Terrestrial flora and vegetation

ATLANTIC ISLANDS FLORA ON THE EARTH.

BIOGEOGRAPHY

Biogeography is the science that links geography and ecology in the study of the distribution of living things on the Earth. On the basis of climatic, geological, soil criteria, etc., there is a hierarchical arrangement of units to classify the Earth's flora and vegetation. On the basis of that classification the national park's four archipelagos come within the Eurosiberian Region, Atlantic superprovince, Atlantic-European province and occupy the Miñense Subsector of the Galaic-Portuguese sector, the latter having a markedly Mediterranean climate, with more severe summer drought.

Different bioclimatic belts resulting from the lowering of temperatures according to altitude leads to vegetation zoning. As altitudes in the national park are low, it is part of the thermocoline horizon. Being strictly coastal and featuring mild winters means that many heat-loving plants unable to withstand cold occur there.

Flax-leaved daphne, a Mediterranean plant

As regards rainfall and temperatures (ombroclimate) and taking into account complete data from the past seven years (prior to 2014), the average temperature is 15ºC and the average rainfall is above 1,000 mm, except on the Cíes Islands. Thus, even though Cortegada is classified as humid, the ombroclimate is considered warm and subhumid.

VERY VARIED PLANT LIFE

Today's plant life on the archipelagos in the national park is essentially determined by the confluence of environmental factors and the by-products of human occupation, each one offering a different panorama.

The **Cíes** Islands, with their rugged cliffs, host a varied flora, which adds more colour to the marine setting.

They are covered in gorse in the higher areas, and eucalyptus, acacias and pines further down, broad forest cover contrasting with the white sand of the beaches and dunes.

Cíes

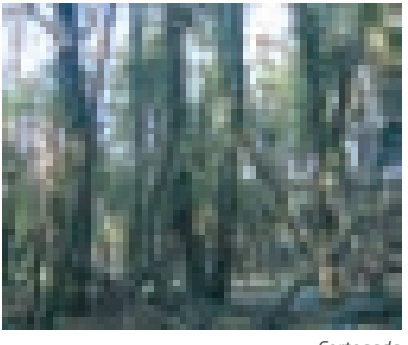
Ons

On the **Ons** Archipelago, with its gentle and flat outline, there are large stretches of gorse with isolated formations of eucalyptus, acacias, pines and small stands of willow. Some parts of the cliffs are carpeted in ground hugging formations of thrift (Armeria pubigera) and offer lovely panoramic views.

Sálvora

On **Sálvora**, the island's large characteristic blocks of granite occasionally show through the low vegetation of gorse, ferns and other herbaceous species. The cliff flora is bent by strong winds and mixed in with the nearby dunes in some areas. The adjacent islands, Sagres, Vionta, Noro, Gaboteira, Herbosa, etc. have low vegetation and herbaceous formations. Vionta, the sandiest of the five, has dune flora and a few broom bushes.

Unlike the above archipelagos, the image that visitors take away of **Cortegada** Island is one of trees: patches of forest, shady woodland of oaks, laurels and willows with climbing plants carpeting the ground, tracts of pine and eucalyptus concealing the ruins of a former settlement, and small patches of ground covered in alders.



Cortegada

Predominantly herbaceous plants grow on the islets of Malveira Grande, Malveira Chica and Briñas, although Malveira Grande has a small stand of Pyrenean oak.

FACTORS THAT ALTERED THE LANDSCAPE

The Atlantic Ocean washes the four archipelagos in the national park, giving form to unique and spectacular scenery on each of the islands. It is the main agent in shaping the landscape either directly through wave action on the coast or indirectly via factors such as strong winds from the sea, making it difficult for living things to survive in such environmental conditions.

An essential feature of the landscape, vegetation is greatly determined by wind, high salinity, summer drought and poor soil development. These factors give rise to a mantle chiefly composed of scrub, in which tracts of woodland are likely to be in the most sheltered spots where soil is deeper, e.g. river beds. Thanks to its sheltered location in the ría and its topography, environmental conditions on Cortegada are milder, differentiating them from the rest of the park's archipelagos.

This landscape has been artificially altered to a great extent since ancient times so the plant life now found on the four archipelagos bears little resemblance to the original island vegetation. Although manmade change began in prehistoric times, most existing information dates from the last few hundred years, when diverse factors led to alterations to the landscape:

Ons Island

- **Fertilization**, crops or livestock excrement altered soil composition, benefiting some species over others. On cliffs, nutrient input from gull colonies also altered plant communities.
- Traditionally, vegetation **growth was controlled** by livestock grazing, a practice which still impacts the scrub on Sálvora today, and by felling for firewood, which mainly affected gorse and broom.
- Arable fields on fertile land and trampling and footpaths caused by livestock and by people led to **surface erosion**, which the increase in tourism has aggravated on the dune systems.
- **Fire** was another factor in transforming the landscape, from burning to create grazing land to wildland fires.
- Ranging from market gardening species to large-scale reforestation schemes involving pines, eucalyptus and acacias in the mid-twentieth century, the **introduction of exotic species** has been a determining factor in altering the vegetation. It is very marked on the Cíes Archipelago.

Gulls on the cliffs

Horses on Sálvora

With the depopulation of the islands in the twentieth century, and the subsequent declaration of the Cíes Islands as a natural park in 1980 and the rest of the archipelagos as a national park in 2002, many of the abovementioned factors either disappeared or were minimised. On Cortegada and Sálvora, for example, there is still grazing by herbivores.

Although the landscape is constantly evolving naturally, it often does so brusquely due to human action. That is when people must once again intervene to turn back the clock. As regards landscape, the Management Plan for the National Parks Network states: "landscape shall be preserved as one of the parks' main values", and "attempts shall be made to return to a state as close as possible to that resulting from natural evolution". It is the responsibility of the national park to preserve, and when necessary, recover, natural development and the ecosystems and landscape which that development gives rise to.

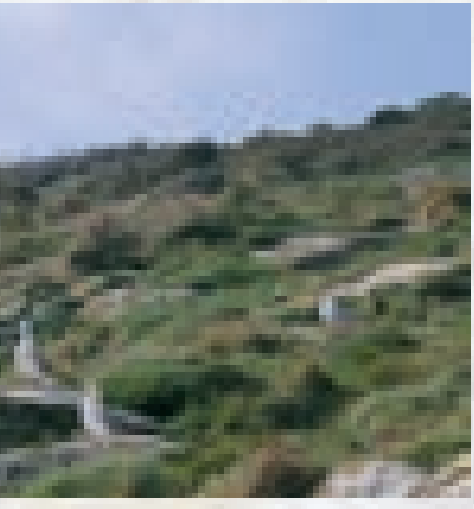
Crops on Ons Island

LARGE NUMBERS OF SEABIRDS ON THE CLIFFS LEAD TO MAJOR CHANGES IN THE DOMINANT VEGETATION

The typical vegetation on most of the Atlantic cliffs does not correspond with the typical community in that same vegetation belt in the rest of Galicia. Environmental conditions on the cliff, including intense winds, steep slopes and high salinity, make the development of plant life difficult. However, over a large part of the Atlantic Islands there is a unique factor that greatly impacts the islands' plant life and biodiversity: seabird colonies, especially Yellow-legged gull.

The strong impact gulls have during the breeding season by trampling, digging and providing nutrients from their droppings gives this habitat its own environmental characteristics and results in a distribution of plant communities on the cliffs that is much more complex than those on the mainland, which are not impacted by the presence of gulls.

