

Nature Watch

Symbiosis in Coastal Marine Communities

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The article gives a brief insight into the world of associations in the marine biome. Mutual co-habitation with plants and animals is witnessed among the lower as well as the higher groups of plants. In order for one to live, the other too has to survive. Hence, the dire need for conservation of India's marine coastal biome is also highlighted here.

Algae, plants and creepers in and around the sea perform vital environmental functions. They form different ecosystems according to changing land patterns. The sandy beach bears sand dunes (strand vegetation), marshy areas of the creek hold mangroves and the restless seawater flushes the algal community. Within each are embedded motile life forms – the animals! The byproducts of one organism form the life source for another. These organisms depend upon or simply co-exist with the plants. Thus is born a symbiosis between plants and their motile inhabitants.

Introduction

Shoals of fish swimming around the seaweed beds, slithering reptiles in the sand dunes and mudskippers climbing the mangrove trees – all witness the mosaic pattern created by flora and fauna in and around the outlets of the sea. A specialized symbiotic association exists in all the ecosystems. India has a 5,689 kms long coastline segmented into estuaries, beaches, rocky shores, cliffs, bays and creeks.

Wetland habitats comprise of mangroves, sand dunes and intertidal vegetation. Among all the marine habitats, mangroves [1] have been found to exhibit the maximum biodiversity. These areas are marshy in nature and are found in regions with estuarine influence. Open coasts (*Figure 1*), though, are essentially marine



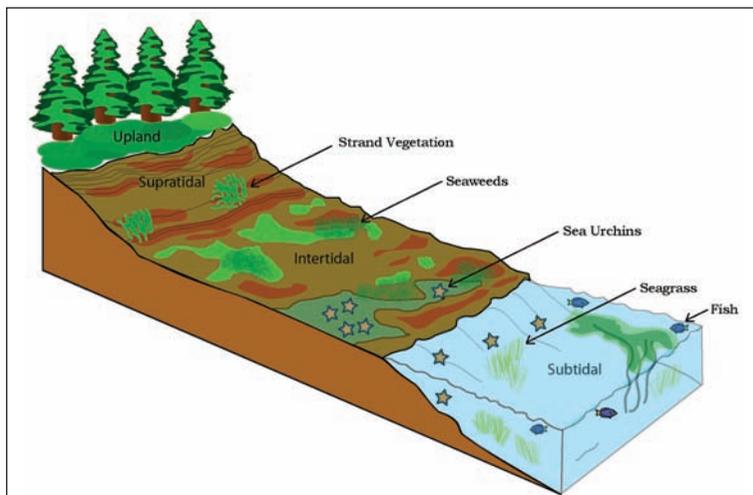
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Keywords

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Figure 1. Schematic showing the zonation of open coast.



and form a habitat for seagrass, strand and seaweed vegetation. Seagrass is unique in being a flowering aquatic plant. It inhabits the middle and lower intertidal zones and is known to support productivity in shallow coastal waters. On the other hand, surviving on the spray of sea water is the strand vegetation which is also known as coastal sand dune flora. Due to changing sea levels, the vegetation is adapted to mobile sandy substrates and saline environment. Relatively more stationary is the seaweed vegetation [2], which remains mostly confined to the rocky parts of the coast. Unlike other vegetation, seaweeds are seasonal in nature and belong to the thallophyta kingdom. Their growth is highly influenced by tides and salinity. Algae are known to form epiphytic¹ associations with mangroves and seagrasses. Besides symbiosis between animals and plants, the lower plant forms are also known to co-exist with higher groups of plants. These habitats offer immense ecological benefits to the environment and are also commercially important.

