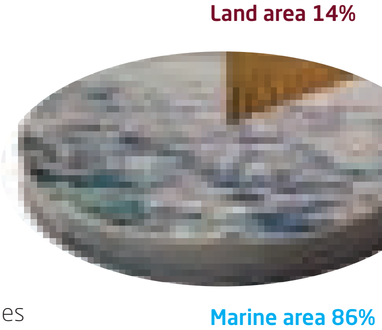
The marine environment

THE SEA OF THE GALICIAN ATLANTIC ISLANDS

The Atlantic Islands of Galicia are, along with the Cabrera Archipelago in the Mediterranean, one of two Maritime-Terrestrial National Parks that exist in Spain. As their protection rating indicates, the sea plays a fundamental role in these spaces. In our case, about 86% of the protected area corresponds to the sea, with 7,285.20 marine hectares protected out of the park's total of 8,480 hectares. The water surrounding each of the islands and the sea beds it covers are protected by the National Park. This protected marine area not only includes the shallower waters closer to the islands but also waters that at some points reach depths near 70 meters. In addition to making up the majority of the Park's area, the highly-valuable marine environment is also one of the main reasons these islands were declared a National Park. Despite the factors that threaten them, these waters are home to healthy communities of sea life and valuable ecosystems.

In this region the sea is impossible to escape, even on land. Ecosystems found on the islands are predominantly coastal ecosystems like dunes, cliffs and coastal scrub. The proximity of the sea also strongly influences life on land and is likely the factor that most impacts the island's terrestrial plants and wildlife, which must adapt to the salt in the air, the ocean winds, the spray of the waves, etc.



If we focus on the 86% of protected marine area in the Atlantic Islands the importance and value of the ocean becomes even more apparent. This marine area is highly valuable in terms of the environment and is a stunning attraction both for its spectacular underwater scenery and its rich fauna and flora, either benthic (living on the bottom), plankton (the organisms that live in water column, carried by the movements of the same) or nektonic (those who actively move independently of water currents).

The high biodiversity that characterizes this marine environment is a consequence of the special oceanographic conditions and of the many habitats, which create ideal conditions for the establishment and development of a large variety of communities representative of the Galician Atlantic seabed.

A WORLD IN CONSTANT MOVEMENT OCEANOGRAPHIC CONDITIONS

In the same way as plants and animals on a mountain must adapt to cold and wind, life in seawater is largely determined by the physical conditions and movements of the sea. Thus, surface and deep currents largely determine aspects like water temperature, nutrient content and water velocity, factors that are key to understanding biodiversity on the islands and how this life is distributed along the different types of seabed.

CURRENTS

Marine currents, both deep currents and those at the surface, play a very important role in biological phenomena, affecting salinity, temperature and water turbidity, and creating favourable conditions for the growth of organisms that have adapted to take advantage of the properties of the currents.

SEA BLUE

When sunlight reaches the sea, part of it is reflected off the surface and part enters the water column, where it is gradually absorbed. Orangey red light is more quickly absorbed. Blue light is the least absorbed and penetrates deepest in clear waters, making them blue.

In turbid waters, such as coastal waters with a large load of particles and suspended micro-organisms, blue radiation is absorbed before the yellow-green kind, giving them their characteristic green hue.

The colour of the water is one of the most spectacular and striking features of the Atlantic Islands. Greenyblue hues, from the palest to the darkest and most unsettling depending on the seabed, the wind, colour of the sky at any given time, etc., are among visitors' most lasting memories.

The primary mechanism giving rise to currents is solar energy. Solar radiation heats the atmosphere and gives rise to winds which move large stretches of the ocean surface and generate surface circulation. Furthermore, solar energy, by causing variations in temperature and salinity by heating or evaporation, also gives rise to differences in seawater density which are the driving force behind deep currents given the tendency of more dense water (colder or more saline) to remain below less dense water.

The following sections describe the great influence on the coast of Galicia of surface currents (the Gulf Stream, which brings warm water from the Equator) and of masses of water moving at depth (ranging from water of Mediterranean origin to the cold waters of the North Atlantic, which play an essential role in upwellings).

TEMPERATURE

Ocean **temperatures are more stable** than those on land due to the fact that water has a high specific heat capacity (the amount of energy that has to be supplied to a unit of mass so that the temperature rises by 1ºC). This implies that natural temperature ranges are much lower in the sea or ocean than above sea level: the temperatures that can be found in marine waters range from -4°C to 42°C, while temperatures recovered above sea level range from -89°C to 58°C. This is why the climate in a geographic area is usually milder on the coast than inland, with more moderate temperatures and fewer seasonal variations.

Water temperature depends to a great extent on latitude and on cold or warm marine currents, the most important variations occurring on the surface, which is more affected by solar radiation and atmospheric phenomena. The Gulf Stream reaches the coasts of Galicia as it does those of all Western Europe. The warm surface waters from the Caribbean make the climate much milder (average temperature of surface waters in Galicia is 14ºC compared with 5ºC on the coast of North America at the same latitude). These warm waters logically also have a significant impact on ecosystems and flora and fauna.

SALINITY

Salinity is the amount of salt in grams in a specific volume of sea water in litres. It is usually expressed in terms of per thousand, ‰. Sea water contains a lot of dissolved salts, the most common being sodium chloride, although there are small amounts of many others such as magnesium chloride or sulphate, calcium sulphate, potassium chloride, etc.