Soil analyses on the Cíes Islands and Ons yielded significantly greater values for nitrogen and other compounds, which appear in high concentrations in gull droppings. As a result, there are some markedly nitrophilous plant communities (which grow in nitrogen-rich soils), with species such as common velvet grass (*Holcus lanatus*), angelica (*Angelica pachycarpa*) or nettle (*Urtica membranacea*). This differentiates them from typical Galician communities. Vegetation that has been shaped by the gull colonies is part of the island landscape, which is always under the influence of the sea and, in this case, that of the birds living in close association with it.



SURVIVING A HARSH ENVIRONMENT: PLANT ADAPTATIONS

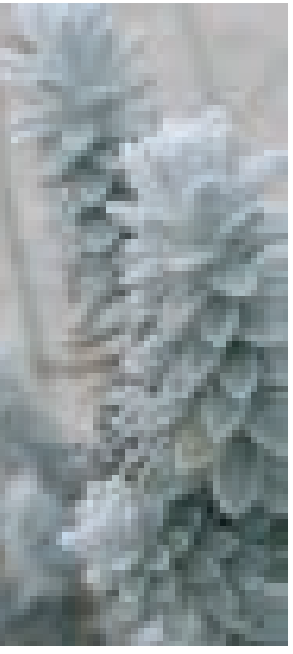
Over time, environmental conditions have fluctuated in different geological time periods. Since they first appeared 400 million years ago, plants have had to evolve gradually in tandem with changes in the environment. Only the species that underwent evolutionary processes which improved adaptation to the new conditions have managed to survive to the present day.

Nowadays, too, environmental conditions vary a great deal from one region of the world to another. This means that in some zones there is tropical forest and in others desert vegetation. That also occurs on a smaller scale in the sense that conditions on the coasts differ from those in the interior. Along with soil type, environmental conditions largely determine the existence of one or other kind of vegetation.

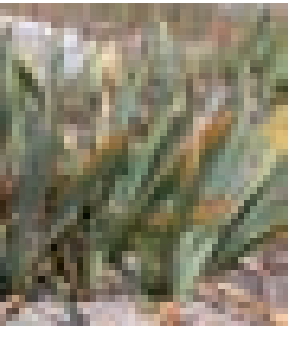
On the coast, vegetation growing on the strip closest to the sea has to withstand high salinity, strong winds, spray, highly porous soils with little capacity to retain water and nutrients, intense insolation due to reflection from the sand, a shifting sandy substrate, etc. The success of plants growing in this environment lies, therefore, in their adaptations to withstand impediments to growth. They have developed mechanisms such as:

- **Adaptations to wind:** Rounded ground-hugging plant formations to withstand the wind. These adaptions are commonly found in thrift (*Armeria pubigera*) or gorse, which grow on cliffs.

The ground-hugging form of armeria.



Cottonweed



Lily of sea

Linaria polygalifolia

- **Adaptations to insolation:** Occurs mainly on dunes where the reflection of light from the sand enhances the effect and increases temperatures. Examples can also be found on cliffs. The plants develop white colouring, hairs, coverings of wax and other substances, thickened cuticles, etc., to reflect light, which has such a direct impact on them. The dune plant known as cottonweed (*Otanthus maritimus*), for example, is covered in hairs.
- **Adaptations to drought:** On beaches porosity of sand makes water retention difficult and leads to very dry environments that are poor in nutrients. To counteract such adverse conditions, some plants develop roots to trap water, e.g. marram grass (*Ammophila arenaria*), or water storage structures like the bulbs or tubers of sea daffodils (*Pancratium maritimum*), or the thickened leaves of sea rocket (*Cakile maritima*). To avoid water loss, plants develop mechanisms that reduce transpiration, e.g. a small leaf surface, hard pointed leaves, a protective wax coating on the epidermis.
- **Adaptations to living in sand:** Apart from the problems already mentioned, life on the sand poses other difficulties. The shifting substrate moves in the wind, leaving roots exposed or burying plants. Having to endure the scarcity of nutrients and the impact of sand on the plant surface, which leads to tissue abrasion and flexion of aerial parts. Reinforced tissues, long roots, smaller leaf size and association with nitrogen-fixing bacteria are a few of the adaptations to counteract the affects. Examples can be found in the hardened leaves of maritime crosswort (*Crucianella maritima*) and the narrow leaves of *Linaria polygalifolia* and *Helichrysum italicum* subsp. *serotinum.*

Sarcocornia perennis

- Adaptations to salinity: High salinity levels in the environment make life difficult for plants as they impede water absorption. Halophilous plants are specially adapted to such settings, and usually look fleshy as they accumulate salts and water in their cells to make up for the salt concentration outside and to facilitate water absorption. Another mechanism involves saving water. To do so, many species reduce their leaf surface area, e.g. *Sarcocornia perennis* and *Salicornia ramosissima*, or excrete salt via glands, which makes them white, thus preventing the parts exposed to the sun from heating up.
- Adaptations to immersion: Plants that spend most of their lives under water are not affected by desiccation. In their case, the difficulties lie in the exchange of gases, trapping light and withstanding water currents. As a result, aquatic plants develop different kinds of leaves: submerged leaves may well be narrow and thin to promote the exchange of O2 and CO2 and light absorption; floating leaves, with no light- and gas-trapping problems will be thicker and rounded to increase floatability. These two kinds of leaves occur in pondweed (*Potamogeton* spp).

ECOSYSTEMS

This section covers different kinds of vegetation on the four archipelagos of the national park. Eight groups of vegetation have been described depending on the habitat occupied or the kind of formation.

Rocks and coastal cliffs

They are highly influenced by the sea, where the beating of the waves, high salinity and poor soils impose very adverse conditions for plant growth and where only specialised vegetation is able to get established. The strong winds in this area also hamper plant growth. As a result the vegetation adopts a ground-hugging form that offers less resistance. The nesting colonies of seabirds, chiefly gulls, are also a factor as their droppings enrich and fertilize the soil causing changes in the plant communities.

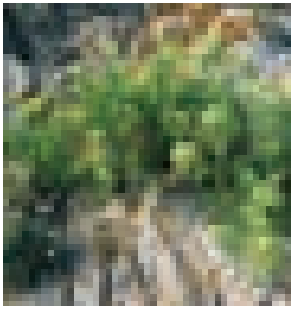
On the Atlantic Islands these ecosystems are broadly represented from the rugged cliffs of the Cíes and Ons archipelagos to the gentler ones on Sálvora, or the uncommon rocky coasts of Cortegada, where the limiting factors are minimised as they are sheltered within the Ría de Arousa.

On the cliffs of Cíes, Ons and Sálvora there are several different vegetation belts which vary according to their proximity to the sea. In the lowest parts nearest the sea, a community occupies cracks in the rocks and is very affected by spray. It features rock samphire (*Crithmum maritimum*), and thrift (*Armeria pubigera* subsp. *pubigera).*

In parallel, in wetter and shadier sectors such as furnas, or caves, there is a community in which sea spleenwort (*Asplenium maritimum*) is predominant. This **vegetation**

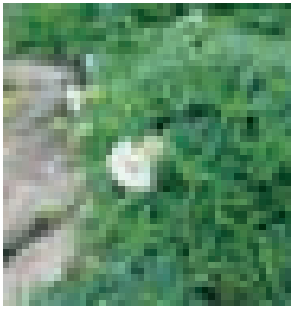
belt is known as **halocasmophytic**, a term that refers to its ability to withstand salinity and to grow among the rocks. It is the only belt on Cortegada, except for the island of Malveira Grande, where cliff scrub also grows.

