Chapter 6

Biodiversity in Central Mediterranean Sea

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Additional information is available at the end of the chapter

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Abstract

The Central Mediterranean Sea is an area that connects the western and the eastern Mediterranean Sea where migratory fluxes of marine organisms are very peculiar. The high biodiversity of these areas is owed to particular hydrological and geomorphological characteristics (Messina Strait and Sicily Channel). The morphology of the Strait of Messina resembles a funnel with the narrow end to the North and the largest one to the South, and its underwater profile can be compared to a mountain whose opposite sides have markedly different slopes. The great biodiversity that characterizes this ecosystem is linked to the particular hydrology of the area. The Sicily Channel (or Strait of Sicily) is a wide water body located between southern Sicily and northern African coasts and represents the transition between the Western (WMED) and the Eastern (EMED) basins of the Mediterranean Sea. Morphologically, the Strait of Sicily belongs to the continental shelf with some other sub-units, as basins, seamounts and 'banks'. The bottoms are generally irregular and canyons are present. Mediterranean Sea has been divided into different biogeographic districts that present great variability in water parameters and biocenosis too. This chapter resumes the main physical, chemical and biological properties of the Central Mediterranean Sea.

Keywords: biodiversity, Central Mediterranean Sea, Strait of Messina, Sicily Channel, biogeography

1. Introduction

This chapter will show the main physical, chemical and biological properties of the Central Mediterranean Sea. These characteristics play a key role in this area that is located in a particular position by collecting all the species that migrate from the Atlantic Ocean to the East and those from the Red Sea moving westwards.

In the recent years, the Mediterranean Sea has been divided into biogeographic districts that have very different characteristics of the waters and of the organisms that inhabit also; for this reason the Mediterranean Sea is divided into eastern, central, western, Adriatic Sea and Alboran Sea. In this chapter, we have presented all the research carried out over the years by several research groups, including the University of Messina, on marine organisms in this area, and the specific conditions that affect their distribution in the western Mediterranean Sea, and as well as physical and chemical mechanisms and climate regulating the very high biodiversity. The faunal composition of the Mediterranean Sea is very complex, because the population is as follows: 20% endemic species; 62% species in the Atlantic-boreal affinity; 13% species in the Mediterranean-Atlantic-Pacific affinity; 5% to the Indo-Pacific species affinity. Each biogeographical district shows faunal elements characterizing it.

As described by Bergamasco and Malanotte-Rizzoli [1], the Mediterranean Sea is an enclosed basin composed of two biggest basins (western and eastern) and different sub-basins (**Figure 1**, **Table 1**).

It is a concentration basin, where evaporation exceeds precipitation. In the surface layer, there is an inflow of Atlantic water which is modified along its path to the eastern basin that was transformed through surface heat loss and evaporation particularly in the Levantine basin (**Figure 2**).

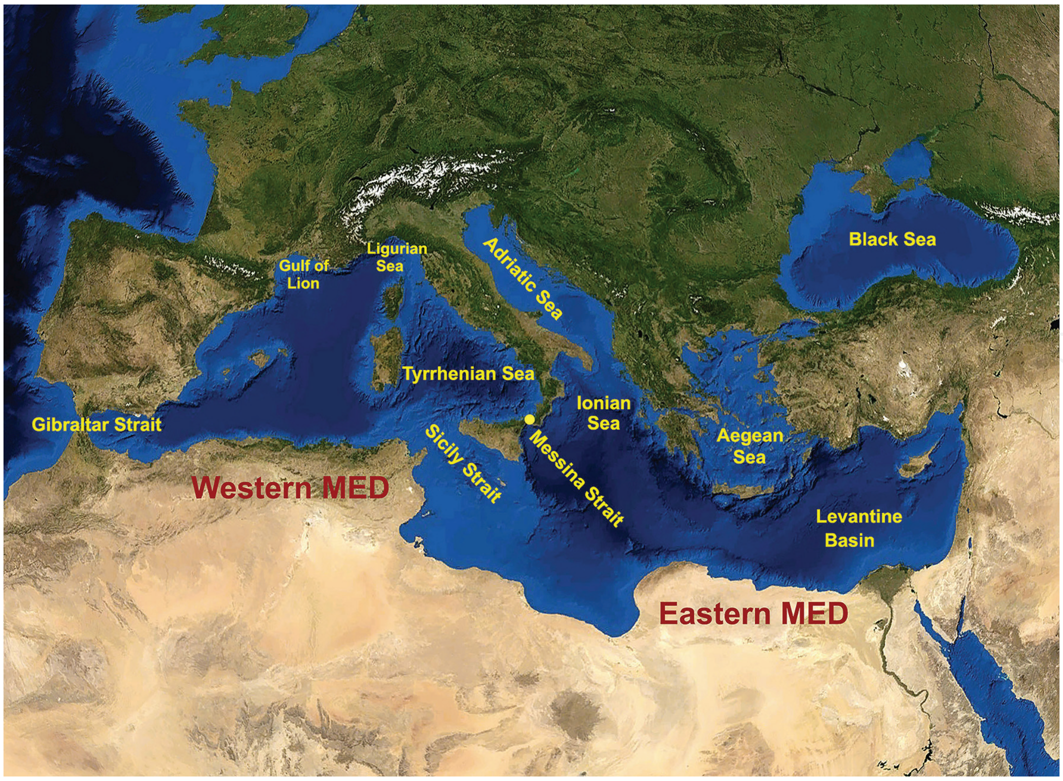

Figure 1. Mediterranean Sea.

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Size	
Surface	2.516×10^6 (km^2)
Volume	3.5×10^6 (km^3)
Maximum depth [3]	5267 (m)
Middle depth	1498 (m)
Length (*W-E*)	3860 (km)
Breadth (*N-S*)	600 (km)
Hydrography	
Water volume gibraltar (*IN*)	35,000 (km^3/year)
Rain input	850 (km^3/year)
River input	350 (km^3/year)
Water volume gibraltar (*OUT*)	36,400 (km^3/year)
Physical-chemical properties	
Salinity	35.6–39.1
Water temperature at bottom	13°C

Source: According to Della Croce et al. [2].

Table 1. Basic facts about the Mediterranean Sea.

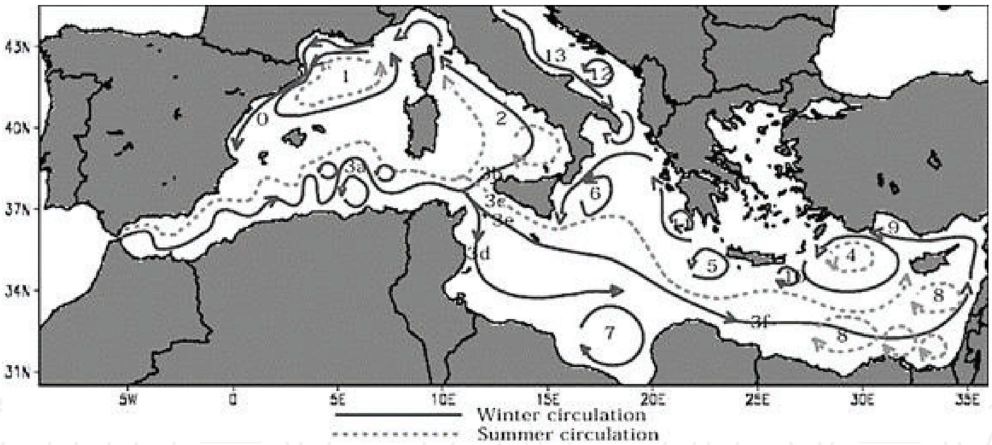

Figure 2. Circulation of Mediterranean Sea (Pinardi e masetti, 2000).

2. Mediterranean Sea

The Mediterranean is the site of water mass formation processes which can be studied experimentally because of its easy research and data collecting. There are two main reasons why the Mediterranean is important. The first one is the impact of the Mediterranean on the global thermohaline circulation; second reason is that the Mediterranean basin can be considered as a laboratory for investigating processes occurring on the global scale of the world ocean (**Figure 2**).