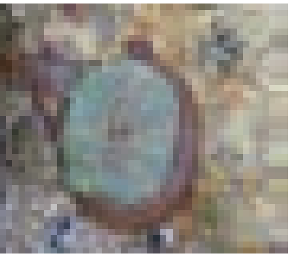
Average salinity of sea water ranges between 33 and 36‰, but on the coast and on the surface it can vary greatly due to meteorological factors, river input, currents, winds, etc. At the ria mouths where the three larger archipelagos are situated it stands at nearly 35%, and is higher in the south because the rias drain through the northern mouth with the resulting input of fresh water from the rivers.

TIDES: LUNAR PROPULSION

Tides are **oscillating movements** of oceanic water which alternatively give rise to an increase in sea level, known as high tide or high water, and a decrease in sea level, called low tide or low water.

By the 18th century Newton discovered that the gravitational pull that the Moon and the Sun exerted on the Earth was the cause of that phenomenon. The Moon, which is much closer to the Earth than the Sun, exerts a pull on large bodies of water on the face of the Earth nearest to it at any given time. The ocean bulges into a very big wave, whose crest corresponds to high tide and the midpart to low tide.

Low tide on Cortegada



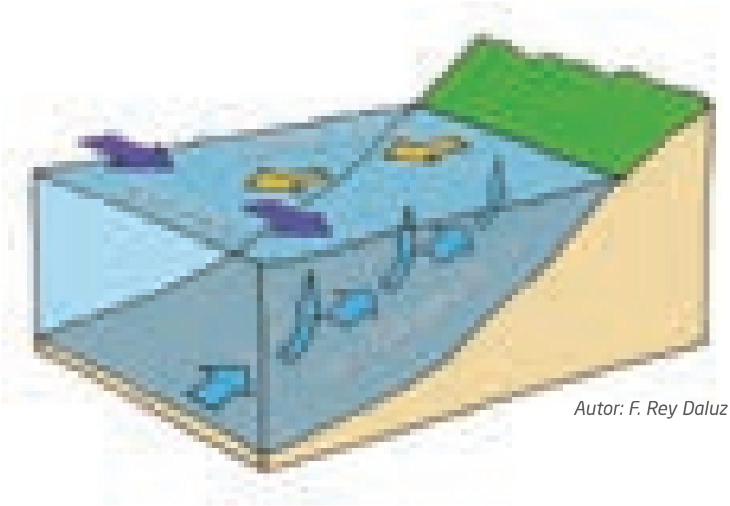
Anemone at high and low tide, respectively

Tides are a complex phenomenon and their breadth and frequency vary greatly among different seas and oceans and even between different regions of the sea or ocean. On these coasts **tidal breadth** (the difference in height between high and low tide) can be as much as 4 metres, but there are also seasonal variations within the same zone due to the relative position of the Earth, Sun and Moon. When the three are aligned close to a full or new moon, the forces of attraction of the Sun and Moon conjoin, generating greater tides. These higher high tides and lower low tides are known as **spring tides**. The breadth gradually dwindles until, in the first or last quarter, the stars being arranged at a right angle and the gravitational force of the Sun counteracting that of the Moon give rise to weak tides known as neap tides, when the tidal breadth can reach around one meter.

These regular variations have an extremely important effect on organisms living in the coastal zone as they have to adapt to drastic changes in living conditions every six hours. Thus, an animal like a mussel that lives on rocks in the intertidal zone and is consequently exposed at low tide must be able to withstand the ebb and flow of tidal currents and also survive conditions found at each low tide: rises in temperature, heat, terrestrial predators and lack of oxygen (the vast majority of marine animals need to be underwater to breathe).

UPWELLINGS: A SOURCE OF LIFE

The richness of the islands' waters is due to the phenomenon known as **local upwellings**. Due to the Earth's rotation, currents in the northern hemisphere tend to deviate their trajectory to the right. On the coast of Galicia the prevailing winds in spring and summer come from the north so the surface water they bring is driven towards the outer part of the rias. During this period the space left by this surface water is filled by deeper cold water, which partially comes from subpolar regions.



Autor: F. Rey Daluz

The water that wells up is rich in nutrients, since there is not enough light at depth there are no algae to metabolize these nutrients, which are available to organisms living in the illuminated surface zone, including the microalgae that make up plankton and are the basis of the food chain. The availability of nutrients, together with high temperatures and large amount of light, lead to a large increase in microalgae and a rich marine fauna, which feeds on them.

Upwellings therefore form the foundation for the great biodiversity found in the water in Galician estuaries and are the reason behind the significantly lower temperature of coastal waters in summer, when winds from the north dominate, an easily-noticed phenomenon when swimming on the islands' beaches.

The nutrients in the waters that well up make the high productivity of the rias

WHEN THE SEA CATCHES FIRE

As a result of the high temperatures, the relative summer calm of the water and plentiful nutrients, microscopic organisms, such as dinoflagelates, multiply and proliferate. Their coloration changes the colour of the sea water, which takes on yellow, blue, brown, green and orangey hues. This phenomenon is generally known as a "red tide".

Water full of minuscule inhabitants commonly changes into spectacular patches of phosphorescent light at night. In Spanish this phenomenon is called ardora or ardentía (burning); in other words, the sea is on fire. This is due to the fact that some species of dinoflagelates give off light when subject to certain stimuli, including disturbance in the water. It is noticeable when a swimmer or shoal of fish crosses areas containing these organisms or when waves containing them break on the beach. They can even sometimes be seen on wet sand as flickering dots of light around one's feet. This phenomenon can surprise island visitors taking a summer night's stroll.