In the same belt in areas much affected by seabird colonies, the previous community is replaced by another halonitrophilous one that is resistant to salinity and high nitrogen contents, whose typical species are scentless chamomile (*Matricaria maritima* subsp. *maritima*), *Cochlearia danica* and nettle *Urtica membranacea*.



Rock samphire

The next vegetation belt of **aerohalophilous grassland** lies above the previous one. It is splashed by sea spray, which leads to the high salinity to which the term refers and to the strong winds in this area. Greater soil development allows the establishment of grassland dominated, depending on the zone, by thrift (*Armeria pubigera*) or sea campion (*Silene uniflora*) and orchardgrass (*Dactylis glomerata* subsp. *maritima*). The typical cliff grassland communities of the northwest of the Iberian Peninsula are dominated by festuca (*Festuca rubra* subsp. *pruinosa*) and Queen Anne's lace (*Daucus carota* subsp. *gummifer*), but in the park it is only common on Ons, being very scarce on the Cíes Islands due to the nitrifying effect of the gull colonies. In the parts most affected by the colonies, these communities have been altered and contain more markedly halonitrophilous plants such as common velvet grass (*Holcus lanatus*) and angelica (*Angelica pachycarpa*). On south-facing slopes associated with this influence, there is a community endemic to southern Galicia consisting of the marigold Calendula suffruticosa subsp. algarbiensis and wall pellitory (*Parietaria judaica*).



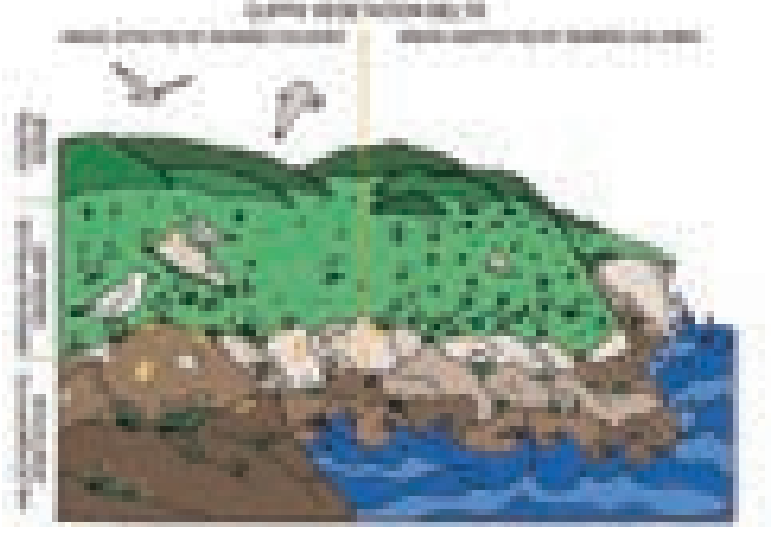
Sea campion

Sea marigold

Coastal gorse

Angelica pachycarpa

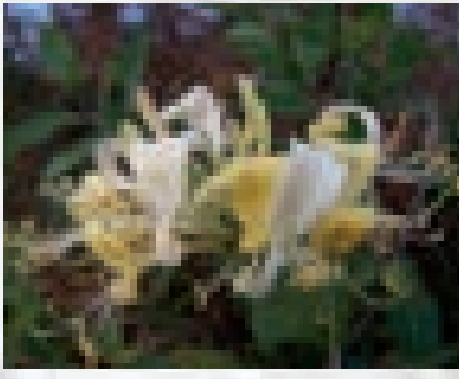
Finally, on the upper part of the cliff (the belt least affected by spray) there is **coastal scrub, cliff scrub or aerohalophilous scrub**. This belt chiefly consists of a subspecies of endemic Galaic-Portuguese gorse (*Ulex europaeus* subsp. *latebracteatus*), which is highly adapted to the harsh ecological conditions in this environment. It grows together with common herbaceous species in aerohalophilous pastures such as *Silene uniflora*; angelica (*Angelica pachycarpa*) and the cliff daisy *Leucanthemum merinoi*, endemic to the coasts of Galicia and northern Portugal; *Dactylis glomerata* subsp. *maritime*; and several ligneous species of optimum Mediterranean e.g. rockrose *Cistus salvifolius*, flax-leaved daphne (*Daphne gnidium*) and broom *Osyris alba*. This scrub extends beyond the domain of the cliff into the east of the islands. On some slopes there are also stands of blackthorn (*Prunus spinosa*), which is dealt with in the section on scrub.



TRADITIONAL CURES USING MEDICINAL PLANTS: DISAPPEARING KNOW-HOW

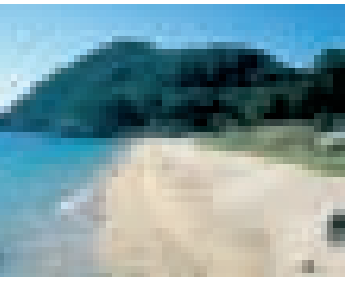
The geographical isolation and harsh living conditions, including a lack of medical care, that led the inhabitants to leave the islands for good in the closing decades of the 20th century gave rise to a wealth of knowhow relating to the medicinal uses of plants. This knowledge is gradually being lost as people emigrate to the mainland and the last generations that used them disappear. Current knowledge about this cultural heritage comes from Ons, the only one still populated and the last one where such remedies are still applied.

Visiting the doctor was normally difficult and sometimes impossible in winter. At best it meant missing at least a whole day's work, so people only tended to go when traditional remedies did not work.



Honeysuckle flowers were used to treat asthma

This traditional medicine was based, on the one hand, on the application of plant-based remedies, and on the other, on rites and magic incantations to ward off illness, especially when the nature of the ailment was unknown and attributed to the evil eye. The few studies conducted in this field indicate that over 40 plants were used for medicinal purposes, including tansy ragwort (*Senecio jacobaea*), honeysuckle (*Lonicera periclymenum*), common mallow (*Malva sylvestris)* and elderberry (*Sambucus nigra*). The remedies were prepared in infusions, ointments or by extracting plant sap, and used for all kinds of ailments, colds, diarrhoea, wounds and rheumatic pains. Now that almost the entire island population has moved to the mainland, where going to the doctor is not usually very difficult, these written documents look set to be the only depositaries of the immense cultural wealth that this knowhow represents.



San Martiño Beach

Sea rocket

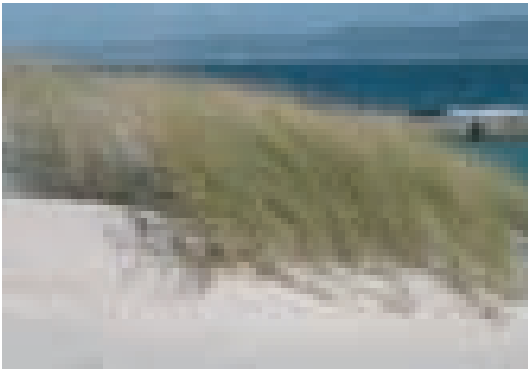
Sea holly

Beaches and Dunes

These habitats withstand high insolation and severe drought and salinity, with a substrate very poor in nutrients which, due to the winds and the lightness of the sand, give rise to shifting and constant changes. These characteristics require species to have a high degree of specialization, forcing the arrangement of different plant communities in belts according to the distance from the sea.

The first vegetation belt closest to the sea corresponds to **beach vegetation**, which is present on all the National Park archipelagos, but not on all the beaches. Here, the accumulation of nitrogen due to the deposit of marine organic remains washed ashore favours the growth of a small number of nitrophilous species with a short life cycle and which are affected by tidal drag. It features a plant association that includes sea rocket (*Cakile maritima*), sea sandwort (*Honkenya peploides*) and sea knotgrass (*Polygonum maritimum*), etc.

