What actually is rain forest?

What does it take to convert forest to rain forest?

Tropical rain forest in the true meaning of the definition can only be found in the ever-wet regions above and below the equator. In other words, there where it is continuously warm, where precipitation occurs throughout the year with an annual rainfall of more than 2000 millimeters and where the dry period only lasts a few weeks.

The Asian monsoon forests, on the other hand, are marked with annual dry periods lasting several months. The rain forests of northern regions like in Canada are subject to even more distinct climatic changes. In addition, they also contain less species than their tropical counterparts. The manifestations of tropical rain forests reach from mangrove forests in coastal regions to lowland/heath-land to mountain rain forests which, for example in New Guinea, can grow at an altitude of 3000 meters. Characteristic are the enormous height of the trees and the segmentation of the vegetation in several levels. On the very top in the crown-top exists a much more dry micro-climate than in lower levels, specially when compared to the “ground floor” where sunlight hardly comes through. Typical, too, is the coverage with climbers, creepers and epiphytes. More than half of the world’s existing animals and plants are indigenous to the tropical rain forest which forms a highly complex eco-system of mutual dependencies and nearly closed cycles.

How does the rain come into the forest?

Only a fourth of the rainfall oozes away into the ground and reaches the river systems. The rest is absorbed by the roots of the trees, then pumped inside the trunk to the treetop. There it evaporates through the capillaries of the leafs. Because the luxuriant foliage of the rain forest forms one large evaporation area, the sweating produces an enormous under-pressure in the veins of the tree trunks, thus acting like a pump engine. In addition, the evaporation produces a bearable temperature in the forest, during with the process cools down the environment.

Over the treetops the ascending vapour turns into clouds which, in turn, produce rainfall for the trees. This is how the rain forest maintains its special water cycle. The water only reaches the “normal” big circulation after an average of seven cycles: the rain flows via brooks, creeks and rivers into the sea. There it evaporates and in the form of clouds reaches the land again, driven by winds.

How do the termites build their artistic homes?

Termites live in caste states where labour is divided. A nest compromises approximately 5000 individuals, some species even have one million. The single insect only functions in that state as part of its entirety. Only by the co-operation of all inhabitants, these insects build their complicated nests. The termites build the most spectacular constructions in the African savanna: gigantic towers with ingenious ventilation systems. Nose-termites, a common American species, build their ball- or egg-shaped homes with diameters up to two meters in trees or underground. For construction material, the nose-termites use chewed timber with saliva and excrements. By using this pasteboard-like batter they create rooms for the regal couple and their offspring, a labyrinth of corridors and a protective hull against the outside environment. Moreover, they make long tunnel-like structures. In the protection of these, the insects reach their feeding places – directly from the main nest. By the way, not all termite species eat timber. A lot eat dead foliage and a lot nourish themselves from substances in the soil or manure. For tropical soils the termites are of similar importance as the earthworms in our latitude (Germany, etc.): they loosen the ground. Because they decompose the plant parts indigestible for most other animals – thanks to microscopic, symbiotic unicellular organisms and bacteria – they accelerate the nutritive substance cycle. If a nest is damaged somewhere, the termite soldiers hurry there and beat back the intruder by using their sharp biting tools. The soldiers of the nose-termites spray their enemies with a gluey, stingy secretion: not always with success. Termite constructions apparently invite certain animals (ants, trogons, parrots, even small mammals) to use them for their own nest – and/or to eat their builders.

What has the Amazon rain forest to do with the Sahara?

As incredible as it sounds: the African desert manures the rain forest in South America. The trade-winds drive whirled-up desert sand towards the west. Massive thunderstorms over the forests of the Amazon region virtually suck them in. There, the rain washes it out again into the atmosphere. The dust and sand particles consist of fine pulverized rock as well as residue of dead plants and animals. They are also rich in organic substances, minerals and trace elements. More than 500 million tons annually are transported from Africa to South America

The nutritive substance cycle in the tropical forest is indeed narrowly closed; but still losses occur which add to substantial amounts because of the enormous areas. These loses are specifically compensated by the dust from the Sahara. Some scientist speculate that the respective expansion of the South American rain forests in the past millions of years directly depended on the fact that, due to climatic changes, the Sahara actually expanded or shrunk.