Bergamasco and Malanotte-Rizzoli [1] provided a short historical review of the evolving knowledge of the Mediterranean Sea circulation that has emerged from experimental investigations over the last decades. They start to describe the old picture of the basin circulation which had stationary and smooth large scale patterns and then they show the major experiments that led to the discovery of the sub-basin scale circulation and its mesoscale features. In conclusion, they described the dynamical discovery of eastern Mediterranean Transient (EMT) in 1990s.

From a biogeographical point of view, the Central Mediterranean Sea (Messina Strait and Sicily Channel) is a geographic, well defined, area, located between the western and the eastern Mediterranean Sea where migratory fluxes of marine organisms are very peculiar, interesting migrations from W to E and vice versa. The highest biodiversity of this area is owed to geomorphology and to oceanographic and climatic properties of the studied areas (Messina Strait and Sicily Channel).

This chapter will show the main physical, chemical and biological properties of the Central Mediterranean Sea. These characteristics play a key role in this area that is located in a particular position by collecting all the species that migrate from the Atlantic Ocean to the East and those from the Red Sea moving westwards.

In the recent years, the Mediterranean Sea has been divided into biogeographic districts that have very different characteristics of the waters and of the organisms that inhabit also; for this reason, the Mediterranean Sea is divided into eastern, central, western, Adriatic Sea and Alboran Sea.

The trophic, genetic, lessepsian and accidental migrations of organisms within the Mediterranean are a major 'cause' of the area's biodiversity. The faunal composition of the Mediterranean Sea is very complex, because the population is as follows: 20% endemic species; 62% species in the Atlantic-boreal affinity; 13% species in the Mediterranean-Atlantic-Pacific affinity; 5% to the Indo-Pacific species affinity. Of course, each biogeographical district shows faunal elements characterizing it.

3. Strait of Messina

The underwater profile of the Messina's Strait can be compared to a mountain whose opposite sides have distinctly different slopes. In the Tyrrhenian Sea the sea floor slopes gently up to 1000 m in the area of Milazzo Gulf reaching 2000 m depth near to the Stromboli Island. Differently, in the southern part (Ionian Sea) the slope is very steep and the depth between the cities of Messina and Reggio Calabria already exceeds 500 m, and reaches 2000 m in opposite to Capo dell'Armi, Cape Taormina connecting line.

The smaller width (3.150 m) of the Strait is along the connecting line between Ganzirri (Sicily) and Punta Pezzo (Calabria). This zone corresponds to a submarine 'relieve' (sill) with depths comprised between 80 and 115 m. In this stretch, the bottom has an irregular line, with the maximum depth of 115 m, which separates a western irregular zone (Ganzirri Bench) from the eastern of Punta Pezzo that is deeper and smother.

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The Strait of Messina is the geographical point of union between the Ionian and Tyrrhenian basins. These, although in continuity, are distinct in their different physical and chemical parameters and physiographic characteristics. The large difference in heights of surface water masses generates very strong currents at each change of tide [4].

The hydrodynamic characteristics and the particular ecological conditions of the Straits are closely related with its geological structure and the intense tectonic activity that characterizes this area. Even the distribution of sediments is affected by seismic activity as well as the intense hydrodynamic regime.

The northern sector of the Strait is characterized by a wide valley (named Valley of Scilla), with a portion deeper and steep beginning at about 200 m depth. The valley became flatten out and then to be less steep towards the Tyrrhenian Sea where it takes the name of Palmi basin. The side walls of the valley, deep and steep, rise abruptly giving a U-shape to the cross section of the valley. In the South sector there is a wide and irregular depression, less engraved (Messina Valley), also having a U-shaped section. Deeper than 500 m, the Messina Valley becomes deeper and develops to a canyon steep (Canyon of Messina) that reaches up to the Ionian Bathyal Plain. It represents the main route of sediment transport, and is spatially extended from the Sicilian to the Calabrian coasts [5]. **Figure 3** shows the Messina Straits and the underwater profile.

3.1. Tides

The Strait of Messina is the junction point (or perhaps better separation), as already said, between two basins, the Ionian and Tyrrhenian, contiguous but dissimilar, having different physical, chemical and oscillatory water characteristics. For this reason, steady and tidal currents are present, also thanks to the particular geomorphology of the whole area which determine several peculiar hydrodynamic phenomena.

Near to the submarine relieve or sill, steady currents flowing southwards from the surface to 30 m and in the opposite direction from this depth to the bottom, with speed that can reach up to 50 cm/s with particular weather and sea conditions. The co-oscillation of Messina's Straits water masses with the tides of the adjacent seas originates tidal currents with almost

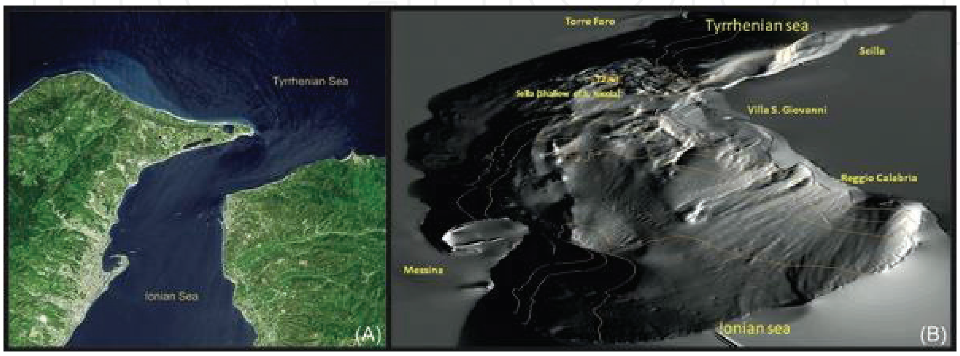

Figure 3. A) Strait of Messina from satellite (http://earthobservatory. nasa.gov.). (B) 3D image of the bottom of the Strait of Messina (Ph. Gianmichele Iaria).

opposite phase and equal amplitude. The relative speeds reach, along the section of the sill Ganzirri, Punta Pezzo, maximum values of more than 200 cm/s in both the flow to North (current 'montante'), and in the southwards (current 'scendente'). Mosetti [6] performed a research based on a long time series of data collected by a network of 27 currentmeters placed at three depths in nine sites in the central part of the Strait, indicate that the speed of the water flow in the Strait can reach, in particular moments and thanks to the coincidence of several components, up to a maximum of 20 km/h [7] (**Figure 4**).

These phenomena are created by the different levels of Tyrrhenian and Ionian Sea; in fact, when in the Tyrrhenian Sea there is low tide in the northern part of the Straits the adjacent Ionian Sea is in the development of high tide and the opposite happens during the next tide change. The difference in height (up to 27 cm) that is created determines that waters may flow into the contiguous basin.

More precisely, in the period of 'scendente' tide the Tyrrhenian waters, that are lighter than the Ionian ones, slide on these. Finally, the entire central part of the Strait is filled by Tyrrhenian water flowing towards South. In contrast, during the 'montante' tide, heavier Ionian waters, rising the central zone of the Strait flowing under the sea surface previously occupied by Tyrrhenian waters. Once over the sill these waters sink towards the northern part of the Strait.

