The composition and structure of rainforests as an indicator of creation rather than evolution

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In an earlier article,[1] I examined the structure and growth of trees and concluded that it indicated the creation of trees by design as being the more likely option than their evolution by chance from unicellular organisms. In past work, I applied a similar analysis to the structure and function of forests. I focused the analysis on the tropical rainforest, with which I was acquainted from my 10 years of fulltime forestry work in New Guinea,[2] and 10 more years of part-time consultancies in Indonesia. Tropical rainforests are more complex structurally than the temperate forests of Australia and Europe, with which I am also acquainted.[3]

The structure, composition, and functioning of tropical rainforests

The reason for the greater complexity of the tropical rainforest is primarily that it grows under more favourable climatic conditions than the temperate forests. The temperature is optimal, 20–35°C for most of the year, and the rainfall is likewise optimal with only limited seasonal variation. As a result, a greater number of species develop to tree size, some of them from families that would not normally reach tree size in other climatic zones. This, in turn, means that the site is more fully occupied, and the structure of the forest is more complex.[4] There is also a greater number of strata which vary primarily in the amount of light they receive (figure 1):

- The *emergent stratum* consists of the tallest trees, which have the maximum exposure to sunlight and therefore a high rate of photosynthesis; it is usually discontinuous, i.e., interrupted by gaps that allow light to penetrate through the canopy.
- The second stratum is continuous (i.e., with no gaps) and less tall and is called the *main canopy*. It also has a high exposure to sunlight and high level of photosynthesis. The trees in this stratum, and in the emergent stratum, can flower and produce seed crops without much hindrance.
- The third stratum, the *understorey*, is discontinuous and consists partly of immature emergent and canopy trees that are awaiting an opening in the main canopy. It also includes some species that are not vigorous enough to compete with the higher strata but can survive and even mature and reproduce in the lower light.
- The fourth stratum is the *shrub layer*. It is also discontinuous and low in height.
- The fifth stratum is the *herb layer*, which is again discontinuous.
- The final stratum is the *root zone*. Here the main associates of the tree roots are the fungi and bacteria.

In addition to trees, there are life-forms that reach adequate light by utilizing the tree. One of these *epiphytes* can grow on the trees of the higher strata. This means that their supply of water and mineral nutrients is without