Dune vegetation is found in the belt above beach vegetation and is present in all dune systems on all the archipelagos, e.g. the Figueiras-Muxieiro dune complex, the San Martiño Beach complex, both on the Cíes Islands, Melide Beach on the Ons Islands and Lagos Beach on Sálvora.



Marram grass

The **first dune front (primary dunes)** is nearest the coast in an area very exposed to marine dynamics so it is often transported by the waves and plant colonization must start over again. The vegetation basically involves sand couch (*Elytrigia juncea* subsp. *borealis-atlantica*) whose long roots enable it to stabilise the substrate and withstand the effect of wave action at high tide and wind, and gradually stabilise the sand behind it. Other species are sea thistle (*Eryngium maritimum*) and shore bindweed (*Calystegia soldanella*).

Secondary dunes form the second vegetation belt. They are still shifting dunes but not as unstable as those mentioned above. As a result a larger variety of species can get established, which stabilises a greater amount of substrate, acting as sand reservoirs, thereby contributing to beach equilibrium. It is a system in constant movement due to the wind and sea which erode it and at the same time enable it to take shape. This strip features marram grass (*Ammophila arenaria* subsp. *australis*), which colonizes the dune crests thanks to its roots up to 4 metres deep. They enable it to become stabilised and successful in this setting, in which the wind blows more strongly and dune morphology is variable. Accompanying species are cottonweed (*Otanthus maritimus*), shore blindweed (*Calystegia soldanella*) and sea spurge (*Euphorbia paralias*).

Linaria Arenaria - A SMALL UNCOMMON DUNE PLANT

Its distribution range is restricted to the western coasts of France and Galicia

Scientific name: *Linaria arenaria*

Family: Scrophularials

Linaria arenaria populations can still be found in the dune systems on the Cíes Islands, Ons and Sálvora. The range of this little plant is restricted to a few points on the French coast and four islands on the Galician coast and it is classified "Endangered" on the Galician Endangered Species List and as "Critically Endangered" in the Red Book of Endangered Vascular Flora of Spain.

This annual plant can grow up to 15 cm and has small yellow flowers from May to June. It lives on relatively well established coastal dunes and stretches of sand. Although undisturbed by slight alterations to the terrain (it may grow along quiet roadsides), it tends to disappear when human pressure increases, and is particularly sensitive to trampling and artificial changes to habitat.

Thanks to the fact that there is no public access the Sálvora population is the highest and densest in Galicia, while on Ons the population is scarce and declining due to pressure from tourism. Given the sensitivity of this species special care must be taken on beaches with dune systems, and access has sometimes to be restricted or denied using fencing in order to protect plants threatened by alterations to the dunes.

Linaria arenaria

Armeria pungens, A PLANT WHICH ONLY GROWS ON THE ISLANDS IN GALICIA, IS A REMINDER OF CLIMATES PAST

Galician name: Herba de namorar das dunas
Scientific name: *Armeria pungens*
Family: Plumbaginaceae

This species of the genus Armeria lives on dunes and stretches of coastal sand, and occasionally on cliffs. It should not be confused with the more common *Armeria pubigera* (Herb of Love), which grows mainly on cliffs.

This small bush may reach 50 cm high, with many long branches that keep the dry leaves. It flowers between March and May.

The importance of this plant in the national park lies in the fact that the only populations in Galicia and northern Spain occur in the dune systems of the Cíes Islands. The species is otherwise distributed across the southwest of the Iberian Peninsula, Corsica and Sardinia. Its presence here reveals a formerly broader distribution range corresponding to a time when climatic conditions in Galicia were more similar to current conditions in southern Spain.

In the event of their disappearance, recovery of such isolated populations would be a very complicated task. Their natural habitat is under permanent threat from tourist pressure and the plants that live there are particularly sensitive to continual transit across the dunes. For that reason it is advisable to avoid walking on them.

Armeria pungens

PLACE NAMES TELL US ABOUT THE FORMER ABUNDANCE OF PORTUGUESE CROWBERRY IN GALICIA, A PLANT NOW FOUND ON THE CÍES ISLANDS

Iberian-Atlantic endemic species
Galician name: Camariña, caramiña.
Scientific name: *Corema album* subsp. *album*.
Family: Empetraceae.

Although this species was cited in the past as being abundant along the entire coast of Galicia, as the names of settlements such as Pobra do Caramiñal suggest, its current situation reflects a severe decline. Nowadays, inside the national park Cíes is the only one in the archipelago hosting this species, more specifically on the strip of scrub on the Muxieiro dunes. This population, together with the Trece Inlet in A Coruña, is one of the main Galician populations, the most northerly one. In the south of the Peninsula it is still widespread.

The Portuguese crowberry is a long-lived and slow-growing shrub that lives on coastal dunes and grows to just over half a metre high. Its narrow leaves are arranged in four rows; the round fleshy fruits are food for several animal species which play an important role by dispersing seeds via their droppings. Young plants grow mainly in open areas so the processes that lead in a non-natural way to greater plant coverage of the dune (e.g. colonization by pines and acacias) will reduce the populations' regenerative capacity. Other causes for their decline are the disappearance of dune systems due to pressure from tourism along the coast and trampling, to which Portuguese crowberry is very sensitive.

Portuguese crowberry

The Muxieiro Dunes are fenced in to restrict visitor access and protect this emblematic species and others However, conservation must not limit restriction on access; rather it should demand a joint effort by managers and visitors.

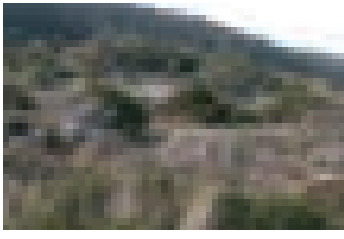
As the further away one goes from the sea, the less harsh the environmental conditions, tertiary dunes or dune fields form. Here the effects of wind and salinity diminish, leading to a rise in the numbers of species colonising this belt and to the extent of coverage. It features a scrub comprising halophilous species (which grow in saline soils) dominated by plants exclusive to the Ibero-Atlantic coast such as "helicriso" (*Helichrysum italicum* subsp. serotinum), figwort (*Scrophularia frutescens* var. *frutencens*), "artemisia de playa" (*Artemisia crithmifolia*) and iberis (*Iberis procumbens* subsp. *procumbens*), and others with a wider distribution range like maritime crosswort (*Crucianella maritima*). On Cíes Archipelago there is a community of Armeria pungens and Portuguese crowberry (*Corema album*).

In the clearings of secondary and tertiary dunes, annual communities feature the "violeta de dunas" (*Viola kitaibeliana* var. *henriquesii*) and shore campion (*Silene littorea* subsp. *littorea*), which is an endemic Iberian species, while Sálvora and to a lesser extent Ons, host the chief Iberian populations of *Linaria arenaria*. On the tertiary dunes there are other communities, with a Galician-Portuguese range, consisting of short grassland, *Linaria polygalifolia* and the grass *Corynephorus canescens* being characteristic species.

Finally, further inland of the tertiary dune there is a **cross-dune scrub**, only found on Cape Vilán and, in the Figueiras-Muxieiro dune system on the Cíes Islands. The large numbers of Portuguese crowberry (*Corema album*) and gorse (*Ulex europaeus* subsp. *latebracteatus*) differentiate this community from other similar ones further south.