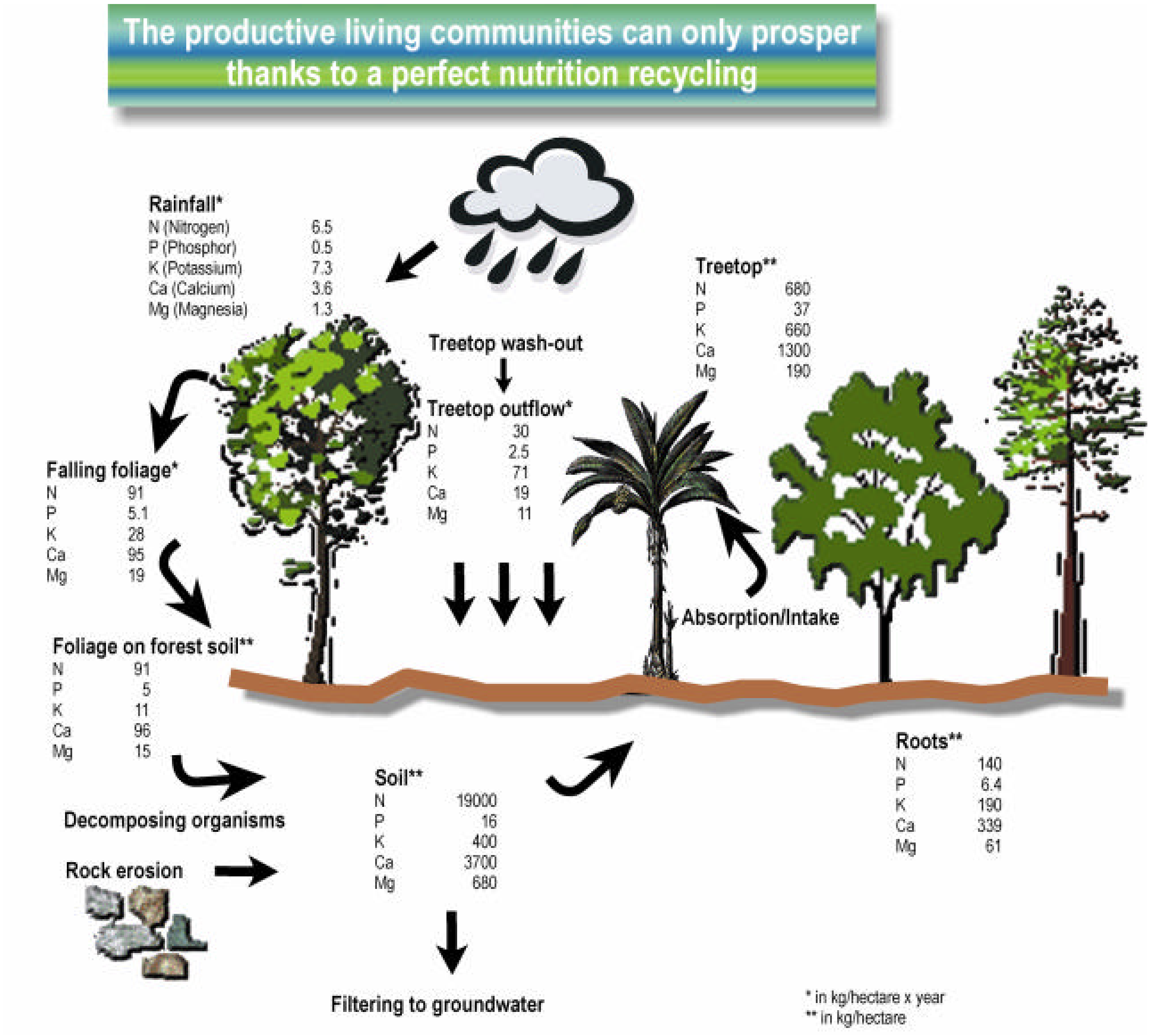
Why do such eye-catching fruits ripen in the rain forest?