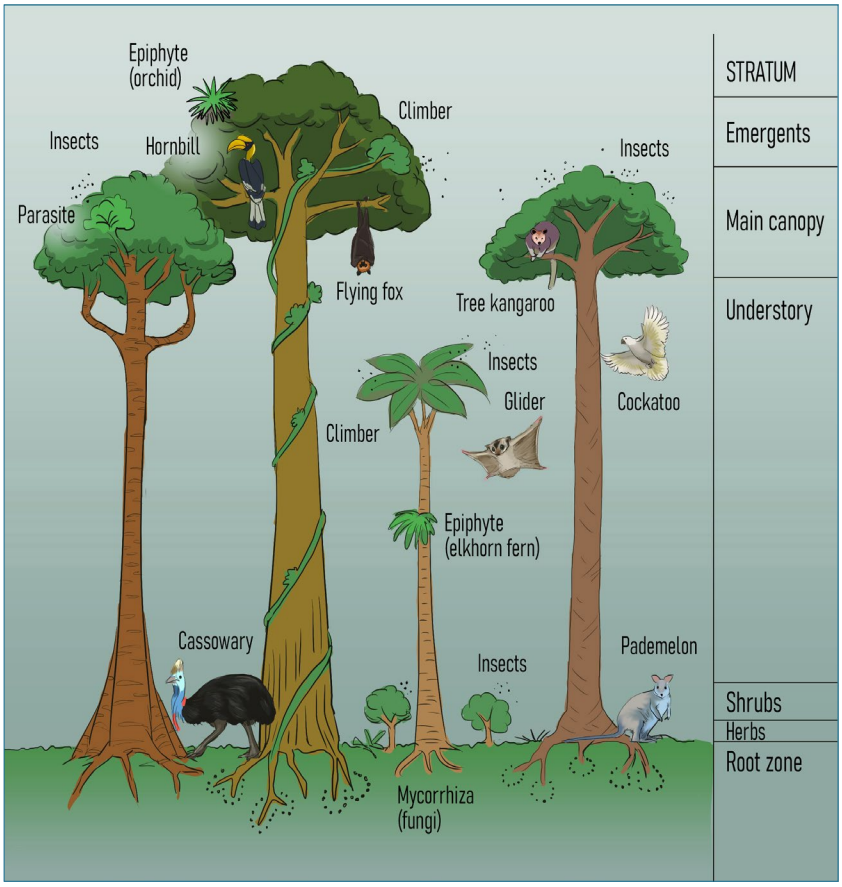

Figure 1. Rainforest ecosystem showing its various strata and animals that interact with it

access to the soil. They compensate for this by having foliage that stores water taken up from the rain and water dripping down from the emergent and canopy trees and store it in their leaves. Some go even further and retain the water in plant debris accumulated around the roots that attach them to the host. The most common epiphytes of this type are mosses, lichens, and orchids.

The epiphytic habit is not restricted to the emergent and canopy strata. Epiphytes occur even on trees in the understorey, and they attach mainly to the tree trunks. Epiphytes in this stratum get less light, but this is compensated for by higher humidity and less loss of water through evapotranspiration. The elkhorn fern even develops a leaf basket for the debris, which it then taps via its roots.

A similar but less beneficial habit is *parasitism*. Here, the epiphyte does not remain attached to the outside bark, but instead penetrates the bark to tap the hosts directly for nutrients and water. The most common parasites of this type are the mistletoes.

Yet another approach for greater light is by the *climbers*. The climber seed germinates in the herb layer and has its roots in the soil, but it grows upwards with a flexible stem, which attaches itself to any tree trunk nearby. It does this either by growing around the trunk spirally or by attaching itself to it by tendrils or spines. Its trunk grows ever higher, with limited foliage, until it gains access to sun in the main canopy, where it develops denser foliage and flowers and fruits. The best-known climber is rattan, a climbing palm. Its stems are commonly woven into tropical-style furniture.

Even at the ground level, where light availability is the lowest, the vegetation has features that make life feasible. The *pitcher plants* have leaves shaped as a jug, which are partially filled with digestive juices that are attractive to insects. The slippery margin of the jug causes insects to fall inside, where they are digested.

Interaction of trees with other life-forms within the rainforest

The variety and complexity of life in the rainforest is great, even when only plants are considered. There are usually more individual component tree species in a hectare of rainforest than in a hundred hectares of dry sclerophyll forest.[5] But the variety becomes even more amazing when the fauna living in the forest are also taken into account. Larger animals living in the Australian–New Guinean rainforest include tree kangaroos, possums, gliders, fruit-eating bats, parrots, birds of paradise, and hornbills, all living in the tree crowns; and cassowaries, feral pigs, and pademelons at the ground level. All these animals are integrated into the ecosystems to various degrees. Although less visible, the insects that pollinate the flowers of the trees are actually more important for rainforest trees than the mammals or birds—they are crucial for seed distribution. Even less obvious, but ecologically significant, are the smaller living forms such as fungi and bacteria. These are essential in the recycling of nutrients that might otherwise be locked in fallen leaves, branches, and trunks of fallen trees. Without them, the great demand for the nutrients by the dominant trees could not be met in the long term.

The effective working of all the ecological rainforest relationships requires adjustments in the behaviour and physical features of each 'partner'. Arboreal animals cannot survive the removal of the trees, as their nutrient supply is derived from the fruit and leaves of the trees, and they are much more susceptible to predation while on the ground. The epiphytes require access to sunlight for energy and the services of insects for pollination and seed dispersion, which is provided by their position high up in the crowns of the canopy trees. But not all of these relationships are symbiotic, or mutually beneficial for each partner; they can also be parasitic or pathogenic; that is, advantageous to one partner at the expense of the other.