Iberis

Shore campion



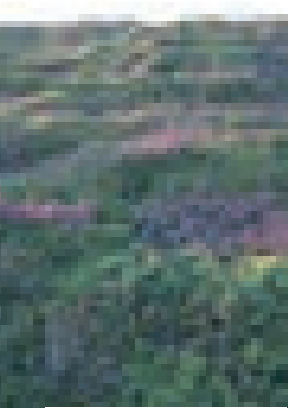
Portuguese crowberries

Coastal gorse scrub

Scrub

Most of the upper part of the national park is covered in scrub, native woody communities whose composition and character varies on the different archipelagos.

Most is coastal scrub (already dealt with in the section on cliff vegetation). It is a climax community, which is a mature and more stable stage of natural vegetation. In other cases it represents a stage prior to the regeneration of arboreal vegetation in the processes of succession, with impenetrable tracts of gorse (*Ulex europaeus* subsp. *latebracteatus*), heathers (*Erica umbellata, E.cinerea, E. ciliaris*), common western brackenfern (*Pteridium aquilinum*) and elm-leaved bramble (*Rubus ulmifolius*). On the Cíes Islands this association is unique in that it does not have any heather (*Erica* spp.), which is common in Galicia.



Heather on the island of Ons

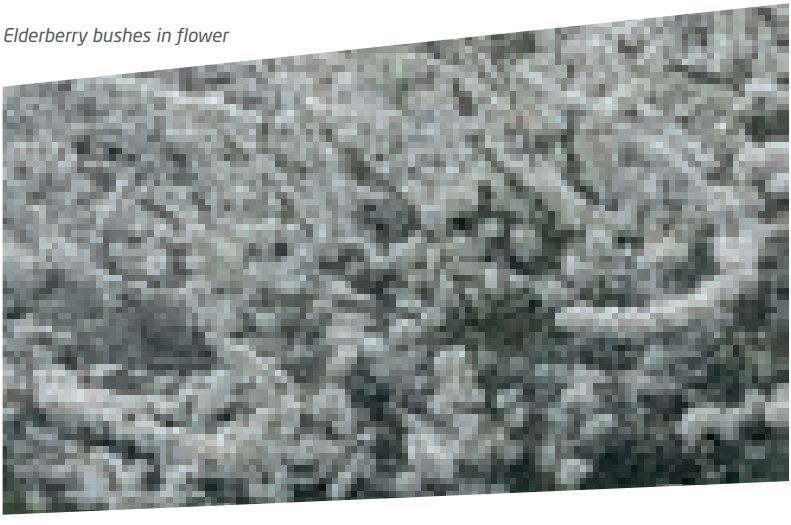
On Ons and Sálvora and rarely on Cortegada there are wet or hygrophilous stands of heather, which grow on deeper wet soils. They feature heather (*Erica ciliaris*) and the cardoon *Cirsium filipendulum*, together with gorse (*Ulex europaeus* subsp. *latebracteatus*).

Another kind of scrub is the broom stands, formations of broom that are very scarce on the Cíes Islands, where only the *Cytisus striatus* species is found, and Corte-

gada, where they are represented by *Cytisus striatus* and *C. scoparius*, a common species in Galicia. They are more abundant on Ons, where *Cytisus striatus* occurs with another very interesting recently discovered broom, recorded in 2001 and the only endemic species exclusive to the national park: the *Cytisus insularis* broom.

The blackthorn formations (*Prunus spinosa*) that live on cliffs as mentioned above are also found in the scrub and are present on all the National Park's archipelagos. While studies on this plant are scare, the species is of great interest as it corresponds to periods that predate the natural tree cover, and could be regarded as native thorn bush communities of the forest ring, i.e. small formations found on the periphery of forests. In this case they replace the forests and are the final stage in this zone. They are spread in patches among the stands of gorse, both on the western cliff slopes and on the eastern face, occupying on deepest soils. On Ons, Sálvora and Cortegada there are also common hawthorn (*Crataegus monogyna*) and elderberry (*Sambucus nigra*).

Elderberry bushes in flower



Cytisus insularis IS THE ONLY BROOM SPECIES EXCLUSIVE TO THE ATLANTIC ISLANDS

Endemic species on Ons and Sálvora

Galician name: Xesta of Ons

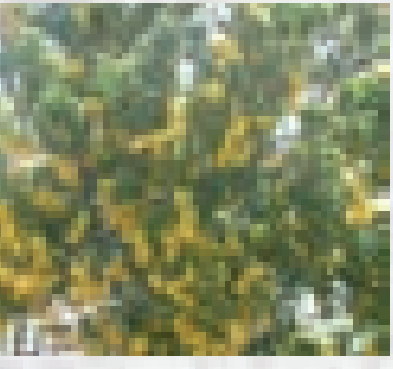
Scientific name: *Cytisus insularis*

Family: Legumes

In 1998 in the course of studies conducted to prepare the proposal for declaration as a national park, a large number of the broom bushes on the island of Ons were seen to have morphological differences compared with *Cytisus striatus*, which it was classed as. When studied in detail, it was discovered to be a different and previously unknown species and was named *Cytisus insularis* S. Ortiz & Pulgar in Bot. J. Linn. Soc. 136(2): 00 (2001).

This woody shrub grows up to 2 metres high and has unifoliate leaves (those of *C. striatus* are trifoliate), flat berries and a larger number of seeds per fruit (in *C. striatus* there are no more than 8, while in *C. insularis* there are usually more than 10).

So far the species has only been found on the archipelagos of Ons and Salvora, basically in the cliffs along with gorse. The restricted distribution area explains why it is one of the most interesting plants among Galicia's rare and threatened flora, and why it is regarded as a distinctive species of the Atlantic Islands of Galicia National Park. It is the only species endemic to the park, and is classed by the World Conservation Union (IUCN) as Endangered and is included on the Galician List of Endangered Species under the same category.



Cytisus insularis

Native Forest

The national park's native arboreal vegetation would be classed as Galaic-Portuguese oak woodland featuring common oak (*Quercus robur*), Pyrenean oak (*Q. pyrenaica*), holly (*Ilex aquifolium*), butcher's broom (*Ruscus aculeatus*), broom (*Cytisus striatus*), flax-leaved daphne (*Daphne gnidium*) and *Tamus communis*, etc. However, the actual situation is very different. Cíes, Ons and Sálvora have scarcely any native trees; there are just a few isolated groves as the environ-mental conditions are more suited to ground-hugging scrub. Trees grow only in sheltered areas on the eastern side of the islands.

On the **Cíes Islands**, native tree cover has been largely replaced by forestry crops of eucalyptus, acacias and pines, is reduced to a small stand of Pyrenean oak (*Quercus pyrenaica*) on the island of Monteagudo and a few on San Martiño, a reminder of the tracts of native forest that once grew on the sheltered slopes. Reforestation with native species got underway in some parts of the archipelago at the beginning of the nineties so there are now some areas where strawberry trees (*Arbutus unedo*), birches (*Betula celtiberica*) and Pyrenean oaks (*Quercus pyrenaica*), etc., grow.

Grove of Pyrenean oaks on Cíes

European alder

On **Ons** the chief vestiges of native forest consist of willow (*Salix atrocinerea*) in farm hedges or near springs and ditches, from where they spread to other parts of the island, and, in the north, some Pyrenean oak (*Q. pyrenaica*), which must have been much more numerous in the past. There are also elderberry bushes (*Sambucus nigra*), chestnut trees (*Castanea sativa*) and laurels (*Laurus nobilis*), and as on Cíes, some parts have been reforested with native species.