The meeting (or better the clash) of these two water masses (Ionian and Tyrrhenian) determines the onset of numerous phenomena which are attributable to dynamic instability that is created and dispersed in the well-known spectacular manifestations of turbulence; these

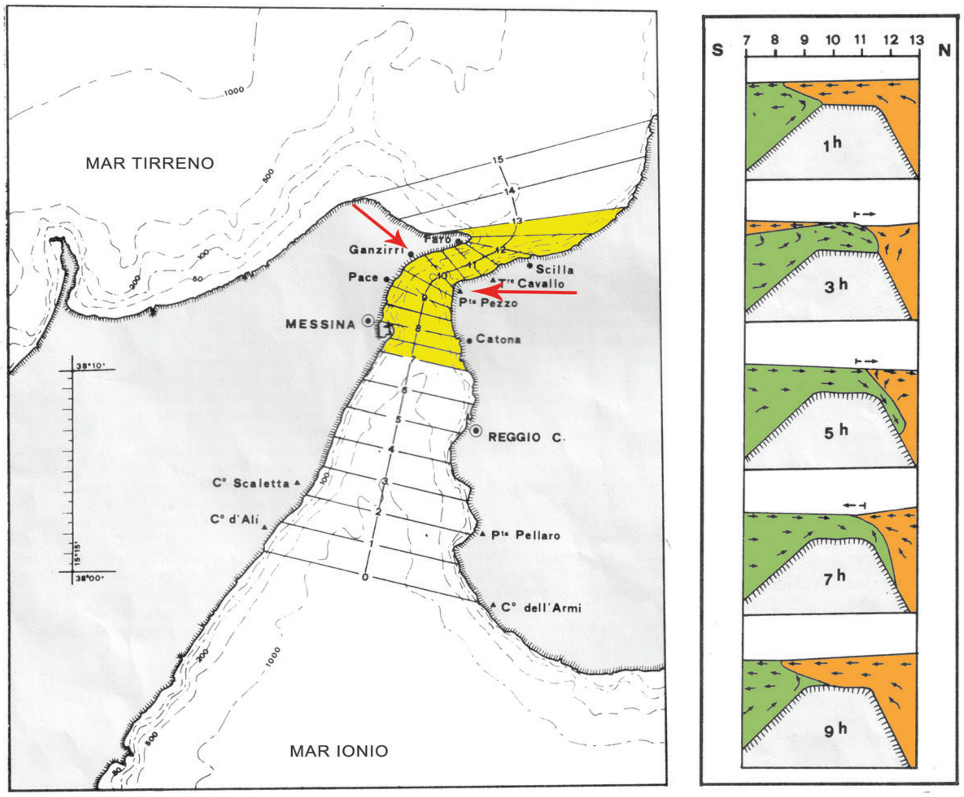

Figure 4. Current trends in the Strait of Messina (Defant, 1941, with data of Vercelli, 1925).

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'disturbances' of the current may occur with development in the horizontal sense (in the case of 'cuts' and 'sea stairs') or vertical (in the case of 'garofali', 'bastards' and 'oil stains'). The phenomena of the first group are characterized by real waves, similar to those occurring in the change of tide in estuaries, which develop when, in the case of the 'montante', the heavier waters of the Ionian Sea rush against lighter Tyrrhenian waters in recession or when, in the case of 'scendente', the Tyrrhenian waters glide swiftly on those heavier from Ionian, already present in the basin. These discontinuity waves develop in particular zones (Ganzirri, Torre Faro and Punta Pezzo) reaching also the central part of the Strait. Sometimes these phenomena are more intense, thanks to the action of winds that mix the different waters.

The vertical phenomena are eddies deriving from the meeting of opposite tidal currents, also favourite by the irregularity of the bottom. The main eddies form in well-known areas. During the 'montante' flow, the mythological 'Scylla' and 'Charybdis' occur such as first is formed on the Calabrian coast, and the other to the South of Capo Peloro. A big 'Garofali' can be observed during the 'scendente' phase at Punta S. Raineri, in front of Messina port. The 'garofali' have a cyclonic rotation, and in them the heavier waters sink above the lighter ones that emerge with turbulent movements. In the case of 'oil spots' the movement is instead anti-cyclonic and waters emerge at the centre of the vortex showing an oily appearance calm surface. The 'bastards' are currents that develop along the coasts, with intensity and direction opposite to that of the main flow; these vary from zone to zone in relation to the bottom morphology [4] (**Figure 5**).

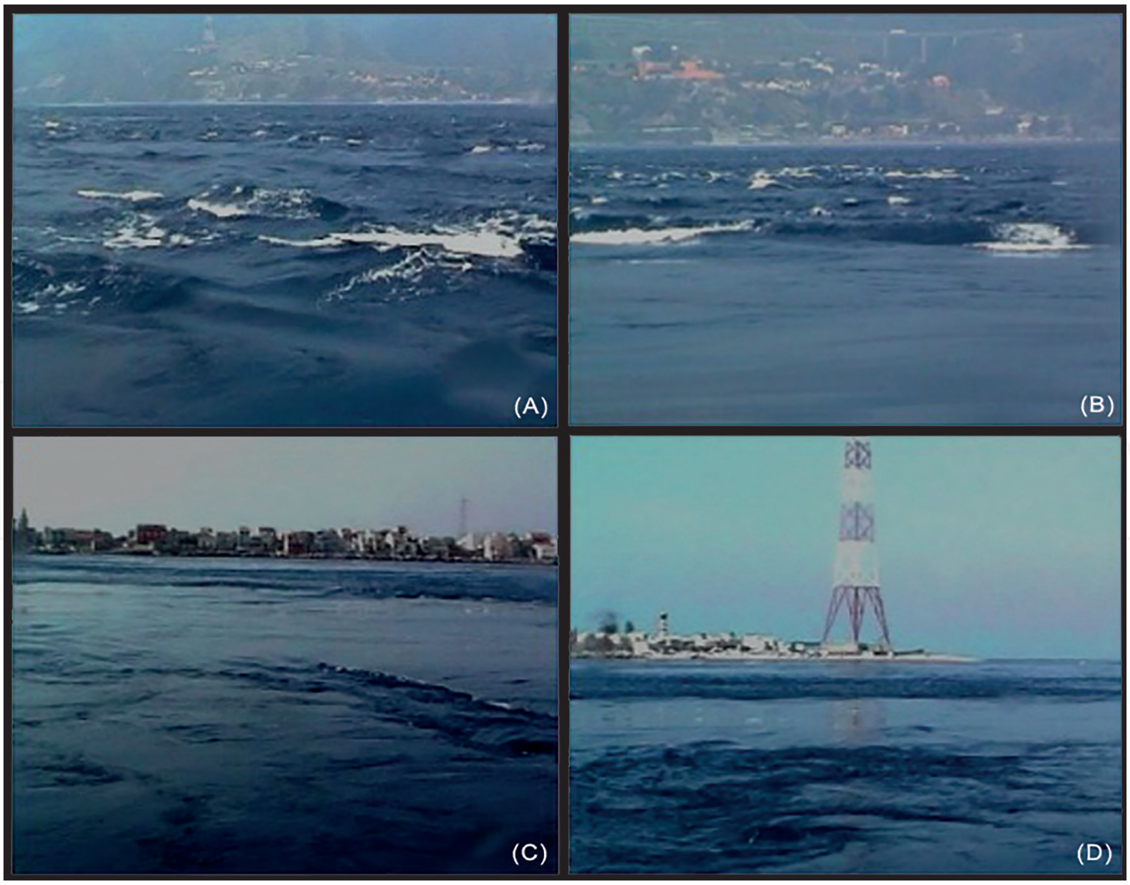

Figure 5. Current trends in surface. 'Cuts and sea stairs' (A–B). 'Oil stains and bastards' (C–D). (Ph. Andrea Potoschi).

3.2. Benthic ecosystem

The benthic ecosystem of the Strait is very composite and it is the result of a long and complex evolution. Coastal bottom populations show ancient origins and come from different geographical sites. The peculiar topography of the bottom, hydrodynamics as well as low water temperature, are the main causes for the presence in the Straits of many exclusive communities of Atlantic origin. For this reason, the Strait of Messina is considered the 'Sanctuary of Atlantic species in the Mediterranean'. It has been largely demonstrated that the high biodiversity can be related to hydrodynamic characteristics of the area. The intense hydrological regime allows the upwelling of deep water rich in organic matter and nutrients which is directly available for coastal benthic populations.

The Strait of Messina, owing to its particular geographic position, represents an exceptional observation point for the migration of species that cross the two basins (Ionian and Tyrrhenian Seas).