Looking for a place to live.

Organism distribution in the coastal ecosystem and zoning

Coastal zone

The presence of animals and plants in the coastal zone is **determined by a series of environmental factors** such as substrate, light, currents, wave action, nutrients and relations with other species. Variations in these factors lead to zoning of marine organisms living on the seabed. Known as benthonic organisms, they occupy specific belts or strips according to their needs and limitations.

Within the coastal zone, the frontier between the ocean and the land, there are several benthonic environments, which are particularly obvious on rocky coasts:

- The **supratidal** zone lies above the highest level of the high tides. It is only reached by wave splash, and although the atmosphere is loaded with salt, prevailing conditions are terrestrial.
- The **intertidal** or **mesolittoral** zone includes between the highest and lowest tides of the year, and is in turn divided into upper, medium and lower mesolittoral. It is a very selective level as every 6 hours it undergoes drastic changes in temperature, salinity, humidity and turbulence. Ability to withstand such conditions determines the vertical distribution of organisms, which however enjoy some advantages such as well-oxygenated water, light and plentiful food.

- The **subtidal** or **infralittoral** is completely marine and includes from the lower limit of the intertidal to the upper limit of the distribution of photophilic algae (those that prefer illuminated zones), at a depth of approximately 30 metres. There is much less turbulence from wave action here and physical and chemical factors are not so variable.
- The **circalittoral** is the barely illuminated zone below the lower limit of the infralittoral as far as the edge of the continental shelf (underwater shelf with a slightly sloping surface near the coast) at a depth of approximately 200 metres. Communities of algae adapted to low light intensity become established in the upper zone, and are progressively replaced by exclusively animal communities.

In each of these environments there are clear differences depending on whether it is a section of exposed, semi-exposed or protected coast, and on whether the substrate is rocky or shifting (sand, mud, shingle, etc.).

Furthermore, in is the **pelagic zone** where the water column goes from the surface to the maximum depth, there are organisms that do not need to be in contact with the bottom.

MARINE ORGANISMS

Human beings are essentially terrestrial. That may be the reason for our ignorance in general of organisms living in the sea. In this framework there are some notions of the nomenclature and basic classification that was used when talking of marine organisms to facilitate the reading of paragraphs specifying the organisms that live in each kind of bed.

Rock with marine organisms

SPECIES SCIENTIFIC NAMES

Living things are classified at several levels. The main ones are: kingdom, phylum, class, order, family, genus and species. A particular species is referred to by its generic name beginning with a capital letter and its specific name in lower case, and we always write it in italics or underlined. For example, the scientific name of the mussel is *Mytilus galloprovincialis*, in which *Mytilus* refers to the genus, and *galloprovincialis* to the species.

When we mention only the genus of a species because we are not interested in going into more detail or because we know the species name, we refer to it as *Genus* sp. (for example, *Patella* sp., an indeterminate species of limpet). However, *Genus* spp. (as in *Zostera* spp.), refers to several species belonging to the same genus.

MAJOR GROUPS FOUND IN THE MARINE ENVIRONMENT

PLANTS

- **Algae** or non-flowering aquatic plants: may be unicellular or very large. The latter are divided into **green** algae (Chlorophyta), **brown** or **dark** (Phaeophyta) and **red** (Rhodophyta).
- **Phanerogams**: flowering plants, like the *Zostera* sp. and *Posidonia* sp. in the Mediterranean.

Green and red algae

LICHENS

They are associations between a fungus and an alga. They are typically terrestrial although some can be found in the coastal zone near the sea.

ANIMALS

- **Porifera** or sponges, so called because their bodies are full of orifices interconnected via an internal system of channels. Natural bath sponges are the skeletons of organisms belonging to this group.
- **Cnidaria** have tentacles with special cells like harpoons (cnidoblasts), with a highly irritating substance, used to catch prey. This group includes jelly fish, corals, anemones and similar animals.
- Worms **platyhelminthes** (flat), **nemertini** (with a proboscis or eversible mouth with sensorial functions), **nematodes** (unsegmented cylindrical worms) and **annelids** (segmented), including the polycheate worms.
- **Crustaceans.** Marine arthropods have a chitinous shell that protects the body and is completely shed to enable them to grow. This group includes goose barnacles, sand hoppers, isopods, crabs, prawns, etc.
- **Molluscs**. This is the most diverse group of marine invertebrates. They have soft bodies covered in a membrane called a mantle which secretes the shell (small, internal or non-existent in some). Includes bivalves such as mussels, gastropods such as winkles, cephalopods such as octopus and squid, and sea slugs.
- **Echinoderms**. Group of organisms with pentarradial symmetry, internal calcareous skeleton covered by the epidermis, with a hydraulic locomotive system (ambulatorial apparatus). Includes ophiurida, starfish, sea urchins and sea cucumbers.
- **Fish** (ichthyofauna). Vertebrates totally adapted to aquatic life may be cartilaginous, such as sharks and rays, or with a bone skeleton such as sole, grouper, etc.
- **Marine mammals**. Vertebrates adapted to aquatic life but breathing air; includes whales, porpoises, dolphins, etc.