Sálvora does not have any large tracts of native forest either, although some willows (*Salix atrocinerea*) and elderberry bushes (*Sambucus nigra*) grow around ditches, while laurels (*Laurus nobilis*) are found in the environs of the town.

The situation on **Cortegada** is very different; it is almost totally covered in trees, and according to various authors the woodland appears to have spread from hedges surrounding the fields and spontaneously colonised the island territory after being abandoned at the beginning of the 20th century. Young trees and scrub have been affected by pressure from grazing goats, now quite few but which still remain on the island.

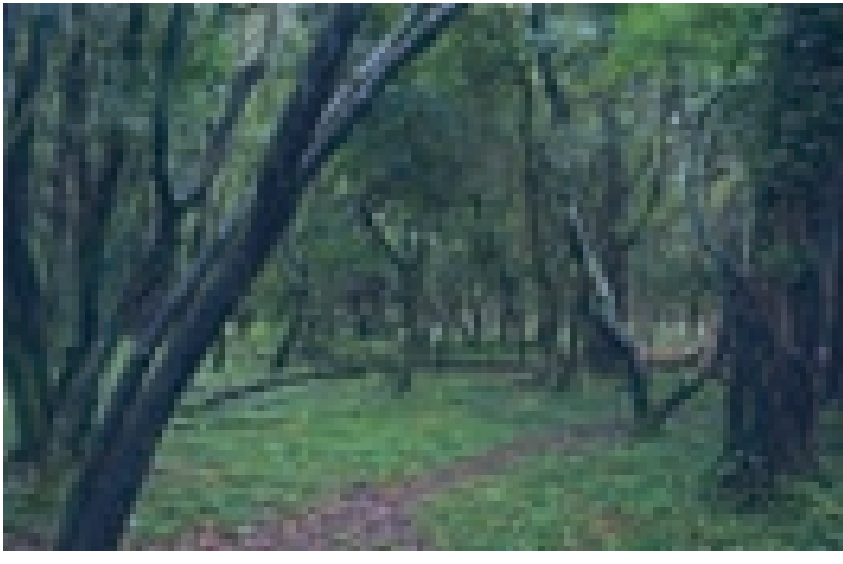
A part of the island is covered by an oak stand (*Quercus robur*), together with laurel (*Laurus nobilis*), common hawthorn (*Crataegus monogyna*), willows (*Salix atrocinerea*), some Pyrenean oaks (*Quercus pyrenaica*) and chestnut (*Castanea sativa*), etc. The abundance of willows and laurels could classify these areas as closely linked to wet soils. The undergrowth in these stands includes plants like ivy (*Hedera helix*), escorodonia (*Teucrium scorodonia*), honeysuckle (*Lonicera periclymenun*),

stinking iris (*Iris foetidisima*) and *Davallia canariensis*, a fern native to the Macaronesia region, which grows on oaks on Cortegada

Laurels on Cortegada occupy soils containing accumulated water. Still to be studied, these formations are very important for their rarity. Very abundant in the lower parts of Galicia at the end of the Tertiary, most were transformed by human activity and at present the laurel stand on Cortegada is the largest on the Iberian Peninsula. These formations have little undergrowth, being virtually reduced to a carpet of wood sage and ivy on the ground, along with a few wood sage plants (*Teucrium scorodonia*) and friar's cowl (*Arisarum vulgare*). Willows (*Salix atrocinerea*) grow on ground permanently or temporarily flooded in the eastern part of the island as a non-specific formation, while in the west they are mixed with common alders (*Alnus glutinosa*).

On Malveira Grande, the closest island in this archipelago, there is an interesting coastal formation dominated by Pyrenean oak (*Quercus pyrenaica*), together with the occasional laurel (*Laurus nobilis*) and common hawthorn (*Crataegus monogyna*).

Laurels on Cortegada



PYRENEAN OAK, REPRESENTATIVE OF ANCIENT NATIVE FOREST ON THE ATLANTIC ISLANDS

Galician name: Cerquiño
Scientific name: *Quercus pyrenaica*
Family: Fagaceae

In the past, Pyrenean oak (*Quercus pyrenaica*) was the dominant native species in the original oak wood-land due to its greater tolerance to drought.

Pyrenean oak is a medium-sized tree (20-25 metres); it is deciduous although it has dry leaves until the new ones emerge. The leaves are very lobulated and hairy, which enables them to withstand low temperatures and summer drought.

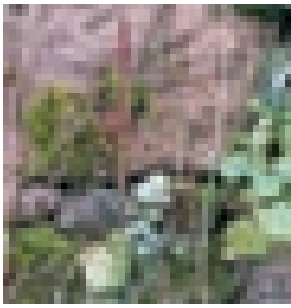
It grows on siliceous terrain like that of the granites of the Atlantic Islands, and the strength and density of its root system are important in forming and stabilizing soil on slopes, which would be more eroded without such cover. Its resistance to drought means that it generally occupies an intermediate position amongst the typical Atlantic oak forests and Mediterranean forest of other species of the genus Quercus, such as holm oaks.

This species has been severely disturbed by human activities, and nowadays few stands remain. On the Atlantic Islands there are only a few groves or isolated examples serving as a reminder of the native tracts that not so long ago grew in sheltered areas, the most important ones being on the Cíes Islands and Malveira Grande on the Cortegada Archipelago. This native vegetation is still threatened by the same factors that brought about its degradation and confinement to small areas, and action is required to boost it, e.g. reforestation or removal of alien species.

Quercus pyrenaica

Rock-dwelling and pioneer vegetation

Rock vegetation grows on rocky outcrops, occupying fissures and spaces among the stones where soil formation begins. The halocasmophytic vegetation of the cliffs would also be classed as rock vegetation, but one with hardly any marine influence, a very common community on rock faces throughout Galicia. It occurs on all the archipelagos in the national park, on crags without halophilous influence, and, on Cortegada, on large trees. It features navelwort (*Umbilicus rupestris*) and the ferns *Polypodium interjectum* and *Davallia canariensis*.



Navelwort

An endangered species of rupicola is found on the National Park's archipelagos. *Rumex rupestris*, a plant classified as "endangered" by the Red Atlas and Book of Endangered Vascular Flora of Spain and as "critically endangered" in the Galician Catalogue of Endangered Species, grows on the Cíes islands and Ons and Sálvora.

Pioneer communities are those that colonize rocks and clearings amongst scrub, also occupying shallow soils. They include sedum (*Sedum arenarium*), *Xolantha guttata* and some grass species.

Aquatic vegetation

- Marsh vegetation

These plant communities are under the direct influence of the sea, where high concentrations of salt are the chief determining factor. Their role as food for many living things makes them of great ecological value. This kind of vegetation is found on the Cíes Islands, on Sálvora and Cortegada on the islets of Briñas and Malveira Chica, where it is the predominant vegetation. Variations in the tides arrange the vegetation into strips or belts in accordance with the degree of immersion.

In the submerged strip, which only occurs on Sálvora, there is a species of flowering plants that may be con-

Halimione portulacoides

Marsh vegetation

fused with algae because of their long thin leaves: the *Zostera marina*, which can be found at depths of up to 10 meters.

Both the Cíes and Cortegada archipelagos have partially submerged vegetation, which is only submerged at high tide, consisting of associations of fleshy plants that accumulate water in their internal tissues as an adaptation to salinity. Sea purslane (*Halimione portulacoides*), with its greenish-silver leaves, *Salicornia ramosissima* and perennial glasswort (*Sarcocornia perennis* subsp. *perennis*) are typical of this belt.