Fruits surround the pollinated seed until full ripe and even then only serve one purpose: to help the dissemination. In moderate climate regions most seed plants are packing their genetic future in light, dry fruits. Capsules, husks or shells which will open once and sow the seed in the wind. In the rain forest, on the other hand, most seed plant species – specially trees – form edible fruits: nuts, berries and other juicy products with nutritious flesh. Glaring colours and intensive smells promise desirable energy supplies like sugar and starch which can be produced by the plants without a big effort. The production of protein, fats and vitamins for the seed, however, requires a lot of energy from the plant. To make the effort affordable, to ensure that as many germinable seeds as possible survive, the plant must protect the seeds from being chewed or disintegrated by digestive juices. Therefore, the seeds are often surrounded by a hard shell which the animal immediately spit out or excrete with their excrements.

On the other hand, some tropical tree species form seeds which require to be digested. These seeds have a protection husk which hampers the germination capacity. This husk has to be dissolved in the stomach or intestines of the animal species who is specialized for the fruits or the respective tree species. Only then, the seeds can germinate.

Why do we find so much richness on such meager soils?

Astonishingly the highly productive rainforest community of life grows often on sandy, unfertile soils. That such an abundance can thrive in such scarcity is based on the climate which offers full-year growth. Fungi, bacteria and other creatures living on soil are decomposing dead plants and animals fast – five to ten times faster than in mid-European forests. The trees immediately take the decomposed products in through their roots and lead them to where they are needed. In the forests of the temperate climate zones, however, the nutrition supply is stored as humus on the ground. The plants in the rain forest have adapted themselves to the relative lack of nutrition in various manners: some live as parasites on other plants and draw of their juices. Epiphytes, on the other hand, use branches only as surface to be nearer to the sun. For example, the Aron-rod plant catches both rainwater and therein contained nutrition by using its specially formed roots. Because as the rain drips down through the green forest levels, it continually filters out minerals. The epiphytical bromeliads and the nest ferns maintain their own little biotopes which they supply with nutritive substances. In the middle of their leafs they collect dust-laden rain water in miniature pools. In the water live algae, bacteria and organic unicellular organisms who decompose foliage and other dead plant material. These micro-organisms serve as food for mosquito grubs. The mosquito larva, on the other hand, is eaten by insects, frogs and tadpoles – and these again by birds, bats and small mammals. The water enriched with the excrements of these animals are taken in by the bromeliads as manure, using suction scales on their leafs. Specialists like the jug-plant of the Asiatic rain forests which preferably grows on nitrogen deficient soils, get their nitrogen and mineral salts from the bodies of insects which they catch with ingenious traps and which they decompose with their digestive juices.



How can the rain forests have an impact on the world climate?

None, if they remain untouched. Other than was earlier believed, the rain forests don’t act as global climate stabilization factors. Because carbon, water and nutritive substances are circulating in these forests in nearly closed cycles, thus having little impact on the global climate. However, if large forest areas are cleared by using fire, the carbon stored in the previous bio-substance disappears as carbon monoxide into the atmosphere – currently between five and eleven billions of tons annually. This equals at least a fourth of the total amount of carbon dioxide which mankind puts worldwide into the air. Incomplete burning, decomposition processes and agricultural usage of the fire-cleared areas leave additional greenhouse gases like methane, nitrogen oxides, ground-level ozone. All these gazes have a considerable impact on the climate. In addition, cleared areas reflect more sunlight. Wind and water erode the topsoil. The areas devastate which in turn increases the reflection and can lead to a regional decrease in temperature. The evaporation and the water content of the air decrease, thus leading to fewer clouds.

If all these climate effects summon up to a warming or cooling is not yet clear. Initially, higher temperatures would be good for the growth of the rain forest. However, the probability for climate anomalies like “El Niño” is growing, too. This cyclic appearing phenomena is the cause of torrid rainfalls or extreme droughts in large areas of the tropics or sub-tropics. Between 1997 and 1999, the massive forest fires which devastated huge areas of rain forests in Amazonia and South-East Asia are attributed to an extraordinary El Niño.