The physical characteristics of the Strait obviously influence the organisms that live in it, and therefore the entire biological environment. For this reason, in the Messina's Strait there is a unique ecosystem for biodiversity, biocoenosis and abundance of species. The intense water flow, the low temperature and the abundance of nitrogen and phosphorus salts (derived from upwelling) make available a large amount of organic matter used by both pelagic organisms and, above all, coastal benthic populations.

These features with the associated phenomena, determine an incredible 'ecological rearrangement' that species with predominantly western distribution tends to mimic an Atlantic type condition. In fact, many species, strictly Atlantic, such as 'Kelp forest' (*Laminaria sp*), live in the Straits of Messina, and their number is largely underestimated as evidenced by the continuous reports in this area by the scientific and local community [8].

As already said, the Strait of Messina, due to its geographical position, is an exceptional point for observation of migrating species that cross the two basins. Many planktonic species live and transit in this zone, even from distant areas, as confirmed by the ancient and recent reports of Atlantic organisms, e.g. *Corolla spectabilis* [9].

About the benthic species, the presence in the Strait of Messina of *Pilumnus inermis* is of particular importance [10]. Until recent years, this species was considered to be only Atlantic; furthermore *P. inermis* shows an association with the hydrozoan *Errina aspera* (the only Stylasteridae in the Mediterranean), well known endemism of the Messina Strait [11]. This particular environment is present in the sill zone between 80 and 115 m depths. This area also represents the perfect environment to harbours and numerous other particular species including the brittle star *Ophiactis balli*, the crabs *Parthenope expansa* and *Portunus pelagicus* [12].

Of course, of great importance are the organism's associations with *Laminariales* of the Strait. In fact, despite their sporadic presence in other areas of the Mediterranean, only in the Strait of Messina, *Laminariales* forms well-structured communities.

Another particular case is represented by *Albunea carabus* that, despite its warm waters origin (Senegal), has been repeatedly reported in the Strait. Its presence has not been reported out the Messina Strait [13].

In term of faunal assemblage, the Strait of Messina has been always considered the 'Paradise of Zoologists', thanks to its enormous biodiversity.

The most interesting species are the benthic invertebrates. The seabed is characterized by a wide variety of colours and shapes due to the abundance of coelenterates (sea anemones and corals), such as the forests of yellow and red gorgonian (*Paramuricea clavata*) from Scylla coastal seabed.

Fish biodiversity is allowed by a great number of species, as groupers, bream, snapper, damselfish, yellowtail and the beautiful and seasonal *Zeus faber* (John Dory or Peter's Fish), visible in these waters, between January and April, when the temperature is maintained at about 14°C [14] (**Figure 6**).

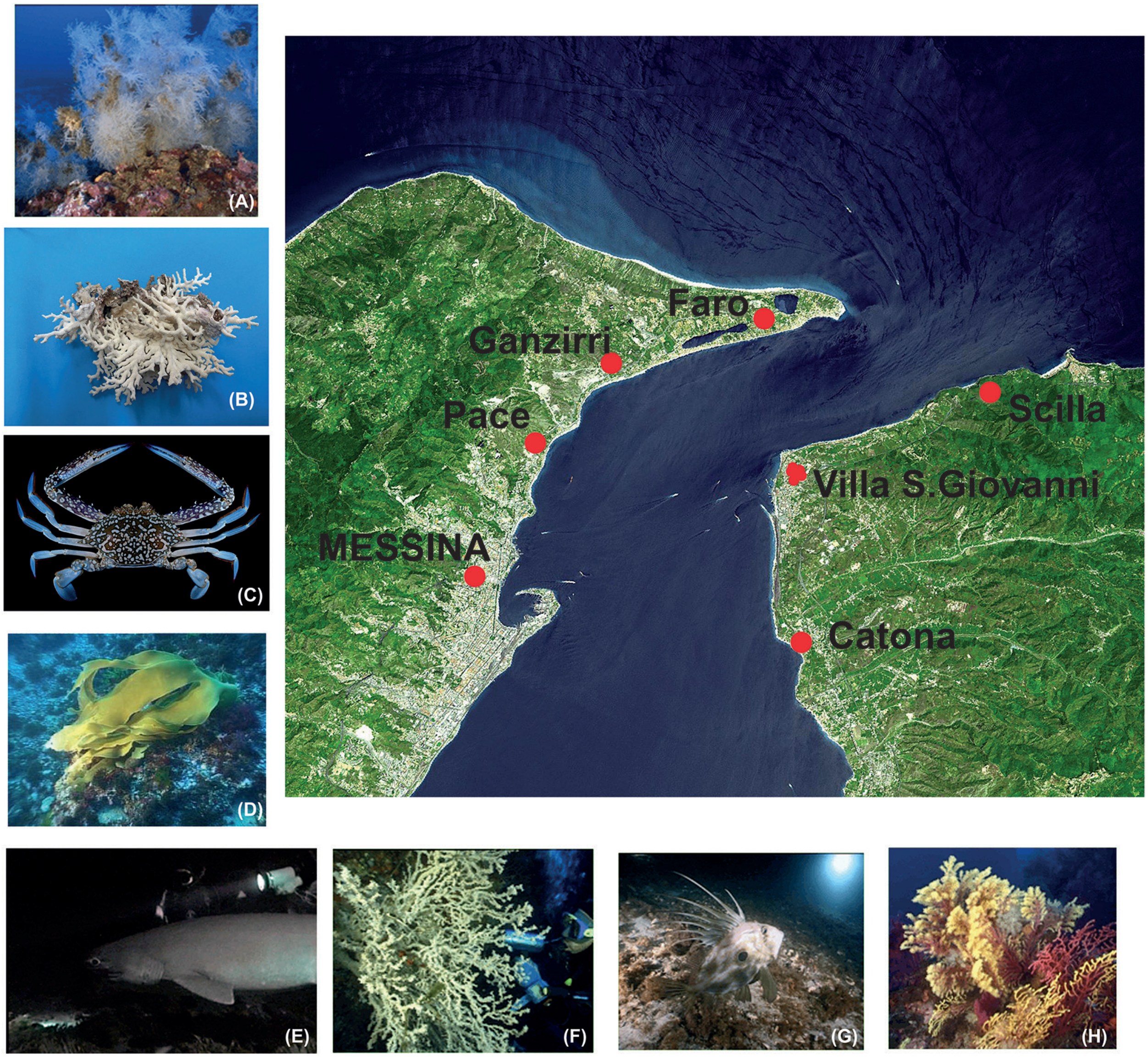

Figure 6. Characteristic species of Strait of Messina. (A) *Antipathella subpinnata*. (B) *Errina aspera*. (C) *Portunus pelagicus* (www.ciesm.org Ph. Bella Galil). (D) *Laminaria ochroleuca*. (E) *Hexanchus griseus*. (F) *Savalia savaglia*. (G) *Zeus faber*. (H) *Paramuricea clavata* (Photos Gianmichele Iaria).

3.3. Beach rock

In the Sicilian and Calabrian coasts of the Strait there is a coastal biotope of considerable interest (in the Sicilian shore, this zone is part of the Oriented Natural Reserve of 'Capo Peloro Lagoon'). It is an extensive stretch of coastline between Capo Peloro and S. Agata, affected by the presence of a rocky bench, from the beachfront, it takes up to several meters deep.

This zone, named **beach rock** (**Figure 7**), is located in a position between the intertidal zone and the upper fringe of the infralittoral. This structure is the only natural hard substrate for the benthic communities inside this bathymetric range, along the Sicilian side of the Strait [15].

Furthermore, due to its particular morphology, the topographic distribution, and on the basis of certain special influences from hydrodynamic regime of the Straits, the structure houses benthic communities completely original compared to what is known to the generality of similar Mediterranean habitats. In addition to its significant interest in terms of geological (proof of age Tyrrhenian) and anthropological documentation (formerly used as a quarry for millstones), the structure is of great importance as it hosts extended Vermetus formations, that is a protected biotope by the European community laws. These formations are also a unique case in the Mediterranean Sea, since they are located on the surface of the substrate, rather than placed in the typical *trottoir* formation [16]. It has been recently assessed that this zone represents a nursery zone for many fish species [17].

