TAPPING THE WEALTH IN JUNGLE TREETOPS[1]

by Donald R. Perry

Abstract. A third generation system of access to the tops of jungle trees is scheduled for construction in early 1986 within a pre-montane wet forest of Costa Rica's Caribbean slope. Known as the Automated Web for Canopy Exploration, the system will be a radio controlled "chair lift" suspended above a shallow valley by a sophisticated network of stainless steel cables. A researcher will be able to travel throughout ten acres of forest—from ground level to above the treetops.

New knowledge about the world in which we live, be it in the sciences or arts, depends upon invention as it does upon research. Where invention flounders, the pursuit of knowledge is stifled. Important fields of science, for example, could not have advanced very far if the telescope, microscope, aqualung, and transistor had never been invented. Just such a situation exists today with regard to the most complex of the earth's biological communities.

These communities are composed of a vast and remarkable spectrum of plants and animals that for the most part remain hidden in the tops of tall tropical trees in an aerial zone known as the canopy. The lowest portion of this zone begins at about thirty feet above the ground and extends upwards beyond successive tiers of leaves to break-taking heights that can exceed that of a fifteen story building. This unseen aerial kingdom is the real jungle of a tropical rain forest; within a forest's airy, three-dimensional spaces can be found about three-fourths of all life, much of which seldom or never visits the forest floor.

The canopy has been a dynamic factory of biological evolution and within its domain exists a vast pool of untapped natural resources (Perry 1984). Ancient jungle canopies were intimately involved with the evolution of flight in birds and bats. They also became the natural template upon which the beginning of human intelligence was forged. Present canopies are no less important than those that have long been extinct; stored within them is the genetic "memory" of millions of species—each with its own unique solution to survival on the planet. They contain an unexplored universe of biochemicals. Researching these aerial reserves would prove useful to such fields as medicine, pharmacology, agriculture, and pest control.

To say that the canopy has simply been out of reach does not adequately explain why such an extensive biological community has defied investigation. Large jungle trees are forbidding for the very reason that they are attractive. Trunks rise like gigantic columns to the forest roof and their lowest limbs are often eighty or more feet above the ground. Limbs and trunks can be overgrown by thick mats of plants that totally obscure the bark. Within these mats may be found scorpions, centipedes, ants, wasps, bees, and potentially deadly climbing tree vipers. Climbing barehanded up vines or using pole climbing spikes could result in more than just an uncomfortable altercation with these creatures.

Until relatively recently the major method of studying or harvesting canopy products has been to collect those which rain to the forest floor or to cut trees and then collect the disheveled communities scattered over the ground. Field biology is the study of life *in situ*: examining organisms in place as they are found in their habitats. A main objective of tropical research is to understand frugivory, folivory, nutrient cycling, and pollination biology along with innumerable other subjects. How can this be accomplished from the ground when most of a tropical rain forest's biota resides out of reach in the treetops? To investigate treetop life it is essential that safe and effortless methods for gaining access to the canopy be devised.

Existing research stations have not addressed this basic obstacle. If one searched through the volumes in a technical library, one would find a variety of antiquated and largely ineffective means for observing arboreal environments such as towers, catwalks, and platforms. At present the

1. Presented at the annual conference of the International Society of Arboriculture in Milwaukee in August 1985.

most efficient way of gaining access to the canopy is to shoot an arrow attached to a spool of fishing line over a high limb (Perry 1978), then use the line to lift a stronger cord that in turn can lift a heavy-duty rope into place. The rope hangs free of the trunk, away from noxious organisms, and is climbed with mechanical ascenders that clamp the rope in a manner similar to prusik knots (Montgomery 1977). The climber hangs in a harness from an ascender connected to the rope and places his (her) feet in rope stirrups which are also attached to the rope by an ascender. The rope is climbed in an "inch worm" fashion by alternately standing in the stirrups while sliding the harness ascender up the rope, sitting, then sliding the stirrup ascender up for another step.

My research (Perry 1983) shows that the canopy has an exclusive set of pollinators. Some were unknown and others were thought to be extremely rare until it was discovered that they service only canopy trees and seldom or never visit the ground. Understanding the vertical distributions of these pollinators would illuminate the degree to which canopy communities are reproductively isolated from understory trees. This type of information could be invaluable for understanding tree speciation and in aiding future reforestation projects.

We know the canopy's undiscovered biological wealth is enormous. Terry Erwin of the Smithsonian Institution sees the canopy as "the last biotic frontier." His work (1982) would suggest that the canopy is also the greatest biological arena on earth. He estimated that between ten and thirty million new insect species live in canopy trees. This translates into a one and one half to tenfold increase over previous estimates of the numbers of insects on our entire planet. Perhaps forty percent or more of all the earth's species reside in tropical canopies.

Insects may seem an unlikely organism with which to support an argument for the necessity of canopy exploration, however, they fill a variety of niches. As leaf eaters they are of fundamental importance to the development of new drugs. Trees and epiphytes, for example, have adapted to folivory by "slapping" insects with protective chemicals. Since different species of insects would be affected by different protective chemicals, the canopy with its vast diversity of angiosperms undoubtedly holds a practically infinite reservoir of these chemicals, many of which are probably physiologically active in primates as well as insects.

