Coral Reef

Coral reef biome

Microscopic builders

The barrier reef or simply “reef” is one of the ecosystems with the highest number of species in the world. It is a wide and massive calcareous formation of animal origins with myriad colours and shapes. Responsible for the building of this biome are *madreporic anthozoa*, also known as the 'builder corals".
Corals or madrepores are composed of small polyps of differing sizes (from few mms to a few cms) surrounded by a calcareous calyx called “corallite” which looks different according to the species. Each polyp hosts unicellular algae called “zooxanthellae”, which give them a brown-greenish colour. This particular combination is called ""mutualism", i.e. both species benefit from living together. The algae, through the **photosynthesis of the chlorophyll**, supply the polyp with energy in the form of sugars, produce oxygen and remove carbon dioxide (which could form carbonic acid and damage the calcareous skeleton of the polyps). In return, the polyp offers protection to the microscopic and numberless algae. Every square centimetres of the madrepore can contain up to one million zooxanthella algae.
The reefs are composed of calcium carbonate (CaCO3) used by the coral polyps to build their own Coral formations develop mostly between the water surface and a depth of thirty metres. They need three environmental conditions to grow:

- a mean water temperature above 20℃ in winter
- constant salinity
- plenty of light.

Only in these specific conditions can the corals grow and reproduce. Some species (such as the brain coral) grow between 5 and 25 mms a year, others (such as the antler coral) grow much quicker, up to 10-20 cm a year.
The reef is an ever-growing ecosystem since new polyps grow on the old ones that die and so the surface area is always composed of live corals

The coral reef in the world

Reefs are only in the Tropical seas and cover a total of approximately 600,000 km^2. The areas with the largest reefs are three:

- the Caribbean
- the western islands of the Indian Ocean
- the Asian-Pacific area.

The latter area is the richest in corals species, with peaks in the Indonesian islands, the Philippines and Northern Australia, while the Indian Ocean and the Pacific have fewer species. There is no relation between the number of coral species and the size of the reef; most of the massive reefs and atolls of Polynesia consist of less than fifty species, versus over five hundred in the Borneo or the Philippines.

Coral inhabitants

Extraordinary algae and plants
The coral structure offers a surprising variety of habitats for plants and animals. In addition to the algae that live within

corals, the vegetal world also includes a large number of red algae, such as the encrusting alga Porolithon of the Asian Pacific area or some green algae, such as the Caulerpa. It has been calculated that 1-5 kgs of algae per square metre are produced every year in the reef. Lagoons and sheltered sandy areas are also home to such water plants as the *Thalassodendron*, which forms underwater prairies like those of the Mediterranean Posidonia, a plant loved by sea turtles as well.

Colourful inhabitants of the reef

Very many are the herbivore animals feeding on the plants that grow in the reef: sea urchins, crustaceans, molluscs and a number of species of fish. Parrot fishes (so called for their strong beak-shaped mouth) and surgeon fishes (so called due to the presence of a lamella as sharp as a scalpel on their tail) are the main herbivores. The mouth of the parrot fish is specialised in taking seaweed off the coral surface, leaving unmistakable marks of their passage. In this way, they also take off the surface layer of the calcareous skeleton, which, undigested, is then expelled in the form of coral sand.
Other big coral eaters are the prickly starfish *Acanthaster;* if many individuals of this species concentrate in one area, they can seriously damage the reef.
The sea worm *Hermodice caruncolata* that lives in the Caribbean can devour one square centimetre of coral in an hour; the lionfish too (such as flag lionfish) mainly feed on coral polyps and other small animals they find amidst the cracks and hideouts that the barrier offers. These fishes have small protruding mouths that, like tweezers, can reach into the narrowest cracks. Many other fishes have mouths like these, such as the angelfish, the beautiful *Zanclus canescens* (similar to the lionfish), some file fishes and many others, all predators of small invertebrates.
The crossbow fish, the globefish and the porcupine fish take off pieces of coral, instead, using their strong mouths.
There are also coral fishes that feed on plankton or waste; but most are predators. Large animals are in the open sea, in front of the reef, such as the large green turtle (*Chelonia mydas*), very many species of sharks and the devilfish (*Manta birostris*).

Odd invertebrates

This particular ecosystem also includes colourful and quirky invertebrates. Sponges certainly are one of the most important invertebrates of the reef. They feed on food particles carried by the water which are filtered through many tiny pores. The larger holes are instead the so-called "oscula", from which the animal drains filtered water. The reef sponges exhibit incredibly different shapes, sizes and colours.
There are very many holothurians, also known as "sea cucumbers" because of the shape of their body, with species that can be over one metre long or short and colourful. Starfishes are also brightly coloured in this ecosystem, for instance the garish blue-purple *Linkia esatentacolata*

Different barriers

We generally speak of "reefs", but this term is general. There are instead a number of coral formations with different origins, shapes and relations to the mainland.