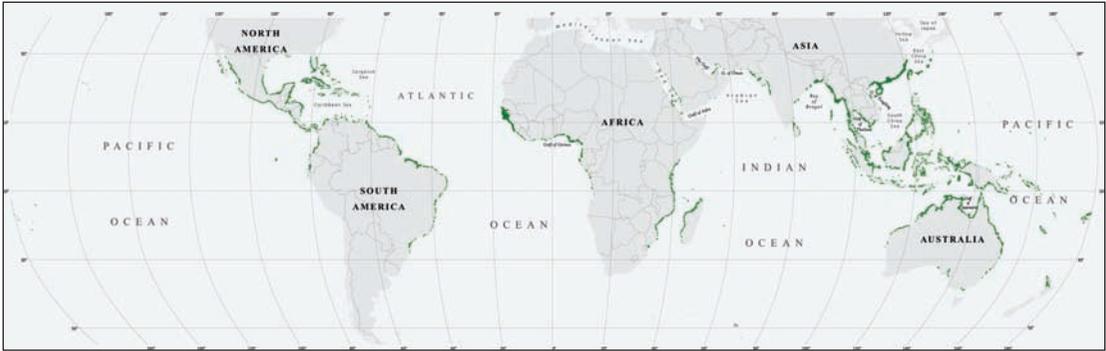
¹ A plant is said to be epiphytic when it grows non-parasitically on another plant. Algae grow as epiphytes on higher plants as well as other algae.

Association in Motion

Mangroves

The mangroves grow in a specialized environment between land and sea, in tropical and subtropical regions of the world. They occur worldwide [3] approximately between 25 and 28 degrees





north and south latitudes (*Figure 2*). Life forms in mangroves are well adapted to marine estuaries and bays. In India, approximately 59 species of mangroves are found. The east coast of India and the Andaman and Nicobar Islands show a higher species diversity as well as a unique distribution of mangrove flora. The luxuriant mangroves of Sunderbans, Bhitarkanika and Gulf of Kutch harbor a variety of animals.

Mangrove fauna can be broadly categorized on the basis of their region of habitat into littoral, intertidal and estuarine. However, a few animals inhabit more than one zone. The littoral or supra-littoral region above the high tide mark comprises of terrestrial environment. It includes aerial, arboreal and soil inhabitants [4]. Birds – both aquatic and tree dwelling (*Figure 3*) – form a prominent part of mangroves as they offer them rich feeding grounds. The tidal forests of mangroves provide an excellent habitat for water birds to roost, rest and nest. About 71 species of herons, egrets, ibis, eagles and flamingos, along with 24 species of waterfowls like pelicans, ducks and cormorants – resident as well as migratory – have been recorded in Kutch. These are the most commonly found birds. The green whip snake, bronze back snake and wolf snake are also found here.

The intertidal mudflat is home to vertebrates including marsh birds (sandpipers), aquatic

Figure 2. World map showing mangrove distribution. Courtesy: www.friendsofmangrove.org.my

Figure 3. Blue egret on mangrove. Courtesy: Stephen Whalen.



² Mudskippers are a species of fish that live along the coasts of the Indian and Pacific Oceans. These fishes are well-adapted to both air and water and climb trees with their modified fins.

snakes, estuarine crocodiles and fish like mudskippers². Flamingos flock to the exposed mudflats during low tides and prey on fish. Mangroves form breeding and nursery grounds for many fish. There are about 105 species of mangrove-dwelling fish in India. Fish like *chanos*, *mugil*, tilapia, milk fish, cat fish, perches and mullets are a common harvest from the mangroves. Besides harbouring larger animals, mangroves are a haven for molluscs and crustaceans. About 20 species of shellfish and 229 species of crustaceans belonging to Indian mangroves have been recorded. The rich deposits of detritus and silt in the mangroves are favoured by these crustaceans for feeding, refuge and breeding.

The invertebrate fauna are represented by gastropod and bivalve molluscs, of which *Crassostrea*, *Ellobium* and *Littorina* are the most common types. Commercial shrimp species like *Metapenaeus* and *Penaeus* are abundant. The mangrove crab (*Scylla cerata*), a large edible swimming crab, inhabits the muddy bottom of mangrove estuaries, as well as coastal brackish water. Another type of crab found in mangroves which is also semi-terrestrial in nature is the fiddler crab (belonging to the genus *Uca*). They are preyed on by mangrove snakes which enter the burrows of these crabs. Insect larvae, polychaetes, sea anemones and a host of microbenthic organisms also exist here.