On the shore of the lagoon on Cíes and Cortegada, there is a community adapted to the high salt and nitrate contents associated with organic remains left by the sea, with sea couch (*Elytrigia atherica*), bentgrass (*Agrostis stolonifera* subsp. *pseudopungens*) and annual seablite (*Suaeda marítima*).

In the upper part of these areas there is a stand of sea rush (*Juncus maritimus*), arrowgrass (*Triglochin maritime*) and sea-spurrey (*Spergularia marina*). On the Malveira Chica and Malveira Grande islets sea kale (*Crambe hispanica*) is accompanied by mallow (*Lavatera cretica*). The island may, in fact, be named after the latter.

• Freshwater Vegetation

Poorly studied, Sálvora's communities of aquatic freshwater plants are located in small pools near springs. The plants in these floating communities, such as pondweed (*Potamogeton polygonifolius*), have leaves on the water surface and take root at the bottom.

Bog Pondweed

Nitrophilous vegetation

This section includes vegetation that prefers environments rich in nitrogen, both in arable fields and areas altered by humans, such as roadsides. High concentrations of nitrogen are due to the accumulation of organic waste or fertilizer use. Given that there existed or exist human settlements on all the park's archipelagos, it is easy to under-stand why this vegetation occurs on all of them.

Wall pellitory

In their study of Cíes, The Guitián brothers differentiate two communities. One is on walls and rock faces and involves wall pellitory (*Parietaria judaica*) and Cymbalaria muralis. The other occurs in shady areas and consists of "apio de caballo" (*Smyrnium olusatrum*). The Atlantic Islands Natural Resources Plan cites other nitrophilous communities, such as the one covering a large part of the abandoned fields on the island of Ons with sweet fennel (*Foeniculum vulgare*), corresponding to stages prior to the development of broom stands, or the aerohalophilous grassland on the cliffs of the islets of Sálvora, on Boeiro (Cíes) and El Centulo (Ons), with the mallow Lavatera arborea and hastate orach (*Atriplex postrata*).

Tracts of non-native woodland

The fifties saw the advent of large forestry schemes, chiefly on the Cíes Archipelago. They were extended and came to account for a large part of the landscape. They mainly involved eucalyptus (*Eucaliptus globulus*) and maritime pine (*Pinus pinaster*) and the park's four archipelagos. There is also a large tract of blackwood acacia (*Acacia melanoxylon*) which, although it was not introduced as a crop, colonized a large part of Cíes and part of Ons. These tracts are not of any great botanical interest as they have little or no under-growth. Maritime pine (*Pinus pinaster*) has the greatest floristic diversity.

Other alien forest species in the park are false acacia (*Robinia pseudoacacia*), Monterey pine (*Pinus radiata*), stone pine (*Pinus pinea*), and to a lesser extent, cypresses (*Cupresus* spp.), plane trees (*Platanus hispanica*) and poplars (*Populus* spp.), among others.

PLANTS THAT POSE A THREAT TO BIODIVERSITY CONSERVATION

Exotic species are those that have been introduced from far away, and which coexist with native species and sometimes compete with them for space and resources, making them invasive species that displace the native ones. The introduction of invasive exotic species is one of the main causes of global biodiversity loss, as in many cases it leads to the extinction of other native species. This loss of biodiversity is accompanied by alterations to the overall functioning of the ecosystem, leading to a deterioration in resources, with the resulting economic and social cost.

In the Atlantic Islands several exotic or alien species are in many cases displacing the native flora. Some examples are *Acacia melanoxylon, Arctotheca calendula, Arundo donax, Robinia pseudoacacia, Eucaliptus globulus, Carpobrotus edulis, Tradescantia fluminensis, Opuntia maxima, Oxalis pes-caprae, Tropaeolum majus,* etc.

Arctotheca calendula

This is an important problem affecting many countries and covered by different regulations and pieces of legislation. In Spain, Law 42/2007 on Natural Heritage and Biodiversity establishes that "the competent public authorities prohibit the introduction of exotic or alien species or subspecies when these are capable of competing with native wildlife species, altering their genetic purity or ecological balances". One of the purposes of RD 630/2013, which amends the Spanish List of Invasive Alien Species, is to establish "the necessary measures to prevent the introduction of invasive alien species and to control and possibly eradicate them".

Moreover, the Atlantic Islands of Galicia National Park prohibits the introduction of alien species in both the Plan for the National Parks Network and the National Park Management Plan.

Although contention and control measures may be applied in the long term as a final resort, most regulation highlight the crucial importance of prevention and early detection as regards monitoring and controlling potential biological invasions.

FUNGI, MOSSES AND LICHENS

This section covers three series of living things little known to the general public, but no less important given the essential role they play in ecosystems. There is still much to discover in the National Park of the Atlantic Islands of Galicia. Thus, the following gives the overall features of mosses; further details on lichens and fungi will be provided when more information becomes available.

Liverwort

Mosses

Mosses and bryophytes are regarded as non-vascular plants; they lack the veins for transporting water and nutrients that vascular plants (the most widely known) have and also differ from the latter in not having true leaves, stalks and roots.

Mosses colonize a large diversity of environments, very often being, along with lichens, pioneers in colonizing bare surfaces where other plants cannot get established. As they do not have an external impermeable wall, most require a wet environment in order to avoid water loss.

Mosses, like lichens, are indicators of pollution given their high sensitivity, particularly to gaseous pollutants.

While there are no studies on the moss species found in the National Park to date, the number of known moss species in Galicia is 558, of which 27% are included on the Red List of Bryophytes on the Iberian Peninsula.

Fungi

Of the three groups the best known is undoubtedly the fungi as they share many aspects of our lives. They have become very important in the food and pharmaceutical industries and play an important role in the food chain as decomposers of organic remains, being known from the moulds that grow on walls, yeasts, skin fungi, plant para-sites, etc.

Although initially included in the plant kingdom, they are currently considered to be a kingdom apart given that they share hardly any features with plants other than the method of reproduction and immobility. Fungi, unlike

Cordyceps militaris with processionary

plants, have no photosynthetic pigment such as chlorophyll, and so do not feed in the same way. Like animals, they need "ready-made" organic matter to be able to synthesize their own, a feature that forces them to live at the expense of other living things or previously converted organic substrates. Fungi are divided into three groups depending on how they feed:

- Parasites: live at the expense of another species in a non-mutual relationship, sometimes harming or even killing the host tree. Ex. *Armillaria mellea*
- Saprophytes: feed on dead organic matter and are fundamental for forming soil through the decomposition process. Ex. *Trametes versicolor*
- Symbiotic: obtain food when interacting with another living being to the benefit of both, such as *Lactarius Deliciosus*, a mycorrhizal species of conifers, preferably of the genus *Pinus*.

Some species of fungi in the National Park are mentioned in existing studies for their rarity or abundance. Thus, Sálvora features *Agaricus devoniensis*, a mushroom commonly found on dunes and abundant in the Iberian Peninsula, *Peziza Prothean* f. *sparassoides*, scarce

Tulostoma brumale

in Galicia and the Peninsula, or species that are first recorded in Galicia such as *Amanita muscaria* var. *inzegae*,

found associated with *Cistus salvifolius*, and *Myriostoma coliform*, a fungus typical of limestone substrates also found on Ons.

Species of note on Ons are *Calocybe gambosa*, a species found in abundance on the Peninsula that is commonly known as "Perrechicho" or "Mushroom of Saint George", and the *Cordyceps militaris*, which fertilizes by parasitizing pupae of the Pine Processionary moth *(Thaumetopoea pytiocampa). Rhodocybe gemina* is a rarely-found species in Galicia and *Descolea maculata* is a fungus linked to the eucalyptus tree which was probably introduced to Galicia with the tree, and the *Tulostoma brumale* var. *brumale*, a small dune mushroom also found on the Cíes Islands that is easy to identify by its spherical head.