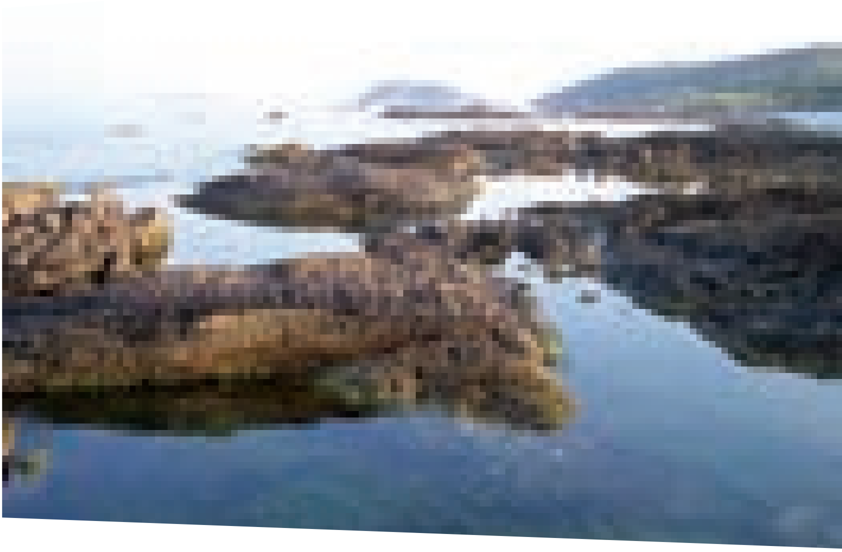
Rocks. A very crowded area

The characteristic that unequivocally identifies coastal rocks is most definitely **water turbulence, which erodes and shapes the coast**. The organisms living there must develop mechanisms able to hold firm to the substrate and withstand the force of the sea. The adaptations that these organisms have developed may be grouped into:

- protective features such as the shells of winkles or mussels, which prevent their being squashed by the force of the water
- features that anchor them to the substrate, as in the case of algae and mussels, which stop them from being dragged along by the currents

On the other hand, thanks to turbulence, coastal water is virtually saturated with oxygen and there is a large amount of organic matter in suspension due to the force of the water breaking up all kinds of dead organisms, which implies certain advantages for organisms in these areas.

Rocky coast on Ons



This, together with the **great variety of habitats** in rocky areas, such as fissures, caves, walls, etc., explains the great diversity of species there, which in turn gives rise to a high degree of competition for space. So, communities usually feature a species that thrives in the prevailing conditions and is replaced by another as conditions change across the supratidal, intertidal and subtidal zones.

SUPRATIDAL

Most of the inhabitants are typically terrestrial organisms such as plants or lichens that have adapted to live in this salt-laden environment. The only representatives of marine fauna are the small winkle (*Littorina neritoides*), a small brown sea snail that lives in fissures and holes in rocks, and the isopod *Ligia oceanica*, which hides under rocks and comes out at night to feed on algae.

INTERTIDAL

Characterised by **high diversity**, it features rather marked zoning in organisms which live according to the time each strip is emerged.

Large areas are occupied by **mussels** (*Mytilus galloprovincialis*) and, in the areas most exposed to the sea, by **goose barnacles** (*Pollicipes pollicipes*), on a base of **barnacles** (balanomorph crustaceans) of the genera *Balanus* and *Chthamalus*, which include the winkle *Littorina neritoides* and limpets (*Patella* spp.).

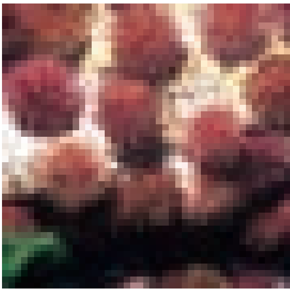
Limpets are a good example of adaptation to avoid desiccation. They adhere so tightly to the rock that they are hermetically sealed and a small amount of water remains inside. When the tide rises, they begin to move slowly in search of food, but when the tide starts to ebb they adhere to the rock again, always in the same spot that the shell has perfectly adapted to in order to improve the tightness of the seal.

Among the algae there are large numbers of incrustating calcareous organisms of the genus *Lithophyllum*, which live on other species such as the small red alga *Ceramium rubrum* on mussel shells, and some other species such as the red alga *Corallina elongata, Gelidium sesquipedale*, the moss *Chondrus crispus* and the genus *Fucus*.

Lithophyllum tortuosum

The gastropods living here include winkles (*Littorina* spp.), thick topshell (*Monodonta lineata*) and *Nucella lapilus*, a predator of limpets, barnacles and mussels, perforating the shell with teeth to eat the soft parts. The purple sea urchin (*Paracentrotus lividus*), marbled rock crab (*Pachygrapsus marmoratus*), sea anemones (*Actinia* spp.) and spiny starfish (*Marthasterias glacialis*) whose staple diet is the mussel, live at this level.

All these animals and plants compete for a place to live, forming a veritable multicoloured carpet on the rock faces.

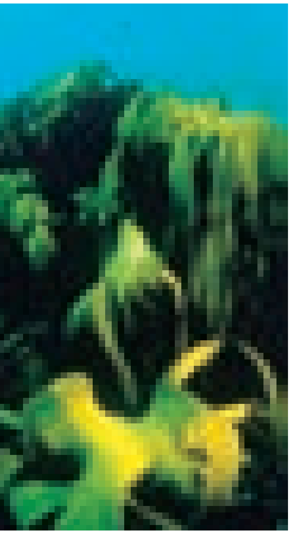


Purple sea urchins

These and many other species who are less able to withstand desiccation live submerged in pools where they seek shelter when the tide goes out. They include anemones (*Anemonia sulcata*), common prawns (*Palaemon serratus*) and fish like gobios (*Gobius* spp.) and blennies (*Blennius* spp.), superbly adapted to life in this environment. These ponds, true oasis where all these organisms find shelter, are also an excellent opportunity to learn more about marine life just by taking a look at the rocks near the beach at low tide, being careful not to disturb the animals in their habitat and to respect the reserve areas.

