef systems have been located further east from Italy, which may be due to the more oligotrophic and warmer nature of the Eastern Mediterranean or lack of extensive survey effort.

In the North Aegean, the area SW of Chios was represented mostly by flat soft sediments and had large numbers of *Funiculina quadrangularis*, with a few sporadic low rock outcrops which were characterised by a covering of a diverse mixture of corals and sponges, most likely indicating higher trophic conditions which may be due to flow of more nutrient rich Black Sea water towards the south west. The geological feature of the low outcrops was the reason for the presence of the corals and sponges. This area was also the northern-most record

for video observation of *Isidella elongata* in this study[10]. In the South Aegean another Strait site had high abundance and diversity between the islands of Kimolos and Sifnos, primarily associated with rock terraces amongst a sloping sedimentary seabed. An important feature amongst the predominantly sponge fauna were many small reefs of live and dead coral *Dendrophyllia cornigera*.

Both of the submerged volcanoes Paphsanias and Kolumbo are situated along the Aegean volcanic arc[3]. They both had high numbers of sponges, but Kolumbo was also characterised by high numbers of large Cerianthidae anemones on soft sediments and ascidians on rocks and old chimneys close to active areas. The volcanos provided a rich range of habitats in terms of hard substrate types, but also very soft sediments. Santorini an emergent volcano is also part of the arc located only 4 nm south west of Kolumbo, but had much lower observed species and abundance with just a few sponges recorded.

SMALL-SCALE HOTPOTS

Small-scale hotspots were found to be related specifically to small geological or anthropogenic features. Within a sedimentary area this could be represented by a single crust, stone or outcrop that was substrate for corals or sponges. Small outcrops were observed in several areas including those noted above, for example SW Kephallinia, Antikythera, SW Chios, Kimolos-Sifnos Strait, South Crete and Kasos Strait (north and south). One specific type was small metre-scale crust and rough, low outcrops south of Chryssi Island (Crete) with very high numbers of shrimp *Plesionika* sp. These features also appeared to have encrusting fauna, although not clearly identified with the exception of the coral *Dendrophyllia cornigera*. In adjacent sites within the same area, other crusts had various corals and sponges and this is one of the few sites with observations of the large coral *Leiopathes glaberrima.*

Anthropogenic traces could also provide the same type of substrate base for corals and sponges, the most common being amphora, that may have been on the seabed for one or two thousand years. In two cases an amphora was the attachment point for large specimens of the arborescent, longevous black coral *Leiopathes glaberrima.*

One last observation was made of a biomass hotspot, a mammal skeleton, possibly a dolphin with just decaying bones visible. The bones were supporting a feeding group, approximately 20 individuals, of the sea urchin *Cidaris cidaris*. Some shrimps of *Plesionika* sp. were also present, probably with respect to an “attraction point” as the skeleton appeared to be well past scavenging for flesh.

Mono-specific habitats

A feature noted in several areas was the presence of visibly mono-specific habitats with respect to filter feeding organisms. This was particularly noted in the submerged volcanos, with sponge habitats in the Paphsanias volcano (probably *Haliclona* sp.), but with many more mono-specific habitats in the Kolumbo volcano with areas of only unidentified Cerianthidae species on sediments (very large individuals), whilst different areas of hard substrate had unidentified Ascidiacea species completely covering some boulders and old chimneys and lollipop sponges on the volcano wall (also present on mud slopes leading up to the volcano wall). Why these almost exclusive habitats occur, with no mixing of species is unknown. However, the absence of taxa with calcareous skeletons (e.g. scleractinians) from volcanic areas could be possibly related to lower pH in the water close to vents/seeps.

Out-with of volcanic areas, three other species seemed to be in mono-specific habitats, the whip coral *Viminella flagellum* which was observed in a mono-specific habitat in an area of cliffs in Antikythera (this species was only recorded in the two Antikythera sites). Caryophyllidae were also observed in a number of sites in low numbers or small aggregations on small rocks or amphora, also as the only visible species present, particularly in the Libyan Sea sites of south Crete. Lastly the siboglinid annelid *Lamellibrachia* sp. was noted as the only species of interest observed in one of the Nile Delta sites.

Gaps and Recommendations

There are several notable gaps that have recommendations attached for our better understanding of biodiversity hotspots of sessile fauna in the deep waters of the Eastern Mediterranean and how they could be better covered by the use of underwater video systems, primarily ROVs. The lack of systematic and consistent coverage means that the present records are only indicative and consequently, there are important missing baselines for the natural range and densities of species, for example *Funiculina quadrangularis* or *Isidella elongata*, that might have been reduced in the last decades as trawling has spread into deeper waters particularly moving Eastwards in the Mediterranean (targeting deep-water red shrimp).

1. Coverage:
    a. There is a definite need to both extend our geographical coverage, both into areas that have not been covered before, for example, the Libyan and Levantine Seas, but also to have denser sampling scheme in those areas that might already have been covered, for example north western and eastern parts of the North Aegean.
    b. There is also a need to revisit areas as video material may have originated from 25 years ago, and with anthropogenic or natural changes, the present situation may have changed.
    c. Finally, there is a need for better depth coverage in deeper waters. Most of the observations analysed in this report were in a depth range of 400-800 m with maximum of 1,570 m. The seabed deeper than this which comprises a large area of the South Aegean and the majority of the Libyan and Levantine Seas are un-visited by underwater systems with imaging technologies.
    d. Marine industries could be used for sources of deep-water video observations. There is on-going exploration and survey for marine resources and related infrastructure. ROV's are routinely used and provisioning could be made in licensing and use to make their georeferenced video material available for study.
2. New surveys need to be undertaken and tailored specifically towards recording species and habitats.
    a. High quality imaging with neutral lighting is required, so that small details can be observed and species can be better identified.
    b. There are also requirements for quantitative imaging to assess species/population densities on the one hand and size structures on the other.
    c. Some sampling needs to be undertaken to ensure identification, morphologies and for genetic records.
3. Abundance estimates issues and confidence in the identification and assignment of biodiversity hotspots requires further research aiming to overcome problems linked to subjectivity, variable data quality and lack of consistency/ transparency in decisions behind categorisations. Habitat suitability or predictive modelling may also be used to assess where vulnerable species may occur.
4. Besides legislation for deep water trawling (ban deeper than 1,000 m), there is little protection given to deep water areas from exploitation and consequent anthropogenic impacts, e.g. activities for oil and gas exploration are moving forward into areas with little or no information on deep water habitats, whilst passive gears have no prohibitions in deep water and may target coral areas[14] and trawling is still permitted at intermediate depths where pennatulid fields or cold water corals occur. Several areas of higher diversity and abundance of vulnerable marine species have been identified. Some of these should be taken forward as sites requiring some form of protection, particularly areas SW of Kephallinia, the Cretan straits and the volcanos in the South Aegean. •

CHAPTER 4 /

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