THE SEAMOUNTS
OF THE
GORRINGE BANK
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Introduction

A seamount is regarded as a geological elevation that reaches a minimum of 1,000 metres in height and can consist of very different physical, geological and chemical properties. Therefore, seamounts can only exist where there are sea beds more than one kilometre deep, or, which is one and the same thing, over 60%–62% of the land surface\(^1\). There are also thousands of smaller elevations that tend to be known as abyssal hills (when they are less than 500 metres) or mounds (between 500 and 1,000 metres).

Whether in isolation or as part of extensive ranges, there are possibly more than 100,000 seamounts around the world\(^2\). At present, close to 30,000 of them have been identified, of which around 1,000 can be found in the Atlantic Ocean\(^3\), where in addition the largest range in the world can be found; the Mid–Atlantic Ridge, which stretches from Iceland to the Antarctic.

The seamounts of the Gorringe Bank were discovered in 1875 by the American exploration vessel USS Gettysburg, commanded by Captain Henry Honeychurch Gorringe, to whom it owes its name. A few years later, in the early twentieth century, Prince Alberto I of Monaco carried out various studies in the area on board the vessels “Princess Alice”, “Princess Alice II” and “Hirondelle II”, which gave their names to other large banks and seamounts between Madeira and the Azores.

Despite the large number of seamounts, it has not been until recent years that there has been an increase in scientific studies on them and they have been given the importance they deserve. Today, only 350 seamounts have been sampled and barely 100 have been studied in any detail\(^4\). In the case of Gorringe, various research vessels have visited the bank to carry out sampling and undertake different tasks of gathering information on its geological seismological and, to a lesser extent, biological history.

Most of the studies have been carried out by taking samples with dragnets, bottom trawl nets, using different sonar systems or even with submersibles. But it was not until 1998 when the Portuguese organisation “Atlântico Selvagem”, in collaboration with the University of the Algarve, undertook the first dives to document the marine life around its peaks. These data have led to the publication of various scientific articles.
Geographical location

The seamounts of the Gorringe Bank or Ridge are located at around 125–150 miles WSW of Cape St. Vincent in Portugal. They cover an area more than 180 kilometres long, with two prominent peaks: the Gettysburg (36°31’N, 11°34’W) and the Ormonde (36°42’N, 11°09’W), whose summits are less than 50 metres beneath the surface of the sea, while the base of the seamounts are rooted in the seabed at depths of more than 5,000 metres. Some people also link this range with another smaller seamount to the west of the Bank, known as the Hirondelle II (36°27’N, 12°52’W), whose peak is around 2,000 metres deep.

Oceana expedition and studies

Recently, in June 2005, Oceana, as part of its transoceanic expedition, visited the Gorringe Bank on board its catamaran the “Ranger” to document the ecosystem of these seamounts in videos and photographs. To do so, it had a team of people consisting of sailors, marine biologists, divers, underwater videographers and underwater photographers.

During the time they spent on the Gorringe Bank, they visited two of its main peaks (Gettysburg and Ormonde), where four divers spent around 40 hours underwater. More than one hundred photographs were taken as well as 10 hours of film, and biological samples were taken, particularly algae, for subsequent identification.

In this way, Oceana hopes to contribute to our knowledge of the ecology of the seamounts, provide visual material for dissemination to the general public and promote the protection of vulnerable European habitats.

These seamounts cover an area of some 9,500 km² and are distributed in a NE–SW direction within a ridge that extends from southern Portugal to the archipelago of Madeira.

Within the range, there are also several other geographical features, such as the Ampere seamount (35°00’N, 12°48’W), with a height of 4,700 metres and two peaks at depths of 40–80 metres; the Seine seamount (33°42’N, 22°24’W) which comes up to 86 metres below the surface of the sea; the Coral Patch seamount (34°56’N, 11°57’W), the Hirondelle seamount (36°25’N, 12°57’W) and the Unicorn seamount (34°45’N, 14°30’W); and further to the west, the Josephine Bank (36°45’N, 14°15’W), with various small elevations and one big one at 178 metres beneath the surface. These seamounts can be found flanked by abyssal plains such as the Tagus and the Horseshoe (to the west) and the Seine (to the east).
1 Geology

Geomorphology, topography and petrology

The Gorringe Bank is located in the area where the African and Euro-Asiatic tectonic plates converge and collide, at the eastern extreme of the boundary or fracture zone known as Azores-Gibraltar. For this reason, some studies point to the possibility that these seamounts were created by the thrust of the African plate, generating an overriding effect. More modern studies have proved that the coverage of the sedimentary structure shows that the zone has been tectonically stable since the beginning of the Cretaceous period, while recent discoveries have located the greatest distortions to the south of the Bank, following a sea ridge in a NW-SE direction for almost 300 kilometres, which includes the Ampere and Coral Patch seamounts, which has resulted in this hypothesis being put in doubt.

At the same time, new studies on the area would appear to put these formations back by many millions of years. While argon analysis of the rocks has led to linking the stratum of these seamounts with volcanic eruptions more than 70 million years ago, studies carried out with seismic reflection and lateral-sweep sonar methods, as well as those based on samples from the Gettysburg seamount, which continually produces bioclastic material which is then exported to the great marine depths, would seem to date the formation of these structures to between 145 and 155 million years ago, coinciding with the Kimmeridgian-Tithonian ages of the Upper Jurassic to the Hauterivian of the Lower Cretaceous, which would also seem to be demonstrated by the fossils of Mesozoic cephalopods that have been found. This would make these seamounts some of the oldest in this ocean, specifically dating back to the original creation of the Atlantic following the fragmentation of the Pangaea supercontinent.

The terrestrial crust of the sea depths to the west of the Iberian Peninsula is characterised by the presence of superimposed sequences of sedimentary rocks, metamplutonic rocks and serpentinitized peridotites.

Both at the Gorringe bank and on the terrestrial crust of the sea beds to the west of the Iberian Peninsula, studies have been carried out to explore the geochemical composition of the gabbros and amphibolites, as well as that of the dolerites.
During the last glacial period, and thanks to the height of their peaks, the current seamounts in the Gorringe bank were actually islands that emerged from the surface. A study on the different shelves that can be found in these seamounts relates them to the glacioeustatic variations caused by the marine transgressions and regressions in the Upper Pleistocene era between 75,000 and 18,000 years ago.
The Gorringe Bank is therefore regarded as one of the areas with the greatest potential for seismic movements, and thus the creation of tsunamis, in the Atlantic, and has been the focus of numerous seismological studies.

The Gorringe Bank divides the Azores–Gibraltar Fracture Zone in two, with one section in the west, between 24ºW and 13ºW (known as the Gloria Fault) and the other section to the east, between 13ºW and 5ºW, to which this range belongs. This area is also known for having a strong geodic anomaly, magnetic anomalies with a strong positive gravity, and as being a North–South convergence zone with a slow rate of 4 millimetres a year. But there is also a more complex seismology in Gorringe, with horizontal pressures and reverse faults.

Various gigantic waves have emerged from this bank or its surroundings due to its seismic activity. The largest of these happened on 1 November 1755, when an earthquake of 8.6 on the Richter scale produced at least three waves of more than 10 metres in height which devastated large coastal areas of Portugal, Spain and North Africa, as well as the Macaronesian Islands, and even reached Ireland and the Caribbean. This tsunami has recently been the subject of various reviews and studies. Another huge tsunami occurred in 1969, whose epicentre was between the Gorringe Bank and the Horseshoe Abyssal Plain, also to the south–west of Cape St. Vincent (36.01N, 10.57W), affecting Africa and Europe.

Other major tsunamis have occurred in the continuation of this fracture, in both the Gulf of Cadiz and in the Mediterranean, specifically between the Alboran Sea and the coast of Algeria.

But other major tsunamis have been detected in more eastern areas, such as the one detected off the coasts of Calabria and Sicily in 1783, or the Strait of Messina in 1908.

