Charmed!
or
A short introduction to teeming life in the forest canopy.[1]

by Paul Romeijn[2]

Why support canopy research?

Science is about fun. It is about the unknown, it is about discovery. In a forest you can loose your way and that's charming. In the forest canopy we meet the unknown; a smashing display of life at its most spectacular .... and at its most complex. Science can help us to appreciate and understand this world. Indeed, science has a role to play, and it can continue to do so as long as it keeps on track of its original mission. Science, in its positive sense, searches -rather than sells- the truth.

Why did I ever get involved in this exotic subject of canopy research? I have no clear-cut answer but my fascination for tropical forests has always been with me. Perhaps naturally so, because I was born and partially raised there. As a child I was fascinated by the capture of wild elephants in Bangla Desh, and by travelling on horseback through the mountain forests of Kashmir. And in Colombia, where I was flown over the jungle in a helicopter several times, nice and low, so you can really experience the canopy. Much later I studied tropical forestry, and later still, I was invited to become Vice President of the Canopy Foundation (Stichting Het Kronendak) in The Netherlands.

The Canopy Foundation

Above all, the Canopy Foundation is about many kinds of research.

Since 1989 the foundation has supported research that resulted in the publication of more than 75 scientific documents, including books. All are about the tropical forest canopies. Well, as a matter of fact, once we supported someone who looked at the ground, only. This was for his research on monkeys. By looking at their food-spills on the ground, he learned a lot about their behaviour and their influence on the canopy, and on the forest as a whole. This demonstrates that although we stick to our subject of the forest canopy, we are not overly dogmatic, I hope.

Recently, we supported research into the relationships between birds and trees in Mexico. We have learned a lot about how birds select their dwelling places in a forest region. This has resulted in a more solid understanding about how we, humans, may select areas for nature conservation, a subject that is little known or understood. In this way, the foundation also supports research into highly practical and applicable matters.

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But we do more than support research.

For example, we also help people with their introduction to tropical rainforests. We liaise with a jungle lodge in Brazil; where we currently work on a scientifically sound lay-out of a canopy walkway. Results of earlier research were popularized and re-written into educational materials. As a result of these efforts, visitors to the lodge will be better prepared to be in the forest. As a result, they will appreciate their encounter with the rainforest even more, we hope.

Another example is our collaboration with the Eden Project. We assist the Eden Project with planting up the Humid Tropics Biome. Why is that? Basically, the Humid Tropics Biome was planted up with trees, just as it should be. If one looks at trees within tropical forests, however, it becomes clear that the trees themselves are host to literally thousands of plants - and especially so in the canopy. That is where we will give the Eden Project a hand over the next few years. It just so happens that the foundation maintains a chair of canopy sciences at the University of Amsterdam. Professor Jan Wolf currently holds this chair and he is our principal advisor to the Eden Project. In this way, too, more people will come to appreciate and enjoy the tropical rainforest even more, we hope.

Where is the canopy?

What and where is the Canopy? This can be understood by looking into form and function. Roughly speaking, the canopy starts where the stem stops. This is no absolute truth, it is a rule of thumb only. There are no strict or clear-cut boundaries. For instance, when branches mimic stems through a process called reiteration we have to accept some fuzziness. Anyway, the stem is for transport and it helps to raise the leaves as high up as possible. It has a sturdy shape with the smallest possible surface area. In contrast, the canopy has a folded shape that provides the largest possible surface area. It is optimized for exchange processes, especially for energy. The canopy can intercept more than 90% of the sunlight, which is the primary energy source. In fact, the canopy is the powerhouse of life within the entire forest.

Another way to look at the canopy is scale (show slides).

Microscopic
Leaf
Branch
Tree
Forest
Satellite

If you wish to study the canopy you first have to gain access. The French Professor Paulin built the first canopy tower in 1946 to observe tree crowns in the Banco forest of Ivory Coast. But a tower only provides access to a very small segment of the forest. Many towers and more than twenty years later, British and German scientists constructed the first canopy walkways that take you from one tree to the next. Today there are quite a few of these walkways, even for tourists, in Sarawak, Brunei, Peru and Costa Rica for example. In the eighties the American Scott Mori explored the canopy with the use of climbing gear that was developed to explore caves. He spent many a night high up in the trees of French Guiana.

Around that time, botanist Nalini Nadkarni started climbing trees in North America to study the plants that live on the leaf compost accumulated there.