Figure 7. Beach rock (Ph. Nunziacarla Spanò).

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3.4. Migration of large pelagic fishes

The Strait of Messina is a crucial point for the migration of many species, located along one of the main Mediterranean routes. Among these, certainly the most important, from an economic and environmental point of view are the large pelagic fishes, i.e. tuna (*Thunnus thynnus*), the albacore (*Thunnus alalunga*), the Atlantic bonito (*Sarda sarda*), the Mediterranean spearfish (*Tetrapturus belone*) and the swordfish (*Xiphias gladius*). Just the 'wealth', high trophic resources of the Strait, determines that here are passing fishes in shallow waters and can be caught with special boats called 'passerelle' or 'feluche' active only in this part of the world. It is important to remember that in the Strait, using with different tools, the tuna can be caught throughout the year, from juvenile to adult. This is possible due to the presence of a local tuna population that moves regularly between the Tyrrhenian and Ionian Seas.

In addition to pelagic fishes, also the cetaceans cross the Messina's Strait; this latter probably represents the most important route in the Mediterranean sea in terms of species diversity. All dolphin species present in the Mediterranean have been reported in the Strait, besides Whales and Sperm Whales; the latter probably uses this way to Strait to reach Aeolian Islands area that represents a good environment, possibly, for their reproduction also.

Finally, the migration of large sharks, as *Carcharodon carcharias* (white shark) and *Hexanchus griseus*, through the Strait of Messina has been largely documented. Specimens of *Hexanchus griseus*, can be found in the moonlight of dark nights at depths between 15 and 30 m in some areas of the Strait (Paradiso and S. Agata).

3.5. Bathypelagic fishes

A further distinctive element of the Strait of Messina is the presence of bathypelagic fauna (commonly called abyssal fauna), which, transported to the surface by the upwelling, can be easily found in the turbulence points, or stranded along the shore in particular weather conditions. These organisms habitually live at bathypelagic depths in the Mediterranean Sea (usually between 300 and 1000 m) [18]. Their massive presence (with all ages represented) in surface water of the Strait is of considerable biological and ecological importance. The easy availability of these 'monstrous' fishes, most of which presenting special light organs (photophores) [19], called in Messina, between the second half of 1800 and early 1900, the attention of scientists from all over Europe. They defined the Strait of Messina as 'the zoologists' paradise'.

Some of these species are not transported to the surface by currents in a totally passive way but perform well-defined vertical movements, especially during the night named 'nictemerali' migrations (diel vertical migration) [20]. These are mainly myctophids whose role in the pelagic trophic network, given the considerable quantities involved, is certainly of primary importance. In the same manner it is possible to find a lot of *Chauliodus sloani* and *Argyropelecus hemigymnus* specimens (**Figure 8**).

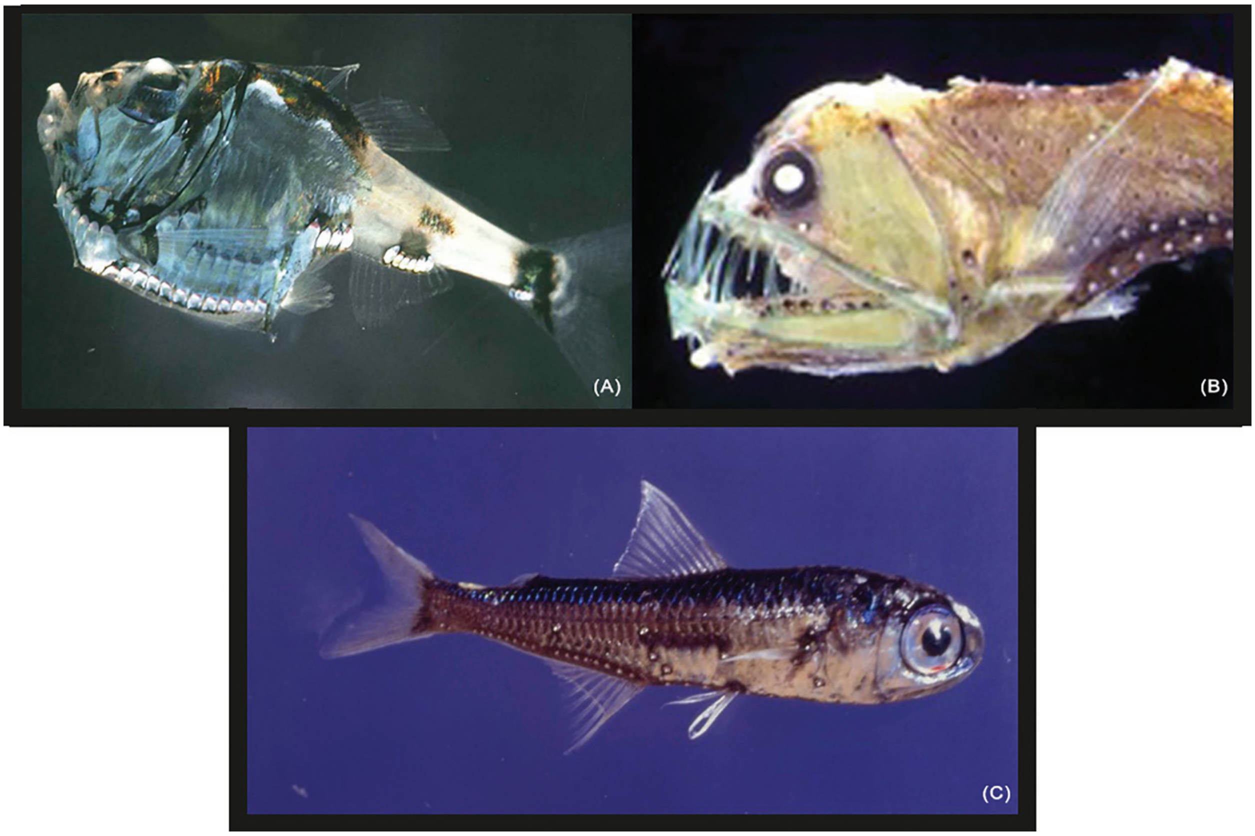

Figure 8. Bathypelagic fishes. (A) *Argyropelecus hemigymnus*. (B) *Chauliodus sloani*. (Ph. Fernand Baguet). (C) *Myctophum punctatum* (Ph. Francesco Costa).

4. Strait of Sicily

The Strait of Sicily is a relatively shallow area with a complex bottom orography [21]. Maximum depths of this area are reached in three different points: Pantelleria basin (1317 m), Malta basin (1721 m) and Linosa basin (1529 m). The valley communicates with the western and eastern Mediterranean Sea by a narrow sill, NW of Pantelleria Island (400–500 m deep), and a wider channel, SE of Malta (500–600 m deep), respectively. By the way, a 'sill' is a critical bathymetric restriction preventing exchange of waters of the same depths inside and outside a basin [22]. Morphologically, the Strait of Sicily belongs to the continental shelf and slope but other morphologic sub-units of the slope are usually identified: basins, seamounts (guyots) and 'banks' [21]. The slope shape is extremely irregular, incised by many canyons, trenches and steep declivity. It is furrowed transversally by the deep, above mentioned, basins (>800 m) and interrupted by 'guyots' and 'banks'. Sediments tend to pile up and fill these basins; the most important are those of Pantelleria, Gela, Linosa and Malta. Volcanism has been and is still active in the area [21]. The raise and successive wash-out of the Ferdinandea Island (now the Graham Bank), in front of Sciacca, occurred in the eighteenth century is an example of the volcanic activity in this area. 'Banks' are typical morphologic units in the Strait of Sicily. Due to its pre-eminent role as a bridge for the western and eastern basin (the two basic hydrological units recognized for the Mediterranean Sea; [23]), the Strait of Sicily has been widely investigated [24–26] (**Figure 9**).

