The beach of Castelldefels

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Introduction

Sometimes, when we have to write an introduction for a text, we try to look for a concept, an idea that serves as both a synthesis and a prelude to what we want to explain. When writing about beaches it is common that the central idea on which the introduction will be developed is balance. Beaches really represent balance. They are an example and a metaphor for balance.

There is a geological balance: if a beach exists it is because the sedimentary balance, the final balance between the sand that arrives and that which leaves, is, at the very least, zero. So much goes in, so much goes out, and that's why the beach remains. It is not an easy balance, as evidenced by the regression phenomena suffered by numerous beaches in our area.

It happens that the beaches are the result of the action of opposite phenomena, erosion and sedimentation, which in turn are the result of the action of the forces that act on the sand that forms them. When the conditions are right, sand accumulates on the coast and beaches are born. If the conditions change, the balance shifts and almost always the result is that the sand goes away and the beach disappears.

The very profile of the beach is also a reflection of the balance that is hidden in a large part of the natural phenomena. Beaches are not homogeneous stretches of sand. Their surface is far from flat and uniform: they present a characteristic profile with various reliefs and slopes, which reflect their origin, their evolution and, sometimes, even their state of health.

On top of the geological balance, another balance develops, in this case biological. The beaches are the space where interesting communities formed by highly specialized living beings develop. Out of the water, on the dunes and coastal sands, a very particular vegetation clings strongly to life and teaches us that it is possible to survive and thrive even in environments that seem inhospitable to plant life. If we look in detail at these plants, we will be able to appreciate some of their adaptation mechanisms, in the form of light colors, reflective hairs, fleshy leaves that act as a water reserve, stems at the bottom of the ground that always stay on the sand and long roots, capable of extracting from the soil up to the last available drop of water.

A few meters down, on the same border between the sea and the land, under the wet sand, some surprising animals, whose size makes them go unnoticed, develop their life cycles by feeding on the migrated organic matter that find there From our perspective it becomes difficult to conceive of such a life, buried in the semi-fluid matter that constitutes the wet sand, in perpetual darkness and continuous movement.

Underwater, the submerged beaches are the scene of a spectacular explosion of diversity. At first glance, the untrained eye may think that it is facing a desert, but this is a mistaken impression. Without the constant danger of desiccation that threatens the inhabitants of the shore, the sands permanently covered by the sea are the ideal habitat for a large number of species of crustaceans, molluscs and polychaetes. A large number of fish find here a favorable place to feed and reproduce.

Beaches are truly a place where natural balance can be seen and touched. Despite this, there is another concept that seems increasingly important to us when we talk about beaches. Is theprivilege

The beaches, we are convinced, are a privilege. Now the idea belongs more to human territory than to that of nature. From the description of the environment, the awareness of its value is born. Beaches are a scarce and coveted commodity. Today's beaches are a weak testimony of the immense sandbars that once formed our coasts. The urban pressure eliminated their space and the human alterations of the coast broke the balance that sustained them. Even a global phenomenon, climate change that threatens to cause a rise in sea level, endangers its future existence.

Beaches are a privilege. Throughout the text that follows this brief introduction, we will present some information about its origin, its morphology, its inhabitants and its problems, but we also wanted to leave a space to relate the use we make of it and the use that we could give them. We are not always aware of the role that beaches play. They represent an authentic defense of the territory located behind it against the erosive action of the sea. They are also a source of economic resources. Since ancient times they have supplied humanity with food and raw materials. Today, they constitute an irreplaceable space for summer leisure and a basic element for an economic sector, tourism, which has largely based its development on it.

Beaches can be many more things. They are an appropriate place to meet nature. They make excellent outdoor classrooms for teaching and learning about the natural processes that make up our world. Even as museums and libraries testify, they are an inexhaustible source of inspiration for art and culture.

The truth is that in Castelldefels we are privileged to have a beach like the one we have.

Acknowledgments

- Tourist Office of the Town Council of Castelldefels, to provide us with data on hotel occupancy.
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- Blai, fisherman from Vilanova, who has provided us with samples of the fauna obtained from the tellerina fishing cages on the beach of Castelldefels.
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- Insub Society (Donostia), to facilitate the means for carrying out the study of the sand and the taxonomic determination of the crustaceans and polychaetes.
- BIODIDAC (http://biodidac.bio.uottawa.ca/), digital resource bank for teaching biology, for the diagrams used in the last chapter of this book.

Targets

This study was initially planned to describe the animal and plant species that live on the coast of Castelldefels, preparing an inventory of the terrestrial flora that lives on the dune and another of the marine macrofauna that inhabits the bottom near the beach.

But as we progressed in the field work, we wanted to know more about the physical environment that surrounds us, about its peculiarities and its dynamics. That is why the result has been, not only a fauna and flora inventory, but also the overall characterization of the beach.

Having said that, the proposed objectives are the following:

- Elevation of the coastal physical profile of Castelldefels, from the Passeig Marítim to a depth of three meters.
- Elaboration of a catalog of the existing dune vegetation.
- Elaboration of an inventory of the marine macrofauna of Castelldefels beach and adjacent seabeds.
- Characterization of Castelldefels beach as an urban beach in the Metropolitan Region of Barcelona.
- Description of biological and ecological aspects of those species that can be of both scientific and cultural interest.

Methodological aspects

Study area

The area studied is limited to both the aerial part of the coast of Castelldefels and the submerged part, by the line of surface buoys that the City Council installs in the summer season to limit and protect the swimming area, and which are anchored about 4 meters deep.

The easternmost part of this area is on the border with the municipality of Gavà, and the Port Ginesta breakwater marks the southernmost limit of the study area, although it already belongs to the municipality of Sitges. To systematize the collection of direct and indirect samples of materials and organisms, four transects have been designed, calledT1, T2, T3,iQ4 (see fig. 1). All these transects represent an imaginary line perpendicular to the Promenade, when it is there, or to the landward beginning of the beach, and which ends at the marine limit of the study area (see figure 1). The T1 transect is located in the Dunes park, the T2 at the Pineda beach, the T3 in front of the Ginesta square and the T4 is next to the Port Ginesta breakwater. On these 4 transects, all the tasks of observation, photography and collection of specimens, taking samples of the substrate and raising physical profiles have been carried out.

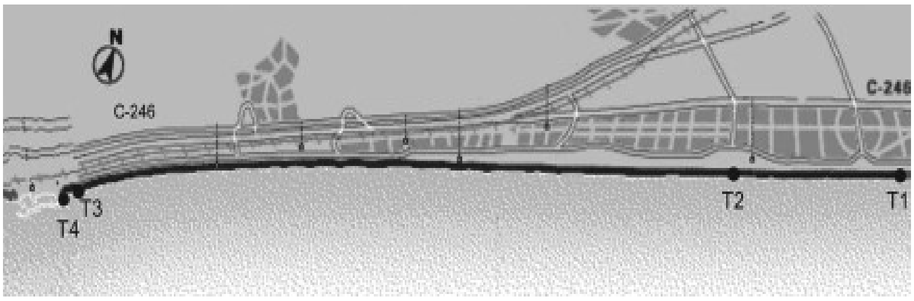


Figure 1.Map of Castelldefels beach showing the stations T1, T2, T3 and T4 used in the study.

Materials and methods

From a methodological point of view, the characterization of the animal and plant communities of a given area requires the use of a specific methodology. This methodology is based on two main parameters: one is the very nature of the community and the physical environment in which it is based. The other is the technical availability and material of the research team.

A beach like that of Castelldefels, if considered in its broadest sense, as has been the intention of this work, cannot be assimilated to a single study, made from a single working method. In order to provide a global view of the beach, we have resorted to various strategies in order to provide the necessary information to be able to characterize both the physical framework and the animal and plant species that live there.

The collection of information has been carried out in a double way: bibliographic research and direct data collection.

Bibliographic research

First of all, a bibliographic search of all the available data relating to Castelldefels beach has been carried out, which has been extended to the beaches around it, both from a physical and biological point of view. The data thus obtained have been fundamental for the physical and geological characterization of the beach, as well as for obtaining a starting point for the study of the dune ridge.

On the other hand, the data on marine fauna and flora are very scarce if we refer to the beaches of Catalonia and we have only been able to have references of a general nature.

The consulted sources appear cited in the chapter dedicated to the bibliography, which is at the end of this work.

Topographic characterization of the beach

Three profiles of the beach have been raised at points T1, T2 and T3, using a TOPCON automatic compensation optical level, model AT-G2 (see photo 1). The profile of the submerged beach has been obtained by measuring the depths at 10 meter intervals from the lower limit of the beach along a transect oriented perpendicular to the shore (150º), drawn with a rope stretched over the surface of the 'water, conveniently strained. The depth has been measured with a measuring tape plumb on the vertical of each 10 meter longitudinal mark. For the purposes of this study, the error caused by the slope of the seabed in the longitudinal measurement of the profile has been considered negligible.

Photograph 1.Taking data with an optical level to obtain the topography of the beach.

Characterization of the sand

To characterize the beach sand, its particle size composition and porosity have been determined.

Photograph 2.Samples in the sand.

Granulometric composition

For the granulometry study, a sample of 50 g of sediment was taken at the same points where the quantitative study of the fauna that lives in the beach sediment was subsequently carried out. This sample was first subjected to drying at 90º C for 12 hours and was subsequently sieved in a CISA vibrating system, with a column of sieves of 2, 1, 0.5, 0.125 and 0.063 mm diameter. The percentage of each fraction was determined by weighing the content of each of the sieves.

With the weights of the different fractions expressed in the form of a percentage curve, the mean and the first and third quartiles (Q50, Q25 and Q75). Based on these measurements, the Selection Coefficient [(S0= (Q25 / Q75)1/2]) has been calculated and the grain size has been established in accordance with the nomenclature proposed by the Geology section of the CSIC .

Table 1.Sampling points for sand parameters.

Point	Station T1	Station T2	Station T3
dune	—	Yes	—
coast	Yes	Yes	Yes
bar	—	Yes	—

porosity

The porosity has been determined by volumetrics, from a sediment sample obtained at the points indicated above. This sample was first subjected to drying at 90º C for 12 hours, filling a graduated beaker to the 400 ml mark. Subsequently, water was added using a graduated test tube until the sample was completely saturated. The porosity has been calculated by dividing the volume of water by 400 and expressing the result as a percentage.

Study of the flora and fauna of the beach

dune cord

The most characteristic element of this area is the vegetation. For its study, it has resorted to the in situ identification of the most representative species, with the help of various field guides of the European flora.

Coastal sand

First, specimens of all the mollusk shells that appear in abundance in this area of the beach have been collected. This collection has been carried out at different points from the beach, from the boundary with the municipal area of Gavà to the Port Ginesta breakwater. A total of 12 trips were made between June and September 2004.

The actual fauna of the coastal sand has been studied from a quantitative sample collection. Sand samples have been taken by marking a square of 20 x 20 cm side and going deeper into the sand up to approximately 40 cm, which have been sieved in a sieve with a mesh diameter of 1 mm, in order to retain the largest fauna of this size.

The specimens collected in this way, when possible, have been photographed live in order to maintain the original colors (photo 2), and subsequently fixed in a 10% formalin solution in seawater for its conservation. Its identification has been carried out using several taxonomic keys, with the help of the magnifying glass and the binocular microscope.

Table 2.Quantitative sampling points.

	Station T1	Station T1B	Station T2	StationT3
Description	mediolittoral	Infralittoral (-3m)	mediolittoral	mediolittoral
First name	T1 A		T2 A	
date	05/26/04	06/06/04	05/22/04	05/22/04
Size cm_2	1200	177	1200	400

Infralittoral sand

The study of the species that appear in this area of the beach has been carried out using two different methods.

First, a sediment sample was taken, analogous to the quantitative samples obtained at the shore. In this case, a cylindrical PVC extractor tube of 15 cm diameter has been used, which provides a collection area of 177 cm^2. The sample was taken by free lung diving, approximately three meters deep, sticking the extraction tube twice about 20 cm into the sand at the bottom.

The material thus obtained has been processed in the same way as the quantitative samples obtained on the shore: sieving of the sample, live photography of the individuals, fixation with 10% formalin and identification of the specimens.

This method of collecting samples presents the problem of its low representativeness, due to the small size of the sample that is obtained. For this reason, in order to obtain a more representative view of the fauna that lives in the infralittoral area of the beach, 4 dives have been carried out to collect specimens of the larger species. The individuals obtained in this way were also photographed live before being fixed and identified.

Photograph 3.System for photographing small invertebrates and plants.

In a complementary way, the collaboration of a fisherman from Vilanova i la Geltrú who fishes in the waters of Castelldefels has been counted on, who has provided different boxes with rejected material, that is to say with individuals of non-commercial species . This contribution has allowed us to obtain some large specimens to photograph and classify.

Rocky breakwater of Port Ginesta

To collect information about the species that live in this sector of the beach, a direct collection of the main animal and plant species has been carried out, both on foot, at the end closest to the beach, and by diving to access the deeper areas.

The largest species have been identifiedon site,while some smaller specimens have been collected for fixation with 10% formalin and subsequently identified with the aid of a binocular magnifying glass.

Fish and other swimming organisms

Important first-hand information has been obtained on the main species that live on the beach of Castelldefels, based on the catch records of the sport fishing championships that are held in the municipality on a regular basis.

These data have been supplemented with those from direct observations carried out free lung diving, which have provided information on the presence of species that, due to their characteristics, are not the object of sport fishing. Data on the species of jellyfish that can occasionally be observed from the beach are also the result of these observations.

Origin, evolution and dynamics of beaches

In a simple way, the coast can be said to be the point where the land ends and the sea begins. There are almost as many types of coastline as there are criteria for classifying them. There are genetic criteria that refer to its origin. From this point of view it is differentiated between primary and secondary coasts. Primary coasts are those whose configuration depends on processes that we could call continental, while, with regard to secondary coasts, marine phenomena play a leading role.

Primary costs

Mechanism of origin	example
Fluvial erosion and marine transgression	Galician rivers
Glacial erosion and marine transgression	fjords
river deltas	Llobregat Delta

Secondary costs

Mechanism of origin	example
marine erosion	Cliffs of the Costa Brava
Marine sedimentation	Beaches of Levant
Coralligenic activity	atolls

Sometimes this criterion, generally known as ashepard classification,it is impractical when it comes to describing the morphology of the coastline. This is why it is common to resort to morphodynamic criteria, which are based on the morphology of the landforms that appear on the coast and the forces that shape them.

From this point of view, the coasts can be classified into:

1. High coasts, formed by cliffs of variable height but which indicate the predominance of erosive phenomena. The action of the waves on the coast tears away the materials that form it, so the coast recedes, while generally gaining height.

2. Low coasts, sandy in nature. The most common form is the beaches, although other forms can appear such as tombols and lagoons, which indicate the predominance of sedimentation phenomena.

Certainly, erosion and sedimentation are two processes with opposite effects, and nevertheless, they are complementary. The materials that are removed in some parts of the earth's crust, accumulate in others, and as a whole, are largely responsible for the physiognomy of our planet.

The formation of the beaches

The sand that accumulates in certain parts of the coast to form the beaches can have a diverse origin. In our latitudes, most of the sand on the beaches originates from river erosion phenomena that occur at the headwaters of rivers. In the high courses, the speed of the water erodes the rocky walls of its bed, and produces particles of variable size that are dragged down the river until reaching the sea.

Other possible sources of sand are the erosive phenomena that occur on the coastal cliffs, as well as the so-called sand biogenic, that formed by fragments of shells of marine organisms, mainly molluscs. In fact, on Castelldefels beach it is possible to recognize these fragments among the coarser-grained sand, which is concentrated at the exact point where the waves break, on the shore of the beach.

It must then be considered that, except for this last type of sand, most of the sediment that forms the beaches has not been generated there, but has been dragged in from other places. Waves and ocean currents, in many cases closely related, are responsible for the transport of sand and its accumulation at those points where a beach will be formed. Once the sand is out of the direct action of the sea, another dynamic element comes into play, the wind, capable of mobilizing the dry sand to finish shaping the morphology of the beach.