Norman Farnsworth and Ralph Morris (1976) have called tropical angiosperms and the protective chemicals they contain ". . . the sleeping giant of drug development." They found that twenty-five percent of all prescription drugs, with a value of about three billion dollars annually, contain angiosperm derivatives. This figure is probably low because Norman Myers, a tropical biologist, now estimates the value of non-canopy drugs from wild angiosperms to be closer to forty billion dollars annually. Yet Catherine Caufield has observed in her book, *In the Rain Forest*, that natural chemicals are shunned by certain chemists in preference to those synthesized in laboratories. The chemists believed "that because they had learned the trick of synthesizing certain substances, they were better chemists than Mother Nature who, besides creating compounds too numerous to mention, also synthesized the aforesaid chemists and pharmacologists."

Knowledge about our planet's chemical wealth is desperately needed for cures to numerous diseases, both old and new. What more relevant habitat should be investigated than the site where our ancestors evolved; where nature's pharmacological laboratories have been in operation for ages to create an incomparable biological and chemical wealth. The canopy could, for example, hold clues for solving a growing plague: Acquired Immune Deficiency Syndrome. AIDS is thought to have come from Central Africa where monkeys were its probable hosts.

Many biologists are awaiting an opportunity to study the treetops unencumbered by the fear of deadly risk—researchers are not high wire technicians nor arboreal apes. It seems inconceivable that the field of tropical biology has abided a century and a half for an invention to provide safe and effective access to canopy riches.

My present objective is to build the first canopy research vehicle which would virtually eliminate risk and at the same time make a ten acre volume of forest accessible from ground level to far above the treetops. I am calling this facility the

Automated Web for Canopy Exploration (AWCE). The system will be constructed in the foot hills adjacent to the Zona Protectora of Braulio Carillo National Park of Costa Rica at Finca Rara Avis which is being developed as a bird watching facility. Normally one would expect that in only a few years the privately owned forest would become an island surrounded by a sea of pasture as neighbors turned to cattle farming for subsistence. This prospect has been at least temporarily defeated by the John D. and Catherine T. MacArthur Foundation which donated a million dollars to help purchase the Zona.

Rainfall at the site—approximately fifteen feet a year—fosters a biotic wealth unmatched by drier regions of the world. Forests exceed 100 feet in height; some trees reaching 150 feet or more. Adding to the area's natural beauty are numerous waterfalls and many species of exotic birds and flowers.

AWCE will be an enlarged version of the rope system I originally used to investigate the canopy (Perry and Williams 1981, see cover of June 1980 *Smithsonian*). For durability AWCE will be a system of stainless steel cables spanning a shallow valley. Strong trees will be the natural support structures for these cables. The configuration of the cables will be much like that of my rope "web." A radio controlled chair lift, powered by a diesel electric generator and hydraulic winches, will automatically and quickly lift two researchers from the ground to above the treetops. They will then be able to travel to all positions above a large triangular section of forest and to any point below including the ground.

AWCE will make possible a broad range of studies that were hitherto impossible. These include trailing foraging animals, operating aerial mist nets, and carrying sophisticated equipment to any point in the forest. Aside from being used directly for research, the system could be used to set up hundreds of observation platforms and catwalks. I am also planning to construct a treetop laboratory called "tree-lab." This would have integrated living and working quarters for three investigators including rain water showers, an insect-free environment, comfortable bunks, and a kitchenette. Three types of optical equipment would be needed for tree-lab: a starlight telescope, a laser tape measure, and a telescope. Funding for AWCE has come from the Institute for Current World Affairs, Montres Rolex S.A., and a grant from the Heinz Foundation.

Construction of the canopy research facility will begin in January or February of 1986. Researchers will be housed at ground level in a two-story dormitory-laboratory. Presently a qualified person is needed who could operate the system on a full-time basis for visitors and researchers.

Unfortunately, the world is in a reckless race to destroy its tropical rain forests. It is estimated that in less than fifteen years most of these forests will be cut for their wood products, or simply cut and burned for agricultural land and cattle pasture. The National Research Council of the National Academy of Sciences estimates that by the year 2100 this activity will drive perhaps 50% of the planet's species to extinction which will be the greatest wave of extinction since the late Cretaceous when an entire assemblage of organisms, including dinosaurs, forever disappeared from the earth. There remains very little time to observe, study, and appreciate what are the most interesting communities of life on the planet.

Literature Cited

1. Erwin, Terry. 1982. *Agra, arboreal beetles of Neotropical forests: Agra platyscolis group systematics (Carabidae).* Systematic Entomology 7(2):185-210.
2. Farnsworth, Norman R. and Ralph W. Morris. 1976. *Higher plants—the sleeping giant of drug development.* American Journal of Pharmacy 147(2):46-52.
3. Montgomery, Neil R. 1977. Single Rope Techniques: A Guide for Vertical Caverns. Sydney Speleological Society.
4. Nadkarni, Nalini M. 1981. *Canopy roots: Convergent evolution in rain forest nutrient cycles.* Science 214:1023-1024.
5. Perry, Donald R. 1978. *A method of access into the crowns of emergent and canopy trees.* Biotropica 10(2):155-157.
6. ________. 1983. Access Methods, Observations, Pollination, Biology, Bee Foraging Behavior, and Bee Community Structure within a Neotropical Wet Forest Canopy. Ph.D. thesis. University Microfilms International, Ann Arbor. 108 pp.
7. ________. 1984. *The canopy of the tropical rain forest.* Scientific American 251(5):138-147.
8. Perry, Donald R. and John Williams. 1981. *The tropical rain forest canopy: A method providing total access.* Biotropica 13(4):283-285.

Department of Biology
University of California at Los Angeles
Los Angeles, California 90024