Shortly after, the French Professor Hallé, together with a balloonist and architect, designed a beautiful and striking tool to observe and research the canopy. The canopy raft was funded by Japanese and built here in England, it has a volume of 7,000 m^3. It consists of a cigar-shaped balloon that can gently lower an observation platform of 600 m^2 onto the canopy. The hot-air balloon, a Montgolfière, is propelled and can be flown like a zeppelin. The mesh wired observation platform offers some degree of comfort to researchers.

The current techniques of access to the forest canopy are well described in the Global Canopy Handbook, a fascinating book with beautiful illustrations from the Global Canopy Programme. In general, access to the canopy has become easier over the years. On top of that, international travel has become commonplace and more affordable. In short, today, canopy research is a realistic prospect.

Why should we do it? Because there is so much to discover. The canopy supports most of the forest's life processes and it contains most of the forest's information, especially in the tropics. This information is vital to help keep our future options open, losing this information leads to reduction of our future options for survival on this beautiful, living, planet.

In order to illustrate this vital role of the canopy for the tropical forests, I will now say a few words on each of the sections of our Rainforest Gathering from a canopy perspective.

Key subjects of the Gathering:

1. What do forests do for us/what do we do for them?

Traditionally, my fellow tropical foresters tend to view the forest as a reserve of unsawn timber. This is perhaps a reductionist point of view, but specialization in science can, and indeed does, perpetuate reductionist views. From this perspective, tropical forests are an untapped reserve that can be 'capitalized to kick-start the economy' of many developing nations.

According to some, timber extraction and subsequent conversion of the forest into low-production pastures can deplete the soil rapidly, and irreversibly. It will earn you a fistful of dollars per hectare only. And to some, it appears to make perfect economic sense, if done on a grandiose scale. World Bank credits were and are made available for these purposes, to be followed by grants for costly and unproductive tree planting campaigns. On depleted, lifeless soils, devoid of seed resources, only severely degraded forests will grow back as a result. Peoples (or should I say tribes?), cultures, music, religion, language, knowledge, insight in forest management, are all lost in the process. I for one, wish to view tropical forests from another, less wasteful, and hopefully, a rather more beneficial perspective.

In this alternative perspective the forest is a reserve of untapped information. The true potential of this information indeed remains largely untapped because, to date, it has remained unknown. Each and every forest organism contains an untold reserve of information, in the form of its gene pool, in the micro-organisms that help it process food and

water, in the way it stores energy, in the way it produces scores of bio-chemical substances, or in the many ways that information can be stored or exchanged with other plants and animals. Yeasts (that help ferment food), bacteria, genetic information, biochemicals, perfumes, rubber, coffee, vanilla, medicines, poisons, fruit, heart of palm, rattan ... and the real list is much longer; all of these products are already derived from tropical forests.

Actually, we have only just begun to explore the information contained in all the organisms that, together, make up a tropical forest. This information is not saved by merely naming all the species and storing all their dried or preserved specimens in a vault. Even according to a recent editorial discussion in the scientific journal Nature, we are far from knowing the true difference between a live cat and a collection of all the parts that make up a dead cat. And we simply don't know how to put that dead cat together again.

I suggest, therefor, that it makes economical sense to safeguard the information for future use, and that the most economical way to maintain and store this information is by keeping it in the forest itself. In this view, it becomes an imperative to *leave the forest intact, as a forest*.

2. Forest regeneration

This is where I have to do my bit to dispel the myth of the 'Virgin' forest. Let's have a look at images of a rainforests in Queensland, Australia. In the first image we see a forest as we all imagine it is supposed to be. The second image shows the same kind of forest, two years after it was hit by a hurricane. Typically, we see the so-called 'liana towers', here is a close-up. The difference between the images is striking but they are all images of natural forests. So, even in a natural situation, forest development is dynamic, or in this case, even volatile. For this you can always consult with our next speaker, Hans Vester, who has studied the influence of hurricanes on forest development for many years.

Next to natural dynamics of the forest, there is the influence of man. Every corner of the earth's forests has been influenced by our presence. In Suriname, Bubberman (pers. com.) could identify the location of settlements that had been 'abandoned' 500 years ago by looking at the dispersal patterns of certain tree species. It appears that settlements were never simply abandoned. Upon abandonment of a site, trees were kept in production for many years for their fruit and nuts. Other trees were clearly favoured over 'natural regeneration', to ensure an even longer term production, such as timber for building canoes by the people of three generations onward. With these examples I hope to have shown to you that there is no such thing as a 'Virgin' forest, if only you look carefully.