Sand transport by marine dynamics

The wave generated by the wind that propagates towards the coast is considered as the main source of energy that drives the changes produced on the coast.

The wind generates the waves in the inland waters, where the water particles have a circular motion. When the wave approaches the coastal area, it undergoes a series of transformations caused by its interaction with the seabed. In still waters, the movement of the water particles goes from being circular to being elliptical, until the ellipse elongates practically in a straight line.

The action of the wind on the surface of the sea water causes a rise or fall of the sea level near the coast, depending on whether the wind blows landward or seaward, respectively. This imbalance generates filling currents (upwelling)or emptying (downwelling),perpendicular to the coast, which can reach high speeds.

In coastal areas where the slope is gentle or there are sandbars, the waves break long before they reach the shore of the beach and the energy of the wave arriving there is much lower than the original. In this case it is talk aboutdissipative beaches,which tend to present a wave breaker on the bar located on the outside of the profile; the wave recovers in its passage through the groove and hits the beach again. When the beach slope is steeper and there are no sandbars in the coastal profile, the waves propagate to the shore without being modified, so the beach receives the full impact of the wave and can reflect good part of its energy. In this case, as opposed to the previous one, we are talking aboutreflective beaches

The breaking waves move rapidly inland, dragging a large amount of the sediment deposited on the seabed. When they reach the shore of the beach, they spread uphill, until their kinetic energy is used up, they stop and the sediment they carry is deposited. The water then returns towards the sea, in favor of the slope, and drags back part of the sediment it had transported towards the interior of the beach. This recoil is slowed down by the following wave, and the material it carries in suspension is deposited there. This point is where the energy level of the wave is greatest, and therefore the finer particles are quickly transported in one direction or another, and the coarser sediment of the beach accumulates here. On the beach of Castelldefels it is common in the summer to observe a belt of thick sand,

When studying the effect of waves on sediment transport on sandy shores, it is important to consider the angle of incidence of the wave fronts on the beach. Usually, this angle is not perpendicular to the shore, which causes the appearance of the so-calledcoastal drift currents.The formation mechanism of these currents is very simple. The waves break against the shore at a certain angle and the materials they carry spread over the beach following this same direction. However, when the wave retreats towards the sea, following the slope of the beach, it does so following a direction perpendicular to the shore.

As a consequence of this phenomenon, the material that the wave drags in its retreat, returns to the sea at a certain distance from the point where it was dragged by the incident wave.

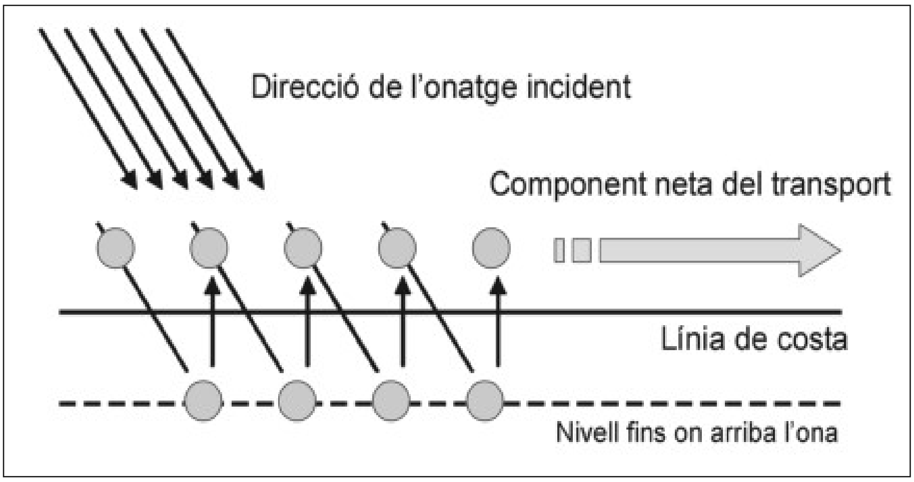


Figure 2.Schematic representation of the displacement of a sand particle along of the beach as a result of the angle of incidence of the wave on the coast.

In many cases, the direction of the incident wave depends on the direction of the prevailing wind. This direction can have a marked seasonal character, so the net component has a cyclical character. However, this is not always the case, and sometimes transport has a dominant sense.

When a solid obstacle appears on the coast, the drift current stops and the sand it carries accumulates. In this way, it is common for beaches to originate on the exposed face of capes and coastal outcrops. It also happens, unfortunately very often, that these obstacles are not natural, but the result of human action, such as breakwaters in ports. In these cases, an accretion phenomenon occurs on the exposed side of the obstacle, while the sand disappears on the protected side. The port has interrupted the drift current and caused a profound transformation of the configuration of the coast, forcing the disappearance of part of the beach.

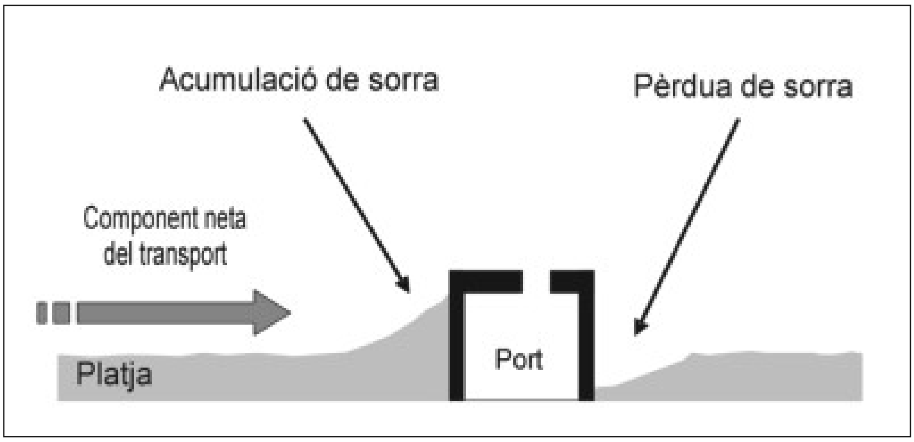


Figure 3.Effect of a port that interrupts the natural flow of sand along a coast sandy

As we have already seen, the action of the waves is responsible for the accumulation and transport of sand to the coast. Sea level, even in non-tidal seas, is not constant, as the areas of the beach exposed to the action of marine dynamics vary continuously. When the water level rises, areas of the beach that were out of reach of the waves are under their influence, and their sand is moved. This is why the beaches do not have a defined profile, but are subject to a continuous process of change. Large storms sweep the sand from the beach out to sea, while the gentle swell carries the sand from the submerged area of the beach inland, and returns it to the beach. There is a winter profile and a summer profile. In winter the beaches lose sand,

Sand transport by wind

The second force that acts on the beach sand is the wind. In particular, it acts on dry sand, that which is already outside the influence of the waves.

It is common for the coast to be subject to strong winds coming from the sea, which cause the sand to move towards the upper part of the beach. This causes, as we will see later, the appearance of coastal dunes, a form of modeling characteristic of sandy coasts.

It can also happen that there are prevailing winds parallel to the coastline. In this case, a movement of the sand appears along the beach, in the direction marked by this dominant wind.

In any case, the wind causes a movement of the sand, which moves by saltation (literally, by leaps) and by surface drag. Faced with any obstacle, the sand accumulates, and this same accumulation slows down the wind even more, so that, little by little, it gains height.

These mounds, which can be considered embryonic dunes, can grow to form genuine dunes, which are arranged forming cords perpendicular to the action of the wind that generated them. It is common for several parallel ridges to appear in a well-developed dune system, which gain height and stability as they move away from the beach shore.

Dune vegetation is a fundamental element in the formation and evolution of dune systems. Pioneer plants, those that are able to grow directly on beach sand, are often responsible for the first deposits of sand. Later, on larger dunes, other species develop that with their long roots contribute to stabilizing the dune, preventing the wind from dragging away the sand that forms them.

The dunes play a very important role in maintaining the stability of the beaches. They constitute a reserve of sand that, after major storms, allows the balance profiles of the beaches to be restored, a fact that, in turn, favors the return of the sand that has been washed inland. In fact, the disappearance of the dune areas due to the urban pressure suffered by the coast, is considered as one of the causes of the current processes of regression that many of our beaches are currently suffering.

Beach morphology

The beaches are not uniform stretches of sand, but have a characteristic relief, the result of the action of the shaping forces that we have presented in the previous sections of this chapter. In a beach that we could consider typical of our latitudes, the following morphological elements can be distinguished.

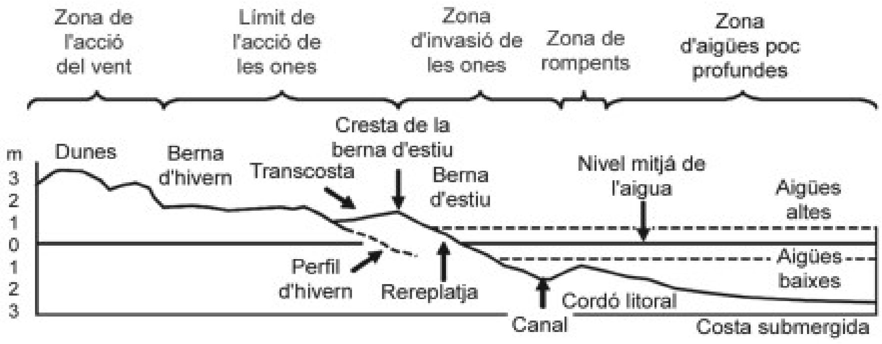


Figure 4.Outline of the morphological elements that characterize the profile of the beaches. Modified from STRAHLER, A. 1997. Physical Geography. Editions Omega, Barcelona.

The most characteristic element of the beaches' profile is the berm, a triangular formation, which has a more or less steep slope towards the sea, and a gentler slope towards the interior. The face facing the sea is named afterpayback,while the one located towards the interior is known as atrans coast

The formation of the berm is a direct consequence of the contribution of sand made by the waves. The waves, as we have already seen, go up the slope of the beach and deposit their material there, causing the berm to grow. The height of the berm is a direct consequence of the height and energy of the wave that created it. Given the differences between the height of the waves in winter and summer, the beaches experience a seasonal change in their profile. In the summer the ridge of the berm advances towards the sea and the slope of the back beach is gentle. Conversely, in winter, under the action of waves of greater size and energy, the summer berm erodes and recedes, while the backbank gains slope.

The transcoast is not subject to the influence of the waves, but to that of the wind, which transports its sand towards the upper part of the beach to form the characteristic dune ridges of the sandy coasts.

Under the water, due to still little-known mechanisms, it is common for sandbars to appear, an elevation of the bottom of the beach, usually associated with a furrow or channel located towards the land. These bars are permanently submerged and constitute a very important element in maintaining the balance profiles of the beach. On the one hand, they contribute decisively to dissipating the energy of the waves, and on the other, they constitute an important reserve of sand for the rest of the coastal profile.

The phenomena of beach regression

In a 2001 report by Greenpeace on the state of the Spanish coast, a worrying fact is collected: 90% of the coast shows signs of erosion, and the Mediterranean coast is the most affected by this problem.

The causes of this phenomenon are diverse, since, at present, each and every one of the factors that affect the maintenance of the balance that allows the existence of the beaches, are being affected in one way or another way

To begin with, the supply of sedimentary materials from the continents to the sea has been reduced, due to the construction of dams that modify river dynamics. Materials eroded on the continent no longer reach the sea. There is no new sand to naturally replace what is lost.

It is also necessary to consider that the sand of the beaches, and even that of the seabed, has been considered on many occasions as a construction material. In this way, large amounts of sediment have been removed from the coast, and this has distorted the natural movements of the sand and unbalanced the topographical profiles of the beaches and adjacent seabeds.

Table 3.Main causes of coastal erosion. Conference Status and pressures of the marine environment and Mediterranean coast. Documents collection, Generalitat de Catalunya. Department of Environment, 2000.

About the contribution of sediments
Bad management of hydrographic basins
reservoirs
Reforestation and abandonment of agricultural land
Sand extraction (dunes, beaches, offshore bars)
On coastal dynamics
Urbanization and tourism
works
Port facilities
Pollution and destruction of marine phanerogams
About the relative level of the sea
Global climate change
Subsidence and compaction

The physical destruction of dune fields to build on them or to build promenades is also responsible for altering the natural balance of beaches. The concept of "useful beach" limits it to being a space for use by bathers, which thus gains value compared to the "unuseful" beach, susceptible, therefore, to being eliminated. This myopic vision does not include the morphological and functional unit that actually constitutes the beach, and by removing the dune fields, a reserve of sand that is vital for maintaining the balance of the beach disappears.

The construction of coastal works and port facilities has altered the coastal dynamics, causing a redistribution of the sand. Generally, the consequences are the disappearance of the beaches located downwind of these facilities and the loss of sand, which is outside the coastal dynamics.

Another aspect to consider is the disappearance of a large number of marine phanerogamous plant meadows, generally due to environmental pollution processes, increased water turbidity, anchoring of sports boats and the destructive effect of trawling. These grasslands fulfill a double function, as they fix the sand on the seabed and reduce the energy of the waves that reach the coast, limiting their erosive capacity.

Finally, it is necessary to consider the effects of climate change, which is causing a rise in sea level, which in turn modifies the coastal balance, increasing the phenomena of erosion.

Physical description of Castelldefels beach

When characterizing a natural space, it is necessary to attend to the most interesting parameters for its description, those that are most characteristic and give it its own personality. Beaches, based on a perhaps simplistic but probably effective consideration, are basically accumulations of sand, and for this reason, characterizing a beach is fundamentally characterizing its sand.

Location and extent

Castelldefels beach does not exist as a natural entity. It is an administrative limitation, since what we know as Castelldefels beach is only a portion of the sandy coast that extends from the mouth of the Llobregat river to the coastal foothills of the Garraf massif.

Despite this, for our purposes, the Castelldefels beach does make sense, as it represents a defined area on which to investigate, take data and present conclusions. In addition, we have considered it an elastic area, the limits of which we have moved at our convenience, in order to be able to better represent the natural reality that is under the borders drawn on a plan.

From this point of view we can establish that our beach, distributed between the municipalities of Castelldefels and Sitges, extends along the 6,600 meters between the municipal term of Gavà and the northern breakwater of Port Ginesta.

Table 4.Data on the Baix Llobregat beaches. (Guide to Spanish Beaches. Ministry of Environment)

Municipal district	Length	Medium width
El Prat de Llobregat	7,985	48
Villadecans	2,480	48
Gave	3,730	39
Castelldefels	5,000	100
Sitges	1,630	50
total	20,825	- - -

Oceanographic and meteorological parameters

To complete the description of the physical environment of Castelldefels beach, it is interesting to make a brief reference to the main oceanographic characteristics of the Mediterranean Sea.

tides

the tidesastronomical,those caused by the gravitational attraction of the moon and the sun, cause movements of the sea level of little importance.

Conversely, the so-called tidesmeteorological,which have their origin in the wind and changes in atmospheric pressure, can cause variations of up to 50 cm.

wind

At the Prat de Llobregat observatory it can be seen that light winds dominate, less than 3 m/s, which account for more than 50% of the observations; 25.8% correspond to calm wind. By directions, it is necessary to mention the extraordinary relative frequency of northerly winds (21.6%). The absolute preponderance of the winds from the third and fourth quadrants stands out and, among these winds, the mestral (NW) and the west (W) are the most frequent, since they represent, between these two directions, more than a third of the observations Also relatively common is the seabass (WSW). Xaloc (SE) and Gregal (NE) give the lowest frequency (Environmental atlas of the Barcelona area,1996).