However, the area with the greatest seismic activity in the Atlantic is the Mid–Atlantic Ridge, where the Euro–Asian and American plates separate, generating a huge number of seamounts and underwater volcanoes, hydrothermal vents and other volcanological phenomena.
Major tsunamis that have affected the south of the Iberian Peninsula:

<table>
<thead>
<tr>
<th>Year</th>
<th>Origin</th>
<th>Location</th>
<th>Description</th>
<th>Cause</th>
<th>MSK Intensity</th>
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<tbody>
<tr>
<td>-218</td>
<td>Cadiz</td>
<td>36°12'N-07°40'W</td>
<td>Tsunami in Cadiz</td>
<td>Underwater earthquake</td>
<td></td>
</tr>
<tr>
<td>-210</td>
<td>Cadiz</td>
<td>36°00'N-10°30'W</td>
<td>Cadiz flooded</td>
<td>Underwater earthquake</td>
<td></td>
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<tr>
<td>-60</td>
<td>SW Portugal</td>
<td>36°00'N-10°30'W</td>
<td>Coasts flooded</td>
<td>Underwater earthquake</td>
<td>9.0</td>
</tr>
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<td>681</td>
<td>Cadiz</td>
<td>36°00'N-08°30'W</td>
<td>Regression of the sea in southern Spain</td>
<td>Underwater earthquake</td>
<td></td>
</tr>
<tr>
<td>1660</td>
<td>Alboran Sea</td>
<td>36°30'N-04°24'W</td>
<td>Rise in sea level (5m) in the port of Malaga</td>
<td>Underwater earthquake</td>
<td>9.0</td>
</tr>
<tr>
<td>1706</td>
<td>Canary Islands</td>
<td>28°17'N-16°37'W</td>
<td>Regression/flooding in Garachico</td>
<td>Volcanic eruption</td>
<td></td>
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<tr>
<td>1755</td>
<td>SW Portugal</td>
<td>37°00'N-10°30'W</td>
<td>Catastrophic tsunami in the south of the Iberian Peninsula</td>
<td>Underwater earthquake</td>
<td>11.0</td>
</tr>
<tr>
<td>1755</td>
<td>SW Portugal</td>
<td>37°00'N-10°30'W</td>
<td>Huge inflow and outflow in Gibraltar</td>
<td>Underwater earthquake</td>
<td></td>
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<tr>
<td>1755</td>
<td>Coruña</td>
<td>Inflow/outflow of the sea in La Coruña</td>
<td>Underwater earthquake</td>
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<td></td>
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<tr>
<td>1756</td>
<td>Balearic Islands</td>
<td></td>
<td>Coasts flooded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1780</td>
<td>Alboran Sea</td>
<td>37°42'N-06°36'W</td>
<td>Flooding of the African and Spanish coasts</td>
<td>Earthquake</td>
<td>10.0</td>
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<td>1804</td>
<td>Alboran Sea</td>
<td>0°50'N-02°50'W</td>
<td>Regression of the sea in the province of Almeria</td>
<td>Earthquake</td>
<td>8.0</td>
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<tr>
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<td>Algeria</td>
<td>36°30'N-00°43'E</td>
<td>Regression/flooding of the sea in Jijel</td>
<td>Earthquake</td>
<td></td>
</tr>
<tr>
<td>1856</td>
<td>Algeria</td>
<td>36°50'N-00°43'E</td>
<td>Flooding in Jijel and Bougie</td>
<td>Earthquake</td>
<td>8.0</td>
</tr>
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<td>1885</td>
<td>Algeria</td>
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<td>Changes in sea level on the coasts of Algeria</td>
<td>Earthquake</td>
<td></td>
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<tr>
<td>1891</td>
<td>Algeria</td>
<td>36°30'N-01°48'E</td>
<td>Regression of the sea</td>
<td>Earthquake</td>
<td>9.0</td>
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<td>1954</td>
<td>Alboran Sea</td>
<td>36°17'W-31°28'E</td>
<td>Recorded by tide gauges</td>
<td>Landslide due to quake</td>
<td>10.0</td>
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<tr>
<td>1989</td>
<td>Gorringe Bank</td>
<td>36°01'N-10°57'W</td>
<td>Recorded by tide gauges</td>
<td>Underwater earthquake</td>
<td>7.0</td>
</tr>
<tr>
<td>1975</td>
<td>AGFZ</td>
<td>35°50'N-17°36'W</td>
<td>Recorded by tide gauges</td>
<td>Underwater earthquake</td>
<td>6.0</td>
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<tr>
<td>1978</td>
<td>Cadiz</td>
<td>36°22'N-06°30'W</td>
<td>Recorded by tide gauges</td>
<td>Underwater earthquake</td>
<td>4.0</td>
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<tr>
<td>1980</td>
<td>Algeria</td>
<td>36°17'N-01°41'E</td>
<td>Recorded by tide gauges</td>
<td>Landslide due to quake</td>
<td>10.0</td>
</tr>
<tr>
<td>2003</td>
<td>Algeria</td>
<td>36°48'N-03°30'E</td>
<td>Damage to boats in the Balearic Islands and coast of the Spanish mainland</td>
<td>Underwater earthquake</td>
<td>9.5</td>
</tr>
<tr>
<td>2003</td>
<td>Algeria</td>
<td>36°48'N-03°37'E</td>
<td>Variation of sea level by 10-15 cm in Mahon and Palma</td>
<td>Underwater earthquake</td>
<td>2.0 (Spain)</td>
</tr>
</tbody>
</table>
Seamounts are an obstacle to the free circulation of the oceans. This gives rise to different kinds of phenomena and disturbances, including an increase in the speed of sea currents, upwellings, turbulence, Taylor cones, eddies, and even jets in the zones where the seamounts interact with ocean currents.

Sea currents in the areas with the greatest depths tend to be very slow, not exceeding a few centimetres per second. But when they come into contact with an obstacle, such as a seamount, the mass of water accelerates due to the “Venturi Effect”, reaching a speed of 25 centimetres per second. It is also known that there are benthic storms at these great ocean depths, something common to areas of both the North and South Atlantic.

The behaviour of ocean currents when they come into contact with seamounts can also be influenced by the topography. Thus while at the Great Meteor seamount (to the south of the Azores on the Mid–Atlantic Ridge at 30°00'N 28°30'W) there are Taylor cones and calm areas with isolated water masses—possibly due to the wide plateau on its peak—at the Ampere seamount the upwellings are more active.

These variations in the movement of water masses have also been detected on the Gorringe Bank; around its seamounts there is an extensive anticyclonic eddy associated with the lifting of nutrients from the rich deep water, giving rise to high concentrations of nitrates and chlorophyll in the shallow waters, which encourages the development of a wealth of flora and fauna on the peaks of these seamounts. It is known that part of the life on these seamounts depends upon the constant supply of nutrients from the superficial layers. In the North Atlantic, the primary annual productivity in oceanic waters is between 45 and 125 g C/m², being much richer in the northern part than the southern.
These effects, generated by the topography of the seamounts, mean that they have become oases of life compared to their surroundings, which tend to feature a much lower biomass and diversity. Meanwhile, this supply of nutrients contrasts with the generalised oligotrophy of deep waters, where only the supply of food from the superficial layers, or the chemoautotrophic production of habitats, such as hydrothermal vents and gas seepage, allow the existence of relatively abundant biomasses. 
Different studies have demonstrated the huge influence that certain seamounts close to the Iberian Peninsula can have on the Mediterranean outflow, detecting that some of the main routes along which these waters flow are around these topographical features. Once the water has left the Gulf of Cadiz, the Mediterranean outflow heads in two main directions. One is to the west, towards the Gorringe Bank, and the other is to the north, via the Iberian continental shelf until it reaches Galicia. There, part of this water heads for the more northernly zones via Cape Finisterre, until it reaches the British Isles (where it can be detected in the large deep-sea coral reefs of the Porcupine Seabight to the south-west of Ireland). A second branch of the MOW heads to the west, crossing the Galician Bank (where other large deep-sea coral reefs can be found). The coincidence of these salty currents with the distribution of some of the main deep-sea coral reefs in Europe has led scientists to associate the distribution and existence of these reefs with the Mediterranean influence.

