

Rain forest

Rain Forest Biome

What is it?

All tropical or rain forests were originally woods located between the Tropic of the Cancer (23° and 27' N) and the Tropic of the Capricorn (23° e 27' S). This area typically has a mean temperature of approximately 25°C with oscillations of no more than 2-3 degrees and plenty of rainfalls (over 1,500 mm a year). In some forests, the annual rainfall may reach 11,000 mm, even if in most areas it is around 2,500 mm. The best word to describe this forest actually is "rainforest". In some forests it rains little but every day (rainforests or equatorial forests), while in others (in the south-east of Asia) dry and rainy periods alternate (tropical or monsoon forests). Nevertheless, for the sake of clarity, the terms "rainforest" and "tropical forest" will be considered as equivalent.

Tropical forests in the world

Tropical forests, or rainforests, occupy the so-called inter-tropical area of the planet, that is the area between the Tropic of the Cancer and that of the Tropic of the Capricorn.

Large rainforests are mainly in Latin America (Amazonia) where they are called selva, in Africa (Congo, Cameroon, Madagascar, etc.), in the Indo-Malay area (Philippines, Indonesia, etc.) where they are called "jungle" (from the Sanskrit *jangala*) and in the Australian area (Australia, New Guinea); altogether, they cover 10% of the lands above sea level. Among these, the Amazonian forest makes up approximately one third of all the tropical forests and is the greatest freshwater reserve on earth.

Characteristics of the tropical forest

Because of the lack of seasonal differences, due to the geographical location of the forests, and the high humidity level the vegetation is luxuriant here. The recurring features of rainforests are basically the following:

- high animal and vegetal biodiversity
- evergreen trees
- dark and sparse undergrowth interspersed with clearings
- scanty litter (organic matter settling on the ground)
- presence of "strangler" creepers (e.g. *Ficus* spp.)
- presence of "buttresses" (i.e. large winged ribs at the base of trunks) and spindly roots in trees living in often-flooded areas.

A thick forest

The foliage of trees are very close to each other and form a very thick canopy.

Only approximately 1% of the light that gets to the canopy reaches the ground and so the lower branches are too dark to let leaves develop and there's virtually no undergrowth. In particular, there are very few herbaceous species.

Moving up from 1 to 20 m above ground, we still find a moderate light (approximately 5%), high humidity and no wind at all. This means there are very few plants with anemogamous pollination, which means pollinated by the wind. Flowers have very bright colours and a strong scent to attract insects, winds or bats for pollination. Many plants have *cauliflora*, which means "flowers on the caulis" or stalk. In this case, flowers sprout straight from the naked stalk and not from the

leaves, so that they are more conspicuous. An example of this particular phenomenon is the cocoa tree, whose flowers, stuck to the stalk, turn into big fruits, which are picked by the monkeys and rodents and eaten far off. In this ecosystem, leaves are generally large and oval, but in most cases they have a down-turned tip at the end, called *drip-tip*, to let rainwater flow down. Prolonged exposure to humidity is actually harmful for the leaves, since it promotes the growth of epiphylla (generally mosses, lichens, algae and mildews growing on the leaf surface).

Most of the plants of this ecosystem are approximately 30-40 m tall (as tall as a 12-storey building). The stalk of these plants is as straight as a pillar up to 20 m, then suddenly branches off into a crown of leaves. The leaves on the canopy are in full light, with not too much humidity and some wind: these leaves are therefore quite small and do not have down-turned tips.

The animals of the tropical forest

There are three essential aspects of tropical fauna:

- huge number of different species
- few individuals per species
- wide variety of survival strategies, morphological (i.e. different body shapes) and behavioural adaptations.

For instance, in the French Guyana alone there are 76 different species of snakes versus approximately 20 in Italy; this figure could lead us to imagine that in this forest one would literally tread on a tangle of reptiles. In fact, despite the huge number of species of snakes, they are so few one could walk for miles in the forest without seeing any.