There is a pleasure in
the pathless woods,
There is rapture
on the lonely shore,
There is a
society, where none
intrudes,
By the deep
sea, and music in its
roar:
I love man not
the less, but nature
more,...
– Lord Byron

The Olive Ridley (*Lepidochelys olivacea*) [5] is the most common sea turtle in Indian waters. The largest nesting site ever recorded is Gahirmatha near Bhitarkanika in Orissa. Other species of turtles are also found in India. Sea turtles are valued for their meat and shell. The Bhitarkanika sanctuary in Orissa is home to over 25 species of common, rare and endangered mammalian fauna such as hyena, jungle cat, spotted deer, sambhar, flying fox and wild boar. The Sunderban mangrove forest is known to be home to some rare species of animals. The water monitor (*Varanus salvator*), a gigantic lizard growing upto 3m in length, is found in similar habitat as the estuarine crocodile. It is known to prey on eggs of crocodiles and turtles. Due to over killing, it has become endangered in India. Another species diminishing in numbers is the crab-eating macaque. In India, it is



restricted to the Andaman and Nicobar Islands. The larger predator that preys on deer, boars and water monitors is the Royal Bengal Tiger (*Panthera tigris tigris*). The tigers in Sunderbans are protected under Project Tiger. About 28 varieties of mammals like tiger, chital, Gangetic dolphins and Malay dolphins are found in the Sunderbans.

Seagrass Community

The marine environment is full of surprises and so is the seagrass³ ecosystem – a marine meadow found in shallow coastal waters all over the world. The seagrass is the only flowering angiosperm that grows submerged in water. It occupies the sandy reef flat, binding the sand with a network of underground rhizomes. This marine biota is highly productive and forms a habitat for a large number of marine fish and invertebrates. They are actively involved in nutrient recycling, sediment stabilization, thereby protecting the ocean floor from erosion. Seagrass meadows are prominent in Tamil Nadu, along the southeast coast of India and the Lakshadweep Islands [6]. The seagrass flora in India is represented by 14 species of which *Cymodocea rotundata* is the most common. The habitat serves as a protective nursery (*Figure 4*) for a variety of fish, conch, lobster and turtle species. The seagrass foliage is home to micro and meio fauna like copepods, foraminifera, ciliates, hydrozoans, bryozoans, etc. The

³ Seagrass beds are known to stabilize the substrate and lower coastal erosion by reducing the force of waves. Being highly prolific, they act as a sink for carbon dioxide.



Figure 4. Blackspot emperor. Courtesy: Paul Asman and Jill Lenoble.



⁴Orissa, followed by Mexico and Costa Rica, forms the largest nesting site for the Olive Ridley turtles. About 600,000 female turtles visit the Orissa coast over a span of one week to lay eggs.

Olive Ridley turtle as well as the green turtle inhabit this submerged vegetation for food and come inland to lay eggs⁴. A herbivorous mammal known as the sea cow (*Dugong dugong*) is another inhabitant of seagrass that also makes an occasional visit to mangroves. It is on the verge of extinction in India.

Sand Dune Vegetation

On land, the turtles nest in the sand dune plants. The sandy mounds which are generally covered with creeping vegetation are known as the 'sand dune ecosystem' and are commonly referred to as the 'strand vegetation'. This ecosystem survives on the tidal spray of water from the sea. They are a natural defense from the sea, preventing storm waves from flooding low-lying areas as well as binding the sand to the coasts [7]. The sand-dwelling strand vegetation exists in the form of mat-forming creepers, erect herbs, climbers, scrubs and trees. Low-lying plants such as herbs and creepers are found in the sandy supra-littoral zone of the beach, whereas larger plant communities (shrubs and trees) are found beyond the beach.

The coastal strand regions are found in Gujarat, Konkan, Malabar (southwest coast), Coromandel – Ceylon (southeast coast), Utkal – Bengal (east coast), and the Andaman & Nicobar islands [8]. In India, 154 species of strand and its associated flora have been reported. Sand binders like *Ipomoea pes-caprae* and *Spinifex littoreus* (also known as Ravan's moustache) protect the sandy beach from erosion. The common toad, lizards and sand snakes often inhabit this area. Shore nesting birds like meadow pipits, skylarks and linnets are also abundant. A tour of the sandy beaches of Goa such as Miramar, Candolim, Colva, Morjem, and Arpora brings to fore the variable growth patterns of sand dune vegetation. The plants tolerate sand erosion, accretion and inundation. The animal component associated with dune vegetation includes rabbits, birds, small reptiles, insects (adults and larvae) and nematodes. Turtles often visit coastal sand dunes for breeding (*Figure 5*). A variety of strand plants such as the *Mucuna* and the *Sesbania* are useful as food or fodder. Seeds of the *Sesbania*



are known to contain minerals, essential amino acids and essential fatty acids. The oil of *Sesbania grandiflora* is medicinally important and other species of *Sesbania* are used in making biofuels.