The bulk of this Mediterranean water clearly seems to flow towards the west. Meanwhile, other researchers have corroborated that a large proportion of these salty masses that reach the Gorringe Bank subsequently take a northerly direction until they combine with the branch that stretches along Galicia, while others continue their journey towards the more westerly zones of the Atlantic. Some of this water even enters the Cantabrian Sea.

This current of Mediterranean water generates meddies that travel large distances, as far as the Gorringe Bank and subsequently spreading across the North Atlantic, reaching distant areas to the north, south and west by means of the Coriolis force and interactions with the topography.

Meddies are solid masses of water with an anticyclonic rotation up to 50 kilometres in diameter and a vertical extension of up to 200 metres which are formed to the south-west of Portugal, particularly in the Portimão Canyon and have an average lifespan of 1.7 years, although some can remain active for almost 5 years. The relief of the Gorringe seamounts represents an obstacle to the trajectory of eddies and the Mediterranean outflow, which gives rise to the formation or destruction of meddies. On other occasions, the meddies that have formed opposite Cape St. Vincent head in a southerly direction until they reach the seamounts of Gettysburg and Ormonde, even reaching the Great Meteor seamount more than 400 miles to the west of the Canary Islands and Madeira. It is estimated that around 15–20 meddies are formed between the south of Portugal and the Gorringe Bank each year, which would allow almost 30 to exist simultaneously in the North–East Atlantic.
The Atlantic influence

With regard to superficial currents, the area in which the Gorringe Bank is located (like the whole of western Europe and the north of Africa) is strongly influenced by the Gulf Stream, particularly by one of its branches known as the Azores Current.

Around the 45ºW meridian, the Gulf Stream divides, forming the Azores Current. This current heads in a south-easterly direction until it crosses the Mid-Atlantic Ridge and reaches the coasts of southern Europe and northern Africa, and ends up mixing with the segment coming from the Mediterranean in the areas close to the south of Portugal, and also with the tropical current rising up from the African shelf. At the same time, the Gulf Stream divides into three more branches which flow towards the south until reaching the Canary Current and subsequently to the west to the North Equatorial Current.

The maximum speed of the Gulf Stream has been estimated at around 100 centimetres per second, and the volume of water it moves depends upon the area, with an average of around 30 Sverdrup. Meanwhile, the width of the Azores Current jet is around 150 kilometres wide and 1,000 metres deep, moving at a speed of some 40–50 centimetres per second and carrying around 10–12 Sverdrup in the Gorringe area. The width, direction, speed and transport capacity of these currents can vary depending either interannually or seasonally and can form countercurrents and cyclonic or anticyclonic eddies.

Other currents

But these are not the only currents that influence these seamounts. Cold Antarctic waters (2°C), rich in nutrients (but with a low oxygen content when they reach this northern area), also reach these latitudes via the depths of the Mid-Atlantic Ridge, having reached the Iberian Basin and the West Gorringe Bank via Discovery Gap with a Sverdrup transport of 0.55.

Despite the numerous studies carried out on the movements of water masses in the North Atlantic, there are still many questions to be answered on the interactions between the different currents, and between these currents and the topography.

Oxygen levels

Despite the fact that ocean water tends to have oxygen levels close to saturation point, some waters, at depths of between 100 and 1,200 metres, can have minimum levels of oxygen, or hypoxia, as has been corroborated off West Africa. These phenomena can also occur in deep water, including anoxic areas. And although the concentrations of oxygen in the depths of the sea vary between <1 and 7 ml/l, the low temperatures allow for gases to dissolve more easily, which enables oxygen levels of 4%–6% to be reached in the majority of the aphotic zone, while in photic zones this could be 3.5%. The vertical movements of the masses of ocean water also have a considerable influence on renewing oxygen at greater than normal depths.
Seamounts have been regarded as “stepping stones” or areas of species expansion. The particular hydrology and the currents caused by the topography of seamounts turn them into hotspots of marine life. This allows the development of unique ecosystems and huge benthic communities of fish and suspensivorous species (including scleractinian corals, antipatharian corals, gorgonias and sponges) that are different from those found in the surrounding areas, which tend to have a much lower biomass and diversity.

It is believed that the huge concentration of plankton around seamounts is due to the effect (sometimes combined) of upwellings and Taylor cones. When these cones occur over shallow seamounts, they can increase primary production by providing the euphotic zone and the highest levels of the trophic chain with solar energy, while working as a plankton retention system in the vicinity of the seamounts.

It is well-known that the waters at depths of more than 4,000 metres, such as those at the base of the Gorringe seamounts, can have very low temperatures (even below 1°C), although they tend to be very rich in nutrients, much of which has accumulated from the “snowfall” of organic material from the superficial layers.

The vertical distribution encouraged by seamounts not only facilitates the existence of different habitats and species but also a different bathymetric distribution of same-species juveniles and adults (bathymetric ontogenic migration), which tend to prefer different depths, this being the case of the different redfish (Sebastes spp.), grenadiers ( Coryphaenoides rupestris) and Baird’s slickhead (Alepocephalus bairdi), which, when they reach adult age, head for deeper waters.

The potential of these vertical migrations of organisms to transfer nutrients from shallow to deep waters, or vice versa, together with the snowfall of animal and plant detritus that concentrates over them helps seamounts to engender rich communities and high levels of biomass.

But the sheer importance of having a substrate in the middle of the ocean where marine life can anchor itself can be easily understood if we bear in mind that 98% of the marine species in existence live on or within a few metres of the sea bed.
The tremendous productivity of these geographical features means that they can be used by migratory species or those with a wide area of distribution as places for feeding or spending key periods in their lifecycles, such as maturing and reproduction. Various species at different biological phases (larva, juvenile, adult or reproductive) may visit these marine oases, guided by one of the oceanic currents that cross them. Indeed, it is known that the long-living orange roughy (Hoplostethus atlanticus) undertakes migrations of thousands of kilometres to lay its eggs on seamounts.

The importance of seamounts in giving life to endemisms is determined by the history of the tectonic plates and by their function as zones for recolonising and extending species. Some seamounts or groups of seamounts can be isolated from the rest and from the surrounding water because of the currents around them. These currents can also, in certain cases, prevent the dispersion of larvae from the seamounts to other places, thus resulting in the appearance of endemisms. This phenomenon is totally contrary to the cosmopolitan distribution of the majority of species in the depths of the sea, which generally have a greater area of distribution the deeper they live, as the environmental conditions at this level are similar in every ocean and they do not come across any determining obstacles.

The peaks of most of the seamounts in the world are several hundred or thousand metres beneath the surface of the sea, which prevents any photosynthetic communities from settling on them. However, in the case of the Gorringe Bank, the shallowness of its peaks means that dense and rich communities of algae and cnidaria with zooxanthellae can develop, which makes them some of the seamounts studied up to the present day with the greatest biodiversity and habitats, as they range from the euphotic to the abyssal zone, giving rise to an incredibly varied range of habitats and species.

Poriferans tend to establish themselves on the hard substrates, such as the giant sea sponges found on the Ampere seamount.

In the fine sand substrates of some Atlantic seamounts, urochordates have been gathered that were initially thought to be endemic to the Josephine Bank, such as the ascidian Siericarpa rhizodes, but which have been found recently on other nearby seamounts and as far away as the Strait of Gibraltar.

Regrettably, studies on the biology of the seamounts of the Gorringe Bank are quite a lot scarcer than studies on their geology or seismology. Most of the data available on these locations is limited to a few scientific expeditions undertaken in recent years, which have gathered information mainly on ichthyologic fauna, molluscs and other invertebrates.
The large number of endemic species found on many seamounts makes them “hotspots” or centres of biodiversity. In the seamounts of the South Pacific, the percentage of endemisms reaches between 30% and 52% of the species identified. In the North Atlantic, this percentage falls to less than 10%, although the lack of detailed studies on many of them could be the reason behind this lower endemicity. Indeed, the seamount that can be regarded as the most studied in this area, the Great Meteor, has 9% of endemisms in the case of fish alone.