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Figure 9. Sicily Channel. (http://earthobservatory.nasa.gov).

A recent evaluation revue of the seasonal circulation of the upper 800 m of the Mediterranean Sea has evidenced a complex dynamic situation in the water circulation.

Flowing mainly in West-South direction, its saline content increases gradually as a consequence of the strong evaporation (38.2–38.9% in the eastern basin). An analogous increase in temperature occurs in summer; in this season a thermocline can be found at about 50 m. For the sill in Strait of Sicily, Morel [21] has estimated that the Atlantic Water (AW) outflowing changes from 37.0 to 37.3% in transit whereas the incoming subsurface water changes from 38.8 to 38.7%. AW arrive to have 39% in the Levantine basin where, in Winter, it cools at 15–16°C and sinks to form the Levantine Water (LW) [27]. Recent further elaborations [28] have suggested that the path of AW in the Ionian basin and in the Strait of Sicily forms a meander in all seasons except in winter; a more complex situation has been also described (for example, Ref. [29]). A schematic representation of water flows can be observed in **Figure 10**.

Especially in the latter area the flow of AW could have not been well resolved but a deeper influence (down to 250–300 m) has been evidenced [28]. In the Strait of Sicily, the LW influences mainly the depth range between 150–200 and 1000–1200 m or less (200–600 m), according to other authors, e.g. Bombace and Sarà [30]. LW is more saline (38.5–38.8%) than AW (38.0%); both masses of water flow overlap. The bulk of these bodies of water follows the same path but in opposite directions, diverging only at the two extremities [22, 24].The boundary layer has been estimated to coincide with the isohaline of 38%. According to the inverse model results [28], the deep water circulation seems to become well discriminated from that of the surface at about 500–600 m, resulting in a level of discrimination (no motion level) at about 400 m. The most striking features resulted by the application of the inverse model were that the LW, after leaving the Strait of Sicily, flows mainly northwards crossing the waters in front of Sardinia, France, Spain and the Balearic Islands [28]. In the Strait of Sicily, the AW extends its influence down to 150–200 m (and more, up to 250–300 m according to other authors [30]) where it meets and partially mixes with the LW. Its surface temperature varies according the

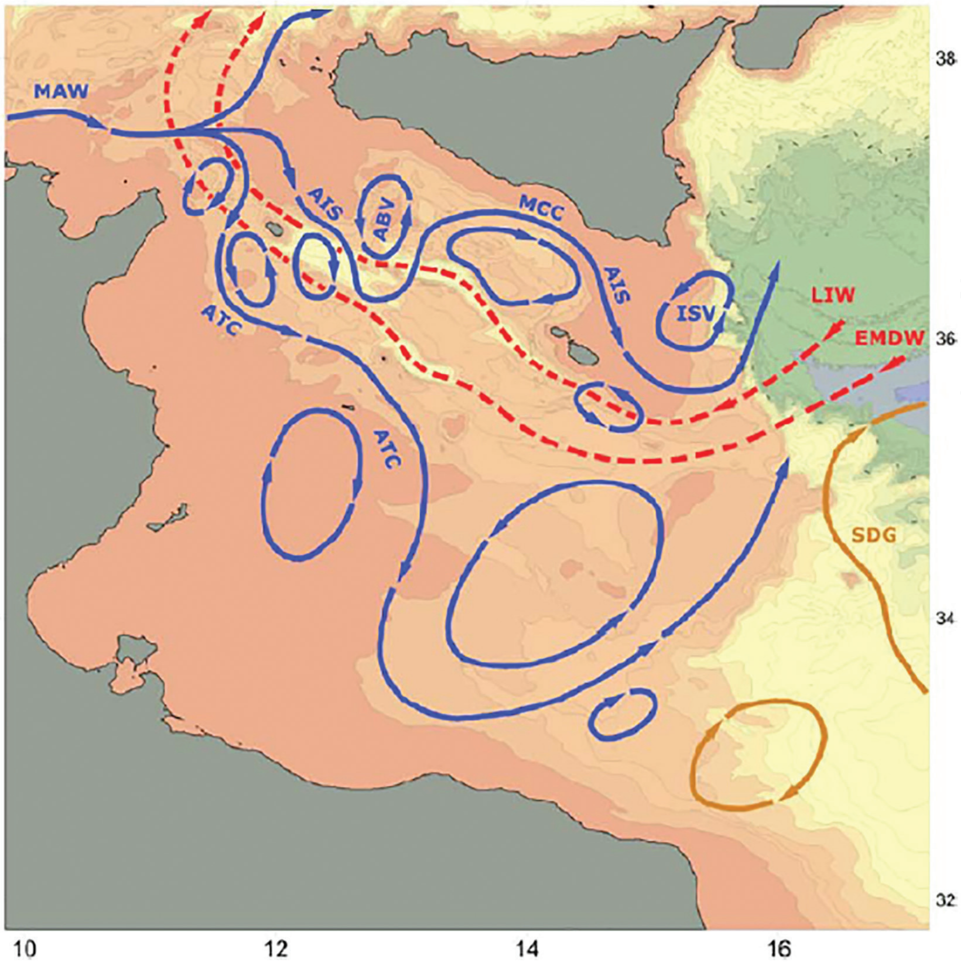

Figure 10. Scheme of the flows crossing the Sicily Channel. The paths have been drawn according to the SSH map from myOcean average data for 2010–2013 period. MAW, modified Atlantic Water; AIS, Atlantic Ionian Stream; ATC, Atlantic Tunisian Current; ABV, Adventure Bank Vortex; MCC, Maltese Channel Crest); ISV, Ionian Chef Break Vortex; SDG, Sidra Gyre; LIW, Levantine Intermediate Water; EMDW, Eastern Mediterranean Deep Water. (UNEP/MAP RAC/SPA, Tunis, 2015).

seasons (about 15°C and more than 22°C in winter and summer, respectively) and its saline content is about 37.5%; flowing towards the eastern basin waters become cooler and more saline. The LW has about 14.2°C and 38.7% when reaching the Strait of Sicily, where its influence extends down to 600–800 m.

4.1. Bionomy

Different studies on the benthic communities in the Strait of Sicily [31, 32] highlighted the dominance of rheophilic species, and with an Atlantic affinity. Large prairies of the seagrass *Posidonia oceanica*, which represents the most widespread and typical ecosystem in the Mediterranean phytal zone [33], characterize wide extension of the infralittoral bottoms down to 40–50 m [32, 34]. The hard substrates in the infralittoral and the deeper bottoms of the circalittoral are colonized by wide populations of large brown algae such as *Cystoseira*, *Sargassum*, and especially *Laminaria rodriguezi* [35]. The sandy bottoms swept by unidirectional