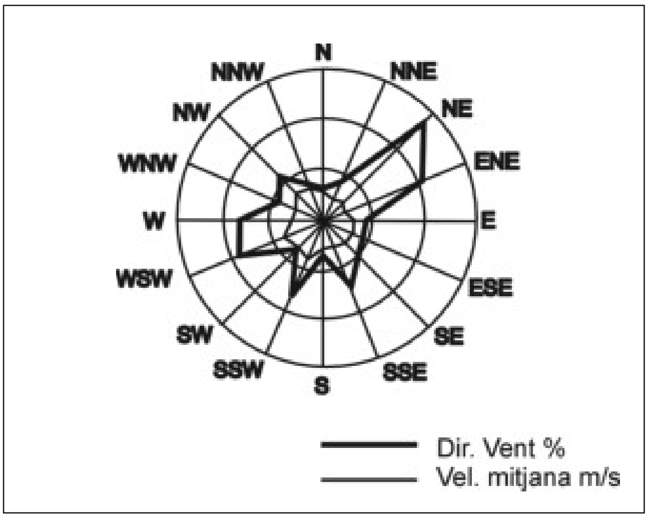


Figure 5.Rosa dels vents in Barcelona, 1994 - 1998.

Other climatological data

Table 5.Water temperature (ºC). Source: Castelldefels City Council.

Minimum in February	13
Maximum in July	26
Annual average	19

Table 6.Normal meteorological values (Prat de Ll. station, lost 1971-2000)

	T	TM	Tm	R	H	DR	DN	DF	DH	DD	I
January	8.9	13.4	4.4	41	73	5	0	1	2	9	149
February	9.9	14.6	5.3	29	71	4	0	0	1	5	163
March	11.3	15.9	6.7	42	71	5	0	1	0	5	200
April	13	17.6	8.5	49	71	5	0	1	0	4	220
May	16.2	20.5	12	59	73	5	0	2	0	4	244
June	19.9	24.2	15.7	42	72	4	0	2	0	7	262
July	23	27.5	18.6	20	69	2	0	2	0	11	310
August	23.6	28	19.3	61	72	4	0	4	0	7	282
September	21.1	25.5	16.7	85	73	5	0	4	0	5	219
October	17	21.5	12.6	91	75	6	0	3	0	4	180
November	12.5	17	8.01	58	74	5	0	1	0	6	146
December	10	14.3	5.7	51	73	5	0	1	1	7	138
Annual total	15.5	20	11.1	640	72	55	1	22	4	73	2524

legend

T	Average monthly temperature (ºC)
TM	Average monthly maximum daily temperatures (ºC)
Tm	Average monthly minimum daily temperatures (ºC)
R	Average monthly precipitation (mm)
H	Average relative humidity (%)
Dr	Average monthly number of precipitation days greater than or equal to 1 mm
DN	Average monthly number of snow days
DF	Average monthly number of foggy days
DH	Average monthly number of frost days
DD	Monthly average number of cloud-free days
I	Average monthly number of hours of sunshine

Topographic profiles of the beach

Using topographical methods, three profiles of the emerged beach have been raised, which correspond to T1 (the northern end, next to the boundary with the municipality of Gavà), T2 (the center of the beach, at the height of Pineda avenue) and T3 (Port Ginesta, at the southern end, already within the municipality of Sitges). The results appear represented in figure 6.

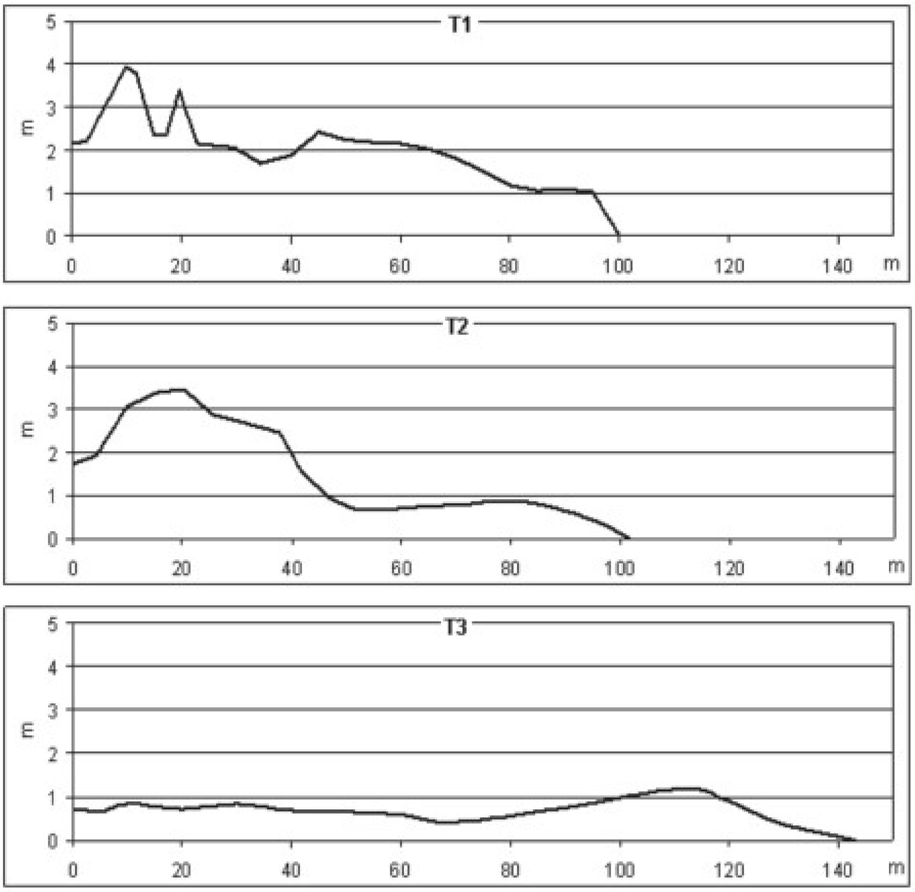


Figure 6.Topographic profiles of Castelldefels beach. The vertical scale takes as a level 0 the level of the sea at the time of making the measurement.

At the central point of the beach, a measurement of the sublittoral relief was also carried out, in order to know the morphological configuration of the submerged beach. The results of this measurement are presented in figure 6.

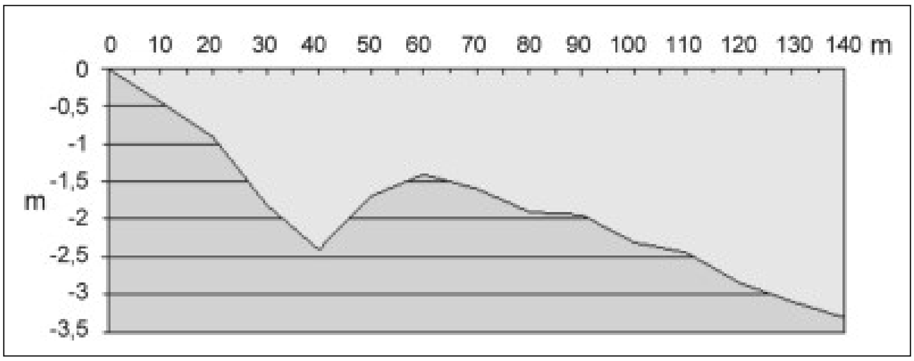


Figure 7.Topographic profile of the submerged beach of Castelldefels at point T2 (at the height of Avinguda Pineda). The vertical scale is noticeably exaggerated compared to the horizontal scale, to allow the relief to be appreciated. The vertical scale takes as level 0 the level of the sea at the time of making the measurement.

The profiles obtained, which we should remember correspond seasonally to the end of summer, show us a beach that conforms to the general model of a dissipative beach (see section on beach morphology).

However, it is appreciated that the beach is not homogeneous in terms of relief. The northern area and the central area are similar, with an area of dunes rising between three and four meters above sea level, while in the vicinity ofPort Ginesta, and by extension in much of what could be considered the southern half of the beach, the relief is much more homogeneous.

On the other hand, the extent of the beach is also greater at its southern end. In fact, it is almost 50% greater, given that, compared to the 100 meters of extension in the northern area, here it reaches 140 meters.

On the surfaced beach, following a land-coast direction, an area of dunes appears, followed by onebermof gentle upward slope, and a more rapid fall towards the sea. The height of the berm above sea level is approximately 1 meter and slightly higher at the southern end of the beach. Its position with respect to the lower limit of the beach is variable depending on the point we consider. In the central area it is 20 meters from the shore, while in the southern area the distance is a little greater, 28 meters, although at this point the beach is also wider.

The northern point, located on the border with Gavà, deviates a little from the general scheme. It seems to present a secondary berm, located 5 meters from the shore and with a steep slope, probably the result of an erosion phenomenon of the back beach.

Under the water, at some distance from the shore, a coastal cordon appears that runs parallel to the shore. The submerged beach continues the downward slope of the berm, until reaching a depth of about 2 meters, about 40 meters from the shore. At this point the bottom rises to a level of -1.5 meters, and then descends again. 140 meters from the shore you reach a depth of 3 meters.

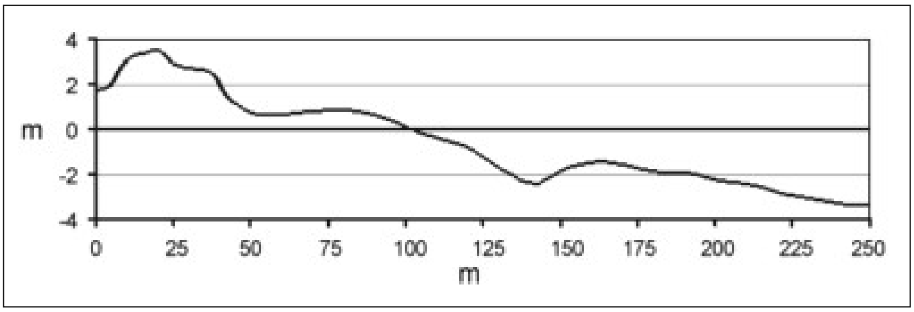


Figure 8.Complete topographical profile of Castelldefels beach at point T2 (at the height of Pineda avenue).

On Castelldefels beach, the morphology of its lower limit can undergo significant changes within a few days. In the summer, it is easy to appreciate how the increases in wave energy modify the slope of the rereplatja, causing various forms of modeling. Sometimes a marked step is created, which can have unevenness close to a meter in height. It can also happen that a secondary berm is formed by accretion of the sand. In this case, the depression between the two berms will appear full of water when the waves are able to overcome the first berm. This is how this toll is formed that some days runs parallel to the shore. When the wave conditions that have caused this alteration of the beach profile disappear, this pool returns to its previous state.

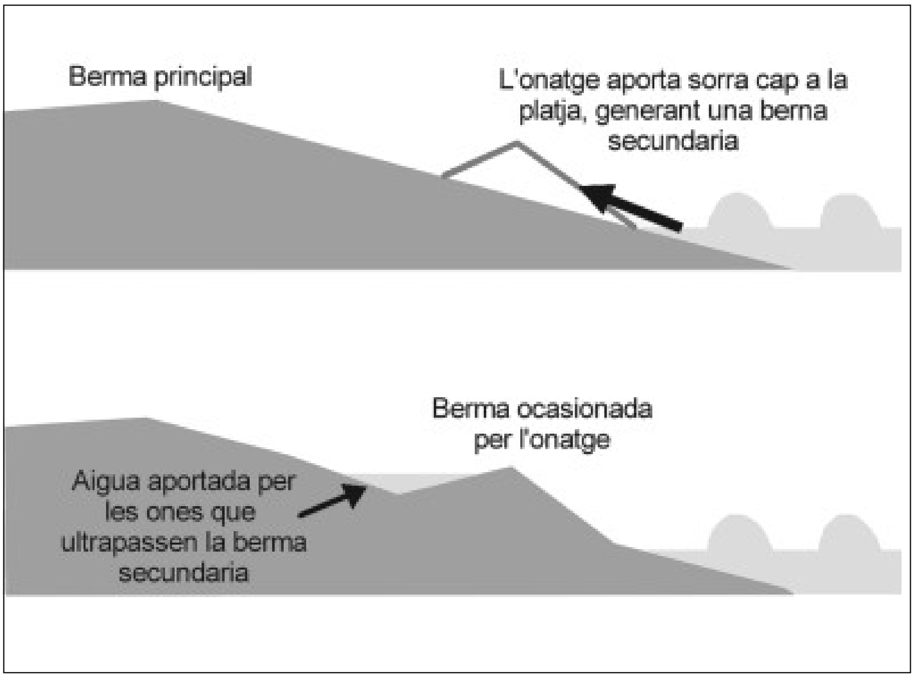


Figure 9.Creation of a secondary berm by wave action.

Photograph 4.Formation of a secondary berm by the waves.

Photograph 5.Toll caused by the appearance of a secondary berm.

Photograph 6.Step at the bottom of the beach.

Characteristics of the sand

To characterize the sand of the beach, attention has been paid to its granulometry, porosity and content in carbonates and organic matter.

The results of the granulometric measurements carried out are presented in the following table.

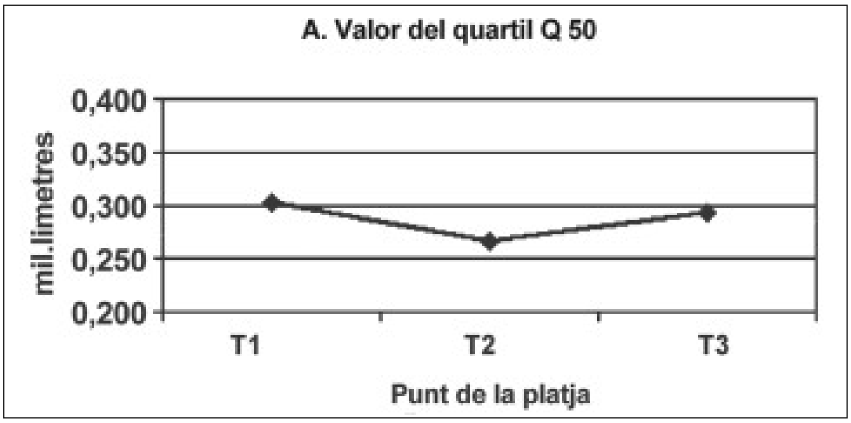
Table 7.Results of the granulometric measurements. The points identified as coast they refer to the lower limit of the emerged beach. The quartiles are expressed in millimeters.

quartiles	T1 costs	T2 dune	T2 costs	T2 bar	T3 costs
Q25	0.412	0.279	0.389	0.211	0.404
Q50	0.303	0.210	0.266	0.168	0.292
Q75	0.207	0.165	0.191	0.125	0.201
Parameter S_0	0.997	0.845	1,020	0.847	1.004

Based on the above data, the following qualitative classification is established:

Table 8.Coefficient of selection and classification of the grain.

	T1 costs	T2 dune	T2 costs	T2 bar	T3 costs
selection	Very good	Very good	Very good	Very good	Very good
size of the Grain	sand average	fine sand	sand average	fine sand	sand average



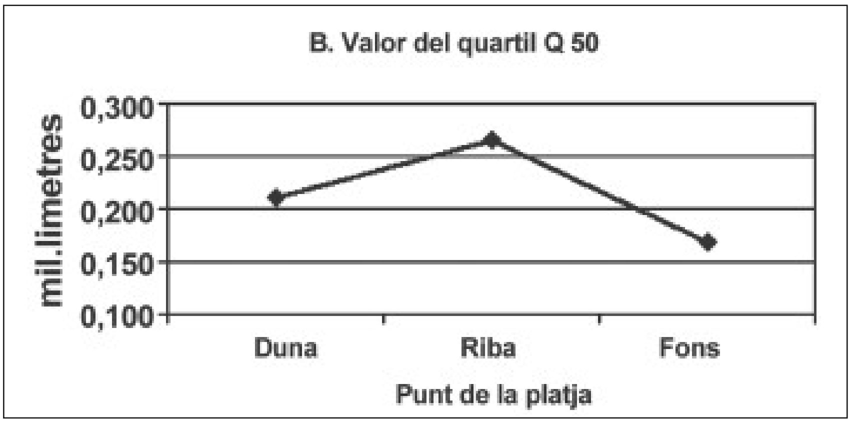


Figure 10.Variation of the average grain size Q50 along a north-south axis (graph A) and a land - coast axis (graph B).