Seamounts that rise up to shallow waters tend to concentrate cosmopolitan or similar species to those found in their vicinity. This could be the reason why a large number of endemisms have not been found on the Gorringe Bank, though on the other hand this region may have a much more important role as a zone for extending and recolonising species than the deeper seamounts. Thus all the species of molluscs identified on the Gorringe Bank can also be found in the Macaronesian archipelagos, the waters of the Iberian Peninsula or in the Mediterranean. In general, the number of endemisms found on the seamounts between the Iberian Peninsula and the Macaronesian archipelagos is still low, but then the studies on flora and fauna are also limited. Two examples of apparently unique species to this zone are the hydrozoa Pseudoplumaria sabinae, and most particularly the discovery of a pycnogonid or pantopod that was previously unknown to science, the Austrodecus conifer, whose genus has not been mentioned before in connection with the North Atlantic.

Marine mammals are also regular visitors to these areas. This can be seen on the Formigas Bank in the Azores, where various species of cetaceans congregate, including bottlenose dolphins (Tursiops truncatus), common dolphins (Delphinus delphis), striped dolphins (Stenella frontalis) and pilot whales (Globicephala melas) around the Davidson seamount in the Pacific off California, where Dall’s porpoises (Phocoenoides dalli), sperm whales (Physeter macrocephalus) and orca or killer whales (Orcinus orca) congregate, and around the Bowie seamount off British Columbia, where sperm whales, Steller sea lions (Eumetopias jubatus) and various species of dolphins and seabirds can be observed.

The importance of seamounts to deep-sea sharks is unknown, but the almost total absence on the continental slope of newborns and juveniles from the main species of deep-sea sharks caught by European fleets has led to the hypothesis being put forward that the seamounts of the Mid-Atlantic Ridge and others in the region may be reproduction zones for these animals. This lack of juvenile deep-sea sharks in coastal waters is not exclusive to the Atlantic, as the same phenomenon has been observed in Japanese waters.

Given the characteristics of certain gastropod larvae, which can drift across the oceans for months, covering huge distances, they are capable of recolonising areas very far away from their usual area of distribution. In fact, on the Ormonde seamount, 56% of the prosobranchs found lead a planktonic life.

It is striking that the malacological fauna found on the Gorringe Bank has more in common with the Mediterranean Sea than with other adjacent Atlantic waters. In fact, 93.5% of the species identified there can also be found in the Mediterranean, and some of them cannot be found anywhere else in the Atlantic apart from these seamounts. It is also worth mentioning that despite their proximity to the African continent, only 29% of the species of molluscs on the Gorringe Bank are also found in the waters of Morocco and Mauritania, a percentage more similar to their affinity with Scandinavian species, with which they share 22.6%. However, similarities with the waters of Madeira (77.4%) and the Canary Islands (80.6%) are much greater. They even have a greater affinity with more northerly species, reaching 54.8% in the case of the Azores and up to 58.1% when compared with Galicia and the Cantabrian Sea.
The lack of nutrients and animal life in the Mediterranean waters that enter the Atlantic through the Strait of Gibraltar, and which in the Gorringe area will be at depths of around 1,000 metres, cannot affect the photic zone of these seamounts, which is where these molluscs were collected. For this reason, the closer affinity with the Mediterranean area is attributed to the lack of studies made of the Portuguese coast, which could increase the percentage of similarities with species on the Gorringe Bank. However, the presence of endemic Mediterranean species (or at least mentioned only in connection with that sea) such as the red gorgonia (Paramuricea clava-ta), buccinidae (Chauvetia mammilata) and the rissoidae (Alvania zylensis), may signify a much greater influence that what is believed. This Mediterranean significance has also been corroborated in studies on hydrozoa found on both the Gorringe seamounts and others in the vicinity. On the French expedition “SEA-MOUNT 1”, 20 species of haleciidae and plumulariidae were identified, of which ten were of Atlantic–Mediterranean distribution, six were cosmopolitan, four corresponded to Atlantic species from adjacent areas, and one was endemic to these seamounts.122

On the other hand, the brachiopod crustaceans found on the seamounts located in the most southerly or westerly positions, such as Great Meteor, Atlantis, Plato and Tyro, have shown greater affinity with the Mauritanian biogeographic region, while species that are common in the Iberian Peninsula or even the Canary Islands and Madeira do not seem to be present.123

Greater disparities have been found in other seamounts, this being the case of the seamounts known as the Nasca/Sala and Gomez Chain in Chilean waters, where the species found have a much greater affinity with those in the Indian and West Pacific oceans than with the south-eastern Pacific ocean where they are found.124

In the case of the seamounts on the Madagascar Ridge, the fauna found there shows much greater similarities with those of Australia and New Zealand, including two deep-sea sharks (Parnaturus macmilla-ni and Proscomynodon plunketi) which up until then had only been found in the South Pacific.125

Another noteworthy fact is the huge taxonomic variety of ichthyologic fauna found on seamounts; despite the fact that the number of species identified barely represents 2%–3% of those existing in the oceans of the world, their taxonomic diversity is exceptionally high, representing between 25% and almost 50% in the case of known families and orders respectively.126

To get an idea of the vast lack of knowledge on the biota of seamounts, we simply need to know that of the most frequently-studied taxonomic group, invertebrates, only 3%–4% of them have been evaluated.127

Work on flora on seamounts even more scarce, if possible, but some discoveries are throwing up very interesting data. In fact, the photosynthetic plant discovered at the greatest depth (268 metres) is a red encrusting alga and was found on a seamount close to the island of San Salvador in the Bahamas.128

List of species

With the information provided in this report from “in situ” studies and the bibliographic compilation, the Gorringe seamounts can now represent almost 150 different species, which makes them, after the Great Meteor, the second seamount in the North Atlantic with the largest number of known taxons.

During this expedition, some 50 different species of flora and fauna have been preliminarily identified. Thirty-six of these are mentioned and documented for the first time, in terms of both Gorringe itself and the seamounts of the North-East Atlantic.

Species of fauna and flora found on the Gorringe Bank (in green) the species corroborated by the Oceana Ranger expedition and in red the new species mentioned for this location by Oceana):
Institute of Oceanology.


Peculiarities of some of the species on the Gorringe Bank

The lists in this study have not included the discoveries of the first explorations carried out at the beginning of the twentieth century (which, as can be seen in the above picture—in which some fish can be identified, such as scobridae, tuna, triglidae and a Mediterranean moray (Muraena helena) and, possibly, some streaked greywack or bluelmouth redfish (Helicolenus dactylopterus) would increase the number of species found on these seamounts), nor those pending publication, this being the case of polychaetes and cirripeds found on recent oceanographic campaigns, such as the Seamount 1 and Seamount 2, amongst others, whose initial results have been made public while this work was being undertaken.

Lepidopus caudatus: the specimens collected on previous explorations in the Gorringe area seem to have more in common with the populations in the South Atlantic than with closer ones, such as those in the Azores, particularly in terms of the number of counts in the vertebral and dorsal regions.

On the Great Meteor seamount, three types of fish were studied, and the conclusion was reached that they were different to those found in the closest continental waters.

The seamounts seem to encourage this isolation, which can give rise to unique peculiarities, such as those mentioned for the Lepidopus caudatus.

Manzonia crispa: this gastropod mollusc was believed to be exclusive to the islands of Madeira. With its discovery at Gorringe, its area of distribution has expanded towards the North–East Atlantic.

Paramuricea clavata: up until now, it was regarded as a species endemic to the Mediterranean, mainly the western part. Its discovery on Gorringe Bank extends its area of distribution by several hundred kilometres.

Pseudoplumaria sabinae: this hydrozoa is an endemism known only on the seamounts of Gorringe and Ampere.

—Description of the ecosystem observed—

The communities of brown algae or kelp forests formed by Laminaria ochroleuca and Saccorhiza polyschides are characteristic of southern Europe and particularly the Iberian Peninsula (as far as the east of the Cantabrian Sea) and in the western part of the Mediterranean Sea with an Atlantic influence, such as the Alboran Sea. The composition and diversity of the kelp forests found on Gorringe’s peaks are very similar to those of the Alboran Sea and Gibraltar Strait.