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and oscillating currents between 40–120 m (but also at lower depth, between the sea-grasses), especially in the centre of the channel (Lampedusa Island), host populations of calcareous red algae, the so-called 'Maerl' [33]. Bottoms between 30–50 and 150–200 m are characterized, using the Péres and Picard's classification [33], as the 'circalittoral' layer. The deeper level, generally associated with the continental slope and the deep steeps around the banks, is the 'bathyal' layer. In the hard substrates of the circalittoral layer, there is present a peculiar biocoenotic series named, thanks to the presence of red coral (*Corallium rubrum*), 'coralligenous bottoms'. They are characterized by: calcareous red algae, sponges, cnidaria (*Eunicella cavolini, Astroides calycularis*), polychaetes (*Serpula vermicularis*), brachiopods (*Argyrotheca cuneata*), bryozoa, crustaceans (*Lissa chiragra*), echinoderms (*Ophidia sterophidianus*), sea squirts (*Rhodosoma callense*) and bivalves (*Manupecten pesfelis*, *Lima vulgaris*). Péres and Picard [33] described another circalittoral biocoenosis of the hard bottoms, the 'off-shore rocks'; the characteristic group is represented by many sponges species, together with the cnidarians already mentioned. Some species, e.g. the Sea urchin *Cidaris cidaris*, are considered as outsiders coming from the bathyal zone. In the area of the Sicilian Straits the circalittoral bottoms between 65 and 105 m are often sandy, with grains from coarse to very fine, nearly muddy, interspersed with abundant larger detritus of organic origin, such as shell fragments, calcareous plants and, less frequently, bryozoan remnants. Soft seaweeds are abundant too: at low depth the green seaweed *Cladophora fracta* is predominant, elsewhere other algae are common (e.g. *Dictyota dichotoma*, *Laminaria rodriguezii*). The presence of sponges is massive, with *Crambe crambe* and others. A non-peculiar distribution is shown by the cnidaria *Pennatula phosphorea*. This species is typical of a particular kind of terrigenous mud-shelf assemblage, characterized by a viscous mud, and it is often associated with *Veretillum cynomorium* [36]; bivalves are mainly occurring with the species, *Acanthocardia echinata*,, *Hiatella arctica*, *Pecten jacobaeus* (assumed to be characteristic of whole western Mediterranean [36]; cephalopods presences are patchy, with *Eledone moschata*, *E. cirrhosa*, *Octopus vulgaris*, *Sepia officinalis* and *Loligo vulgaris*. Around Lampedusa, the crustacean galatheid *Munida curvimanna* is observed on sandy-muddy grounds, while *Galathea strigosa* lives on the 'Maerl' bottoms [37]. Many fishes of commercial interest live in the meso littoral layer, among which the most important red mullets, both the rocky one (*Mullus surmuletus*) and the muddy one (*M. barbatus*), and the pandora bream (*Pagellus erythrinus*); common are other demersal species such as the Sea robins *Lepidotrigla cavillone*, the flatfishes *Solea kleini*, the scorpion fish *Scorpaena scrofa*. The Sicilian Channel Strait presents some species of sub-tropical attitude, such as the Portuguese sole *Synaptura lusitanica*, the corb *Umbrina ronchus*, *Cynoponticus ferox*, *Facciolella oxyrhyncha*, *Epigonus constanciae* [38]. In the Sicilian Strait, the hard bottoms of deeper bathymetric zones, those of the bathyal layer, are characterized [39] by many huge 'buildings' produced by madrepores (*Madrepora oculata*, *Lophelia prolifera*), generally forming scattered clumps, that give origin to the 'white coral assemblages' biocoenosis [33], locally known as 'cannelleri' (Ragonese, S. personal communication): those presents strong and stony corms that make extended surfaces of the grounds between 300 and 450 m dangerous for the fishing activity, or even untrawlable altogether. Another white coral, *Dendrophyllia cornigera*, is less hard but still an obstacle for fishing, lives at higher depths; in fact, it colonizes rocky substrates exposed to hydrodynamics, while the former corals prefer finer sediments. The most typical biological indicator species is the Sea pen *Funiculina quadrangularis*, even if it is now quite rare especially on the trawlable grounds; the occurrence of such a species is closely related to the abundance of the food supply. In a few zones, the brachiopod *Terebratula vitrea* is dominant, but always associated with *F. quadrangolaris*. Among the crustaceans of this layer, the pink shrimp *Parapenaeus longirostris* (often associated with the presence of *Funiculina*) is the most interesting; the Norway lobster, *Nephrops norvegicus*, is caught here too; cartilaginous fishes are well and constantly represented in the layer with the dogfishes (*Etmopterus spinax*, *Scyliorhinus canicula*) and the skates (*Raja oxyrinchus*, *R. miraletus*). The northern part of the channel, i.e. the western Sicily, does not show significant differences from the other areas [40] while in the southern most part (in front of Capo Passero) are present the wreck fish *Polyprion americanus*, the grouper *Epinephelus guaza* and various Sea robins *Trigla* spp. [41]. The characteristic facies of this bionomic stratum is composed of *Isidella elongata* (Gorgonacea) that is associated with the red shrimps *Aristaeomorpha foliacea* and, depending on the zones, *Aristeus antennatus*. Parts of the same facies are the brachiopod *Tenebratula vitrea* and the echinoderm *Brisingella coronata* [37]. In western Sicily (i.e. the northern part of the Sicilian Strait Channel), the mesobathyal layer shows some typical and exclusive species, such as the sponges *Pheronema grayi* and *Poecillastra compressa*, the cnidaria *Lophogorgia sarmentosa*, *Madrepora oculata*, *Lophelia prolifera*, *Dendrophyllia cornigera*, *Calliactis parasitica* and *Amphianthus dohrni*, the crab *Anamanthia rissoana*, the gastropods *Natica millepunctata*, *Lunatia fusca*, *Buccinum humphreysianum* and *Fusinus rostratus*, the cephalopods *Bathypolypus sponsalis*, *Heteroteuthis dispar*, *Alloteuthis media*, *Abralia veranyi*, *Histioteuthis reversa*, *Chiroteuthis veranyi* and *Octopoteuthis sicula* [40]; in the northernmost area, the fishes *Chlorophthalmus agassizi* and *Aulopus filamentosus* are present too [41].

5. Conclusion

The Strait of Messina and the Sicilian Channel, part of the Central Mediterranean Sea, are considered as two unique exclusive ecosystems. The Strait of Messina is the point of contact between the western and eastern parts of the Mediterranean Basin. It presents unique biological communities and animal organisms and extremely rare seaweeds and is a great reservoir of biodiversity. For its peculiarities and for the seaweeds and animals that live in, it is considered as a sort of 'Atlantic Island' in the middle of the Mediterranean Sea. The two areas are to be considered as migratory routes for many species of fish (many of commercial interests) and headed whales in the Southern Tyrrhenian Sea, some species for genetic reasons also. The Central Mediterranean is a hot spot of biodiversity that sustains important endemic species and communities that interacts with two adjacent basins, eastern and western, concentrating and redistributing an important species budget. Finally, the reasons for which the Central Mediterranean is to be considered as a hot spot of biodiversity are to be found in its particular hydrology and geomorphology of the seabed.

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References

[1] Bergamasco A, Malanotte-Rizzoli P. The circulation of the Mediterranean Sea: A historical review of experimental investigations. Advances in Oceanography & Limnology. 2010;**1**(1):11-28

[2] Della Croce N, Cattaneo Vietti R, Danovaro R. Ecologia E Protezione dell'Ambiente Marino Costiero. UTET Libraria SRL, editor. Editel-Torino; 1997. pp. 15-196

[3] Barale V. The European marginal and enclosed seas: An overview. In: Barale V, Gade M, editors. Remote Sensing of the European Seas [Internet]. Springer Netherlands: Dordrecht; 2008. pp. 3-22. Available from: http://dx.doi.org/10.1007/978-1-4020-6772-3_1

[4] De Domenico E. Caratteristiche fisiche e chimiche delle acque nello Stretto di Messina. In: Geronimo D, Barrier, Mantenat, editors. Le Detroit de Messine, Evolution Tectono-Sedimentaire Recente (Pliocene et Quaternaire) et Environment Actuel. Paris; 1987. pp. 225-235

[5] Colantoni P. Marine geology of the Strait of Messina. In: Di Geronimo, Barrier, Mantenat, editors. Le Detroit de Messine, Evolution Tectono-Sedimentaire Recente (Pliocene et Quaternaire) et Environment Actuel. IGAL Paris; 1987. pp. 191-209

[6] Mosetti F. Some news on the currents in the straits of messina. Boll di Oceanol Teor ed Appl. 1988;**6**(3):119-201

[7] Tomasino M. The exploitation of energy in the straits of Messina. In: Guglielmo L, Manganaro A, De Domenico E, editors. The Straits of Messina Ecosystem; Università degli Studi di Messina, Messina; 1995. pp. 49-60

[8] Fredij G, Giaccone G. Bionomie des fonds a Laminaires du Detroit de Messine. In: Geronimo D, Barrier, Mantenat, editors. Le Detroit de Messine, Evolution Tectono-Sedimentaire Recente (Pliocene et Quaternaire) et Environment Actuel. Paris; 1987. pp. 237-238