Castelldefels beach is made up of medium sands, with an average grain size of approximately 0.3 mm, quite homogeneous along its entire length. The selection coefficient can be considered very good, which indicates that particles of different sizes do not appear excessively mixed.

If we analyze the evolution of the average grain size along a land-shore axis, it is observed that the largest value corresponds to the shore of the beach, and that a smaller grain appears both in the dunes and the submerged beach This is a usual phenomenon, caused by the contribution of coarse sediment that the waves carry out in their final run over the sand of the beach. The retreating wave, with a lower transport capacity, returns the smaller particles to the sea. At the same time, the wind blowing from the sea drags the small particles that have been left out of the action of the waves towards the upper part of the beach. The joint action of these two mechanisms causes the distributiongranulometricobserved

porosity

Porosity is a measurement that determines the percentage of empty space between sand particles. The degree of porosity has important ecological implications, given that it is closely related to factors of vital importance for the survival of numerous species, both animal and plant, that live on the beach.

On the emergent beach, in the vegetated dune zone, the porosity of the sand means that rainwater quickly penetrates the ground, and is beyond the reach of most of the plants that live there . On the other hand, the empty space between the grains is a favorable place for the appearance of atmospheric moisture condensation phenomena, which provide a quantity of water indispensable for the development of the vegetation of the coastal sands

On the shore of the beach, the space between the grains is occupied by water, which allows the life of organisms that develop their life cycles buried in the sand. The following table shows the results of the measurements carried out.

Table 9.Porosity values obtained in the measurements carried out on the beach of Castelldefels Two measurements were made for each sampling point.

Point	Replica 1	Replica 2	Average value
T1 costs	34%	32%	33%
T2 dune	37%	39%	38%
T2 costs	36%	46% *	36%
T3 costs	39%	36%	37%

The value marked with an asterisk was considered anomalous and was not considered for obtaining the mean values.

It can be considered that they are normal results, given that the bibliography consulted indicates that values close to 40% are common.

Organic matter and carbonates

The percentage of organic matter presents low values, as can be expected in a beach of medium sands where contributions of organic matter do not occur.

Table 10.Percentages of organic matter obtained in the measurements carried out on the beach of Castelldefels. Two measurements were made for each point of sampling

	T1 costs	T2 dune	T2 costs	T2 bar	T3 costs
Replica 1	1.930%	1.210%	1.430%	1.360%	1.060%
Replica 2	1.990%	1.050%	1.380%	1.250%	1.18%
Average value	1.960%	1.130%	1.405%	1.305%	1.120%

If the evolution of this parameter is observed along a north-south axis, it is observed that its value decreases along this axis and the lowest percentage is obtained in the sample corresponding to the vicinity ofPort Ginesta

It is not wise to venture an explanation of this phenomenon without having more samples that confirm the real existence of a northern gradient – south regarding the content of organic matter in the sediment of the beach.

Table 11.Carbonate values obtained in the measurements carried out on the beach of Castelldefels.

	T1 costs	T2 dune	T2 costs	T2 bar	T3 costs
value	23.770%	25.730%	24.230%	29.06%	26.810%

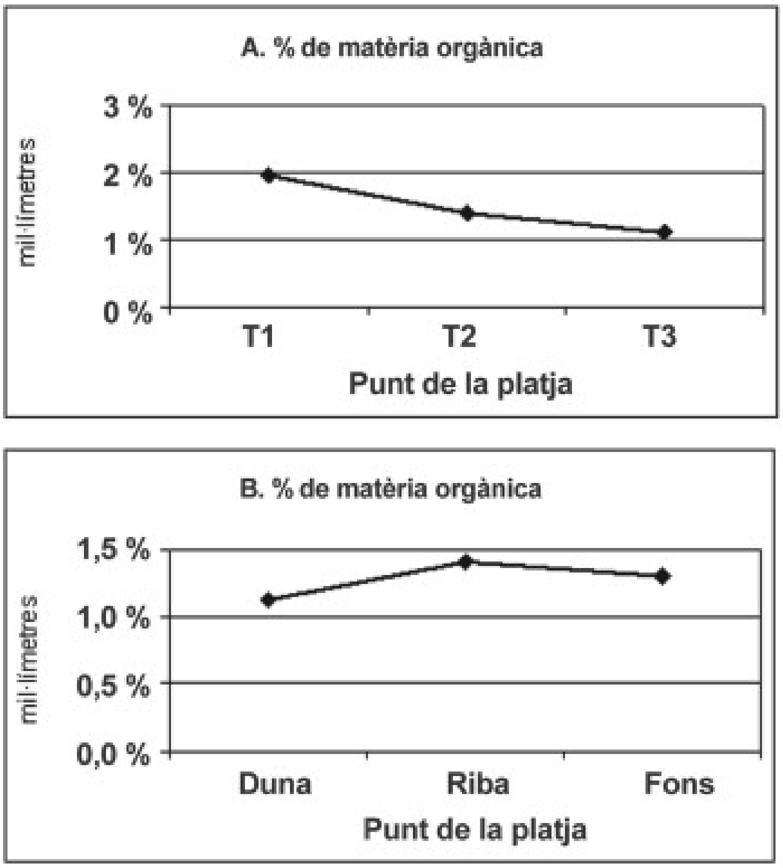


Figure 11.Variation of the percentage of organic matter in the sediment of the beach of Castelldefels along a north-south axis (graph A) and a land-coast axis (graph B).

Evolution of the beach

A beach is the result of the balance between the sand that arrives and the sand that leaves. Unfortunately, at present, most of the beaches of the Mediterranean coast, between the south of the Costa Brava and the Strait of Gibraltar, are subjected to a greater or lesser degree to erosion processes that have made a good part disappear of its extension. There are points where the retreat rate reaches 8 meters per year, while average values can be estimated at 1 – 2 meters per year (Lechuga, 2002).

If we now consider the beaches that stretch from the port of Barcelona to Port Ginesta, the situation is variable. In general, in the northern area the trend is clearly erosive, with a retreat rate of 30 meters per year in the period from 1947 to 1981.

In its central area, the process has a fluctuating character, with an accumulated advance in the period from 1947 to 1995 of about 2 meters per year north of the Remolar lake, and slight retreats on the beaches south of Viladecans.

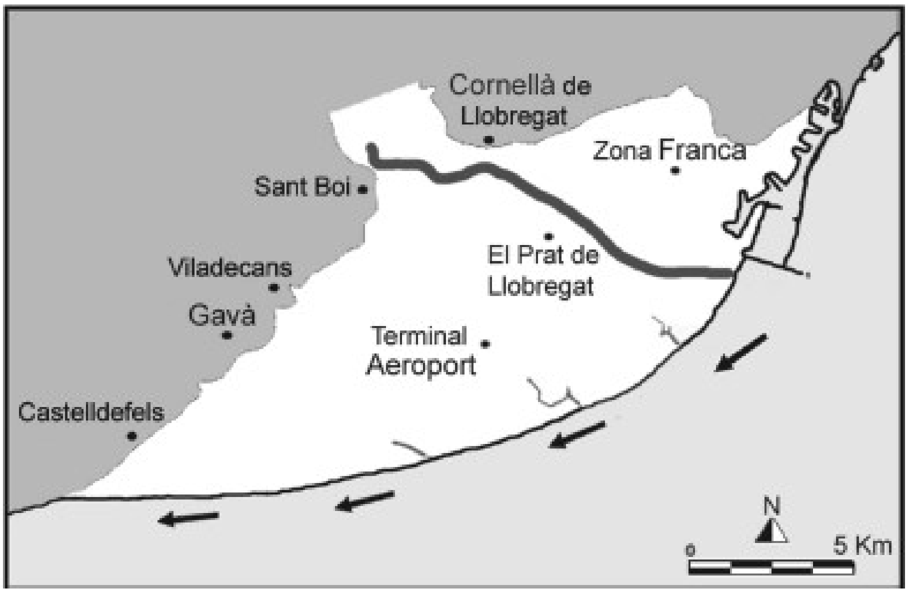


Figure 12.Transport of sediments in the Llobregat sector. Modified Ports Plan of Catalonia, Generalitat de Catalunya.

In the south, from Castelldefels to Port Ginesta, the character of the beaches is stable and even increasing, with advances of 2 meters per year in the period 1947 - 1981 (Sánchez - Argila and others, 2002).

The role of beaches

Beaches are living natural systems and as such, change over time and space. They have a role and perform a function in nature. They are populated by a multitude of living beings, as we will see in later chapters, each of them with a particular history but linked to that of the others by means of simple or complicated trophic, chemical or relationship networks. The structure of the beaches changes according to aspects and physical phenomena such as the geomorphology of the space, winds, sea currents, river avenues, etc. Its influence is not limited only to the coastline but reaches the back beach and even kilometers inland.

Over time, a series of regulations between the geomorphological, climatic and biological phenomena are revealed which allow establishing relative balances for the maintenance of the different habitats. An example is the loss of sand on the beaches during the winter and its recovery in the summer. Erosion processes are necessary for the recharge of beaches, dunes, deltas, etc.; but if the rivers do not bring sediment, these coastal systems cannot be maintained.

Certain regulations are established over time between the climatic, geomorphological and biological systems. Thus, the maintenance of habitats is due to relative balances that occur between the different systems. Beaches, for example, can lose some of their sand in the winter and regain it in the summer. An exceptional event, whether of natural or human origin, such as a storm, causes imbalances that will affect new readjustments of natural systems. The construction of a defense or a port without taking into account these readjustments can have important consequences such as displacement and increased erosion, which can involve the destruction of a wetland or a beach, of so as to leave the coast still more vulnerable to the attacks of the sea, and move the sand to other places, causing it to cover rocky ecosystems of high biological productivity.

Coastal formations serve to support a great diversity of habitats that have developed thanks to natural processes. For this reason, most coastal habitats are dependent on the processes of flooding, erosion and deposition for their maintenance.

The typical vegetation of the beaches is responsible for the formation of dunes, which help cushion the impact of the waves, since they retain much of the sand that the wind brings back to the beach during storms.

The marine phanerogam grasses that occupy considerable areas on the sandy bottoms of the coast also help to retain and consolidate the sand, at the same time that they are very productive and very species-rich communities, where they feed and reproduce. The high biodiversity of these communities makes them one of the most important on the Mediterranean coast.

It is important to consider natural processes as resources for the maintenance of coastal ecology and not as risks. The risk factor appears whenever human presence and activity do not recognize or respect natural processes. Man's footprint on the beach is manifested in a series of aggressions such as pollution, the destruction of communities and the loss of biodiversity.

The beach is also a recreational and tourism resource for humans, but the rush to make money and uncontrolled speculation have caused economic activities to endanger the same resource.

The demand for uses on the Catalan coast has been very intense. The urbanization of the territory is the consequence, an urbanization without control and without planning that has become, by itself, the main ecological problem of our coast. This occupation, which began in the 1960s, is based on a model of mass tourism, which leads to uncontrolled and poor-quality urbanization, which prioritizes short-term profitability and which transforms the traditional villages of fishermen in chaotic cities, where poorly constructed apartments and hotels are mushrooming, in municipalities that do not have the basic infrastructure to accommodate so many people in such a short time.

The coast is one of the richest, most fragile territories and at the same time with the most human occupation in Catalonia. Of the 672 kilometers of the Catalan coast, only 39.64% is under the protection of the Areas of Natural Interest Plan, known asthe COMB46.5% corresponds to urban land, plus 5.7%, which is land that can be developed. There is therefore only 8.16% of the coast (55 km) of non-developable land that the new Urban Master Plan of the Coastal System aims to protect. This new Plan was approved by the Minister for Territorial Policy and Public Works of the Generalitat de Catalunya in May 2004 and is currently in a public information period, open to all citizens, councils and competent bodies.

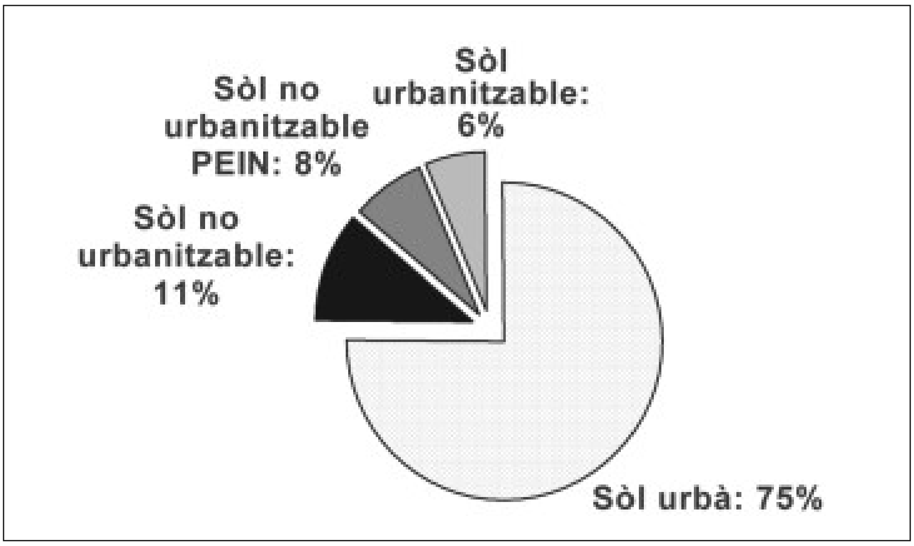


Figure 13.Soil classification on the coastline of the metropolitan region of Barcelona (source: Draft of the Urban Master Plan of the Coastal System. Dept. of Policy Territorial and Public Works. GENCAT, May 2004).

The general purposes of the Plan are:

Urban planning: avoiding the indefinite continuation of urban occupation of the coastal strip, while avoiding the establishment of an urbanized continuum in certain areas.

Heritage: to preserve coastal areas free of construction for their landscape, historical, archaeological, scientific, educational, environmental, agricultural, forestry, cultural and symbolic values of leisure and quality of life.

Environmental: enable the continuity of the system of open spaces in the territory, while ensuring the environmental quality and especially the connection and the biological exchange of the land spaces of the interior with the beaches and the sea.

Economic: managing the coastal area as a basic and lasting resource for economic development, tourism and the population's quality of life.

The final approval of the PDUSC and the future Comprehensive Protection of Catalonia's Coastline Act will be two valuable tools for planning the territory which does not ignore its natural dynamics, its biodiversity and which gives preeminence to the interest of the majority and future generations over the short-term benefit of a minority.

Castelldefels, metropolitan beach

Castelldefels (41º 16' 48.5" N and 1º 58' 36" E) is the westernmost municipality on the coastline of the Baix Llobregat region and the Barcelona Metropolitan Area. It has an extension of 1,241 Ha and more than 50,000 inhabitants. The most outstanding anthropic characteristic of the municipality is that it forms an integral part of the first crown of the Metropolitan Area due, among other things, to the deployment of the transport infrastructure network. This is why Castelldefels maintains a city-rest function, acquired from the 1920s. The urban occupation of the territory has gone from being dispersed, the result of a rural economy, to having a strong disharmonious urban increase, without plans or provision of minimum services.

The last 25 years of democratic municipal management have made it possible to deepen both the provision of services and the reorganization of this city through urbanization policies and the provision of public spaces between existing neighborhoods. The sustained growth of the population of Castelldefels is mainly due to new inhabitants coming mainly from changes of residence in other centers of the metropolitan region, but also to a strong dynamic of conversion of second residences into first ones.