While Saccorhiza polyschides is very widespread throughout Europe and North Africa (from Norway to Ghana), Laminaria ochroleuca is only found from Cornwall (south-west of Great Britain) to Morocco and Mauritania, although recently it has also been mentioned in Namibia. However, Saccorhiza is an infrequently found species in the Macaronesian archipelagos, although it can be found in the Canary Islands.

Despite the fact that Laminaria ochroleuca is habitual on the Iberian coasts, there are very few data on the presence of this alga in the Macaronesian archipelago, except for on seamounts such as the Formigas Bank in the Azores or in some areas of the Canary Islands.

The kelp “forests” observed on both the peaks of the Gorringe Bank were predominated by Laminaria ochroleuca, which formed more dense communities, amongst which could be found some more dispersed examples of Saccorhiza polyschides. Beneath them, like an “undergrowth”, various brown and red algae were growing, predominately Zonaria tornufortii, frequently accompanied by Dicystoptyris membranacea, as well as suspensivorous invertebrates, especially porifera and cnidaria, together with echinoderms and crustaceans.

In areas where the rock was more exposed, and over the haptonia of the laminaria, Rhodophyceaea algae and the odd colony of green Valoniaceae algae could be found. And on some of the red algae, hydrozoa were growing like epibionts.

These communities, dominated by Zonaria tornufortii, which could be found on both peaks of the Gorringe bank, formed notably thick blankets of vegetation, generating dense concentrations similar to those of Cystoseira spp. found in other parts of the Atlantic and Mediterranean.

In the steeper areas, more exposed to currents, or even in the rock fissures, there were acyonacea, but these tended to be small or medium in size.

The Iberian–Macaronesian–Mediterranean zone (including the seamounts in this area) is one of the areas with the greatest diversity of alcyonacea in the North Atlantic. Indeed, some 89 species have been counted. With regard to the genus Paramuricea, this has only been detected on three seamounts in the Mediterranean, but these tended to be small or medium in size.

The only batoids found (spotted torpedos —Torpedo marmorata) displayed characteristic behaviour, appearing in numerous groups, one on top of the other.

Other pelagic fish, such as the Bermuda chub (Kyphosus sectatrix) or Atlantic bonitos (Sarda sarda), appeared on other occasions alongside the amberjacks. The chub is a fish more characteristic of the Western Atlantic, from the Caribbean to Bermuda. Other pelagic fish, such as the Bermuda chub or Atlantic bonitos, appeared on other occasions alongside the amberjacks. The chub is a fish more characteristic of the Western Atlantic, from the Caribbean to Bermuda. While Saccorhiza polyschides is very widespread throughout Europe and North Africa (from Norway to Ghana), Laminaria ochroleuca is only found from Cornwall to Morocco and Mauritania, although recently it has also been mentioned in Namibia. However, Saccorhiza is an infrequently found species in the Macaronesian archipelagos, although it can be found in the Canary Islands.

The following table gives a list of the species found on the Gorringe Bank which can also be found on other banks and seamounts in the North–East Atlantic, from the Bay of Biscay to the north of the Canary Islands, including the Eratosthenes seamount in the Mediterranean.

Small, unidentified pelagic fish, but possibly clupeiforms, were also spotted in the area. With regard to large pelagic species, only a large ocean sunfish (Mola mola) measuring between 1.5 and 2 metres in length was seen, which remained on the surface for a few minutes less than half a mile from the peak of Ormonde.

On the surface of the sea, numerous by–the–wind–sailors (Veilella velella), most of which were dead and just displayed their “sail”, drifted along with the current. We were also able to observe various layings by non–identified cephalopods.

The most common seabirds in the area are petrels (Procellariidae), which feed on the abundant plankton and the remains of organisms floating on the surface.

The one turtle found was spotted at less than 10 miles to the north east of Ormonde, this being a very large sub-adult loggerhead turtle (Caretta caretta) which was resting on the surface of the sea.

In general, both the fauna and flora present on the Gorringe bank is characteristic of the North–East Atlantic (particularly the area between the Iberian, Mediterranean, Macaronesian and North African areas), with the presence of some species that are widespread in the Atlantic, such as the triggerfish (Balistes carolinensis), the Atlantic bonito (Sarda sarda), and other cosmopolitan species such as amberjacks (Seriola spp.), chlorophyceaea Valoniaceae algae and different rhodophyceae.

The following table gives a list of the species found on the Gorringe Bank which can also be found on other banks and seamounts in the North–East Atlantic, from the Bay of Biscay to the north of the Canary Islands, including the Eratosthenes seamount in the Mediterranean.
Despite the disparity of data between some seamounts and others, which does not allow for a proper evaluation of the similarities between them, certain echinoderms seem to be the most common species in every location. Also, the presence of reef-forming corals such as Lophelia pertusa, and certain species of molluscs appear over and over again.

The similarities of the Gorringe biota with other seamounts in the area are as follows:

<table>
<thead>
<tr>
<th>Seamount</th>
<th>Coincident species</th>
<th>Total documented</th>
<th>Percentage of similarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ampere</td>
<td>13</td>
<td>26</td>
<td>50%</td>
</tr>
<tr>
<td>Antialtair</td>
<td>2</td>
<td>5</td>
<td>40%</td>
</tr>
<tr>
<td>Atlantis</td>
<td>13</td>
<td>59</td>
<td>22%</td>
</tr>
<tr>
<td>Conception</td>
<td>3</td>
<td>11</td>
<td>27%</td>
</tr>
<tr>
<td>Cruiser</td>
<td>9</td>
<td>34</td>
<td>26%</td>
</tr>
<tr>
<td>Dacia</td>
<td>2</td>
<td>2</td>
<td>100%</td>
</tr>
<tr>
<td>Erathostenes</td>
<td>2</td>
<td>23</td>
<td>9%</td>
</tr>
<tr>
<td>Galicia</td>
<td>2</td>
<td>5</td>
<td>40%</td>
</tr>
<tr>
<td>Hyeres</td>
<td>6</td>
<td>19</td>
<td>32%</td>
</tr>
<tr>
<td>Josephine</td>
<td>26</td>
<td>96</td>
<td>27%</td>
</tr>
<tr>
<td>Le Danois</td>
<td>4</td>
<td>16</td>
<td>25%</td>
</tr>
<tr>
<td>Meteor</td>
<td>14</td>
<td>185</td>
<td>8%</td>
</tr>
<tr>
<td>Plato</td>
<td>4</td>
<td>17</td>
<td>24%</td>
</tr>
<tr>
<td>Seine</td>
<td>3</td>
<td>12</td>
<td>25%</td>
</tr>
<tr>
<td>Tyro</td>
<td>2</td>
<td>5</td>
<td>40%</td>
</tr>
</tbody>
</table>

In total, 47 of the species of fauna and flora on the Gorringe Bank coincide with the 325 species documented on the other seamounts: i.e., less than 15%.
4 Threats to the biodiversity of the Gorringe Bank: fishing

Although it has been proved that life can emerge in even the most extreme locations, the biomass is, generally speaking, much greater in places that provide it with a more favourable environment. Thus many species concentrate in areas such as seamounts, canyons and other marine topographical features where the greater speed of currents prevents the accumulation of sediments and facilitates the upwelling of nutrients.

Portugal allows fishing over all the seamounts to the south of Portugal, including the seamounts of the Gorringe Bank, Seine, Josephine, Ampere and Dacia, by vessels from the mainland as well as from the islands of Madeira.

Although we do not know the true scope of the fishing effort carried out in the area, or what fishing techniques and gear are most regularly used, during the time that Ocean was working in this area, buoys marking fishing pots for crustaceans could be seen to the south of the Ormonde seamount.

Given the importance of suspensivorous species to seamounts, trawling results in a huge amount of accidental catches of these creatures, as well as those that use the structures formed by them as habitats. This means that the habitats formed or participated in by gorgonias, corals and sponges are significantly affected. We should not forget that sea beds with gorgonias give shelter to a multitude of species of invertebrates and vertebrates; in communities of porifera, more than 130 different species associated with them have been found, and that in deep-sea coral reefs, mainly formed by Lophelia pertusa, more than 800 different species have been counted.