Other fungi of interest on the Cíes are *Campanela caesia*, sparsely distributed on the peninsula, which was first recorded in Galicia on the Cíes Islands, and *Gyroporus ammophilus*, a species associated with pines and which colonizes coastal dunes, although it is found under strawberry trees on the islands.

Cortegada, where more than 600 taxa are found on its barely 45 ha of land, is the archipelago of the greatest mycological interest in the Park, with species that are rare or were first recorded in Galicia on Cortegada and the unique fact that some come from extremely different environments. A perfect example is *Favolaschia calocera*, native to Madagascar, which was first recorded in Galicia on Cortegada; it had only been recorded once before in Spain, in Asturias.

Many of the numerous *Hygrocybes* found are rare and *Hygrocybe flavescens* and *Hygrocybe calyptriformi*, the latter found elsewhere at over 800 m elevation, contrast with the appearance of *Torrendia pulchella*, typical in more southern areas. These latter two species are included on the European Red List.

Other rare species on Cortegada are *Dendrocollybia racemosa* and *Clavulina amethystina*.

Finally, the well-known *Macrolepiota procera*: this is an abundant species on the peninsula and is found on all of the National Park's four archipelagos.

Recent studies in the Park cite taxa that could be new species, but the results are still awaiting publication.

Macrolepiota procera

Lichens

While lichens are one of the organisms that are with us constantly and are found both in the countryside and in the city, in a multitude of substrates, for many people they go completely unnoticed.

Its uniqueness is in its dual nature, as lichens are composed of a fungus and an alga that live symbiotically to create another new organism with unique features. While the algae that forms part of lichens can be found living freely in nature the fungi cannot, since it obtains carbohydrates from the algae. These protect the algae and provide it moisture.

Symbiosis provides advantages for the lichen's two components separately, taking into account the habitats in which they live. Lichens generally live in areas where neither fungi nor algae could grow in isolation, since the first would be destroyed by the weather and the second would be unable to find food. These organisms are found at all latitudes, from Arctic and Antarctic zones to Ecuador and at all altitudes, from sea level to high snowy mountains.

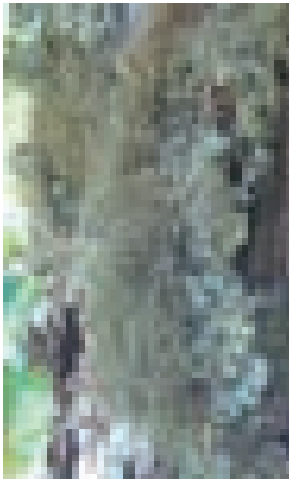
Cross section of a lichen where the fungus and algae cells can be seen

They can live on a range of different substrates such as rocks, bark, sand, soil, wood and even glass, leather, metal, plastic, paint, iron, etc. The only places they are not found is at sea, except on rocky coasts, in places where air pollution is too high (called lichen deserts) and on animal tissue.

In short, as a result of symbiosis lichens are pioneers, cosmopolitan and ubiquitous.

Lichens can take on a wide range of growth forms that can be grouped into seven morphological types:

- Crustose: grows completely adhered to the substrate and is very difficult to separate from it.
- Squamulose: small scale-like structure.
- Foliose: leafy, easy to remove from the substrate.
- Fructicose: looks like small shrub or beards.
- Compounds: have a part that can be encrusting, foliose and squamulose and another fructicose.
- Gelatinous: gelatin appearance as cyanobacteria produce algae that gives them this consistency.
- Leprose: powdery or mealy.



Black belt with Lichina spots

There are transitions between these morphological types.

Lichens have had various uses throughout history: some have been used for medicines like antibiotics while others, like *Roccella* spp., are harvested in Galicia as a natural dye. There are also edible varieties: *Umbilicaria esculenta* is considered a delicacy in Japan and *Aspicilia esculenta*, typical in arid and semi-arid areas and which becomes more visible after heavy rain, is the biblical "*manna*". Today their most important use is as biomarkers of pollution.

In the National Park there are 231 species of catalogued lichens, the majority of which have restricted distribution and 17 species of which are listed on the European Community Red List of Macro-lichens under different threat categories: *Heterodermia leucomelos* on the Cíes Islands and Sálvora, *Phaeophyscia orbicularis* on the Cíes, *Parmelia hypoleucina* on the Cíes, also a newly discovered example in Galicia, *Ramalina siliquosa* on the Cíes and Sálvora, *Sclerophyton circumscriptum* on Ons and Sálvora, *Teloschistes flavicans*, a yellow fruticose lichen that prefers land close to the coast, is found on the Cíes Islands and is in decline in Europe due to pollination, and *Sticta fuliginosa* on the Cíes and *Usnea rubicunda* on the Cíes and Ons.

In addition to these species a number of lichen are noteworthy for their restricted distribution, including *Bactrospora carneopallida* on the Cíes Islands, the only recorded place in grows in all of Europe, and *Physcia scopulorum*, only recorded in Spain on the Cíes Islands and on Sálvora. Sálvora also boasts *Lecanographa dialeuca*, previously known only in the Macaronesia region. On Cortegada there are lichens typical of wet protected areas like *Baeomyces rufus*, which grows on rocks and the ground, and *Porpidia tuberculosa*, a whitish lichen that lives on acidic basic siliceous rocks. On Ons, where the terrain is largely covered in scrub, there is less diversity among the lichens. *Buellia fimbriata* is important as it was only found in the Mediterranean region until now.

The National Park's most representative lichens are those that colonize the rocks along the coast. Three typical coastal lichen belts are clearly represented:

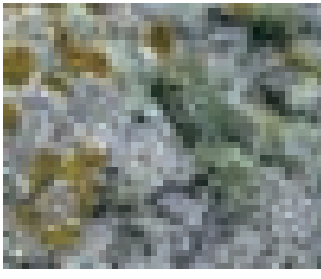
- Coastal zone: Black or ***Verrucaria belt***. Between the extremes of spring tides; submerged at high tide. Most representative species: *Verrucaria* gr. *maura* and *Lichina pygmaea*, all very dark blackish or greenish in colour.
- Lower supracoastal zone: Orange or ***Caloplaca belt,*** subjected to splashing and occasional submerging under spring tides. Species of orange *Caloplaca - Caloplaca littorea, C. marina*, etc.
- Upper supracoastal zone: Ramalina belt, subjected to ocean spray. Most representative species: *Ramalina cuspidata, R. siliquosa, Xanthoria parietina* and *Pertusaria gallica*. A characteristic community of whitish-gray lichens grow in this same zone, but on rocks shaded and protected from the wind, predominately *Roccella* spp., *Diploicia canescens* and *Dirina massiliensis*.

In addition to these coastal communities lichens can be found:

- On trees: *Parmelia* spp, *Physcia* spp., *Ramalina* spp. and *Usnea* spp.
- On buildings made with cement: *Caloplaca aurantia, Lecanora campestris.*
- On moss-covered slopes and rocks: *Cladonias* spp., *Leprarias* spp. and *Baeomyces rufus*.
- And in damp and shaded places (particularly in the laurel stands on Sálvora: *Lepraria* spp. and *Trentepohlia* sp., which is very well developed.

Black belt with Lichina spots

Ramalina belt



Orage belt with Caloplaca spots

Lecanora campestris crustose lichen