Its proximity to Barcelona (15 km) has made Castelldefels beach one of the busiest in the Metropolitan Area and has turned it into a metropolitan leisure hub. In fact, the first bathing establishments were established at the beginning of the last century. In the 1940s and 1950s, the bourgeoisie of Barcelona and other towns in the Baix Llobregat chose Castelldefels as their summer holiday destination and in this period a large number of second residences were built, as well as the first hotels and restaurants. Since 1994 it has been recognized as a Tourist Zone, with 6,206 hotel places spread over 34 establishments.

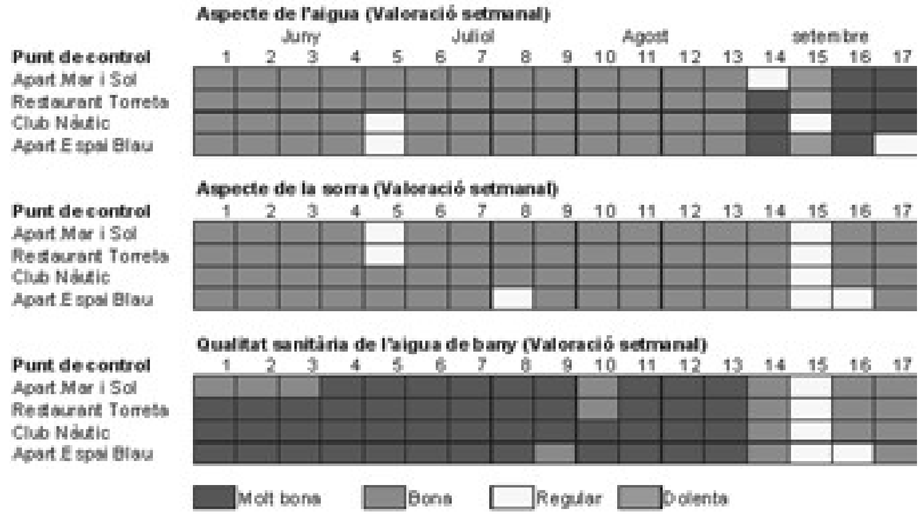
Currently, Castelldefels can have, in the peak moments of the summer season, more than 200,000 people in its municipality, who can enjoy a beach almost 5,000 meters long by 100 meters wide, where the climatology and water temperature favors swimming (25.7º on average in July) and with areas where you can still enjoy the typical Mediterranean dune and its vegetation.

The quality of the sand and bathing water of Castelldefels beach is quite good and the services that can be found there mean that it is considered one of the highest quality urban beaches in the Metropolitan Region of Barcelona.

Despite having all its urban or developable sun, Castelldefels beach has small natural areas, such as the dunes that, in an interrupted form, border much of its length. In the first section of the Passeig Marítim, there are natural or naturalized lungs such as the Pineda Park or the Dunes Park.

As for the second section, its design is designed so that it is a soft structure, made of wood and that allows you to enjoy the coastal dunes, its vegetation and its fauna up close.

Table 12.Appearance of the water and sand of Castelldefels during the period June - September. 2004. (The quality of the water is rated in cfu/100 ml. Provincial Council of Barcelona)



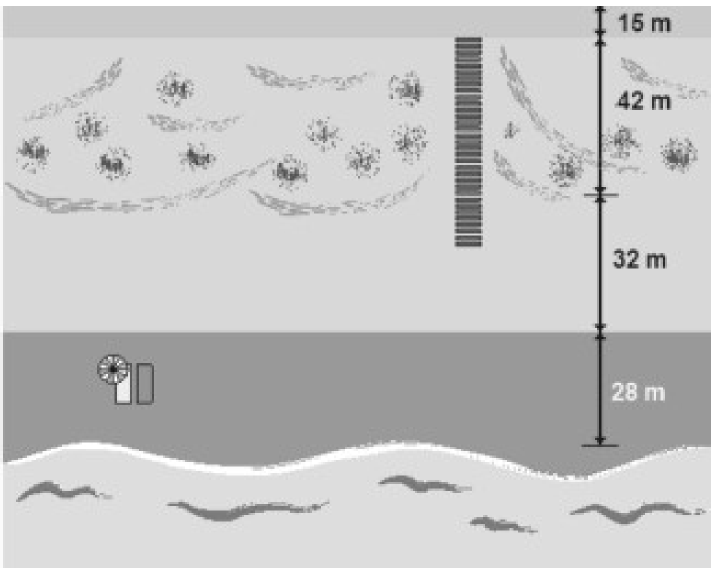


Figure 14.Scheme of the Castelldefels Beach: the gray area is the one mostly occupied by users; the light brown area is usually free or used for ball sports.

In previous studies on beach mobility and uses, a beach is considered oversaturated when the space available per user is less than 4 m^2.

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Photograph 7.Sand leveling and cleaning machine.

Photograph 8.Four by four that collects the trash from the beach every day.

In the case of Castelldefels and in the high summer season, it is clear that one could speak of an oversaturated beach, but it must be taken into account that users generally occupy 46% of the total space available, which corresponds to a variable strip depending on the area, about 50 meters. The rest corresponds to the sandpit furthest from the shore, which users take advantage of to play paddles or ball in great comfort.

Table 13.Average hotel occupancy by month and year (in %).

	93	94	95	96	97	98	99	00	01	02	03	04
January					30	41	47	52	47	46	47	48
February					41	48	54	58	54	58	62	52
March					51	59	69	72	70	70	59	63
April					67	66	71	73	71	70	73	60
May					59	72	75	73	73	71	74	68
September Santa	43	46	66	80	83	86	89	90	78	73	79	65
June	35	40	50	67	67	71	82	76	80	73	76	72
July	40	65	65	72	76	78	87	81	80	77	77	79
August	57	70	70	85	85	93	94	86	83	84	80	80
September	35	35	35	54	69	74	77	72	66	72	72	
October				48	59	64	78	69	61	72	66	
November				41	40	57	57	55	61	63	52	
December				39	42	44	69	51	47	53	52	
average	42	51	57	61	59	66	73	70	67	68	67	

Table 14.Castelldefels Beach equipment. Source: City Council of Castelldefels, 2004.

Season: from June 12 to September 12, from 10 a.m. to 7 p.m

beach
Length: 4,840 m
Width: 90 m
Degree of employment: high
Degree of urbanization: 100%
Composition: sand
Type of sand: golden
Swimming conditions: calm
Wind: windy

Cleaning up
Daily sand cleaning
Water cleaning:
1 Pelican boat

Access and equipment
Beach access: motorway C-32, freeway C-31
Adapted buses:
L94, L95, L96, L97 RENFE:
Baixador de Castelldefels WC: yes

Showers: yes
Walkways for the disabled:
on Calle Ones
2 wheelchairsamphi-bugy

Environmental aspects It has vegetation: yes
Protected area: no
Blue Flag: Yes

Emergency equipment: 2 surveillance chairs 4 first aid stations
1 intervention aid site quick
2 surveillance towers 6
Information columns municipal
4 type I boats 1 vehicle
5 fixed stations
15 portable stations
24 life jackets
16 torpedo buoys
16 heads of 100 m 10 life-saving floats 5 cervical collars
5 respiratory resuscitation equipment 8 first aid kits 5 inflatable splints
5 bunk beds
8 portable bunk beds
5 recognition bunks 10 binoculars
5 manual resuscitators

Signage:
Signposted beach 200 m 5 entry and exit channels of boats
4 places of relief
1 rapid intervention site

The biological environment

Dunes and coastal vegetation

Introduction to the vegetation of coastal sandbars

Coastal sandbars are spaces characterized by their special environmental conditions, the result of their proximity to the sea and the nature of the substrate on which they are located. These environmental conditions, in addition, have the property of undergoing large variations in small distances along the land - coast axis, which causes the appearance of marked physical gradients, which are translated in the form of characteristic vegetal bands. In general, plants closer to the coastline have to face harsher environmental conditions than those that choose more protected positions.

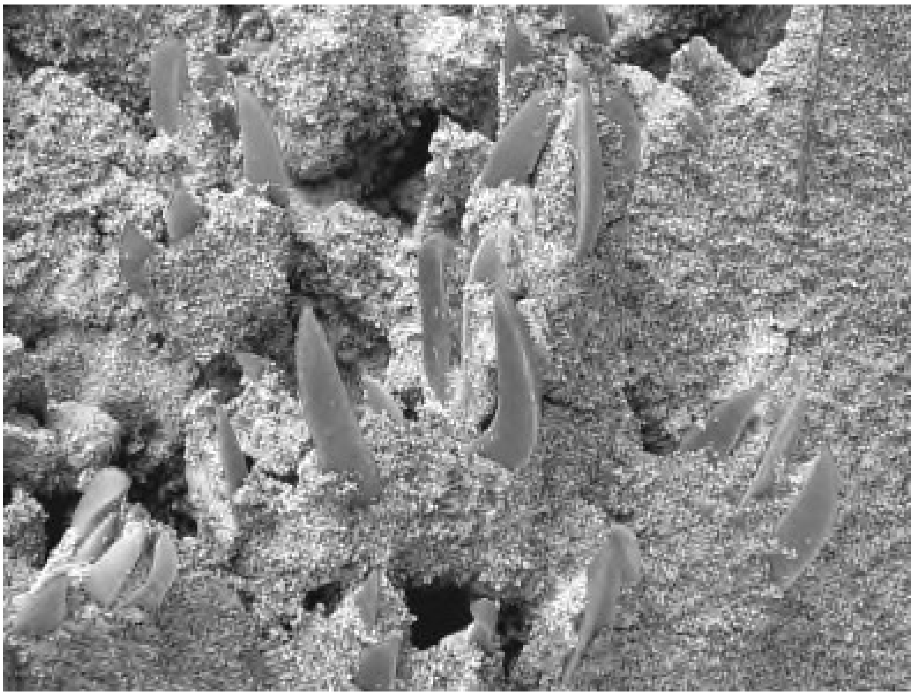
The mobility of the substrate

The vegetation of the coastal sandbars rests, as its name suggests, on the sand of the beach, an unconsolidated material that is able to modify its position according to the effect of the dynamic forces that shape its relief, as explained in the chapter dedicated to the morphology of the Castelldefels beach.

This mobility means that plants, especially those that grow on the area closest to the sea, run the risk of being either buried or with their roots exposed, depending on the changes in the height of the sand. In the most well-adapted species, such as the abalone (Medicago marine),the covering by the sand stimulates the growth of the plant, which in this way tries to keep its stems and leaves out of the sand.

The salinity

The proximity of the sea results in the presence of salt around the beach. This salt does not so much arrive directly using sea water as a vehicle, as it is carried by the wind that blows from the sea, the so-calledsalty breathThe consequence is that the plants located on the coast have to withstand a high degree of salinity and for this they have developed several strategies. The most common are those related to water management, but there are more surprising mechanisms. The sea radish,Cakile maritime,it is able to concentrate the salt it absorbs and expel it outside in the form of small hypersaline droplets.



Photograph 9.After a strong summer storm, the sand of the dunes without consolidate is dragged down by the water, and buries the plants that develop there, like the specimen of Carpobrotus edulis in the photograph. If the situation is prolonged, the plant will have to be able to grow upwards to re-emerge above the level of the beach surface, or it is in danger of being drowned by the sand.

Availability of water and nutrients

The nature of the sandy substrate, characterized as we have already seen by a high porosity (40% of the soil is space between the particles that make it up) and the almost total absence of fine materials, silts and clays, cause the capacity to retain the 'water and nutrients is very low. Rainwater quickly penetrates the ground, dragging the mineral elements necessary for the development of plants. From this point of view, sandy soils are poor soils, poorer the closer we get to the sea.

To face the problems arising from the scarcity of water, the plants of these environments present various adaptations, ranging from the possession of deep roots to the adoption of metabolic measures to save water , a true policy of austerity in the consumption of water resources, which goes through the development of storage organs, such as thickened leaves and stems.

temperature

Beaches are places where the soil can reach very high temperatures in the summer, due to the lack of plant cover and the absence of water in the upper levels of the soil. Sandy soil is a very poor thermal conductor, and significant thermal oscillations can occur between day and night, especially in the most superficial layers.

In addition to the heat transmitted by conduction from the ground, the plants are subjected to the effect of solar radiation, and to the desiccant effect of the wind, which on a beach like that of Castelldefels is a factor that must be taken into account consideration.

The effect of temperature on plant species must be related to the availability of water in the environment where they live. The most immediate effect of heat is increased perspiration. Water is absorbed from the soil by the roots and released into the atmosphere in the form of water vapor that leaves through the stomata of the leaves. In fact, it is the main mechanism by which plants mobilize water and nutrients from the soil into their tissues. However, when water is scarce, induced transpiration levels due to a high temperature, they would cause death by desiccation of the plants. To avoid this, the species that inhabit these coastal environments have developed adaptations similar to those of plants in desert climates.

For example, among the dune plants it is easy to find examples of cuticles thickened and protected with waxes to prevent water loss through transpiration, the appearance of light colors to reflect solar radiation and the presence of more or less silvery hairs , which have a double function: they limit the circulation of air over the epidermis of the plant and help to reflect solar radiation.

General pattern of the vegetation of the coastal sands

There is a generalized model to describe the vegetation cover of coastal dunes, which describes three characteristic zones. Each of these bands presents its characteristic species. Coverage, diversity and biomass increase along the coast-to-land direction:

- A first band, with discontinuous coverage, made up of the beach jull community (Agropyrom junceum),located at the foot of the dunes closest to the sea.
- A second band, arranged from the tops of these first dunes, called yellow dunes because they maintain the color of the sand of the beach, towards the interior, which corresponds to the borró community (Ammophila arenaria).
- A third band, which occupies the so-called gray dunes, where the substrate is stabilized and the soil formation processes have begun, where the crucianella community appears (Sea Crucianella).

Despite this, it must be considered that the anthropogenic modifications of the coast have been particularly intense on the sandy surfaces. These spaces were largely urbanized, which caused serious alterations in the relief and dynamics of dune ecosystems, or even their complete disappearance. The original morphological structure in many cases has disappeared, and at the same time it can cause a serious distortion in the distribution pattern of the characteristic species. After all, the rapid spatial variation of the environmental conditions, origin at the same time of the appearance of the characteristic vegetal bands, was largely supported by the morphology of the land. The successive belts of dunes form a screen that softens the rigors of marine influence, wind and salinity. If the morphological structure is altered, the plant distribution pattern also undergoes changes.

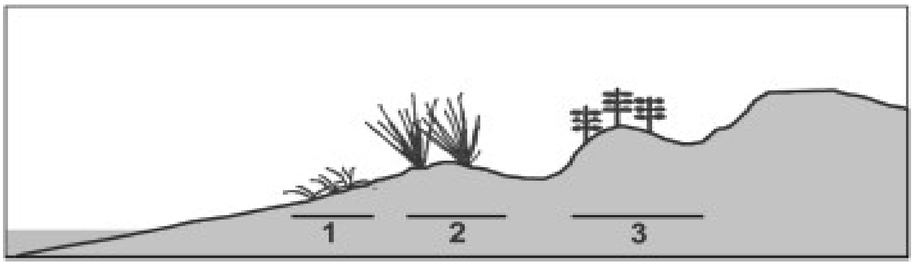


Figure 15.General zonation model of Mediterranean coastal dunes:
1) Embryonic dune and beach jull community. 2) Yellow dunes and borró community. 3) Gray dunes and community of Crucianella maritima.

Photograph 10.Castelldefels beach. Zones 1 and 2 of the previous image.

The vegetation of Castelldefels beach

On the beach of Castelldefels there is plant cover throughout its extension, but only in a few points can the original dune structure be recognized. As shown by the topographical profiles made, the dune relief is more evident at the northern end of the beach, on the border with the municipality of Gavà, while at the southern end, already in the municipality of Sitges, the beach presents a much more monotonous profile.

Parallel to the relief, the vegetation of the beach, whether we pay attention to the species that make it up or to their spatial distribution, responds more to the established model the further north we place our observations. In fact, the southern end of the beach has vegetation that is more typical of poor, wet soils than of beach dunes.

