INSTITUTE OF CURRENT WORLD AFFAIRS

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4284 Hemlock Road
Branchport, NY 14418
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Why Canopy Research?

Peter Martin
INSTITUTE OF CURRENT WORLD AFFAIRS
4 West Wheelock Street
Hanover, NH. 03755

Dear Peter,

I am devoting this report to a review of my fellowship project, the Automated Web for Canopy Exploration (AWCE).

The canopy contains some of the most important communities of life on earth, and for ten years I have been acutely aware of the need for a vehicle to study tropical rain forest treetops. None of the world's research stations as yet can effectively study these aerial zones. It is clear that something must be done if tropical research is to be pushed into a productive technological age. Although people familiar with North American temperate forests might not appreciate the great need for a tropical treetop vehicle, its importance becomes apparent to all people who visit Neotropical rain forests, meaning forests of Central and South America.

Neotropical forests have lush communities of life that live on the limbs and trunks of tall trees. These communities are composed of a vast and remarkable spectrum of plants and animals that, for the most part, are hidden in the canopy. The lowest portion of this zone begins at about thirty feet above ground and extends upwards through successive tiers of leaves to breath-taking heights that can exceed that of a fifteen-story building (see diagram). About three-fourths of all jungle life resides within a forest's airy, three-dimensional space. Much of this life seldom or never visits the forest floor.

The importance of these communities is only now beginning to be appreciated. Terry Erwin, of the Smithsonian Institution, has discovered some interesting possibilities about the wealth of canopy life. Extrapolations from his samples of canopy insects suggest 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 the planet's species reside in tropical canopies. This

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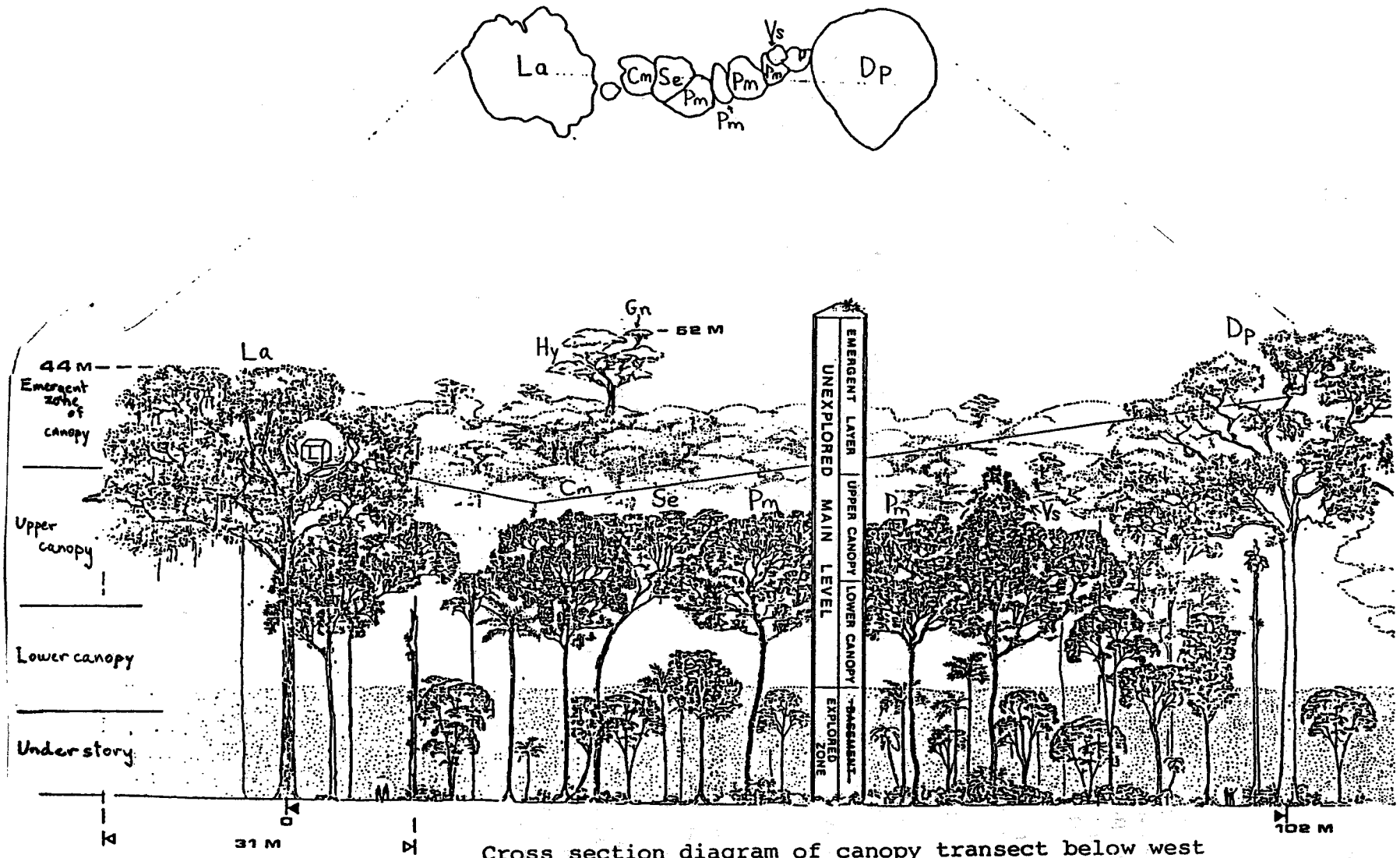
Donald Perry is an Institute Fellow who is developing a new system of access for conducting research in the tops of jungle trees.