Despite the relatively short time that bottom trawling has been taking place in deep waters (it started at the end of the Sixties), the damage it has caused is already very evident and today their nets are already reaching depths of 2,000 metres. Studies on the impact of trawl nets on deep-sea ecosystems and seamounts are sufficiently explicit when it comes to demonstrating the damage caused by this kind of fishing. On the seamounts in Australia, it was proven that areas where fishing did not take place showed between 46% and 106% more species and between 200% and 720% more biomass. In studies carried out to the north-east of Great Britain, the scars left by bottom trawlers were already visible in up to 12% of sea beds photographed at depths of between 700 and 1,300 metres.
It is believed that some of the most sought-after species by the fishing industry, such as the orange roughy, which live in the areas around seamounts, require considerable oceanic production estimated at 10 times more than the area they occupy.161

It is believed that deep-sea sharks could be the group of fish that has declined the most in different parts of the North Atlantic from the impact of fishing, given their tremendous vulnerability. This is of particular concern for this species group, which is normally long-living with a low reproduction and growth rate, as 35% of the chondrichthians that exist in the world are confined to deep waters.162 Even more so if we bear in mind that before the 1980s, deep-sea shark fisheries were almost non-existent in Europe as a whole.163

Longevity studies on some of the main species of sharks caught in these fisheries have proven that they are very long-living species with a very low reproduction rate. In the case of the leafscale gulper shark (Centrophorus squamosus), it can reach up to 70 years old.164

Research on Australian seamounts has shown that the areas where intensive bottom trawling has taken place have left exposed rock in 95% of its extension, while in areas where fishing had not taken place this only came to 10%.165

Many of the species that live on seamounts, particularly those that live at great depths, evince characteristics that make them particularly vulnerable: great longevity, low reproduction and low growth rate. In other words, the fall within the classification of K-strategy species: those that experience difficulties in recovering their populations in the event of overexploitation. Generally speaking, deep-sea species mature at a very advanced age.166

In addition to this, unique distribution patterns and habitats, isolation or the impossibility of dispersing larvae, and endemism or differences between some of the species on seamounts from other populations in the same region, make them unique species and thus at high risk of overexploitation or even extinction.167 With regard to habitats, their physical destruction by bottom trawling gear or other human activities can make their recovery impossible, or it can take thousands of years.168

There are countless examples of this vulnerability. From vertebrates such as the orange roughy (Hoplostethus atlanticus), which can live to more than 125 years old and not become sexually mature until the age of 30 or the bluemouth redfish (Helicolenus dactylopterus) which can exceed 40 years of age, to the cold-water corals and gorgonias such as Lophelia pertusa and Primnoa resedaeformis, whose colonies can live to more than 200 and up to 500 years old respectively, while the reefs they create can have taken more than 8,000 years to build.169

The impact of bottom trawling on these reefs and colonies of cnidaria can be devastating, as demonstrated by studies carried out in Alaska, which came to the conclusion that a single bottom trawler is capable of dragging up almost 1,000 kilos of gorgonias and deep-sea corals from the sea bed in a single cast. Or in Norway, where it is estimated that between 30% and 50% of all their coral reefs have already been damaged or destroyed.170 Even the corals and gorgonias that survive the onslaught of the bottom trawlers can show damage in the long term. This has been corroborated in Alaska, where on sampling a community of alcyonaceas coral that had been damaged seven years earlier, almost 25% of the surviving colonies had lost between 80% and 99% of their branches.171

There are many doubts about the possibility of there being commercial deep-sea fisheries that are both economically viable and sustainable at the same time. To avoid the overexploitation of some of these species, such low catch levels have been proposed (this being the case of the orange roughy for which a stock recovery of barely 2.5% a year would only allow catches of barely 1%–2% of its virgin biomass per year), making any kind of exploitation practically unviable. For this reason, many deep-sea fisheries are based on exhausting stocks one after the other and on searching for new fishing grounds to exhaust, this being the case of the blue ling (Molva dypterygia).181

ICES has already warned that many species of deep-sea fish are overexploited or exhausted. A recent article published on the website of this scientific institution left no room for doubt on the poor state of these stocks and pointed out the huge fall in species such as the blue ling (Molva dypterygia), the grenadier ( Coryphaenoides rupestris), the orange roughy (Hoplostethus atlanticus), the ling (Molva molva) and the tusk ( Brosme brosme). In the case of these last two species, the CPUE (catch per unit effort) has fallen by 70% in the waters of the northern and western British Isles since the 1970s. For this reason, an immediate reduction in the catches of these species has been proposed.
Numerous studies have warned about the impact of bottom trawling over seamounts and other vulnerable ecosystems, including the decline of target species and the destruction of slow-growing benthic species. And hundreds of scientists have called for a ban on bottom trawling over these ecosystems.

Despite the fact that it is known that almost one thousand species of demersal fish are caught in deep waters by trawl nets, only a few dozen of these species have any commercial use. This means that the rest are discarded.

There are many examples of the lack of selectivity and the impact on both targeted and non-targeted species in these fisheries of the North–East Atlantic. In the Rockall Trough it is normal to catch some 40 to 50 different species of benthopelagic fish in casts made by bottom trawlers, the majority of which are of no commercial interest. To the west of Ireland, in one single three–four fishing session, a bottom trawler working at between 840 and 1,300 metres caught 14 different commercial species and an unknown number of other species, including corals and sponges. In the French fleet’s grenadier fishery, the majority of which are of no commercial interest. In the French fleet’s grenadier fishery, the majority of which are of no commercial interest. In the French fleet’s grenadier fishery, the majority of which are of no commercial interest. In the French fleet’s grenadier fishery, the majority of which are of no commercial interest. In the French fleet’s grenadier fishery, the majority of which are of no commercial interest. In the French fleet’s grenadier fishery, the majority of which are of no commercial interest. In the French fleet’s grenadier fishery, the majority of which are of no commercial interest.

A recent study to estimate the level of vulnerability of the species that are found around seamounts compared to other fish reached compelling conclusions. Species that use seamounts, particularly those that congregate there, are much more long–living, have a lower natural mortality and a very low capacity for recovery and response to disturbances, and this is demonstrated by the significant reductions in their populations in barely a few decades of fishing. The result of this study gave a maximum level of acceptable, sustainable catches for exploiting these species as just 5% of their biomass.

A large proportion of the deep–sea fishing effort centres on these geographical features. While the species at the abyssal sea floor tend to be fish with bland flesh and big, loosely–attached scales due to the weakness of the sea currents there, for quite the opposite reason, the species on the seamounts have much more robust bodies. This means that while the former have little marketable value, those from the seamounts are much more sought–after internationally.

Both kinds of fish are very vulnerable to overexploitation, as the former tend to suffer serious damage when caught and even if they manage to escape from the nets many of them do not survive (and these escapes from the nets can be more than 80% in terms of numbers and more than 40% in terms of weight).

But although bottom trawling has the greatest impact, it is not the only form of fishing that damages coral. Longlining, fixed gillnets or any other system of fishing that comes into contact with the sea bed has the potential to damage these communities. Between the Gulf of Alaska and the Aleutian Islands, where there are extensive “forests” of corals and sponges, deep–sea longlining can accidentally “catch” coral on 0.1% of their hooks. Although this percentage may seem small, every year hundreds of thousands of hooks are cast, so the cumulative impact can be very considerable.
5 Conclusions and proposals

ICES was already saying in 2002 that “the most effective way of mitigating the effect of trawling on these habitats is to close such areas to fishing.” and that “the only proven method of preventing damage to deep–water biogenic reefs from fishing activities is through spatial closures to towed gear that potentially impacts the bottom."

A few years earlier it had pointed out that “In the light of the environmental sensitivity of the deep–sea floor, a general trawl ban for the deep–sea seems sensible and possible for some fisheries and/or areas. As a short term step for the implementation of such measures, zonation systems to prevent expansion of trawl fisheries into new areas should be instituted as quickly as possible. Gear limitation to longlines should be considered.