In the northern part of the beach, at least from Avinguda Pineda to the border with Gavà, it is easy to observe specimens of the most characteristic species of the coastal dunes, such asAmmophila arenaria,the Cakile maritime,theCalystegia soldanella,theSporobolus pungensand theEryngium maritimum.

As already mentioned, the characteristic structure of coastal dunes is not always easily identifiable, although, in general terms, their physiognomy is maintained. Thus, for example, it is not difficult to observe a first layer of vegetation formed essentially by theSporobulus pungens,that points tenaciously from the sand at the foot of the first line of dunes, which in turn are covered by the striking mattes of the blur (Ammophila arenaria).

The area occupied by the vegetation is variable, between 30 and 50 meters in most of the beach area that goes from the northern limit with the municipality of Gavà to Pineda avenue. The percentage of plant cover is variable, so much so that there are areas where it can be considered 100% and areas where the estimates made show values lower than 10%.

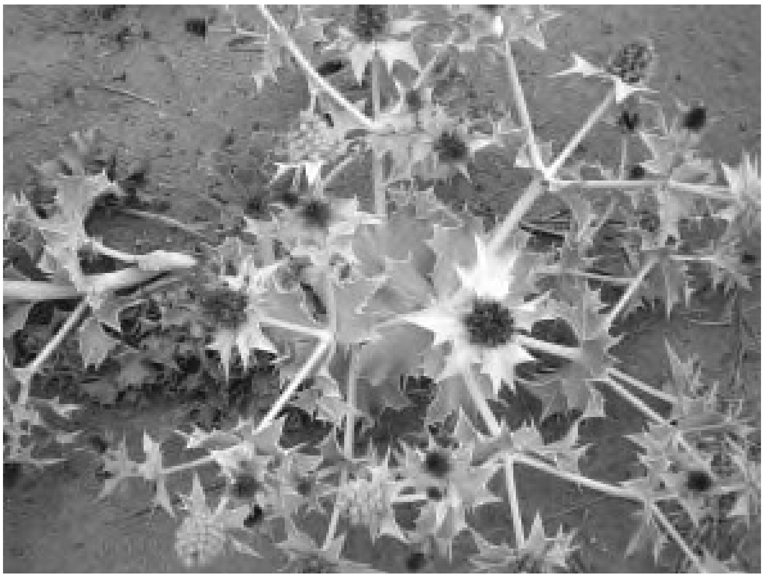
Table 15.Species identified on Castelldefels beach.

species	E	L	c	p	X
Agropyrom junceum	X				
Ammophila arenaria	X				
Cakile maritime		X			
Calystegia soldanella	X				
Carpobrotus edulis					X
Cyperus capitatus	X				
Echinophora spinosa	X				
Eryngium maritimum	X				
Euphorbia paralias	X				
Cyperus capitatus		X			
Lagurus ovatus			X		
Lobularia maritime			X		
Medicago marine	X				
Pancratium maritimum	X				
Polygonum maritimum					
Kali salt			X		
Scabiosa atropurpurea				X	
Sporobolus pungens	X				
Galician Tamarix				X	
Tribulus terrestris				X	
Xanthium echinatum				X	X

E: Exclusive of marine sands. L: Exclusive of the coast. C: Own dunes, but shared with other continental ecosystems. P: Characteristic of poor soils. X: Exotic origin

Photograph 11.Sporobulus grass (Sporobulus pungens) is frequently the plant species that appears located closer to the sea, on the exposed side

Photograph 12.The gorse (Ammophila arenaria) is the species that frequently appears on the first dune line on Castelldefels beach.



Photograph 13.sea panic (Eryngium maritimum)

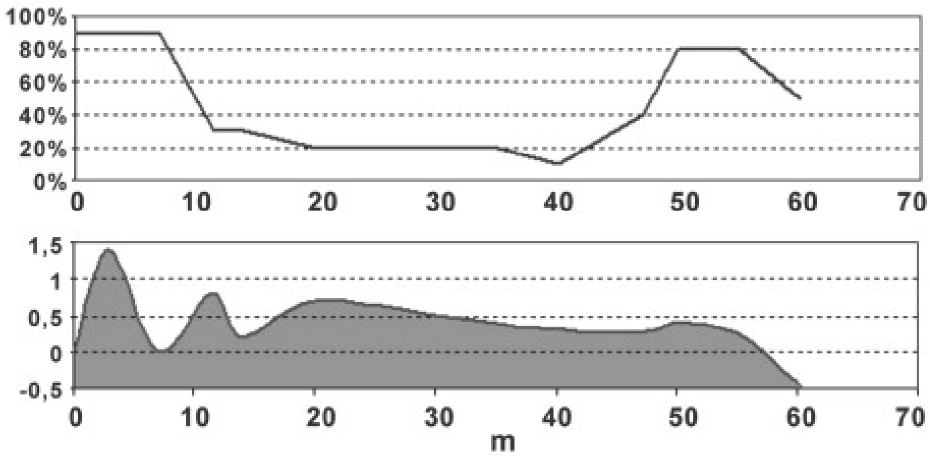


Figure 16.Percentage of plant cover in the northern area of Castelldefels beach, on the border of the municipal area. The lower graph represents the profile of the beach (the coordinate point 0,0 represents the Promenade, with the units in meters) and the upper one represents the estimated percentage of plant cover.

Photograph 14.Image corresponding to the previous profile, showing a view from the ground towards the sea In the land adjacent to the promenade, elevated above the beach and the promenade itself, the vegetation has the highest coverage density and also its maximum diversity in terms of species is concerned.

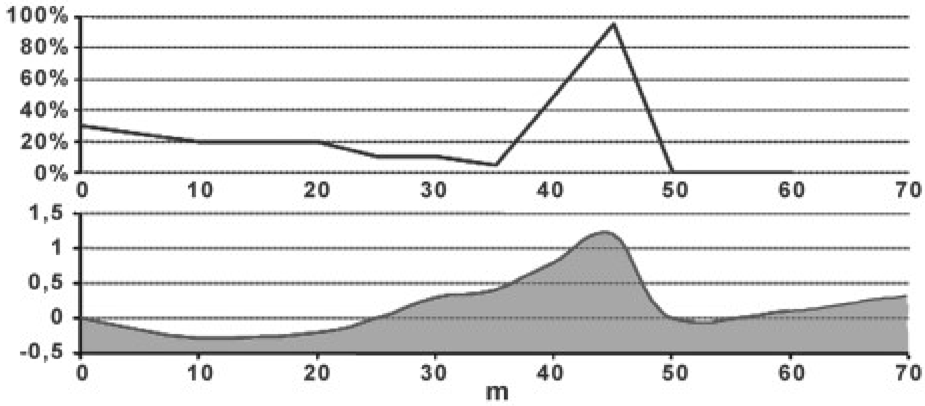


Figure 17.Percentage of plant cover in the central area of Castelldefels beach, next to the "Los Personajes" hotel establishment, specifically right at south of the access to the beach. The lower graph represents the profile of the beach (the coordinate point 0.0 represents the promenade, with the units in meters) and the upper represents the estimated percentage of plant cover.

Photograph 15.cat's claw (Carpobrotus edulis).

Photo 16. Tribulus terrestris.

The covering peak located on the dune corresponds to a dense bush of Carpobrotus edulis.The flat area adjacent to the seafront has a mixed type of vegetation that caters to the species that live there, and mixes with those that are typical and even exclusive to the sandy ecosystems coasts (Eryngium maritimum, Medicago marineorPancratium maritimum, for example) with a large number of species less exclusive to these environments, such as the very abundant oneTribulus terrestris

At the southern end of the beach, next to Port Ginesta, the presence of vegetation is much lower, whether we look at the number of species present or the percentage that reaches the vegetation cover. Species that can be considered typical of the coastal dunes are just beginning to appear.

Although there is no complete data on the flora of Castelldefels beach, it is possible to establish a qualitative comparison with the data available in the Biodiversity Data Bank of Catalonia (http://biodiver.bio.ub.es/biocat /homepage.html). Based on this source of information, where the results of several field studies carried out on the Castelldefels beach are collected, it can be seen that approximately 50% of the taxa identified in the studies located in the biodiversity database of Catalonia have have in turn been identified in this work.

The fauna of the dunes

Although the study of the fauna that inhabits the dune area of the Castelldefels beach was not included in the objectives of this work, we consider it interesting to include here a very brief review on this aspect of the biological environment of the beach. Insects are the most abundant zoological group, so it is not surprising that, during the spring and summer months, their presence is palpable on the beach. It is easy to observe numerous specimens of butterflies, beetles and grasshoppers, just to name the most well-known and easy-to-identify groups.

There are no species that can be considered exclusive to beaches, but there are some species that seem to find this environment one of their preferred habitats.

the screwPisan Thebesit is probably the most representative animal species of the fauna of the dunes and sand dunes in Castelldefels, since we can observe it, especially in the summer, forming agglomerations on the leaves and stems of most of the dune vegetation plants.

Photo 17. Theba Pisana.

Problems and threats

At this point, and especially on the Mediterranean coast, it is nothing new to announce that coastal ecosystems are threatened spaces. Urban pressure, the result of a certain development model, and the voracity of the tourist industry, made the coast a coveted territory. Despite this, the anthropogenic alteration of the coastline is not a story that began in the 20th century. From a long time ago, either to gain land for agriculture or citing reasons of public health, other characteristic areas of the coast, such as wetlands, suffered significant reductions in their extension.

Be that as it may, coastal ecosystems have seen their extent reduced progressively and unstoppably until reaching the current situation. It is clear that the physical destruction of space is the most serious and definitive threat to any natural space, but as we will see, it is not the only threat. In fact, once the urban evolution of the coast is stabilized, the appearance of exotic species capable of competing with the native flora is emerging as the great threat to the continuity of the dune ecosystems, together with the genetic depletion of the populations which have survived but are currently isolated from each other.

The banalization of the ecosystem

A particularly dangerous threat because it generally goes unnoticed, is the result of the loss of identity of the dune ecosystem. The morphological alterations cause the breakdown of the spatial scheme of the plant communities, at the same time that they significantly modify the environmental conditions, the rigor and hardness of which prevented the appearance of other less tolerant species. When the conditions soften, by decreasing the mobility of the substrate and increasing the contributions of water and nutrients, as a result of the intense human activity on the beach and its surroundings, the space becomes habitable for other species.

The species that we consider characteristic of the dunes now have to compete for space and resources with other species, generally typical of poor terrain and anthropized spaces, which are many times more effective in using these resources. A cursory glance at the beach dunes, covered in abundant vegetation, might lead one to think that the ecosystem is in good health, but that would be a false impression. The species native to the dunes end up relegated to the most extreme corners, where the environmental conditions still give them an advantage over their competitors.

Genetic isolation

Whether due to the physical destruction of the habitat or the dispersion of the original plant communities, which remain like islands surrounded by plant groups of different specific composition, it can happen that the species typical of coastal sands end up forming small groups, separated from each other by distances such that sexual reproduction between specimens from different enclaves is impossible. It is what is known as agenetic isolation,the consequences of which are fatal in the long term for the affected communities.

It is not easy to measure the level of genetic isolation of a community. Castelldefels beach is part of a beach that stretches without interruption from the mouth of the Llobregat river to Port Ginesta, where the characteristic species of the dunes are still well represented. Therefore, this does not seem to be an imminent threat, as long as sufficient plant populations are maintained throughout its entire extent.

Invasive species

Sometimes the alteration materializes in the form of the presence of foreign plants, also calledinvasive plants,which have generally been introduced by human action, either voluntarily or unconsciously.

This is an unprecedented phenomenon, which can be considered to have acquired planetary dimensions. Its ecological consequences are unpredictable, since new species are continuously introduced into ecosystems that are alien to them, and cause changes that can be irreversible. The immediate consequences are the homogenization of plant communities and the disappearance of those species that turn out to be more vulnerable.

On the beach of Castelldefels it is easy to find extensive patches of Carpobrotus edulis,commonly known ascat's claw,a plant of South African origin widely used in gardening for its resistance, adaptability and ease of reproduction and cultivation. Precisely, it is these qualities that make it very dangerous for the maintenance of the biodiversity of dune ecosystems. Their ability to grow and reproduce by stolons, together with their way of growing, forming dense mats that cover 100% of the substrate where they settle, threaten the rest of the typical dune species.

TheCarpobrotus edulisit competes with native plants, competing for space with existing plants and preventing the development of new seeds. It also uses soil resources, mainly water, and even alters soil chemistry, thus modifying the natural conditions under which the original plant community develops.

TheCarpobrotus edulisit is not exactly a new arrival plant in our latitudes. Coming from South Africa, specifically from the Cape Town region, where the climate is similar to the Mediterranean, it arrived in Europe at the end of the 17th century. Its threat is not limited to European coastal areas, as it is possible to find references to it in places as far away as California or the Pacific Islands (Binggeli and Starmer, 1997 in Hawaiian Ecosystems at Risk Project, 2004, http:// www. hear.org/).

It is not difficult to find examples of the alarm raised by the presence of this plant and the proliferation of various initiatives to eliminate or restrict the threat it poses to the local flora. It is particularly interesting that there are not only initiatives aimed at the eradication of exotic flora, but also those that try to prevent the introduction of more specimens of this dangerous species.

Table 16.Examples of actions onCarpobrotus edulis.

entity	performance
Spanish Society of Ornithology / Bird Life.	Cabrera Archipelago National Park. Field of work 2004: Eradication of non-native flora: Carpobrotus edulis, Nicotiana glaucaAnd others.
Ministry of Environment Environment of the Junta de Andalucía.	Coastal juniper recovery plan in Huelva and Cadiz, 2003. Elimination of the alien species C.eat
Ministry of Environment Environment of Principality of Asturias.	Environmental impact statement for the closure of the Zeluán landfill (Avilés), 2001. Prohibition to the developer from using, among other species, theCarpobrotus edulis in landscape restoration tasks.
State Secretariat for Waters and Coasts. Directorate General of Coasts.	Eradication project of C.eaton the coast of Mallorca, 2002.
Environmental Office of Miguel University Hernández / Caja de Ahorros del Mediterráneo.	Environmental volunteering project: Extraction of invasive plant species (C. edulis and others) in the micro-reserves of Pinet, La Marina and Guardamar (Alicante), 2004
Autonomous Community of the Region of Murcia.	Decree 44/1995, of 26 May, approving the Natural Resources Management Plan for the Salines and Sandstones of San Pedro del Pinatar. Consideration ofCarpobrotus acinaciformisamong the "exotic species of desirable elimination"

The problem of invasive species is also full of paradoxes. For example, it is still curious that the most characteristic species of our coastal dunes, theAmmophila arenaria,is considered a dangerous threat on the west coast of the United States (Pickart, J., 1997).

In reality it is still a facet of the same problem. theAmmophila arenariait was introduced to the United States at the end of the 19th century, specifically in San Francisco, to stabilize sandy soils for the US Soil Conservation Service. TheCarpobrotus edulisit was also introduced in California shortly after, at the beginning of the 20th century, to stabilize the slopes raised in railway works (Albert, MI, 1995). In both cases it was about finding a solution to a technical problem using a living resource, which ended up escaping human control.

Photograph 18.Large patch of the invasive speciesCarpobrotus edulis,spread over the promenade, near Carrer 11.

In Castelldefels it is not difficult to observe the use of this plant in public and private gardens. Precisely, in the vicinity of the study point located on Avinguda Pineda, it is observed how from the garden of the abandoned leisure establishment L'Oasi a dense bush of this species extends over the Passeig Marítim , right at the point of the beach where there is also a dense population ofC. edulisamong the typical vegetation of the dunes.

Practically in the same place, it can be observed as theC. edulisit has been used for ornamental purposes in the Parc del Mar area, which also borders the Passeig Marítim. It cannot be affirmed that there is a relationship between these facts and the presence ofC. edulison the beach, but given the characteristics of this species, it is not too prudent to consider that it is not the most suitable species to be used in these places.