Gobio sheltered in an intertidal pool

SUBTIDAL



Kelp forest

Spider crab

European conger

Here the outstanding features are the **forests of large brown algae**, regarded as one of Spain's coastal communities that host the greatest wealth of species. They consist of *Saccorhiza polyschides, Laminaria ochroleuca* and *Laminaria hyperborea*, species of large algae that may grow to 2.5 m, strongly anchored to the substrate in exposed and semi-exposed areas. Like great trees, they allow a large number of animals and plants to live among and on them so that a large diversity of species finds their ideal habitat in this ecosystem, which functions like a veritable forest. Regarding plants, the rich undergrowth of red algae also grows on the kelp itself.

These areas supply food and shelter to many species of animals such as polychaeta (bristleworms), abalones or ormers (*Haliotis tuberculata*), the limpet *Helcium pellucidum*, which feeds on the kelp, the velvet swimming crab (*Necora puber*) and the common spider crab (*Maja brachydactyla*). Spider crabs camouflage themselves by attaching fragments of algae, sponges and other organisms to their shell and feet, enabling them to go unnoticed when at rest.

In summer, nudibranchs or sea slugs are common, with bright colours that warn they are toxic in order to put predators off.

Many fish also seek refuge and food in this forest, e.g. pollack (*Pollachius pollachius*), conger eel (*Conger conger*), grouper (*Polyprion americanus*), gobies and blennies.

The kelp undergrowth and kelp-free areas contains the brown alga *Cystoseira baccata*, which although not rich in species, does indicate the presence of the clean pollution-free water that it needs to grow.

"Fields" of anemones often occur among the forests of brown algae. They arise from the herbivorous action of sea urchins. This action controls and limits the spread of the brown algae, which in turn aids the growth of calcareous incrustating algae of the genus *Litophyllum* on which the anemone *Anemonia viridis* grows, forming "fields".

These kelp forests have great ecological value for their productivity and the richness of the species that find refuge here. While these forests are fairly dense across all the rocky areas surrounding the island throughout the National Park, *Laminaria* spp. populations have undergone considerable decline in recent years. The causes is as yet unknown, although a hypothesis has been posed that the decline is due to an increase in water temperature resulting from climate change.

The morphology of the substrate determines the organisms that can live in each area. Where it is vertical, there are Crinoidea of the Echinodermata (*Antedon bifida*) and Ophiuroidea (*Ophiotrix fragilis*), and in caves and fissures, the soft coral known as dead man's fingers (*Alcyonium* spp.), gorgonias (*Lophogorgia* sp. and *Eunicella* sp.) and the sponge *Cliona celata*. Where there are small caves there may be octopus (*Octopus vulgaris*).

Dead man's fingers

RECENT ARRIVALS:
THE THREAT OF INTRODUCED SPECIES

The species in a specific ecosystem are the result of an equilibrium which normally needs hundreds of years to develop and can be upset by different factors in a much shorter time. One of the most important threats to algae is the introduction of alien species, which may replace native species and great changes in the communities of algae and, as a result, in the entire food chain, as just like in the terrestrial ecosystems, plants are the basis.

The major problems currently affecting the Galician coasts are caused by the brown alga *Sargassum muticum* from Japan. It most likely arrived in a consignment of Japanese oysters and was discovered for the first time in Europe in 1973, on the Isle of Wight (United Kingdom). From there it spread rapidly to the Mediterranean, the first record for Spain being on the coast of Guipuzcoa in 1987. In Galicia it is very widespread, inhabiting sheltered and semi-exposed rocky coasts. Sometimes so thick that the local algae die out (in this case kelp are the worst affected), it also represents an important problem to shipping and local economies.

Another aspect of human activity that needs to be borne in mind as regards this plant in the wild is that it is sometimes difficult to control, and we must be aware of the huge impact that our actions are having. In such cases, we must always be cautious and refrain from acting unless we are absolutely sure of the effects that our actions will have on the environment.

Shifting Beds

Life under cover

In areas with less hydrodynamics in which sedimentation prevails over erosion, the seabed has shifting substrates consisting of loose material. The common denominator is the fact that wave action and currents constantly stir up the surface layer to varying degrees depending on the degree of exposure in any given area. Such **substrate mobility** makes it difficult for species to stabilise so most organisms bury themselves in the sediment while always maintaining a link with the surface (endofauna) or move over it or clinging to shell fragments. A glance at the shifting substrates produces an initial impression of desert-like bleakness, when, in fact, they host large numbers of animals. The major shifting beds in the park consist of sand, maërl and shingle; there are, however, also muddy areas around Cortegada and in Cíes Lake.

Sandy stretch on Ons

SANDY BOTTOMS

These form in areas where the water loses force and deposits the sandy sediment that it carries, eroding it at the same time. They form fine sands with a large proportion of clay and silt in more sheltered areas and large and medium-grained sand (except for the fine-grained sand on Cortegada) in the more open areas of the islands. These features are in constant motion either due to the sea or to the wind in the subaerial part. However, defining vertical horizons of distribution like those in the rocky beds is particularly complex as a result.