Oceana would like to state its total agreement with the opinions and proposals put forward by the ICES and reiterate the need for them to be implemented urgently.

Furthermore, OSPAR defined as “sensitive habitats” those which, if negatively affected by human activities, could only recover in a 5–25 year period, while “very sensitive habitats” are those which need an even higher period of time in which to recover. In this way, it set the criteria for selecting protected marine areas and zones closed to human activities on the high seas and great sea depths. It is more than evident that the Gorringe seamounts, as well as other seamounts and all the biogenic reefs in Europe, fall within these criteria. OSPAR has also included seamounts and deep–sea corals on its list of endangered habitats.

The European Commission has also recognised the importance and vulnerability of these habitats, as demonstrated by its adoption of urgent measures, under article 7 of Regulation 2371/2002 of December 2002, protecting areas such as the Darwin Mounds in the Exclusive Economic Zone (EEZ) of the United Kingdom, and the proposal to protect the sea beds of the archipelagos of the Azores, Madeira and the Canary Islands against bottom trawling. Furthermore, Directive 92/43/EC regards the ecosystems of deep–sea areas as habitats of community interest and includes “reefs” in annex I.
In annex II the Directive also includes some of the species found on these seamounts, such as the loggerhead turtle (Caretta caretta); in annex IV the long–spined sea urchin (Centrostephanus longispinus), and in annex V the Mediterranean slipper lobster (Scyllarides latus).

Other international agreements to which European countries are signatories also include on their lists some of the species found there; in its annex II, the Berne Convention enumerates all the hydrobatidae and the loggerhead turtle, while the Bonn Convention features this reptile in annex I.

Other species on the seamounts are only given protection if they are found in the Mediterranean. This is the case of Laminaria ochroleuca and Lithophyllum lichenoides which can be found in annex I, and the long–spined sea urchin in annex II of the Berne Convention.

This is not forgetting the different resolutions and recommendations of the United Nations via UNICPOLOS, the Convention on Biological Diversity, or its General Assembly, amongst others, to protect seamounts, deep–sea coral reefs and other vulnerable ecosystems.

It is evident that the importance of the seamounts of the Gorringe Bank and their habitats and the species they shelter are worthy of special protection status. But it is also evident that in terms of marine protection matters, European legislation is very deficient and needs to be improved urgently.

Oceana therefore proposes the revision of the annexes of the European Habitats Directive to include all threatened and vulnerable ecosystems, habitats and species. As a first step, the following should be included in these:

- Seamounts
- Carbonated mounds
- Hydrothermal vents
- Underwater canyons
- Marine phanerogam meadows
- Coralligenous communities
- Maerl beds
- Kelp or laminaria forests
- Deep–sea coral reefs
- Sponge communities
- Reefs of annelid polychaetes (i.e. sabellidae)
- Mollusc reefs (i.e. vermetids and mytilids)
- Communities of Cystoseria sp.
- Other vulnerable communities of environmental importance, especially all biogenic reefs and algae “forests”.

Also, it should immediately adopt as its own the annexes of other conventions with partial or total competencies in the marine environment, such as the Barcelona Convention, the Berne Convention, the Bonn Convention, the Oslo–Paris Convention, etc.

The Gorringe seamounts possess unique aspects that make them worthy of the utmost interest:

- It is a mountainous massif that originated at the beginning of the formation of the Atlantic Ocean;
- It is the only European seamount with such a wide range of habitats, ranging from abyssal zones at depths of more than 5,000 metres to the euphotic zone;
- It could be a unique example of the combination of Mediterranean, Atlantic–Iberian, North African and Macaronesian flora and fauna;
- Its state of conservation is still very good, and it is of great interest not only from an environmental point of view but also from seismological and geological perspectives, amongst others.

All in all, the characteristics of the Gorringe seamounts meant that this natural seascape is of exceptionally high value, and should not only be a protected area but could easily be the first exclusively marine National Park in Europe and the world.
**GLOSSARY**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiotic</td>
<td>Inanimate, not deriving from living beings. The lifeless component of the ecosystem. A place where life is impossible.</td>
</tr>
<tr>
<td>Abyssal</td>
<td>Applies to the area between the depths of 4,000 and 6,000 metres and to the organisms that live in these depths.</td>
</tr>
<tr>
<td>Aerobic</td>
<td>The part of the water column where sunlight does not penetrate, usually beneath 200 metres.</td>
</tr>
<tr>
<td>Anaerobic</td>
<td>All respiratory processes that do not require oxygen.</td>
</tr>
<tr>
<td>Annelid</td>
<td>Worm with a long cylindrical body, segmented in the form of rings.</td>
</tr>
<tr>
<td>Amphibolite</td>
<td>Metamorphic rock, formed basically from amphiboles and plagioclase with a massive texture and dark green colour, usually as a result of the metamorphosis of basic igneous rocks.</td>
</tr>
<tr>
<td>Anoxia</td>
<td>Absence of oxygen.</td>
</tr>
<tr>
<td>Anthozoa</td>
<td>Or Anthozoa. Animal from the cnidaria family which has the appearance of a flower, with a cylindrical body and a mouth surrounded by tentacles; such as corals and anemones.</td>
</tr>
<tr>
<td>Anthropic</td>
<td>Resulting from human activity.</td>
</tr>
<tr>
<td>Bottom trawling</td>
<td>A fishing technique using a net in the shape of a sack which is dragged along the sea bed by one or two boats, together with weights, chains and metal doors.</td>
</tr>
<tr>
<td>Augite</td>
<td>Pyroxene which is characterised by a monoclinical crystalline structure in dark green or black.</td>
</tr>
<tr>
<td>Autotroph</td>
<td>Organism capable of synthesising its own food from inorganic sources, which is the case with the majority of green plants and some bacteria.</td>
</tr>
<tr>
<td>Basalt</td>
<td>Fine-grained basic volcanic rock, formed mainly from plagioclase and pyroxene. Basalts constitute 90% of rocks.</td>
</tr>
<tr>
<td>Bathymetry</td>
<td>Branch of oceanography that deals with measuring the depth of oceans, seas and lakes.</td>
</tr>
<tr>
<td>Bathyside</td>
<td>Order of elasmobranch fish, characterised by a flattened body with the pectoral fins fused to the sides of their heads, with the branchial opening on the ventral surface, such as rays or fantails.</td>
</tr>
<tr>
<td>Benthic</td>
<td>Relating to organisms that live on or over the sea bed, whether fixed or mobile.</td>
</tr>
<tr>
<td>Benthopelagic</td>
<td>Fish that live and feed close to the sea bed and in intermediate waters close to the surface, such as hake and grenadiers.</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Ecological diversity and diversity of life; variety and variability of organisms and ecological complexes in a specific area.</td>
</tr>
<tr>
<td>Biogenic</td>
<td>Formed or created by living organisms.</td>
</tr>
<tr>
<td>Biomass</td>
<td>Amount of living material present at a specific time and place.</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Group of species or organisms of fauna and flora which live in or are characteristic of a specific habitat.</td>
</tr>
<tr>
<td>Bivalve</td>
<td>A creature belonging to the group of molluscs whose shell is formed by two articulated sections, such as mussels or clams.</td>
</tr>
<tr>
<td>Accidental catch</td>
<td>Organisms caught during fishing operations of which they are not the target. These could be different species from what are being sought, or specimens of the target species that are smaller than permitted.</td>
</tr>
<tr>
<td>Cetacean</td>
<td>Order of mammals that live in the water whose extremities have evolved into fins, such as whales and dolphins.</td>
</tr>
<tr>
<td>Thermohaline circulation</td>
<td>Currents caused by temperature and salinity variations.</td>
</tr>
<tr>
<td>Clarified</td>
<td>Hermaphrodite marine crustacean whose larva is free-swimming; in its adult state, it lives attached to underwater objects, e.g. barnacles.</td>
</tr>
<tr>
<td>Chlorophyll</td>
<td>Plant pigments formed by a long chain of carbons, hydrogen, oxygen, nitrogen and a magnesium molecule, chlorophyll alpha (C55H72O5N4Mg) and beta (C55H70O6N4Mg).</td>
</tr>
<tr>
<td>Cnidaria</td>
<td>Group of animals, generally marine ones, also known as coelenterates. They are characterised by their stinging cells or cnidoblasts. It includes jellyfish, corals, anemones, etc.</td>
</tr>
<tr>
<td>Community</td>
<td>All animal or plant populations that interact in a specific place and time.</td>
</tr>
<tr>
<td>Condritothyans</td>
<td>Class of fauna that includes all cartilaginous fish such as sharks, rays (elasmobranches) and chimerae (holocephali).</td>
</tr>
<tr>
<td>Taylor cones</td>
<td>Taylor cones or columns are sea currents that make an object move in a rotatory flow, pulling it through a column of fluid parallel to the axis of rotation.</td>
</tr>
<tr>
<td>Corallinaceae</td>
<td>Family of red algae from the Corallinales order, characterised by their calcium carbonate excreta. This gives them their “stony” appearance, similar to corals.</td>
</tr>
<tr>
<td>Current</td>
<td>Horizontal movement of water in the form of a “river” within a general circulatory system.</td>
</tr>
<tr>
<td>Crust</td>
<td>This is the most solid outer layer of the Earth, positioned above the mantle, and is the superficial part of the lithosphere.</td>
</tr>
<tr>
<td>Cosmopolitan</td>
<td>Organisms that are widely distributed in the different regions of the world.</td>
</tr>
<tr>
<td>Cretaceous</td>
<td>Geological period belonging to the Mesozoic era, approximately 145 to 70 million years ago.</td>
</tr>
<tr>
<td>Cetacean</td>
<td>Class of arthropod with branchial respiration with two pairs of antennae, compound eyes, a body mostly covered by a shell, whose metamorphosis passes through the larval phases of nauplius, mysis and zoea. This includes crabs, prawns, amphipods, etc.</td>
</tr>
<tr>
<td>Demersal</td>
<td>Relating to organisms which, opposite to pelagic organisms, live close to the bottom of the sea.</td>
</tr>
<tr>
<td>Detritus</td>
<td>Organic remains produced by the decomposition of plants and animals.</td>
</tr>
<tr>
<td>Diatomitutes</td>
<td>Group of unicellular microscopic or very small algae, classified as protists. Diatomitutes include endosymbiotic species (zooxanthellae), eco- and endoparasitic species, bioluminescent species and toxic algal bloom species.</td>
</tr>
<tr>
<td>Dispersion</td>
<td>The ability of a population or species to colonize new habitats.</td>
</tr>
<tr>
<td>Dololites</td>
<td>Rough, granular basalt rocks. The most common dololites are ophytic, resulting from the crystallisation of the feldspar before the augite.</td>
</tr>
<tr>
<td>Ecosystem</td>
<td>Group of organisms from different species which interact between themselves and with the environment in which they live. Or the integration of biocomplex and biotype.</td>
</tr>
</tbody>
</table>
Ecotype

