# Window on the Tropics

Mountain, Plain and Garden
The Magazine of Denver Botanic Gardens
Volume 55, Number 2, Fall 1998

# Canopy Research of Tropical Forests

*Overhead, at a height, perhaps of a hundred feet, is an almost unbroken canopy of foliage formed by the meeting together of these great trees and their interlacing branches; and this canopy is usually so dense that but an indistinct glimmer of the sky is to be seen, and even the intense tropical sunlight only penetrates to the ground subdued and broken up into scattered fragments... it is a world in which many seem an intruder, and where he feels overwhelmed...*

A. R. Wallace,
*A Tropical Nature.*
Macmillan, London. 1878.

E.O. Wilson has called forest canopies "the last frontier" of biological research on the planet. The tree tops have long eluded scientists and explorers because of the logistical difficulties of reaching the canopy and because of the challenges to collect data in these lofty heights. Only in the last decade have field biologists begun extensive exploration of this unknown world of plants, insects, birds, mammals and their interactions. These achievements are attributed to the development of several innovative and creative techniques that facilitate ascent into tree crowns.

Ideas about forest canopies had changed very little over the past 100 years until the 1970s, when biologists first adapted mountain-climbing hardware for ascending tall trees. Over the past ten years, a number of field methods have facilitated a better sense of understanding of this complex, above-ground ecosystem. In a scenario similar to coral reef ecology, with the 1960s advent of scuba diving, canopy biologists are using new techniques to quantify the species, their interactions and the attributes of this above-ground environment.

There are several reasons that canopy access has become a priority for many scientists. First, as rain forests continue to dwindle, the urgency of surveying the biodiversity in tree crowns challenges some researchers. There are arguably millions of as-yet-undiscovered organisms throughout forest canopies, some of which may contain important economic and medicinal products. By virtue of their complexity, tropical tree canopies reputedly house the largest diversity of terrestrial organisms. Second, canopy processes are essential to life on our planet as the canopy is the major site of production of energy via photosynthesis that fuels many aspects of global climate and other important functions. Third, many researchers admit to simple curiosity to explore this previously inaccessible region of forests. For example, how many orchids remain undiscovered in the upper regions of tree crowns? How many species of beetles exist? Which plants produce important toxins that can be utilized in medicine?

The first major breakthrough in canopy research was the application of technical mountain climbing hardware for ascending tall trees. Single rope techniques (termed SRT) allow

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*Using ropes to climb a kapok tree in a Peruvian Amazon forest.*

scientists to reach the mid-canopy with ease, and hang suspended to make observations of pollinators or to count epiphytes. But ropes have two obvious limitations: they are not conducive to collaborative work (because one rope holds only one person) and they are not useful for reaching the uppermost canopy since these branches are too slender to support the ropes. Other solo techniques include tree bicycles, climbing spikes and ladders.

For those who do not feel comfortable dangling from ropes in mid-air, the use of more permanent canopy bases may provide a secure perch for study. Towers are stable for long-term observations but are limited in that only one or two trees are usually within reach of one tower. Platforms and bridges can be linked to form complex networks of access between many trees. The use of canopy walkways is a wonderful way to bring groups of scientists or students into the canopy together for collaboration.

Canopy walkway systems now exist in most forest types throughout the world, including Australia, North America, Ghana, Peru, Costa Rica, Western Samoa, Indonesia and Belize. The walkway system in Peru, part of the Amazon Center for Education and Environmental Research (ACEER), will be the site for the 1999 Jason Project for Education, whereby scientists will conduct field research on epiphytes (air plants) and canopy ecology in view of hundreds of thousands of students on three continents via live satellite linkage.

Of a more colorful and innovative nature, the Radeau des Cimes (or canopy raft) has been designed and used successfully by a French scientific team under the direction of Professor Francis Hallé of Institut de Botanique in France. Its inflatable raft is 27 meters in diameter and forms a platform on top of the forest canopy that is utilized as a base for research on the trees around its perimeter. A dirigible (or hot air balloon) moves the raft to new positions throughout the jungle, where research can be conducted on the atmosphere just above the canopy.

During 1991 and 1996, I was fortunate to participate as a canopy biologist on Radeau des Cimes expeditions to Cameroon, Africa and French Guyana, South America. In both sites, we pioneered a new canopy technique called the sled. This small 16 x 16-foot triangular mini-raft was towed across the canopy by the dirigible, similar to a boat with a trawling apparatus on the sea. It facilitated collection of canopy leaves, flowers, vines and epiphytes, as well as their pollinators and herbivores. A *National Geographic* television special called "Heroes of the High Frontier," highlights our use of this sled for research.

Another relatively new technique involves construction cranes that have been relocated from urban sites to the rain forest. A 40-meter crane was erected in 1991 in a Panama dry forest by researchers at Smithsonian Tropical

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*A canopy walkway system in a tropical rain forest in Belize.*

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*A canopy sled carried by a dirigible over the treetops of French Guyana.*

Research Institute. Since then, five other cranes have been either operable or in progress, including sites in the coniferous forests of Washington state, a tropical rain forest in Venezuela, a wet tropical forest in Panama, a rain forest in Malaysia, and a tropical rain forest in Australia. Cranes are quite expensive to install (up to $1 million) but they offer unparalleled access to the uppermost canopy as well as to any section of the understory that is within reach of the crane arm.

Once the logistics of canopy access are solved, a bigger challenge lies ahead: collecting meaningful information about this complex world of the treetops. Canopy studies range from measuring sessile organisms (orchids, trees, sedentary insects) to mobile organisms (flying insects, birds, mammals) to canopy processes (studies of the interactions of organisms). All of these different topics require sampling designs that are effective at heights, can be operated in an air medium, and can be safely employed while dangling from a rope or some otherwise precarious position.

## Many questions remain unanswered:

1.) How many species are there in the tropical rain forest, especially the canopy?
2.) How many epiphytes, or air plants, live within the branches of one canopy tree?
3.)How do pollinators find their host plants in this complex array of green leaves?
4.) How can we effectively implement conservation practices to maintain tracts of rain forest for future generations?

The pressures of human population give an added incentive for scientists to undertake studies in tropical forest canopies. The next ten years will be critical, as scientists attempt to understand the ecology of the canopy before much of our rain forests are cleared or fragmented. Hopefully, canopy research will illuminate more ideas about how rain forests function and will contribute to our conservation of these important forests.

**AUTHOR BIOGRAPHY**

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