Does this imply that all human impacts on forests are OK? Of course it doesn't. The nature and extent of the impact determine the conditions and options for future regeneration. We are beginners at understanding the dynamics of forest regeneration. At a conference on this subject in Brasil, our foundation's president Professor Oldeman addressed an audience of foresters and forest scientists with these words: "Nothing in the real forests today reflects any effect of the political slogans of sustainability, biodiversity and ecocertification or labelling. This sorry state of the forests is at least partly due to the fact that very few of the ecological theories today reflect real forests (Oldeman, 1997)." Without a sound ecological theory, tropical forest regeneration must remain a daunting task indeed. We wouldn't even know

what we are talking about! Would Professor Oldeman have spoken these words without making a contribution to a sound ecological theory? Well, of course he wouldn't have.

Professors Hallé and Oldeman are the pioneers of tree architecture that they discovered some forty years ago, when they closely observed the structure of the forest canopies in Ivory Coast, Congo and French Guiana. Trees grow according to a limited set of architectural models. These models can be observed worldwide, but it is easier to identify them in the tropics than in temperate climates. The tree architecture proved to be scientifically sound, two models that were predicted in theory were later found to exist in real life. It is quite hard to overstate the importance of this discovery.

Tree and forest architecture determine conditions for growth and restoration, with the canopy as principal seed source. The canopy, if present, sets conditions for germination because it casts shade and regulates the rainfall below. Specific combinations of light, shade, moisture, temperature and specific micro-organisms in the soil favour the germination of specific seeds and determine the chances of success for the juvenile trees. These conditions for regeneration continuously change, in disturbed and undisturbed forests alike. Where these conditions change, the results of forest regeneration will change, too. The architecture of trees and forests help us to understand and recognize the underlying processes. Together, they have become the cornerstone for building an ecologically sound and highly *dynamic* view of life in a forest.

Prof. Oldeman developed his copyrighted concept of 'canopy farming'. Canopy farming © leaves the forest essentially intact because the cultivation of canopy products takes place within the natural, intact canopy. This Canopy farming © thus starts there where timber mining stops. It seeks to develop products with a maximum added value, and with a minimum mass. In its purest form this relates to information (Romeijn *in* Vester *et al.* 2004).

3. Climate change: opportunity for paradise regained?

In 1989, as a result of the first canopy raft campaign over French Guiana, the concept of the 'forest siesta' was published for the first time, if I am correct. Forest take an afternoon nap, roughly between 10.00 and 16.00 hours or so, when the trees close their stomata and stop transpiration. In 2005, this information reached a meteorologist. He immediately observed that this factor was not taken into consideration in the models for climate change and carbon sequestration that we use today and that the models might have to be re-written. If so, this is once again an interesting and unexpected result of research in the tropical forest canopy.

The Global Canopy Programme of people like Andrew Mitchell and Nell Baker, present at this meeting, seeks to set-up a coherent set of permanent canopy observation stations in the tropics. One of the things they set out to do is to study how the canopy helps maintain our climate and, in turn, how climate change may affect the forest canopy. The first speaker of tomorrow, Antonio Nobre, will speak about the fascinating subject of how the Amazon rainforest maintains it own rainfall. But the programme is wider that this and we are happy to be collaborate with Andrew Mitchell's team, especially on the subject of canopy farming ©. For the coming years, I hope the Global Canopy Programme will receive the recognition and funding it so clearly deserves.

4. Rainforest pharmacy

We supported the work of Anne Visscher. She researched medicinal plants in Peru and Brazil. She also won the Foundation's Thurkow Prize in recognition of her excellence. She has a participative approach to her subject and took the knowledge base of local medicine men as her point of departure. Anne too, became fascinated by the role of complexity for the viability of eco-systems. In other words, how much complexity is needed to make a system self-regulating and self-perpetuating? This fascinating subject brought her from working with medicine men of the Amazon rainforest to her current research at NASA, the American space Agency. There she studies Terraforming of Martian soils. I just hope that Anne's example can help convince young people that research on the medicinal plants of the tropical forest canopy can be part of an attractive, open-ended career.