Seaweed Zone

The most important marine resource with numerous applications is the marine alga. Till date, more than 800 species of seaweeds have been reported from the entire coastline of India and they are large contributors to the process of primary productivity. Being seasonal in habit, seaweeds are highly variable in growth patterns as opposed to other coastal vegetation. The algal ecosystem consists of the planktonic⁵ as well as benthic algae [9]. The benthic algae grow in the intertidal zone of the seashore. Sponges, ascidians, sea cucumbers and sea anemones are associated with filamentous and coralline algae. Deep-water dwelling algae such as *Sargassum* and *Stoechospermum* co-exist with sea urchins, brittle stars, crustaceans and polychaetes. Species composition and diversity of fauna depends on the shape, size and distribution of the algae on shore. Smaller organisms belonging to amphipods, bivalves, tiny crabs and other crustaceans are often seen embedded in the thalli of *Porphyra*. While smaller forms of crustaceans and mollusks seek shelter on the thalli of *Padina*, *Gracillaria*, and *Ulva*, larger gastropods have been found to anchor to filamentous algae such as *Chaetomorpha* (Figure 6).



Figure 5. Sea turtle laying eggs.

Courtesy: David Danzig.

⁵ Free-floating or drifting algae are referred as planktonic algae or phytoplanktons. They are primary producers and reside in pelagic zone of the ocean. They can grow upto depth of 200 m in the ocean. On the other hand, benthic algae denote algal forms that are attached to the substratum. They are capable of growing upto 20–40 m depth till the extent of availability of sunlight.



Figure 6. *Chaetomorpha* on gastropod.



Both macro and microalgae are consumed by grazers and filter feeders, which are ultimately passed down the chain to decomposers. The accumulation of nutrient-rich sediment provides a substratum for benthic algae.

Consequences of Habitat Destruction

Mangroves play an important role in carbon sequestration by trapping carbon in their biomass. In addition, they support major fishing activities along the shore and are essential for the growth of corals as they help in trapping land-derived sediment from entering the corals. Consequently, destruction of mangroves has led to a coral decline. Mangroves play an important role in absorbing pollutants. They are crucial in stabilizing the shoreline and perform the critical function of protecting the shore from storms, hurricanes and floods. However, rapid urbanization has led to deforestation of mangroves in coastal cities. Mangroves are destroyed to create aquaculture ponds, which eventually make way for new construction. Classic examples of mangrove degradation are found in Mumbai and Kolkata. Rapid rates of deforestation have led to an increased amount of sedimentation in the human settlements and cultivation areas. In addition, uncontrolled growth of rural population and their dependence on fishing have led to over-harvesting of juvenile fishery resources. These factors have a negative bearing on the health of coastal plant communities.

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Destruction of habitats invariably leads to a decline of its inhabitants. Some globally threatened birds like the spot-billed pelican, painted stork, black-headed ibis, Eurasian spoonbill and the lesser flamingo are reported from some of the protected marine areas of India. Most of these ecosystems are on the verge of getting damaged. Some of the seaweed species found along the Mumbai coast have vanished due to increased pollution. Anthropogenic activities have led to depletion of strand vegetation. It has been uprooted to make way for beach shacks in Goa. Dredging, boating activities, increased sedimentation and pollution pose a threat to seagrass communities. Such destructive activities can



have serious implications to the dependent flora and fauna.

Sustenance of these resources requires implementation of policies, laws and conservation strategies. The Coastal Regulation Zone Notification of 1991 plays a crucial role in protection of mangroves as they are considered eco-sensitive and categorized in CRZ1. People's participation, afforestation activities, education and training can go a long way in achieving the goal of protection and conservation of marine areas.

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Suggested Reading

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Every creature is
better alive than
dead,
Men and moose and
pine trees,
And he who
understands it aright
will rather preserve its
life than destroy it.

– Henry D Thoreau

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