The sandy coast

With this term we refer to what technically speaking it would bethe mediolittoral floor,that is to say, that portion of the coast that is periodically covered and uncovered by the waters. It essentially corresponds to the shore of the beach, the area of sand to which the waves reach.

Generalitats of the biological communities of the marine benthos

Let's define thebentoslike the set of plants and animals that live in a very close relationship with the bottom. We consider benthic organisms all those that live at the bottom, move there, are buried there or depend on the solid substrate to survive. In general, the animal and plant species of the benthos are structured into floors or stages according to a series of environmental factors such as lighting, humidification, hydrodynamics, temperature, etc. The response of the organisms to these factors causes them to be structured in different communities along a vertical axis, especially in the first meters, where the variations are more intense. The floors that stand out in the Mediterranean are:

a) Supralittoral floor: characterized by an occasional degree of mullena in the form of splashes of waves in moments of rough seas. It is a permanently emerged area. Its upper limit is located where the most halophilic terrestrial plants disappear and the lower, where the lichen disappearsVerrucaria symbalana,in the case of rocky substrates. We must bear in mind that the splashes of sea water are, for the organisms adapted to live in this area, not only a degree of mullena, but also a contribution of food and oxygen.

b) Mid-littoral floor: wetted by the ebb and flow of the waves and, therefore, with a more regular water supply than the upper floor. In rocky substrates, this floor begins with the appearance of sea acorns of the genusChthamalusand ends where we find species not tolerant to emersion.

c) Infralittoral floor: it is permanently submerged. Its lower limit is located at a depth at which light reaches 5-10% of the intensity of the surface.

d) Circalittoral floor: begins below the infralittoral and reaches the maximum depth compatible with plant life which, in the Mediterranean, is considered to coincide more or less with the edge of the continental shelf (around 150 meters of depth).

The benthic communities of soft substrate bottoms

Unlike hard or rocky substrate bottoms, the boundaries between supra, medio, infra and circumlittoral floors are blurred, especially between the upper floors. Transitional areas between communities can be as wide as those occupied by those communities. In addition, phenomena of overlapping and masking of communities occur.

They are bottoms with less stability than rocky ones, since they support a greater energy flow. In this sense, these funds are said to present «planktonic» characteristics. In contrast, communities living on soft or sandy bottoms have less spatial structure.

Hard substrate communities are highly vulnerable to environmental changes, unlike what happens in the physical structure that supports them. In contrast, soft substrate biological communities are less vulnerable to environmental changes in the physical substrate itself, as this is highly ductile and malleable. They are more adapted to the rapid changes in the physical structure of their habitat (table 17).

Table 17.Comparison between the levels of vulnerability of the two types of substrate i of the biological communities that live there (Biota).

	vulnerability		Complexity of the communities biological
substrate	Of the substrate	From the community	
Carry	come down	high	high
soft	high	come down	come down

In the upper levels, that is to say, in the supralittoral and mediolittoral areas, wetting does not depend so much on the contribution of water movements as on the water retention capacity of the sediment.

In summary, the bottom communities of sandy shoals, in areas of breakers, are subjected to a greater influence of environmental factors; we think, for example, that the sand bottom of the first few meters is mobile, unlike a rock substrate. These changing conditions mean that over time some communities are replaced by others. Because of their extent, soft-bottom communities are of fundamental importance and occupy most of the surface of the continental shelf, numerous coastal areas and almost all of the abyssal shelf. Circalittoral soft bottoms are of great economic importance, as they host communities rich in commercial species or in species that serve as food for commercial species.

From an ecological point of view, the environmental conditions of the mediolittoral mean that it can only be inhabited by species highly adapted to life under the sand. These species are constantly faced with the danger of desiccation, and only in the bosom of wet sand do they find the necessary conditions to survive. Compared to rocky bottoms, sandy bottoms are much poorer in species.

The size and classification of the sand particles that make up the beach determines the volume of free space that exists between these particles. Porosity is the physical parameter that expresses this concept, and as seen in the section dedicated to the physical environment, it reaches values close to 40% on Castelldefels beach. The porosity, along with the size distribution of the sand particles, determines the amount of water and oxygen that can be in the sediment. On the other hand, the more water the sediments contain, the greater their fluidity, and this fact allows burrowing animals to bury themselves in the sand and move around in it. Coarse sediments retain less water than fine ones, and are therefore less suitable for the development of burrowing animal communities.

The problems are not only related to desiccation. It is also necessary to consider that the shore of the beach is an environment poor in food resources. When the sediment consists of sand and the organic matter content is low, the lack of food resources is a limiting factor for the development of rich and diverse animal communities. In the mediolittoral of the beaches there really is no primary production, that is to say, there are no plants that produce organic matter from sunlight, CO_2 from the atmosphere and mineral salts from the soil. For this reason, the food of the inhabitants of this ecosystem depends on the nutrients that arrive there dragged by the currents. They are food chains, or more precisely, trophic networks, very short and based on the use of food particles that are deposited there coming from the outside. These particles they are directly used by the organisms that live under the sand, or they are used by bacteria and other microorganisms, and these bacteria will later be part of the diet of these organisms.

When organic matter is very abundant and the presence of fine sediments allows the development of large populations of microorganisms, the intense activity they develop can deplete the oxygen in the interstitial water. The environment becomes anoxic and generally takes on a dark color, the result of the appearance of iron sulphides. It is a situation that has not been observed at any of the points on the Castelldefels beach included in this work and it is almost certain that it does not occur at any other point on the beach.

Species found

Based on the samples taken, it can be established that the mediolittoral area of Castelldefels beach is inhabited by a small number of species, which also do not have particularly high population densities. The following table presents the results obtained.

Table 18.Estimation of the number of individuals per square meter on the shore from Castelldefels beach

species	Station T1	Station T2	Station T3
Polychaete annelids			
Nerine cirratulus	8	8	25
Ophelia radiata	8	67	2,300
crustaceans			
Gastrosaccus sanctus (mysid.)	8	33	
Eurydice affinis (isopod)	8	117	50
Gammarus planicrurus (amphip.)		17	

No precise references have been located from similar work carried out on beaches in our geographical environment, so it is not possible for us to issue an assessment on the data collected. Yes, it can be affirmed that both the number of species and the densities they present are much lower than the data obtained from studies carried out on Atlantic beaches, mainly Galician, which are probably the most studied beaches due to the importance economic of the shellfishing that is carried out there. This is not a difficult fact to explain, considering that the Atlantic beaches, subjected to the action of the tides, present more suitable conditions for the development of this type of zoological communities, and that the waters of the ocean Atlantic are much richer in nutrients than those of the Mediterranean Sea.

Regarding the species found, the polychaete annelids are the most abundant and without any doubt, the easiest to see. They are worms of the same trunk as earthworms, small in size (from 0.5 to 3 cm) and mobile. Two are the species found: theNerine cirratulusand theOphelia radiata. They are microphagous and filter-feeding species, that is to say, they feed on small food particles found between the grains of sand, such as organic debris, bacteria, etc. TheNerine cirratulusbelongs to the spionid family; it digs tubes in the sand, has two long palps on its head, and is blue or green in color. the Ophelia radiatait belongs to the ophellid family, without palps and in color between pink and red.

theOphelia radiatais the most abundant species, and can reach densities of more than 2,000 specimens per square meter in the vicinity of the breakwater of Port Ginesta, values much higher than those shown by the rest of the beach, although the sizes observed are much smaller We have no explanation for these results, so we simply collect them without venturing any explanation.

The rest of the animals that we can find on the shore of the beach belong to the group of crustaceans, more specifically, they are amphipods and isopods, small-sized crustaceans that are very abundant in all the marine environments of the planet, and also in fresh waters, and even and there are all species of isopods that live in moist places, far from open water.

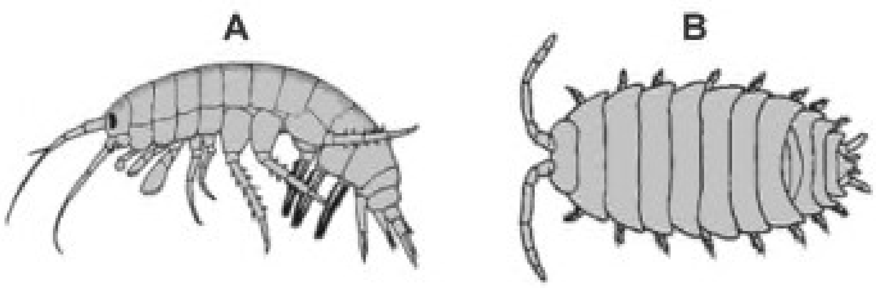


Figure 18.Characteristic forms of amphipods (A) and isopods (B).

Isopods are small crustaceans without a shell. They get this name because they all have the same walking appendages. They have an oval shape and are flattened in the dorsiventral area. Their diet is detritivorous, that is to say, they feed on dead remains. We found only one species of this group, theEurydice affinis.This species is about 4 mm long. The eyes are not pedunculated and it has 2 antennae in the cephalic region.

Amphipods differ from isopods, among other things, in that they are laterally flattened. They are also very small in size and show great convergence with the isopod lifestyle. In general they are omnivores (they eat everything), microphages and detritivores. They have a great ability to adapt to different aquatic environments, but, on the other hand, they last very little time out of the water. Only one is the species found in the study area: theGastrosacchus sanctus.

We must say, however, that in one of the sand samples from the beach the Missida crustacean has also appearedGastrosacchus sanctus. Myssidas are small shrimp-like crustaceans that occupy a wide variety of environments in both fresh and marine waters. They are essentially swimmers, so we consider their finding among the sand samples to be anecdotal.

It should also be noted that at least one species of mollusk, theDonax trunculus,it is possible to sometimes find live specimens (not dead shells) buried in the sand of the beach shore. In fact, the mollusk shells are the most striking biological element on the Castelldefels beach, although its habitat is not the mediolittoral, but the infralittoral, the beach permanently submerged and covered by water, to which we will refer in the next section of this work.

The submerged beach

The ecological environment

The submerged beach, the stretch of sand that continues under the water following the slope of the beach, corresponds to the zone or infralittoral floor. Here the environmental conditions are more constant, especially if we compare them with those prevailing a few meters higher, on the mediolittoral floor. Although the threat of desiccation has disappeared, the rest of the environmental factors that characterize the soft bottoms, which have been described in the previous section, are also present here.

Species found

The task of characterizing the fauna that inhabits this part of the beach has been carried out through several different methodological paths. On the one hand, there is the fauna that lives buried in the sediment. The results of the study carried out are shown in table 17.

Table 19.Result of the sample obtained at a depth of 3 meters at the point of sampling T1, expressed in individuals per square meter.

species	Station T1
Polychaete annelid	
Glycera tridactyla	56
Amphipod crustaceans	
Siphonoecetes kroyeranus	395
Hippomedon denticulatus	56
molluscs	
Ensis siliqua	282

These results can be considered poor in terms of the number of species that actually inhabit the sediment of the infralittoral beach. This is due with all certainty to the limitations of the sampling method used, which has caused an underestimation of the real fauna richness. Probably the sample size does not reach to represent the callminimum area,which, without going into precise definitions, is the volume or size of the sample that includes a significant and representative percentage of the community that is to be characterized.

For this reason, the data from this sample cannot be taken into account as an absolute reference, but as a more qualitative than quantitative contribution to the knowledge of the fauna of the study area.

To complete the information on the fauna that lives buried in the sediment, several qualitative samples were also collected, since it seemed very difficult to establish with due precision their respective abundance. In these samples, in addition to the species already mentioned, specimens of polychaetes were foundNerine cirratulusiOphelia radiata,the same ones that appear in the sand on the shore of the beach.

On the other hand, the empty shells that appear on the beach are a valuable source of information. They belong to species that, due to their size and dispersion, are difficult to study with methods like those used in this work, but their remains constitute a source of information that allows, at least, to determine their presence in the study area. At least it is possible to find shells of 27 different species of bivalve molluscs and gastropods in the sand of Castelldefels beach. Since there is a lack of quantitative data, it is not possible to determine which species are the most abundant, but probably, and due to the abundance of their remains on the shore, these species are the Donax trunculus,themactra corallina,theAcanthocardia tuberculata,theTellina flatand theChamelea hen

Photo 19. Tellina planata.

Photo 20. Mactra corallina.

Photo 21. Chamelea gallina.

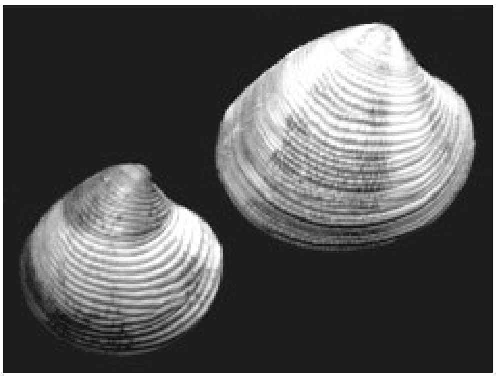


Photo 22. Acanthocardia tuberculata.

Table 20.Mollusc species found in the sandy infralittoral from Castelldefels beach.

bivalves	gastropods
Acanthocardia tuberculata	Acteon tornatilis
Callista chione	Bolinus brandaris
Chamelea hen	Canceled Chancellery
chlamys varia	Fisserella nubecula
Donax trunculus	Fasciolaria lignaria
Dosinia lupinus	Hinia reticulata reticulata
Ensis siliqua minor	Hebraeus Naticarius
Glycymeris glycymeris	Neverita josephinae
Mactra coralline	Sphaeronassa mutabilis
Mactra corallina lignaria	Mediterranean Turritella
Mysia undata	
Tapas decussatus	
Tellina fabuloides	
Sharp tail	
Tellina flat	
Tellina pulchella	
Venerupsis rhomboids	

Direct observation, through free lung diving, made it possible to increase the list of species present on Castelldefels beach. Probably the most prominent group is that of decapod crustaceans, the crabs, of which three different species were identified. Two of these species, the Portumnus lattipesand thepolybius vernalis,they belong to the family Portunidae,widely distributed throughout the world, and are considered characteristic inhabitants of shallow sandy bottoms.

The third species is theDiogenes the pugilist,a very abundant hermit crab on the beach of Castelldefels. In fact, although there is a lack of data to prove this, it could be responsible for the extremely rare empty shells of gastropod molluscs, sea snails, on the shore of the beach, while the shells of bivalves are very abundant . Hermit crabs have a soft abdomen and need to protect it inside the hollow shell of a sea snail. As the crab grows it is forced to change shells, making the availability of dead snail shells a limiting factor for hermit crabs. Because of this, it is difficult to find empty gastropod shells, since these are not washed up to the beach by waves and currents.

The observations made also allow the list of species belonging to other zoological groups to be expanded. One of the most curious species is the Podocoryna carnea,a hydrozoan cnidarian that has found a solution to the problem these organisms face when trying to develop on sandy bottoms. There are free-living cnidarians, such as jellyfish, and sessile-living ones, such as corals and gorgonians. The sessile-living cnidarians need a solid substrate to hold onto, and for this reason the appearance of species of this zoological group is not frequent on sandy bottoms. The Podocoryna carnea has solved this problem by developing on the empty shells of large molluscs and hermit crabs, which perhaps constitute the only possibility of anchoring in a bottom where sand is the dominant material.

To finish with the sources of information used for the determination of the benthic species present in the study area, it is necessary to cite the samples from trawl fishing, which have allowed to obtain live specimens of most of the species of molluscs, whose empty shells appear on the shore of the beach.