The significance of the complexity of tropical rainforest

Just as a tree could be considered as a natural counterpart to a skyscraper, a tropical rainforest can be considered a natural counterpart to a metropolis. A metropolis taxes human administrative skills to the limit, as shown by upheavals in our cities at present. We can take a lesson from the successful 'self-management' of rainforests.

As discussed above, not only is there a rich diversity of tree species in tropical rainforest, but they vary greatly in the way that they cope with the available light, which is essential to their survival and growth. A seedling of one of the main canopy species needs to progress from the herb stratum with its minimal light through the marginally better light of the shrub and understorey strata. It may remain there until a disturbance of the main canopy allows it to enter that stratum with its full light availability and correspondingly higher photosynthesis. Only then can it develop adequate foliage and begin the reproductive stage of flowers, fruits, and seeds.[6] It may bear epiphytes on its branches. It will be periodically stressed by storms.

By contrast, the smaller trees of the understory complete their life cycle wholly below the main canopy, never reaching the full sunlight and, hence, have much reduced opportunity for growth and reproduction than the trees in the main canopy. The insects that assist in the fertilizing of their flowers will be poorer in number and different in species, and fruit production and dispersal will be correspondingly less. On the other hand, the chances of storm damage and the loss of water

by transpiration are less than in the main canopy. The epiphytes tend be of different species and more likely to be attached to the trunk than branches of the smaller understorey trees. The conditions available to the shrubs and herbs are different again.

However, the biggest difference is in their root zone. Here the sunlight is totally unavailable and there is great proliferation of fungi and bacteria in the soil. The fungi are not suppressed by the lack of light, since they get their energy by decomposing the leaves and branches shed from the trees above. Their contribution to the 'community' is consequently different. By facilitating the decomposition of the debris from above, they release the minerals and nutrients locked up in them for uptake by the trees. Their interaction with the trees is not a competition but instead a collaboration—called 'mycorrhiza'—between the fungi and the tree roots. The fungi greatly enlarge the surface area of the tree roots, resulting in a better uptake of nutrients. The trees provide the fungi with sugars, so that the interaction between them is mutually beneficial. The trees convert, by photosynthesis, the energy of the sunshine and the carbon dioxide (CO_2) of the air into carbohydrates (sugars). The fungi break down the carbohydrates in the plant debris, passing on the nutrients to the trees.

The other product of the interaction is the release of carbon dioxide. Mycorrhiza operate by the fungus positively interacting with the tree roots without damaging them. This is radically different from parasitism, in which the fungus enters the roots and damages them by robbing them of nutrients and carbohydrates. Sometimes the fungi even destroy the root systems and kill the trees. This is the mode of operation of the imported fungus *Phytophthora cinnamomi*, which has caused so much damage to Australian trees and forests.[7]

The origin of the rainforest—chance or design?

The intricacies of a rainforest are not described here to impress the reader with science, but to get across the complexities of their ecosystems. Because the plants and animals within them are not closely genetically related, the adaptations needed for their supposed evolution would need to occur separately and repeatedly in many different genera and families without any design or plan, purely due to the environmental pressures and chance.

Particularly improbable is the evolution of beneficial interactions such as the mycorrhiza. The common relationship between trees and fungi would be expected to be in competition for resources such as water, energy, and nutrients. However, fungi derive their energy from the breakdown of organic tissue. The normal function of outer tissue in trees, the bark, is to prevent the invasion and destruction of inner tissues. In mycorrhiza the facilitation of the entry into the tree's inner tissues for the fungus, and the collaboration with the fungus in the enlargement of the root system, results in the improved uptake of nutrients. It has the marks of design, not chance. The passing on of the tree's energy sources, the sugars, to the fungus, goes even further in pointing to design, not chance.

The minute progressive changes that are postulated for evolution would not have happened in a vacuum but in the complex rainforest environment. Even the minutest step would be tested by the interaction with the other components of the ecosystem and the environment.

If the evolution of trees is highly improbable, then the evolution of the highly integrated rainforest ecosystem by chance is even less likely. Creation by design is the credible explanation.

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