SANDY COASTAL VEGETATION

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Summary

Sandy coastal ecosystems are severely threatened all over the Tropics due to their location near the ocean, ideal spots for tourism, recreation and summer homes. They also provide environmental services to man in the form of buffer zones against storm surges, reduced beach erosion, and recreation areas, among others. Therefore understanding the ecology of the organisms that inhabit these regions is extremely important if humankind is to conciliate the use of the environment with preservation of ecological processes so as to take advantage of the services provided by these ecosystems.. Our aim in this chapter is to describe what we know about various aspects of the vegetation of these sandy coastal plains. To form a backdrop for this scenario, we first define the landforms that underlie this coastal vegetation and the environmental factors that have the greatest influence on the plants. Then we stress the extremely heterogeneous nature of the underlying substrate and how this is reflected in vegetation physiognomy and structure. We also discuss variations in species diversity at various scales and how these plants are distributed geographically. Finally, we consider various conservation aspects of these ecosystems.

1. Introduction

Sandy coastal deposits are found on shores all over the world, from polar latitudes to the tropics. The forces that create, mold and destroy these deposits are basically wind, sea level oscillations and the presence or absence of vegetation. Time is also an important factor in this process, especially on prograding shorelines. A profile of these sandy deposits represents a time series, from young beach sands to older, often stabilized, inland deposits. Ecological zonation is clearly demonstrated on sandy coasts especially as one walks from the beach inland. The forces mentioned above create an extremely varied landscape, from tall dunes and beach ridges where the water table lies deep below the soil surface to wet slacks that lie between these dunes and beach ridges, some of which are permanently flooded. This variety is reflected in the diversity of vegetation types and relatively large numbers of plant and animal species that are generally found along the coast.

The plants of these sandy plains are grouped together in communities, or plant formations, that owe their special physiognomy to habitat conditions found at the site, to the kinds of species that have managed to arrive and become established locally, and to the length of time these species have been growing together, free from major disturbance. The long-term evolutionary history of the coastal plain during the Quaternary period and the kinds of ecosystems that occupy the surrounding landforms are two other factors that exert a strong influence on the vegetation physiognomy and floristic composition of each area of coastal plain. Coastal plains can be regarded as islands scattered along the coastline because they are often isolated within amphitheaters formed by coastal mountain ranges or rocky headlands, bordering on bays or coves. Or they may be isolated from other areas of sandy coastal plains by the estuaries of large rivers. Extensive dune fields often develop on low-rainfall coasts in the Tropics (e.g., Lençois Maranhenses, Brazil; Skeleton Coast of Namibia, Africa) and may extend for many kilometers inland. These often lie near a cold water upwelling that brings nutrients to the surface from the depths of the ocean, thus providing rich fishing grounds (e.g., coastal Peru; Cabo Frio region, Brazil).

Coastal plain ecosystems are seriously threatened because of their location beside the sea. Summer houses and seaside resorts spring up overnight in many parts of the Tropics, resulting in biodiversity loss, environmental disturbance and conflict-of-interest issues. Many countries have special coastal management programs, but these focus mainly on fisheries conservation, leaving much to be desired as regards preservation of plant cover. Coastal conservation units exist in many parts of the world, but they are often effective on paper only.

Here we present a description of the various types of plant communities that are found on sandy coastal plains and discuss the main environmental factors that influence the plants in these communities, what kinds of species are most common and how diverse are these communities, what is the geographic distribution of the majority of the species, and what are the most common threats to these habitats. But first we must define the landforms that underlie these coastal plain communities.

2. Landforms in Coastal Areas

The vegetation which we will be dealing with in this chapter overlies a variety of landforms or substrate types. These landforms, plus the prevailing regional climate, greatly influence the plant communities and so it is important to understand more about them.

Coasts are dynamic in nature, ever-changing because of a myriad of forces that act upon them. They are constantly evolving, and globally plate tectonics, or movements of the Earth's crust, contribute greatly to these processes as do relative sea-level changes. Remember that in the not-so-distant past (some 18 000 years ago), sea level was 100 m or more below present levels, and that during more recent times (some 5 100 years ago), sea level was 4-8 m above its present level. So the coastline we know today has migrated over considerable distances, especially in areas of low declivity. Sea-level rise in these areas inundates beaches and swales, and on some coastlines, may totally erode beach ridges. Older landforms of Pleistocene age lying farther inland at higher topographic levels are sometimes spared from erosion by rising sea levels, being found in coastal areas even today. So, coastal plant communities overlie sediments that vary greatly in age.

On low coasts, tides play an important role in coastal dynamics, as for example in the state of Amapá on the Brazilian coast. Here tidal amplitude is up to 12 m, one of the largest in the world. Another factor that influences coastline evolution is the sediment source, which may lie quite far inland (sediments brought to the shore by large rivers) or which may be close by (a broad continental shelf). Winds play an important role in the dynamics of coastal habitats, such as, for example, in forming waves that upon reaching the coast erode or rework the sandy sediments of the intertidal zone.

Changes in coastlines are largely the result of changes in sediment supply. The sediment source may have disappeared, such as when replenishment from rivers is interrupted or when sediments from the continental shelf have been transported to dune fields. Man's interference in coastal areas (attempts to "stabilize" the coastline, occupation of the narrow strip most affected by storms, etc.) also affects coastal processes and may cause the retention of sediments or the disappearance of the natural buffer strip that protects zones farther inland from storm surges.

The most common sandy coastal deposits are beaches, beach ridges, dunes, and strand plains. Beach ridges are long sandy deposits that run parallel to the coastline, often isolating lagoons in areas of shallow coastal waters, whereas dunes consist of wind deposited sediments that lie atop the beach ridges or strand plains. Mobile dunes are often found near the beach, where wind action is more intense, while dunes stabilized by vegetation usually lie farther inland, behind the mobile dunes.

3. Vegetation Types and Community Structure

As can be seen from the above, sandy coastal environments are characterized by environmental heterogeneity that is caused in part by geomorphological diversity. They are found on a variety of landforms and the plants that grow there are greatly influenced by oceanicity, that is, the influence that the ocean exerts on continental land masses. The resulting scenario is a mosaic of vegetation types.

The best approach to presenting these vegetation types is perhaps along the natural gradient from the beach inland. Here we have not only a gradient of factors resulting from the presence of the ocean (e.g., salt spray, wind velocity), but also a temporal gradient in the age of the substrate, which increases in this direction. On broad coastal plains this gradient may not be continuous in a sea-inland direction due to the presence, today or in the past, of rivers, estuaries, lagoons, or other landforms. In this case, the sequence of natural accretion processes has been interrupted, as for example by the presence of a former river bed (paleocanal) that reveals where a river once cut through the sandy ridges to reach the sea, or by the nonalignment of these very ridges that reveals the presence of strong erosive action during sea-level oscillations.

Near the ocean, plant communities on sandy deposits usually reveal a sharp zonation pattern subdivided into an outer pioneer zone and an inner dense coastal thicket. Plant communities farther inland do not necessarily follow a linear sequence across the dune field or strand plain. However, they are located along a gradient of increasing community complexity, that is, greater species richness and cover, taller stature, and greater biomass.

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Biographical Sketches

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