Animals of the canopy

The great vertical development of the vegetation forced many animal species to adapt to move on trees and in the air to reach many sources of food, such as leaves, flowers, seeds and fruits that are in the tall foliage.

In some tropical areas (for instance in Borneo), the arboreal species make up 45% of the total amount; in temperate forests, they are only 5 – 15%. The morphological adaptations developed by some species include: prehensile tails, extremely developed muscles, claws that have a grip on trunks and branches (for instance the arboreal pangolin, *Mamis* spp. in Asia and Africa).

Birds of the canopy

Birds, such as, for instance, the *Ara macao* parrot, have adapted to fly in a thick and tangled environment: short and rounded wings, long tails to orient themselves better.

Under the canopy and on tall branches there are monkeys, sloths with large, strong nails they use to hang from branches, small birds feeding on nectar (hummingbirds in America, sunbirds in Africa), many-coloured birds (toucans, parrots, birds of paradise), arboreal snakes, large butterflies, bats (flying foxes).

Gliding birds

The so-called "extreme" adaptations to arboreal life are the "flying" species that are for instance in the Borneo forest: these species have a membrane stretching from their body to their upper limbs forming a surface large enough to hold the animal as it flies. In addition to the many species of flying squirrels (*Petaurista* spp. and others) inhabiting other regions as well and the flying lemur or cynocephalus (*Cynocephalus variegatus*), there are also a flying tree frog (*Racophorus nigropalmatus*), a flying snake (*Chrysopelea pelias*) and a flying lizard (*Draco volitans*). These animals are all provided with membranes and protrusions that let them glide from the forest foliage. They cover considerable distances: approximately 50 metres for a snake and over 500 metres for the Cynocephalus.

In this biome, there are comparatively few large mammals. Unlike those of savannahs, they do not live in packs nor hunt together, but live alone or in pairs.

Amidst the luxuriant vegetation, the field of vision is very limited and this is why many animal species rely on their sense of smell and hearing rather than on sight (especially insects, birds, frogs, pro-simians and monkeys).

In the tropical forest, most animal activities take place at dawn, at dusk and at night, when such animals as bats, tree frogs (*Dendrobates* spp.) and lemurs start to come out and fill the forest with all sorts of noises.

Life in the shade

For each forest layer, there are different habitats and therefore different animals, apart from a few exceptions, such as, for instance, insects that can be found on the ground, on the foliage or in intermediate layers.

Starting from the ground and going back up along the different layers through to the limit of the tallest foliage, we can find animals adapted to different habitats.

The soil of the tropical forest typically has a scanty hypogean flora (of the subsurface); there are actually very few earthworms and the most common underground larvae are those of cicadas and coleopters feeding on plant roots and sap. One can often find small mounds of loose earth with a tunnel in the middle: this is what remains of a cicada larva that, after a long wait, that in some species may take longer than 10 years, comes out to metamorphose by clinging to the base of a stalk and emerging from its cocoon after a short while. Unlike the long underground life, winged life seldom lasts more than a year.

The animals that are on the forest floor are mainly fossorial mammals (rodents and armadillos), terricolous monkeys, boas and pythons, frogs, fowls, leopards and jaguars, snails and ants, spiders and scorpions.

The lungs of the world

For over one hundred million years, the tropical forest has played a crucial role: it serves an extraordinary and relentless biological and geopedological function which is absolutely necessary for men and animals to survive. Firstly, the trees protect the ground from the erosion of the rain and have a role in the earth-air circulation of water. Transpiration is a way to transfer water from the ground to the air: this occurs through the pores of the leaves, the stomas. In a forest with a thick vegetal covering, more than 80% of water leaves the ground through transpiration. The water vapour thus produced by the tropical forest and dispersed in the air keeps the climate wet and promotes the growth of vegetation. In addition, the trees take carbon dioxide, one of the gases responsible for the greenhouse effect, from the air. Through the photosynthesis of the chlorophyll, the plants, by using energy from sunlight, fix carbon dioxide and release oxygen. Another function of this ecosystem is that it acts as a laboratory for the development of species. Many varieties of plants, shrubs, mosses, fungi, slowly develop to occupy the small interstices of this ecosystem. This results in a great diversification. For instance, this forest has over 300 species of birds and its flora is equally plentiful. And moreover, the Amazonian basin is the largest freshwater reserve on earth (approximately one fifth of the freshwater existing on earth).