Supratidal and intertidal: Beaches

The upper part of the beach, which only gets wet at high tide, is home to sand hoppers (*Talitrus saltator*), an impressive jumper that remains buried at shallow depth to keep wet during the day and comes out at night to feed among the seaweed and debris that are washed onto the beach with the tide.

On the strip closest to the water **the permanent ebbing and flowing of the tide and the waves continually sweeps the seabed** in such a way that there is virtually no macrofauna and the only algae are microscopic.

Cuttle fish

Subtidal

Rock with algae on a sandy bed

Like the supratidal and intertidal zones, here the algae are predominantly microalgae, although species such as *Cystoseira tamariscifolia* and *Dyctiota dichotoma* take advantage to anchor themselves to isolated rocks amidst the sand. In more sheltered and lighter zones *Padina pavonia*, *Taonia atomaria* and *Colpomenia peregrina* occur.

Here the abundance of faunal species increases in relation to the beaches. **Sand-dwelling populations of bivalve molluscs** live here, e.g. great scallop (*Pecten maximus*) and queen scallop (*Aequipecten opercularis*) which beat both valves (or shells) to propel themselves along. There are also banks of goose barnacle (*Cerastroderma edule*), pullet carpet shell (*Venerupis pullastra*), rayed artemis (*Dosinia exoleta*) and razor fish (*Ensis* spp.). The latter live buried in permanent deep dens where they move to the upper part and send out extendible appendices to breathe and filter feed.

Gastropods are not so numerous in rocks, but *Hinia incrassata* and cowries (*Trivia* spp.) are common. The cuttle fish (*Sepia officinalis*) is also common, camouflaging itself perfectly on the seabed by varying the colour of its skin. The longest animal found in the National Park also lives on the seabed: the bootlace worm (*Lineus longissimus*). Specimens up to 30 meters have been found.

Turbot

Among the crustaceans the most representative species are crabs such as hermit crab (*Diogenes pugilator*), which occupies empty snail shells to protect its soft abdomen, or the hairy *Atelecyclus undecimdentatus* crab.

The heart urchin *Echinocardium cordatum* buries itself and feeds on organic matter mixed into the sand. Other echinoderms are the Ophiuras (brittlestars) and the sand star *Astropecten irregularis*, voracious predator.

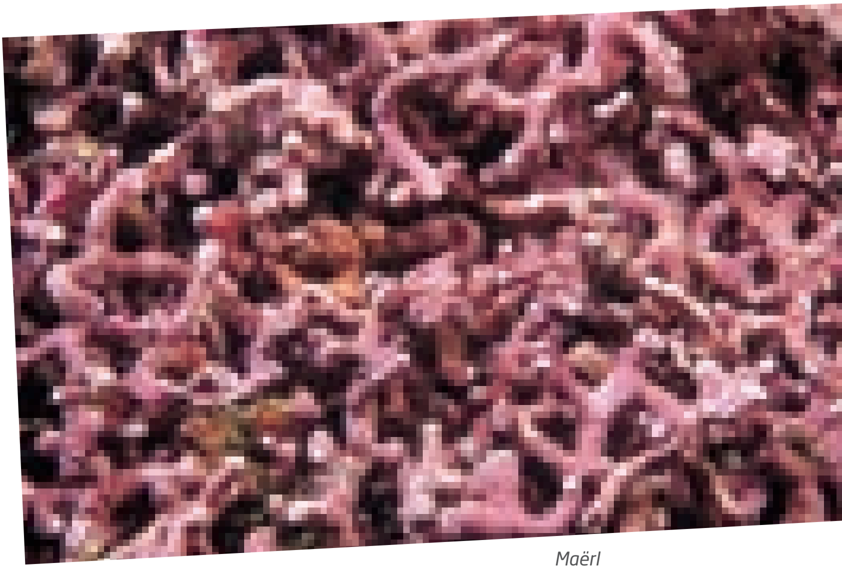
A number of flat fish live on the seabed and blend into the bottom or partially bury themselves, such as the flounder (*Platichthys flesus*), turbot (*Psetta maxima*) and rays (*Raja spp.*). Other fish that bury themselves in the sand are the lesser weever fish (*Echiichthys vipera*), which can inject poison into the feet of any bathers who step on it at low tide, and the lesser sand eel (*Ammodytes tobianus*), which can also be found swimming in large shoals.

Besides all these organisms, the stretches of sand contain a diminutive and rich interstitial fauna in the tiny holes between the grains of sand.

MAËRL BEDS

The term "maërl", from Breton, refers to coral bottoms, which have very a specific substrate and fauna. They consist of **calcareous algae** in the form of free branched strongly calcified arbuscules several centimetres wide. The species that form the maërl banks in Galicia are *Lithotamnion corallioides* and two different species of *Phymatolithon* (*P.calcareum* and another yet to be identified). The maërl banks in Galicia and the islands appear as either pure maërl or mixed beds with different proportions of shingle, stone, gravel, sand or mud.