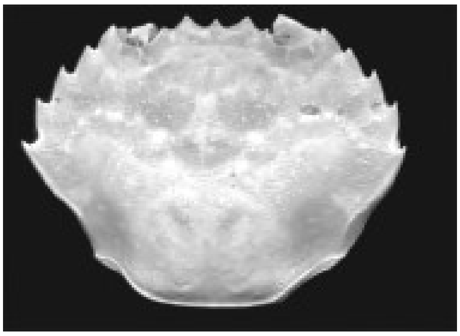
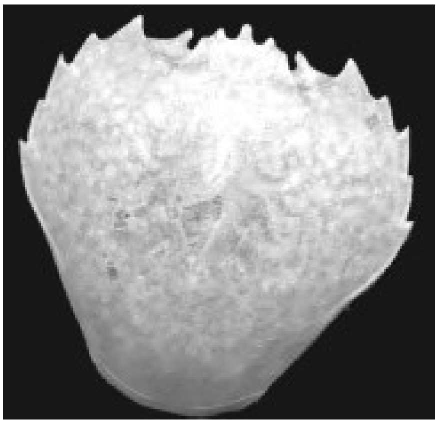


Photo 23. Shell of Polybius vernal



Photograph 24. Portumnus shell lattipes

Photograph 25. Diogenes pugilator.

Photograph 26.Colony of hydrozoa on an empty shell.

Photo 27. Portumnus lattipes.

Photo 28. Naticarius hebraeus.

Table 21.Fish species identified in the sandy infralittoral of the beach of Castelldefels.

species	
Boops boops, (crazy)	Ophichthus rufus, (snake, red shingle)
Chelon labrosus, (smooth, smooth)	Pagellus acarne, (pagel, aligot)
conger conger, (conger, conger)	Pomatoschistus minutus, (small gobit)
Dicentrarchus labrax, (bass, sea bass)	Sciaena umbra, (crow, corvina)
Diplodus sargus, (sardine, bream)	Solea vulgaris, (tongued, tongued)
Diplodus vulgaris, (mojarra)	Trachinotus ovatus, (popcorn)
Lithognathus mormyrus, (mabre, herrera)	Raja sp., (streak)
Mullus surmuletus, (rock dock, salmon)	

As for the fish, there has been valuable data from the sport fishing catches of the championships that are held on the beach. This information has been completed with the observations made by diving, and in total it can be noted that at least 19 species are present in the study area.

To finish this section it is necessary to mention some occasional visitors to the beach, species that we cannot consider typical of the area, but which appear frequently enough to make it interesting to mention them. It's the jellyfishRhizostoma pulmo, Cotylorhiza tuberculataiChrysaora hysoscella,as well as hydrozoaOld ladyAll these species have been seen this summer on the beach of Castelldefels, although the most abundant, and with an almost continuous presence throughout the summer, and which in previous years has lasted at least until the month of December, is theRhizostoma pulmo.

The breakwater of Port Ginesta

In the chapter on marine benthos generalities, we already defined the different zones or stages into which we can divide the coast on a vertical axis: supra, medio, infra and circumlittoral. It is on the rocky coasts that these divisions become more evident and where the communities called of hard substrate,the most visible, attractive to the human eye and complex among those on the coast.

The harbor breakwaters are man-made constructions and erected, in many cases, in places where the previous physiognomy of the coast was that of a sandy beach, as is the case of what has been built at Port Ginesta. It is a structure formed by piling blocks of granite stone in a more or less cubic shape, sitting on the sandy bed of the beach. At that time, the construction of the breakwater meant a major change in the structure and diversity of the pre-existing biological communities, a change that involved the replacement of some soft-bottom species by hard-bottom species. This allows us to comment on the concept of succession,which is the natural sequence by which, in a specific habitat and over time, some organisms are replaced by others until they reach a stable community, which remains over time.

When a new substrate settles in the environment, as is the case with the stone blocks of the breakwater, a whole series of new species colonize the new spaces; they are calledpioneer speciesThese are animals and plants that are characterized by rapid growth and a high rate of reproduction. The biological cycles of these new species will modify the physical and chemical characteristics of the substrate and allow the establishment of new organisms, with longer biological cycles, with larger sizes and with defense systems that allow the viability of the offspring. Relationships of competition for space and for food will also be generated between the different organisms, until reaching predator-prey ties. Little by little, the environment will become stable. Stability is a property of an ecosystem or a biological community by which it remains with very few variations over time, as long as the external environment or environment does not undergo significant changes. Stable communities are also considered to be those that are able to adapt quickly to external changes. On the other hand, we can understand that if a biological community is well adapted to the environment, it will mature over time, it will become older and this is opposed to stability, since the more mature a community is, the worse it can withstand modifications important environmental Therefore, stability and maturity are not always synonymous concepts.

One of the environmental characteristics of benthos is the intensity of gradients on the vertical axis. The main factors with very pronounced variations are: lighting, hydrodynamics, temperature and pressure. The response of the organisms to these variations are important changes of the populations along the vertical axis. Near the surface, where the gradients are more intense, the communities are arranged in well-defined bands or strips, an arrangement known as zoning

At the breakwater of Port Ginesta and all the other places on the rocky coast, we can clearly see the zoning of the communities arranged in bands parallel to sea level. They are the stages explained in the chapter "El sandy coast" and which we develop below for the specific case of the breakwater:

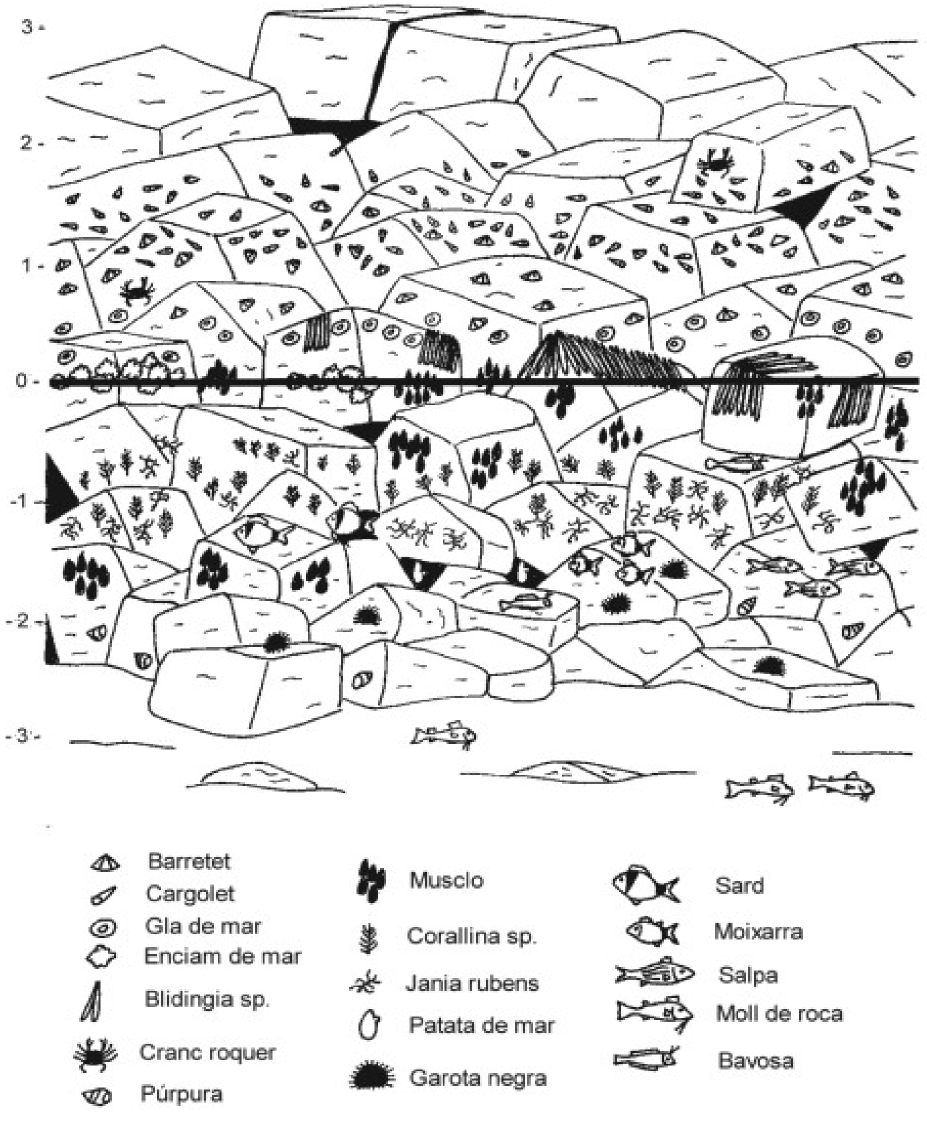


Figure 19.General aspect of the Port Ginesta breakwater where they are represented schematically some of its inhabitants.

Supralittoral stage

The characteristic of this area is that it gets very wet from time to time, only when the force of the waves makes the water reach, in the form of splashes, the species that live there. It is an area where marine organisms can withstand long periods of dryness. At the highest level, there is a belt formed by the black screwLittorina neritoidesand for two types of hat: thePatella caeruleaand thePatella caerulea subplana. Clamshells are molluscs with a single unbolted shell. Regarding their diet, they are strict vegetarians and this means that there is little presence of algae in this strip. When the weather conditions cause the sea to be calm, especially in anticyclonic periods of the summer, these molluscs close and tightly compress their shell against the rock, and thus keep inside the moisture necessary to survive during these periods .

Photograph 29.General view of the Port Ginesta breakwater.

A little further down you can see the cirriped crustacean Chthamalus sp.,calledsea acornThis species belongs to a group of sessile crustaceans, meaning that they cannot move. They live within a calcified exoskeletal structure, composed of several plates. Their limbs have developed respiratory functions and capture food particles, which come with the sea water. When external conditions are adverse, they can close the plates of the exoskeleton and withstand long periods of time without getting wet.

The isopods are also typical of this areaIdotea metallica,and the rock crab,Pachygrapsus marmoratus,although, as they are vagile species, they can move everywhere.

As a curious fact, it has been detected on the coasts of the Baltic and North seas, the presence of theIdotea metallicareplacing the populations of the native speciesBaltic IdoteaThe Mediterranean species reaches the northern beaches traveling on logs, plastics, bottles and other floating objects tossed up by the sea currents. It is believed that the small increases in temperature due to climate change have favored that theIdotea metallicacan be established perfectly so far north.

Mid-littoral stage

It is the area periodically wet by the coming and going of the sea water. In the case of the Port Ginesta breakwater, it ranges from 0 to 3 meters deep. In this stage we find the first primary producers: green algae Ulva sp.i Blidingia sp.Both are pioneer and opportunistic species and are usually very abundant in harbor breakwaters and in areas with high contributions of organic matter. theUlva sp.,commonly called sea lettuce,has the thallus laminar and curled at the ends, while the Blidingia sp.it has elongated and tubular thallus. In the summer season, it is easy to observe, in the wake of the water, large accumulations of small specimens of the rock musselMytilus galloprovincialis,that disappear when autumn comes.

Infralittoral stage

It is the permanently submerged area. Here it has been possible to determine both photophilous species or those that live in illuminated areas, as well as species that are typically sciophilous or from dark areas, due to the large number of cracks and holes that exist between the stone blocks. As depth is gained, the gradients of environmental factors such as temperature, light, hydrodynamics, etc., become smaller and biological communities become more stable.

We find again, in this area, the rock musselMytilus galloprovincialis,which covers a large part of the surface exposed to the light of the stone blocks, mixed with sea acornBalanus sp.and calcified red algaeCorallina sp.iJania Rubens

Other species that can be observed in well-lit areas are the black garota or sea urchin, theArbacia lixula,and the gastropod mollusk Thais haemastoma,the latter subject to poaching. In the cracks and holes that form between the stone blocks we can observe the ascidian Microcosmus sulcatus,calledsea potatofor its wrinkled appearance, and the bryozoanMyriapora truncataor coral bord. Both are suspensory species, that is to say, they feed on the organic particles in the water. It is also common to find the common octopus hidden in the spaces between blocks (Octopus vulgaris)which is also poached.

As for the fish, we observed the following species of sea slugs: the Parablenius rouxi,theParablenius gattorugineand theParablenius zvonimiri. All of them are fish that live on the rocks and among the algae, motionless, waiting for their food. Other fish, which we can see swimming both alone and in groups of a few individuals, are: the sardine (Diplodus sargus),the varied (Diplodus vulgaris),the salpa (sarpa sarpa)and, stirring the sand at the bottom, the rock pier (Mullus surmulentus).

Nevertheless, and in view of the lists of fish caught in Castelldefels in sport fishing contests, it is quite certain that other species also arrive at the breakwater of Port Ginesta in search of food or shelter.

Table 22.List of the most characteristic species of the Port Ginesta breakwater, distributed according to the different stages.

TAXON	SUPRALITAL	MEDIOLITORAL	INFRALITTORAL
Seaweed		Sea lettuce (Ulva sp.) Blidingia sp	Corallina sp Jania Rubens Colpomenia sp
molluscs	hat (patella caerulea) Black screw (Littorina neritoids)	rock mussel (Mytilus galloprovincialis)	rock mussel (Mytilus gallo provincial) Pop (Octopus vulgaris) purple (Thais haemastoma)
crustaceans	rock crab (Pachygrapsus marmoratus) sea acorn (Chthamalus sp.) Idotea metallica		sea acorn (Balanus sp.)
Bryozoans			Coral reef (Myriapora truncated)
Echinoderms			girl (Arbacia lixula)
Agreed			Sea potato (Microcosmus sulcatus)
fish			Sardinia (Diplodus sargus) Various (Diplodus vulgaris) Salpa (sarpa sarpa) Slug (Parablellnius zvonimir) white slime (Parablennius rouxi) capsicum (Parablennius gattorugine) Rock pier (soft surmulent)

Some recommendations on the vegetation of the beach

Castelldefels beach is not a homogeneous space. In its northern area, the vegetation is more similar to the model established for dune ecosystems than in its southern area. As a whole, it houses a good sample of the flora characteristic of the dune ecosystems of the Western Mediterranean, given that most of the species exclusive to these environments are represented. From the point of view of biodiversity, the value of this enclave is very high, since these are communities that have seen their numbers seriously reduced as a result of the urban pressure that the coast has endured during the last decades

The presence, abundant in some points, of the species should be highlighted Carpobrotus edulis,a plant of South African origin, widely used in gardening, which constitutes a serious threat to the native flora. In fact, the generic threats to coastal dune ecosystems are urban pressure, genetic isolation and competition from invasive species. On the Castelldefels beach, the urban pressure seems to have stabilized and the populations are of such an extent that it can be thought that there is no risk of genetic isolation. It is therefore necessary to avoid the risks arising from the introduction of foreign species into the beach ecosystem, a fact that certainly happens with some frequency, given the high number of gardens and urbanizations with gardens that are located near the beach .

Recommendations

Actions to improve knowledge of the vegetation on the Castelldefels beach

- Elaboration of a complete and updated botanical census of the vegetation of the Castelldefels beach.
- Establishment of several control points to carry out a follow-up and monitoring plan for the state of the plant communities on the Castelldefels beach.

Actions to combat the threat posed by the presence of theCarpobrotus edulis

- Preparation of a distribution map of C. edulis on the beach of Castelldefels.

- Development of a plan to monitor the evolution of, at least, the points where the species is most present and the points located in the areas where the native flora is best preserved.

- Develop a plan for the eradication of this species on the beach and its surroundings.
- Limit, by the legal channels that are considered appropriate, the presence of C. edulis around the beach, both in public and private actions.

Actions to recover native flora

- Study the feasibility of carrying out work to recover the native flora, through the planting of specimens and the sowing of seeds.

- In relation to this last possibility, try to create or promote the creation of a plant and seed nursery of the most threatened and most interesting species.

Disclosure and awareness activities

- Design and present in Castelldefels educational centers activities and routes that show the flora of the dunes, to try to integrate their knowledge and encourage an appropriate attitude of respect for this flora among the entire local school population.

- Study the opportunity and possibility of increasing the protection levels of the vegetation on the Castelldefels beach, especially in those points where the direct human impact may be greater.