5. Rainforest communities

Here I will touch upon the importance of human diversity. Rainforest communities live in small groups that are dispersed over large areas. This is commensurate with conditions set by their forest environment and very hard for city dwellers to understand. Forest dwellers are the managers of the rainforests we once perceived as being 'Virgin' forests. They were able to live there *while keeping the forest intact.*

We have much to learn from the few communities that are still capable of this remarkable feat today. In order to do that, we may have to look much closer into forest management in Papua New Guinea, or in the Southern Highlands of Ethiopia. Let's take the latter as an example.

The foundation supported Tadesse Kippie, a native of the Southern Highlands Gedeo country. He was born of illiterate parents and had to walk to school for 2 hours a day. The village elders sent him off into the world to find useful knowledge and a good education. As a result, he obtained his PhD degree in The Netherlands at Wageningen University. In his dissertation, he analyses the 5,000 year old Gedeo land-use practice that feeds over 450 people/km^2 in the rugged, mountainous tropical region of the Rift Valley. The Gedeo achieve this without any terracing, tilling or agrochemical inputs, while they maintain high levels of soil fertility and food security.

Some have described the Gedeo lands as an 'edible forest'. In his dissertation, Kippie argues that food security is largely safeguarded by maintaining a complex, multi-rotational system with high biodiversity. In the surroundings of Dilla the staple crop, *Ensete ventriculosum* (Welw.) E.E. Cheesman (MUSACEAE), plays a key-role. The ensete is also known as the 'tree against hunger'. From what we already know of this system, we understand that its principles are highly relevant to biodiversity and food security in all mountainous tropical areas of the world.

The communities that live in the forest *and keep it intact* share the dynamic view of life in a forest. These communities are as diverse as the forests they live in. I sound a word of warning about removing such peoples in the name of forest protection. We could easily loose the forest in the process. Rather, I would suggest that human diversity offers the best safeguard for biological diversity.

6. Threats/solutions

Metropolitan greed and outdated economic models both fuel today's unrelenting destruction of the world's tropical forests. However, these make no economic sense, in the long run. The import, or copying, of European and North American land-use systems into the tropics has led to a long string of destructive developments, too.

I have tried to demonstrate that deforestation is large-scale liquidation of vital information. The tropical forest canopies are, par excellence, *the* location where we find this information in its most concentrated form. With the liquidation of information, we narrow our options for survival on this planet.

This requires us to go a bold step further than merely 'protecting' or conserving' biodiversity. We need to develop production systems that have biodiversity as their point of departure. This is very different to the biological narrowing that we know from agriculture, with its narrow species base and artificial farm environment. Narrowing biodiversity is a threat for humans, and its artificial spreading (genetic manipulation, precision agriculture) is a huge biological risk.

One example is the production of soy beans in Latin America. The entire production relies on one single clone that has been manipulated to withstand Roundup, the wheatkiller that is used extensively to eliminate all forms of plant life other than the crop. If, on the other hand, biodiversity is to become the point of departure, then we need intact forests with intact canopies with a healthy gene pool of soybeans as integrated part.

New, dynamic models of life in the forest can help develop more productive economic models. We need to take a new and careful look into traditional communities, into their perceptions of life in the forest and into their ways of rainforest management. I have no doubt that many of the solutions we seek can be found in the forest canopy, precisely.

Summing up

I have briefly outlined a number of aspects of the tropical forest canopy along the lines of the presentations at this Rainforest Gathering. In every one of them, the canopy plays a key part.

Every time we throw away the base material contained in the forest canopies, we deny ourselves part of our future. Remember, we cannot put the dead cat together again. And I believe that we do have an obligation to perpetuate life.

The forest canopies are a celebration of life. Understanding the diversity and complexity of the information of this living system is relevant to our survival. If it is relevant to our future, then it is relevant to young people. So, we should tell them about it. And this is where, once again, the Eden Project comes in.

Last year we celebrated a canopy week here at Eden. I remember well the words of Eden's Education Director Dr Jo Readman: "Eden is a theatre for the interest of the tropical rainforest." When we, specialists, are allowed tell our stories here, we are really in debt to the Eden Project; the exposure of the Eden Project is phenomenal.

Together with the Eden Project, we can help the next generation to develop the respect, knowledge and insight of the tropical forests that we so clearly miss. This is the best imaginable safeguard for the future of the forests and their canopies.

But it all starts by being charmed. And I hope that our Foundation delivers a contribution to this cause.

And with this, I have come to the end of my presentation. But I will not stop speaking until I have thanked our Chairman John Pike, and after saying a *BIG thank you*, for the organization of this Rainforest Gathering, to you, Don Murray and your team here at the Eden Project.

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