Why no one is suffering of hay fewer in the rain forest?

Because hardly any pollen flies around. The single exemplars of a plant species are often quite far apart from each other so that a pollination by wind would not be successful.

Thus, the plants in the rain forest have found other methods to secure their propagation. A lot have developed large blossoms in glaring colours, attractive odours and sweet nectar to bait animals which in turn take and disseminate pollen: mostly insects, but also birds, bats and other little mammals. In a co-evolution lasting for millions of years, plants and pollinators have adapted to each other quite perfectly. *Heliconia*, for example, has a glowing red, tube-like calyx. The nectar on its bottom can only be reached by certain humming-birds with long, rounded beaks which load themselves, unnoticed, with pollen prior to their flight to the next blossom. This is a very efficient kind of pollination: pollen with the genetic material of the plant lands exactly there where it has to – on blossoms of the same species.

Orchids of the species *Gongora* bait bees with alcohol containing sugar cocktails. The doped insects fall to the lower level of the blossom where they swoon in the pollen. Other orchids feign to the males of "their" bee species the sex odour and the buttocks form of their female partners, or they bait them in narrow tubes where the only exit leads through pollen-laden anthers. Some plants, on the other hand, which have specialized themselves for nocturnal creatures, bloom only at night time.

In our latitudes (Europe), most blossom plants of a certain species blossom at the same time. In the rain forest, however, such lures for mass-blossoming are missing – specially the seasonal changes of temperature and length of days. Thus, some blossom are opened throughout the whole year. This has the advantage that pollinating animals can mark the plant's place and can get their food on fixed "tours".

What is the link between lilies in the Amazon region with cacti in North American deserts?

The beginning of the genealogical tree of the cacti are weeds of the species *Pereskia*. From these leafed plants stem the *Pereskia* species which nowadays shoot up on trees in Brazilian rain forests as liana with long stems and thorns. Descendants of these rain forest plants are also the thorny guys that grow as leaf-less balls or tubes in the desert regions of the American continent – and which serve as ideal, bizarre background for some western movies. In primeval times, birds maybe have carried *Pereskia* seeds from more humid areas, like the tropical rain forests, to drier forests. Somehow, *Pereskia* plants also reached by these means the deserts and steppes of America and gradually adapted themselves to the drier environment.

Thus, they have stopped to grow leafs. Because through the split openings (which serve the supply and disposal of gases for the photosynthesis) leafs normally also loose a lot of water. The green surface of the column or ball sized stem are enough for the emigrated *Pereskia* tribe to perform photosynthesis.

To the features that link "modern" cacti with their ancestor *Pereskia* belong the thorns: they protect the water-containing desert plants from thirsty animals. This story of the formation of a species, however, goes even further: it appears that during million of years some cacti seeds from the desert again reached the forest. Presumably with bird excrements, they also landed on the branches of treetops. Because they were able to store water, these re-migrants could stay right there on top. From them some of the epiphytical cacti of the rain forests of Middle and South America emerged.

Certainly, the epiphytical cacti had to adapt themselves to the lack of light in the treetops (corona). This means they had to produce more green area for the photosynthesis. However, the genetic program to grow leafs seems to have been lost during the evolution.

Instead of this, *Rhipsalis*, an epiphytical climbing cactus species, has formed a longer stem and increased its surface by branching out. Such differently shaped outgrowth now hangs luxuriously down from the treetops, looking like leafs. Thus, the epiphytical cacti have “re-invented” their leafs during the evolution.

Why does the strangle-fig strangle?