Cross section diagram of canopy transect below west perimeter rope of study site at La Selva. One to two acres were accessible with this prototype system. AWCE * will have the same basic design except it will be on a much larger scale. Transects will exceed 300 meters and operation will be automated providing access without exertion.

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incomprehensibly large insect community, together with the vast community of flora and fauna specialized for treetop life, leads to the inescapable conclusion that the canopy is the most complex habitat of life on the planet.

It is a well-known fact that knowledge about the world in which we live, be it in the sciences or arts, depends as much upon invention as it does upon research. Devising a single, effective piece of research equipment is a priority consideration for all fields of science, because new equipment ultimately gives birth to thousands of studies. Important fields of science, for example, could not have advanced if the telescope, microscope, aqualung, and transistor had never been invented. Where invention flounders, the pursuit of knowledge is stifled. Just such a situation exists today in the field of tropical biology, merely because the proper equipment for effectively studying canopy communities has not been devised.

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The canopy has been a dynamic factory of biological evolution (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. Within today's forests are a vast genetic storehouse of millions of species -- each with its own unique solution to survival on the planet. These forests contain an unexplored universe of biochemicals. Researching these aerial genetic reserves would prove useful to such fields as medicine, pharmacology, agriculture, and pest control.

To say that the canopy has been inaccessible 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 with thick mats of plants that totally obscure the bark. Within these mats are scorpions, centipedes, ants, wasps, bees, and potentially deadly climbing tree vipers. Climbing barehanded up vines or using pole-climbing spikes on trunks results in contact with these poisonous creatures.

Until fairly recently, the major method of studying or harvesting canopy products has been to collect those that rain to the forest floor, or to cut trees and then collect the di-sheveled communities scattered over the ground. Field biology is the study of life <u>in situ</u>: 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 to use safe and effortless methods to reach the canopy.

At present the 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 away from the trunk, avoiding 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 that 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 up the harness ascender; then sitting and sliding up the stirrup ascender for another step.

A portion of my research (Perry 1983) has shown that the canopy has an exclusive set of pollinators. Some of these 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.

Insects may seem an unlikely organism with which to support an argument for the necessity of canopy exploration. As leaf eaters, however, 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 plants produce different protective chemicals, the canopy and its vast diversity of angiosperms hold a practically infinite reservoir of these chemicals, many of which are 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. Nevertheless, the importance of canopy organisms is not well recognized. For example, 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 synthesising certain substances, they were better chemists than Mother Nature who, besides creating compounds too numerous to mention, also synthesised 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. It is possible, for example, that the canopy could hold clues for solving a growing plague: Acquired Immune Deficiency Syndrome. AIDS may have originated in Central Africa where monkeys may have been primary hosts.

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My objective is to construct the first canopy research vehicle, with a design that virtually eliminates risk, to provide access to a huge volume of forest. Called AWCE, this system will be built in the foothills adjacent to the Zona Protectora of Braulio Carillo National Park on Finca Rara Avis.

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, and cover of November 1984 SCIENTIFIC AMERICAN). Those who have read my earlier reports will remember that AWCE is a radio-controlled chair-lift that will be suspended above a shallow valley by a network of stainless-steel cables. The cables will be supported by strong trees along two ridges of a valley. The system will be powered by gas engines and hydraulic winches. One or two researchers will be carried from the ground to above the treetops where 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. Anyone willing to ride a ski lift would be able to use AWCE.

AWCE will make possible a broad range of studies that were hitherto impossible. These include following animals, operating aerial mist nets, and carrying sophisticated equipment to any point in the aerial forest. Aside from being used directly for research, the system could be used to set up many observation platforms for a wide range of behavioral and physiological studies.

All qualified scientists will be invited to use the system free of charge. Use of AWCE will be determined by the scientific merit of a project and the availability of time slots. It is hoped that AWCE will eventually become an active educational and scientific facility for an international group of scientists (Malaysia, Philippines, Africa, New Zealand, Australia, Europe, North America, South America).

Funding for the AWCE has come from Montres Rolex S.A. and the H. John Heinz III Fund of the Pittsburgh Foundation, as well as from private donors in the United States.

AWCE is plodding along the path to completion. Parts for the system have been ordered and are being assembled by John Williams, the project engineer. It is possible that we will have to test AWCE before shipping it to Costa Rica.

Amos Bien, the owner of finca Rara Avis where AWCE is to be constructed, has informed me that an all-weather road now reaches his property. He assures me that, although the road turns to mud in the rainy season, it will always be accessible by tractor. Rara Avis is situated in the foothills just north of San Jose,

the capital of Costa Rica.

Starting costs for AWCE will likely exceed the $20,000 budget by two to three thousand dollars. The most expensive items were John's $8,000 fee, followed by $4,500 for the seven thousand feet of cable.

The only remaining obstacle is Costa Rican customs. I hope to have the system completed by mid-March.

Sincerely,

Dan

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