This structure of vertical layers of sedimentation in which only the algae at the surface level are alive provides an **intricate network of refuges that ena-**



Maërl

bles the beds to host a wide diversity of animal life. The maërl beds are primarily an important habitat for populations of bivalves (many of them commercially valuable) like the yellow carpet shell rayed artemis (*Dosinia exoleta*), queen scallop (*Aequipecten opercularis*) and great scallop (*Pecten maximus*), as well as gastropods such as turban top shell (*Gibbula magus*), hermit crabs of the species *Anapagarus hyndmany* and the long-clawed porcelain crab (*Pisidia longicornis*). For its variety and abundance the polychaeta and small crustaceans such as amphipods and isopods stand out, and among the fish, the lesser sand eel (*Ammodytes tobianus*) are noteworthy. The amphioxus (*Branchiostoma lanceolatum*), which looks like a fish even though it is an invertebrate, spends the day buried with its head sticking out.

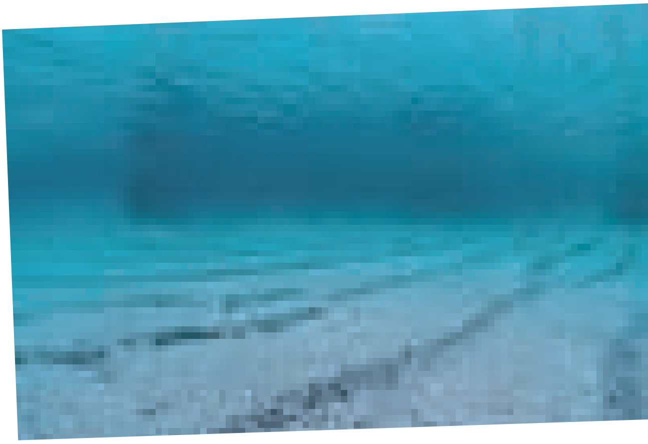
Besides these species, which live in the maërl all their lives, others seek refuge there in their juvenile phases, e.g. velvet swimming crab (*Necora puber*), spider crab (*Maja brachydactyla*), common cuttlefish (*Sepia officinalis*) and commercial fish species. These beds serve as a refuge where the young of these species can survive and grow to become part of the breeding population.

The maërl beds are considered a coastal habitat of high ecological value at a European level due to their high faunal and algae diversity and as areas of high productivity. Moreover, the algae that form maërl are very slow growing and these beds are particularly vulnerable to a number of influences: trawling, the proliferation of invasive species, accumulation of fine sediments, etc. All this means that uses of the beds must be strictly regulated.

SHINGLE BOTTOMS

Shingle bottoms consist of **remains of mollusc shells**, above all bivalves and gastropods. The remains form a layer several centimetres thick where most of the animals living there are buried. The only plants are microscopic algae or small incrusting algae on shell fragments or on the shells of living animals.

There is a variety of hidden fauna: bivalves such as the great scallop (*Pecten maximus*), variegated scallop (*Chlamys varia*), yellow carpet shell (*Venerupis romboides*), goose barnacle (*Cerastoderma edule*), razor fish (*Ensis spp.*) and rayed artemis (*Dosinia exoleta*); gastropods such as the Nassaridae (*Nassariidae spp.*) and the snail Charonia lampas; cephalopods such as the cuttle fish (*Sepia officinalis*) and octopus (*Octopus vulgaris*);



hermit crabs (*Eupagurus spp.*); and a variety of polychaeta (bristleworms), echinoderms, sponges, Ophiurae and Holoturiae (sea cucumbers), which live among the shells or on them. There are also flat fish, rays (*Raja spp.*), lesser weever fish (*Echiichtys vipera*), etc., already mentioned above in connection with other kinds of beds.

Octopus on a mixed maërl-shingle bed

THE LAGOON, AN UNDERWATER MEADOW

Located on the Cíes Archipelago, between the islands of Monteagudo and El Faro, closed off by a dike and by Rodas Beach, this shallow saline lagoon can boast high biodiversity. Although it has a small surface area, there is a great variety of different environments of inter and subtidal sand and rock, and in spite of the fact that its characteristics correspond to a protected area, the tide coming in across the dike transports organisms from exposed areas species associated with different kinds of seabed with different degrees of exposure found there.

Fish fauna is particularly important in the lagoon thanks to the broad range of refuges and plentiful food there. Just strolling along the adjacent dike, you can spot a good sample of this diversity in the shape of thick-lipped grey mullet (*Chelon labrosus*), two-banded seabream (*Diplodus vulgaris*), ballan wrasse (*Labrus bergylta*), pollack (*Pollachius pollachius*), rainbow wrasse (*Coris julis*), conger eels (*Conger conger*), gobies (*Gobius* spp.), blennies (*Blennius* spp.) and even eels (*Anguilla anguilla*); the latter has been declared as vulnerable in the Red Book of Vertebrates of Spain.

From the same place, with a little patience and luck, you may spot octopus (*Octopus vulgaris*), cuttlefish (*Sepia officinalis*) and spider crabs (*Maja brachydactyla*) in the wild.

The sensitivity and fragility of this system mean that the lagoon's great ecological value is easily threatened and so it is important to minimize human pressure on it by avoiding walking in certain areas and by studying and monitoring the potential effects of artificial structures such as the dike or quays. In fact, there has been a degree of saturation in recent years due to sediment accumulation in the lagoon caused by sand from the sand dune and the effects of the dike on the lagoon's hydrodynamics. Its vulnerability has led to its being declared a Reserve Area in the Atlantic Islands of Galicia Natural Resources Plan, one of the legal instruments governing national parks.