Many different species

The exact number of species living on Earth is unknown. Some studies suggest there must be between 10 and 50 million living species and of these, only 1.5 million have so far been classed. Overall these figures are named biodiversity (diversity of life). The word biodiversity is used to describe the number and variety of organisms living on Earth. It is defined in terms of genetic inheritance (concerning the variation of genes between species), species (concerning the variety of species in a region) and ecosystems, which are the result of over 3 billion years' evolution.

Even if the tropical forest is one of the places that has most been degraded by man in the 20th century, it still has one of the highest biodiversities. It has been estimated that over 50% of the biodiversity of the biosphere is located in this ecosystem, which covers just 7% of the Earth: 43 different species of ants have been observed on one tree of a Peruvian wildlife sanctuary, as many as all over Great Britain. 700 species of trees have been counted in 10 1-hectare forest areas, randomly selected in the Borneo, approximately the same number as all over North America. In an area as large as just one half of San Francisco, there are 545 species of birds, 100 species of dragonflies, 729 species of butterflies. This remarkable variety of animal species, such as birds, may be partly accounted for by the fact that each subspecies tends to live in a specific layer of the forest.

Over a few thousands of years, there have been 5 different mass extinctions, the most famous being certainly that of

dinosaurs that took place approximately 65 million years ago. Today, we are seeing species disappear at a slow but constant rate because of man, whose pace is remarkably faster than the natural one.

The origin of tropical forests

Until last century, tropical forests were larger than they are today. Fossil finds prove that forests developed in the Tertiary period (between 65 and 2 million years ago) in south-eastern Asia and their flora was not different from today's. Some aspects of their structure in the late Pleistocene (after the last glaciations, 10,000 years ago) have been explored by palaeontology (the science that deals with ancient living beings through fossils) and bio-geography (the science that deals with the geographical distribution of living beings on the earth's surface and its causes). The past of this ecosystem is now being investigated through fossil pollens and phytolites (mineral inclusions in leaves, stems and fruits).

The largest tropical forests probably extended in the post-glacial area. The study of the past and current diversification and distribution of the living species suggests that in the Amazonian area there must have been stretches of forests running through the prairies; when these "strips" of forest joined together, their species spread to other areas and the forests achieved today's biological diversity.

In distant ages, the tropical forests covered northern countries as well, including the Thames valley in the UK, which was rich in tropical flora and fauna. The succession of climatic changes made it disappear, while at the tropics the tropical forests survived and extended.

Carbon sequestration

Forests help to remove carbon dioxide from the atmosphere and transform it, through photosynthesis, into carbon, which the forests then "saved" in the form of wood and vegetation. This process is called "carbon sequestration". Generally, approximately 20% of the weight of trees consists of carbon, and the entire biomass of the forest acts as a "carbon absorption tank". Also the organic material in the ground in the forests, as for example humus that derives from the decomposition of dead plant material, acts as a carbon tank. In this way the forests can capture and store enormous amounts of carbon. In fact, according to FAO, the forests of the planet and their undergrowth absorb a total of over a trillion tons of carbon, twice as much as the amount found in the atmosphere. In the balance between emissions and absorption of carbon dioxide, an ecosystem is considered a carbon sink when it absorbs more carbon dioxide than the amount it emits. Instead, an ecosystem is known as a carbon source when it emits more CO₂ than what it absorbs. Carbon sequestered from the biomass is known as carbon stock.

In a forest, carbon is stocked in compartments:

- epigeal biomass, i.e. the live organic substance above ground;
- hypogean biomass, i.e. live organic substance underground;
- necromass, i.e. dead organic substance in wood;
- litter, i.e. the dead organic substances on the surface of the ground, such as branches, leaves and animals;
- organic substance in the ground.