[9] Berdar A, Giacobbe S, Leonardi M. Prima segnalazione per il Mediterraneo di Corolla spectabilis Dall, 1871 (Thecosomata). Boll Malacol. 1982;**18**(1-4):35-40

[10] Giacobbe S, Spanò N. Pilumnus inermis (Decapoda, Brachyura) in the straits of Messina and the Southern Tyrrhenian Sea (Mediterranean Sea): Distribution and some aspects of its ecology. Crustaceana [Internet]. 2001;**74**(7):659-672. Available from: http://booksandjournals.brillonline.com/content/journals/10.1163/156854001750377939

[11] Rinelli P, Spanò N, Giacobbe S. Alcune osservazioni su crostacei decapodi ed echinodermi dei fondi a Errina aspera dello Stretto di Messina. Biol Mar Medit. 1999;**6**(1):430-432

[12] Smriglio C, Mariottini P, Giacobbe S. Jujubinus errinae n. sp. (Gastropoda Trochidae) from the Strait of Messina, Mediterranean Sea. Biodiversity Journal. 2016;**7**(1):59-66

[13] Giacobbe S, Spanò N. New Records of Albunea Carabus (L., 1758) (Decapoda, Anomura) in the Mediterranean Sea. Crustaceana [Internet]. 1996;**69**(6):719-726. Available from: http://booksandjournals.brillonline.com/content/journals/10.1163/156854096x00736

[14] Costa F. Atlante dei pesci dei mari italiani. Mursia Editore, editor. Milano; 1991. pp. 1-430

[15] Bottari A, Bottari C, Carveni P, Giacobbe S, Spanò N. Genesis and geomorphologic and ecological evolution of the Ganzirri salt marsh (Messina, Italy). Quaternary International [Internet]. 2005;**140-141**:150-158. Available from: http://www.sciencedirect.com/science/article/pii/S1040618205001102

[16] Scuderi D, Terlizz A, Faimali M. Osservazioni su alcuni tratti della biologia riproduttiva di vermeti biocostruttori e loro ruolo nella edificazione dei "trottoir." Biol Mar Medit. 1998;**5**(1):284-289

[17] Capillo G, Sanfilippo M, Panarello G, Spinelli A, Manganaro A, Spano N. Preliminary investigation of an intertidal zone's faunal assemblage (Beach Rock, R.N.O. Capo Peloro, NE Sicily). Journal of Biological Research. 2016;**89**(s1): 1-20

[18] Scotto Di Carlo B, Costanzo G, Fresi E, Guglielmo L, Ianora A. Feeding ecology and stranding mechanisms in two lanternfishes (Hygophum benoiti and Myctophum punctatum). Marine Ecology Progress Series. 1982;**9**:13-24

[19] Baguet F. Bioluminescence of deep-sea fishes in the straits of messina. In: Guglielmo L, Manganaro A, De Domenico E, editors. The Straits of Messina Ecosystem. Università degli Studi di Messina, Messina; 1995. pp. 203-212

[20] Andersen V, Sardou J, Nival P. The diel migrations and vertical distributions of zooplankton and micronekton in the Northwestern Mediterranean Sea. 2. Siphonophores, hydromedusae and pyrosomids. Journal of Plankton Research [Internet]. 1992;**14**(8):1155. Available from: +

[21] Morel, A. Charactères hydrologiques des eaux échangées entre le bassin oriental et le bassin occidental de le Méditerranée. Cah. Ocean. 1971:**23**(4):329-342

[22] Hopkins TS. Physics of the sea. In: Margalef R, editor. Western Mediterranean. New York: Pergamon; 1985. pp. 100-125

[23] Sverdrup HU, Johnson MW, Fleming RH. The Oceans, their Physics, Chemistry, and General Biology. New York: Prentice-Hall; 1942

[24] De Maio A, Moretti M, Sansone E, Bregant D. Idrologia del Canale di Sicilia, Nave Dectra, ottobre 1969. Volume di Studi in onore di G. Aliverti. Napoli; 1972

[25] Grancini GF, Michelato A. Current structure and variability in the Strait of Sicily and adjacent areas. Annals of Geophysics. 1982;**5**:75-88

[26] Ragonese S, Bianchini ML, Di Stefano L, Bertolino F, Campagnuolo S. Study of the selec- tivity and assessment of the coefficient of retention of the trawl nets used for red shrimp fishing (Aristaeomorpha foliacea Risso, 1827 and Aristeus antennatus Risso, 1816; Crustacea-Aristeidae) in the Sicilian Channel (Central Mediterr. Sea), Project MED, 92/010, final report to the European Community, D.G. XIV, Bruxelles. 1994, 190 pp

[27] Gorgy S, Shaheen AH. Exploration des lieux de Pêche de la République Arabe Unie. — Résultats hydrographiques de l'expédidition du Shuyo-Maru dans la Mer Méditerranée et la Mer Rouge. In: Proc gen Fish Coun Médit. 1963. pp. 139-70

[28] Tziperman E, Malanotte-Rizzoli P. The climatological seasonal circulation of the Mediterranean Sea. Journal of Marine Research. 1991;**49**(3):411-434

[29] Ovtchinnikov IM. Circulation des eaux de la mer Méditerranée. In: Burkov VA, editor. Hydrobiologie de la Méditerranée. Gidrometeoizdat, Leningrad; 1976. pp. 240-313

[30] Bombace G, Sarà R. La pesca a strascico sui fondali da -500 a -700 metri nel settore a Sud-Est di Pantelleria. Mem Minist Mar Merc. 1972;**33**:77

[31] Giaccone G. Struttura, ecologia e corologia dei popolamenti a Laminarie dello Stretto di Messina e del Mare di Alboran. Mem di Biol Mar e Oceanogr. 1972;**2**:37-59

[32] Cinelli F, Fresi E, Mazzella L, Ponticelli MP. Deep algal vegetation of the western Mediterranean. G Bot Ital [Internet]. 1979;**113**(3):173-188. Available from: http://dx.doi.org/10.1080/11263507909426641

[33] Pères JM, Picard J. Noveau manuel de bionomie bentique de la Mer Mediterraneè. Requeil des Trav la Stn Mar d'Endoume Bull. 1964;**31**(47):5-137

[34] Cinelli F. Le Fanerogame marine: Problemi di trapianto e di riforestazione. Mem di Biol Mar e Oceanogr. 1980;**10**:17-27

[35] Suriano C, Mazzola S, Levi D, Giusto GB. La biocenosi dei substrati duri circalitorali a grandi Phaeophyceae (Laminaria rodriguezii Bornet, 1888) nel Canale di Sicilia e nel Canale Maltese. Oebalia. 1992;**17**(Suppl):429-432

[36] Pères JM. History of the Mediterranean biota and the colonization of the depths. In: Margalef R, editor. Western Mediterranean Key environments. Oxford, UK: Pergamon Press; 1985. pp. 198-232

[37] GFCM. Living deep-water resources of the Western Mediterranean and their exploitation. Stud Rev Gen Fish Coun Mediterr. 1970;**44**:38

[38] Fredj G, Maurin C. Les poissons dans la banque de données Medifaune. Application à l'étude des caractéristiques de la faune ichtyologique méditerranéenne. Cybium, Journal of Ichthyology. 1987;**11**(3):215-342

[39] Arena P. Studio sulla possibilità di razionalizzare e rendere più produttiva la pesca a strascico nel Canale di Sicilia e nel Mediterraneo centro-meridionale: Mimeo, Palermo; 1985

[40] Arena P, Li Greci F. Indagini sulle condizioni faunistiche e sui rendimenti di pesca dei fondali batiali della Sicilia occidentale e della bordura settentrionale dei banchi della soglia Siculo-Tunisina. Quad Lab Teen Pesca. 1973;**1**(5):157-201

[41] Scaccini C, Piccinetti R. Stato attuale della pesca in acque profonde nei mari italiani. Boll Pesca Piscic Idrobiol. 1970;**25**:5-35