Rainbow wrasse

Swimming in the Pelagic Zone

The pelagic zone, which extends from the water surface down to depths, contains organisms that do not need to be in contact with the bottom and do not depend on it directly although they may do so due to the kind of food they ingest. They are divided into:

- plankton: organisms that move passively, being swept along by the currents. It is in turn divided into phytoplankton or plant plankton, and zooplankton, made up of animal organisms.
- nekton: more active organisms able to withstand marine currents.

The original Greek term "plankton" means "wandering". It consists mostly of microscopic beings, but also includes other easily visible ones such as jelly fish. Although small, these organisms form a kind of living broth which forms the basis of marine food chains, and as such regulates to a large extent the structure of oceanic ecosystems.

School of Salema porgy (Sarpa salpa)

As regards fish, part of the nekton, it is possible to tell apart pelagic species, which spend their entire lives in the water column or in contact with the bottom only at specific periods, and demersal species, which are indirectly associated with the bottom via food, e.g. sea bream (*Diplodus* spp.) and thick-lipped grey mullet (*Chelon labrosus*), from those mentioned in the sections devoted to the various kinds of seabed.

Pelagic fish are not brightly coloured, and, as is often the case in Nature, have cryptic colouring that imitates the natural habitat and serves to fool predators and to stalk its own prey. So, most have a greyish blue back to blend in with the blue of the sea as seen from above, while their silver abdomens blend into the shimmering surface when seen from below.

Their long spindly, hydrodynamically-shaped bodies help them move very fast in this **domain of great swimmers**, where they tend to live in large shoals for protection.

Amongst the most common fish in this area are the lesser sand eels (*Ammodytes tobianus*) and Atlantic mackerel (*Scomber scombrus*), which occur in large shoals, and solitary fish such as John Dory (*Zeus faber*).

Cetaceans also pass through this area. Perfectly adapted to pelagic life, the bodies of these marine mammals have undergone important changes that have left them with a fish-like appearance very different from the typical body patterns of mammals. Bottlenose dolphin (*Tursiops truncatus*), common dolphin (*Delphinus delphis*), porpoises (*Phocoena phocoena*) and pilot whales (*Globicephala melas*) can occasionally be seen, although never close by, around the islands and also from boats travelling to them.

Diving around the Atlantic Islands:

Site location

The geological composition and oceanographic conditions of currents, wave action, etc. determine the kind of seabed in any given zone.

More exposed to the continual beating of the waves, the western side of the Atlantic Islands in Cíes, Ons and Sálvora is quite homogenous as far as the seabed is concerned. It almost totally consists of rock. The force of the ocean prevents small-grain sediment being deposited there, and constantly erodes the coast, forming cliffs. However, in deeper waters of this western side, where the force of the waves is lower at 25-30 meters depth, some areas of medium and coarse sand and shingle have been deposited, especially in the Cíes Islands and Sálvora.

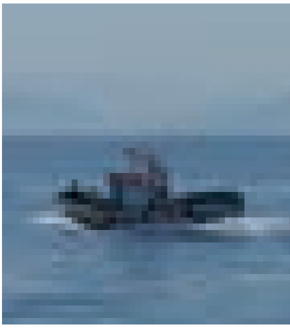
There is a greater variety of marine habitats in the more protected eastern part facing the estuaries. The various types of substrates in different areas are the product of hydrodynamics and sediment dynamics. There are beds with different-sized shingle and maërl sand as well as

rock. Sálvora's eastern side is flanked by a strip of mixed rock, sand and maërl, with sands located in deeper waters. The entire eastern coast of Ons is surrounded by a rocky platform that gives way to large areas of predominately medium-grained sand and maërl banks at approximately 10 meters deep. Finally, sand beds in the Cíes are located in shallower waters, occupying almost the entire eastern side of the islands, and are interspersed with areas of rocks and maërl.

Cortegada is an exception within the Atlantic Islands as it is located in the innermost part of the Arousa Estuary, with less marked hydrodynamics, where the surrounding seabed chiefly consists of predominantly fine and muddy sands; even when rocks appear on the strip adjacent to Cortegada and the islets they are interspersed with sand.

The marine environment is the national park's chief asset, one of the reasons underlying its status, and one of the best conserved ecosystems within the park. Protecting and improving it are priority aims in park management.

Sustainable fishing, a viable alternative



Nowadays when, worldwide, 30% of major fishing reserves are over-exploited and 52% are exhausted, requiring efficient management to prevent further decline (FAO, 2012), any references to fishing always seem to signify something negative. However, viable alternatives to unsustainable fishing do exist, bearing in mind that managing the exploitation of marine resources must be compatible with biological, economic and social resources.

The rich seabed of the Atlantic Islands has helped to sustain local populations through fishing and shell fishing. The fishing has been largely of the inshore kind on a small scale and more environmentally friendly than the industrial variety as catches are smaller and more selective.

The current aim is to regulate this activity in order to **make conservation and improvements to this exceptional marine ecosystem compatible with maintaining sustainable inshore fishing in park waters**. This is based on:

- setting out the kinds of fishing tackle and number of catches compatible with conservation
- marine zoning, which would regulate the different uses (sailing, anchorage, subaqua diving, fishing, etc.) and would include totally off-limits integral reserves; they would act as natural nurseries that could even help to regenerate the park's external marine ecosystems.

Regulating fishing in the national park not only makes conservation and sustainable use possible, but also yields economic and social benefits for the entire surrounding community, enhancing social cohesion and becoming a powerful management tool.