Without sunshine, the photosynthesis cannot work and without the latter, hardly any plant can grow. The treetops of the jungle giants swallow up the majority of the incoming sunlight. Only one percent reaches the ground level. Therefore, the plants of the rain forest have adopted a variety of strategies to get some of this energy required to survive. Orchids, ferns, Aron-rod plants and bromeliads, for example, live very high in the branches. A special subtlety is exercised by the strangle-fig: as young plants they live on branches like epiphytes. However, over a period of time, they let grow aerial roots downwards. As soon these reach the soil, the strangle-fig can get water and nutritive substances from the soil. The roots become thicker and form sprouts extending sideward until they have completely surrounded the host tree. The tree’s capillaries are slowly strangulated: eventually the tree dies. The strangle-fig has become a tree itself, with a hollow, tube-like stem. Certain species also form stem-like support pillars. The corona, the treetop of the strangle-fig can be as big as several giant jungle trees together: the largest known strangle-fig covered an area of two hectares.

Can plants also grow on the dim ground level?

A few plant species have adapted themselves to the semi-darkness on the ground. They nourish themselves from the by-products of rotten foliage and therefore profit from the photosynthetic efforts of other plants. But there exist low-light specialists that even here can perform photosynthesis – ferns, for example, which grow extremely slowly. Or the palm *Chamaedorea metallica* which has blue iridescent leafs. Thanks to this colour, it can exactly use this part of light that reaches the ground. Some blossoming plants creep on the floor and cover large areas. Blossoms or even fruits are only developed if they find light. Tree seeds which fall to the ground rest there until one day a tree falls down, leaving an opening in the thickly closed treetop. Only then, they begin to sprout.

Why are there such bizarre animals in the tropical forest?

The massive beak of the toucan (*Ramphastos sulfuratus)* and the incredible tail feathers of the quetzal appear, on first sight, to be a mere mood of nature. However, these features probably make the males more attractive for the females. Because a colourful plumage could be interpreted that the male possesses good health in respect to nutrition – of much importance in an environment where the available nutritive substances are scarce.

Some animals, on the other hand, look like caricatures with their huge eyes: for example, kobold-makis (*Tarsius sp.*), geckos or a lot of frogs. These saucer-like eyes are a result of the adaptation to a way of life which happens mostly at dusk. Nocturnal animals, however, have their visual organs mostly impaired and orient themselves by other means – flagellate spiders, for example, with the aid of mechanical and chemical sensors which are attached to their long grope legs.

Some species have developed the most eccentric camouflage and deception tricks under the diktat of the evolution – to survive or to perish. And, vice versa, the species that have “invented” unpleasant smelling substances or poisons to avoid of being eaten, are covered with “warning dresses”. Then there are the creatures which are not specially conspicuous to the layman: flea crabs for example. The extraordinary thing with them is that their species normally lives in the water, as planctont or habitant on the ground. However, some species of the flea crab succeeded in adapting themselves to the life on land: in the humid environment which they find on the ground of the rain forest and where they live from fallen foliage.

Despite of the enormous evolutionary pressure, a lot of native, primeval creatures have survived here. Because in the last 60 millions of years the rain forests have maintained their humidity and warm temperature. Only in the last 1.8 million years stronger climatic changes occurred. This, indeed, changed the expansion of the rain forests, but core areas remained to which the fauna and flora could retract. Thus, on the ground of tropical forests we can find moss ferns which were present there 300 millions of years ago. Even tree ferns are “living fossils”. Among the animals, the stump-feet (‘Stummelfüsser’) is probably one of the most burlesque creatures. Scientists assume that these caterpillar-like creatures with their short leg stumps the phylogenic link between the slugs and the arthropods. Further primeval tropical animals are the sloth, the armadillo, the tapir and the makis – lemurs of which the smallest are the size of a mouse.

How much rain forest gets lost and why?

The lion’s share of the forest losses is due to clearing for agricultural usage. According to estimates of the Food and Agriculture Organisation (FAO) of the United Nations, about half of all – then – tropical forests have been converted into farm land and pastures or have been completely devastated: a total of 20 million square kilometers. Further large forest areas had to make space for cities, industrial and energy production complexes. In many places the rain forests are forested for veneer and other timber, or they land as firewood in the domestic household.

Out of 1.7 billion hectares of tropical rain forest only a mere 328207 hectares are cultivated using sustainable developed methods.