Surf barriers

Surf barriers look like coral belts parallel to the coast; they get bigger as they are farther out to the sea and are linked to the coast by an internal flat reef. Its actively growing part is in the area of the barrier that looks onto the open sea because the environmental conditions (light, oxygen, food) there are more favourable to the growth of corals; on the contrary, the shallowness of the internal areas increase the temperature, salinity and the sediments that reduce the growth of the corals.
Surf barriers are typically to be found in most coastal reefs in the Read Sea, Eastern Africa and the Caribbean.

Shelf barriers

Shelf barriers develop parallel to the coast, but, unlike surf barriers, are not linked to it.
They can also be in the open sea and grow in all directions, with different shapes. They start to grow as small barriers; then, the seabed starts to sink so the corals may grow vertically. When completely developed, this type of barrier may extend into a grid of reefs and islets, separated by lagoons and canals formed by the currents, waves and winds.
Barriers like these can be found in Australia, for instance the Great Reef, in Papua-New Guinea, off the New Caledonian coast, in the Fiji islands and off the coasts of Belize and Bahamas.

Atolls

The term 'atoll' means a coral formation encircling a round lagoon; the term actually comes from the Maldivian “atholu” which means "islands arranged in a ring".

These madreporic structures generally occur in deep oceanic waters at the level of ancient submerged volcanic islands. Most atolls are in the Pacific, but there are some in the Indian Ocean as well. Some countries consist only of atolls, for instance the Maldives.

Invaluable richness

The "reef" biome serves many different functions. Barriers are actually the ideal place for fries (i.e. the young fish before adulthood) to be born and grow, then they will become the population of adult fish that will be fished in the oceans across the world. In developing countries, 20-25% of the catch (approximately 10 million tons a year) live in reefs. In the Pacific area, 90% of people's protein intake comes from fishing on the reef. In Asia, the lives of one billion people depend on the fish living in the reef. It has been calculated that, if properly managed, just one square kilometre of reef could supply approximately 15 tons of fish and other food every year.

Corals could be useful in other fields as well, for instance medicine. The first studies on corals proved that one half of the new anticancer drugs could be extracted from these marine organisms.

Another important function of corals is the protection of the coasts. The structure of the reef actually mitigates the violence of the tropical waves and hurricanes. Without this protection, the coasts would be damaged, and the fish and prawn farming which is spreading in Tropical countries would be destroyed.

The real wealth of the reef is however **bio-diversity**. Until today, approximately 4,000 species of fish and 800 species of coral have been classed, and it has been calculated that between 1 and 9 million species of vertebrates and invertebrates live in or somehow benefit from the reef.

The naturalistic value of this ecosystem cannot yet be estimated in economic terms, but researchers are certain that the loss of species, that in the reef has been estimated to reach one million species over the next 40 years, will affect the stability of the ecosystems and therefore man's life.

The origin of coral reefs

The oldest finds of reefs date back to approximately 500 million year ago.

Back then, waters with a mean temperature of 20°C co uld be found up to a latitude of 40-45 degrees north and south. In the Palaeozoic age (560-290 million years ago), reefs covered a surface of 5 million square kilometres and had an extremely high rate of vertical growth (up to 200 ms per million years).

Approximately 360 million years ago, there was a period of approximately 4 million years during which reefs were reduced to 1,000 square kilometres, disappearing nearly everywhere. The causes of this change were the decrease in the earth's temperature and the collision of the ancient super-continent Gondwana with the North-American shield, which caused the sea current to change.

From then on, the movements of the earth's crust and the climatic changes continued to affect, alternately, the growth and destruction of reefs. A new sea, the Thetis, formed in the Mesozoic age (approximately 260 million years), extending east to west and joining together the Atlantic, the Mediterranean, the Indian Ocean and the Pacific, and this change led to a new development of the reefs.

The Mediterranean, a sea that today has no reefs at all, used to have the largest number of corals, being home to 65 genera versus the approximately 30 genera living in the entire Atlantic today.

Around the end of the Tertiary (25 million years ago), the Thetis split up under the pull of the continental drift and today's oceans rose, affecting the distribution of reefs all over the world. Madreporic formations moved towards the Indo-Malay region, after the Mediterranean Thetis had closed up, and India moved closer to Asia.

In the Pliocene (11-14 million years ago), the reefs of the western Atlantic also grew apart from the Asian Pacific area because of the appearance of the lands that later on would have become Central America. The two main coral regions that still exist today were born during this era: the Caribbean and the Indo-Pacific.