Breeds or subspecies adapted to a particular type of environmental condition.

Eddies

Eddies are circular currents of water that are faster and narrower than those around them, with specific physical and chemical properties. They can reach several hundred kilometres in diameter. They can either be anticyclonic (when they go in a clockwise direction) or cyclonic (anticlockwise).

Venturi Effect

Acceleration that takes place to a fluid when its flow is tightened or constricted.

Bioluminescence

Class of vertebrates that includes sharks and rays. Almost exclusively marine.

Endemism

Organism that can only be found in a specific region.

Epibiont

A non-parasitic organism that lives at least one phase of its life cycle on top of another, larger, organism.

Epiphyte

Organism that lives on the surface of a plant or alga, getting support but not food.

Echinoderm

A marine animal with a calcareous skeleton and spines. Its body is divided into five radially symmetric sections, e.g. holothurias, starfish and sea urchins.

Scaphiophi

Organism that grows predominantly in shaded areas.

Species

Taxonomic classification ranking below genus defining related organisms capable of interbreeding.

Spines

Bony radials that support some fins.

Phanerogam

Upright plant that produces flower and fruit.

Feldspar

Minerals from the silicate group. They are made of silicon and oxygen plus other components. They are the essential components of endogenous and metamorphic rocks.

Phytoplankton

Microscopic plant organisms that float in aquatic ecosystems.

Formation

Fundamental lithostratigraphic unit. Body of rocks identified by their lithological characteristics and stratigraphic position.

Oceanic Trench

A very deep linear depression located at the base of some continental slopes.

Photosphere

Organism that prefers to settle in well-lit areas.

Photosynthesis

A metabolic process whereby plants transform inorganic compounds into organic matter (food), releasing oxygen and using energy from sunlight. The simplified equation of the process is:

\[ \text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{M.Org.} + \text{O}_2 \]

Coriolis Force

The Coriolis Force is produced by the rotation of the Earth, which tends to divert the trajectory of objects over a surface; to the right in the northern hemisphere and to the left in the southern.

Gabbros

Igneous rocks with a basalt composition.

Gastropod

Class of molluscs whose body is covered by a spiral shell, such as snails.

Genus

Taxonomic classification between species and family; a group of very similar species.

Gnesis

A metamorphic rock with notable foliation and granitoid composition, generated by high level regional metamorphosis.

Genads

Sexual organs responsible for producing gametes.

Granite

Acid plutonic rock with quartz, potassium feldspar, plagioclase and mica. 10 - 65 % of its feldspars are plagioclase and 5 - 100 % are anorthite.

Habitat

Place and type of environment in which organisms live. It can be geographical, physical, chemical or biological.

Haptorion

Cylindrical structure or modified branch which serves to anchor the alga in the substrate.

Hydrozoa

Or hydrodardia. Animal from the coelentera or oceanteers group which, throughout its life, has a polyp or jellyfish shape.

Jets

Jets are turbulent streams of water that form when waters with different densities come into contact, which may give rise to eddies.

Larva

Period in the development cycle of certain animals between embryo and adult.

Abyssal plain

A plain on the ocean floor at great depths.

Malacologic

The part of zoology that studies molluscs.

Bioclastic material

Sedimentary rocks, predominantly made up of bioclasts (the name given to any fossil element, whether whole or fragmented, of animal or plant origin, whether transported or not).

Meddies

Meddies are eddies of Mediterranean water and thus have greater salinity and a higher temperature.

Metamorphism

Series of processes whereby an original rock changes its mineralogy and structure, managing to completely melting.

Methane

This is the simplest hydrocarbon, the product of anaerobic decomposition.

Mollusc

Class of animals with a soft, non-segmented body generally protected by a shell, such as snails, clams or octopus.

Nutrient

Any organic, inorganic or ionic compound used mainly for the nutrition of primary producers (algae and microalgae).

Longlining

Fishing gear consisting of a main fishing line from which other secondary lines hang at intervals, with baited hooks at the ends.

Pantopod

Sea spiders. Arthropods about which there are many doubts as to their taxonomic classification. Previously they were considered to be part of the chelicerata family (spiders, scorpions, horseshoe crabs, etc.) but today they are given a separate classification.

Pelagic

Organism that lives in a column or mass of water, whether swimming or floating.

Peridotites

Igneous rocks of predominantly dark minerals consisting of around 75% ferromagnesium silicates and plagioclase feldspars.

Phylum

Taxonomic classification between kingdom and class.
**Exclusive Economic Zone (EEZ)** A maritime area that extends to 200 nautical miles from the base line (represented by the low-tide line of the coast), over which the coastal nation has sovereignty rights to explore, exploit, conserve and administer all the natural resources in the waters, sea bed and marine subsoil, as well as jurisdiction over scientific research, protection of the marine environment and the establishment and use of artificial islands.

**Euphotic Zone** Zone in the water column where sufficient light enters for intensive photosynthesis to take place, to the extent that over-saturation of oxygen can occur.

**Photic Zone** Zone in the water column where sunlight penetrated.

**Zooxanthellae** Dinoflagellates or unicellular microscopic photophile algae that live in symbiosis in the tissues of certain invertebrates such as corals, gorgonias, anemones, sponges, molluscs, etc.
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