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WHAT'S UP?

The Newsletter of the International Canopy Network

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Nalini M. Nadkarni, Editor *Amber Neilson, Editorial Assistant*

A New Tool for Canopy Access; The Crown Balloon System

The crown balloon system is a new method designed to permit routine access to inaccessible regions. This unique system utilizes groups of balloons with two main units having six balloons each, together with two separate but attached balloons, to give a system total of fourteen balloons, each of which is about 9 m in diameter. The six balloons of a main unit are clustered to give either a flat set of six in a triangular grouping or a set of three over three. The inner three balloons are attached to and support a triangular frame (Fig. 1).

A position halfway between two extremes of flat to stacked configuration, the "crown configuration", seems to be the most convenient arrangement for travel in general. Movement occurs by throwing out grapples (and/or sea anchors) and then by winching to these points. When traveling downwind, the winches can be used as generators. During daylight hours, power is generated from sheets of photovoltaic cells on the tops of the balloons. The main units also have rechargeable batteries. Free flight is reserved for emergency situations.

The gross lift of the system is about 10,000 pounds and the maximum recommended onboard-crew is sixteen (the minimum is four). All basic life support systems are integrated into the design. A crew should be able to reside just over a jungle canopy or over a sub-artic forested region for up to a year. Periodic resupply by helicopter is suggested to reduce the need to transport large quantities of basic food supplies and to permit transport of a maximum amount of scientific equipment.

Standard systems onboard the main units include; compressed air, electrical power (230VAC, 24 VDC), a vacuum system, refrigeration, cryogenics (liquid nitrogen and liquid helium), air conditioning, heating, a tiny galley, a toilet and shower, a hammer-headed saw (a chain saw for cutting into a jungle canopy to avoid high winds and also to free fouled grapples), a distillation unit for ballast water (from rain water or ground water) and safety nets.

The two separate but tethered balloons are used to set and retrieve grapples and to inspect, clean, and repair each other and the balloons on the main units. They each have a hammerheaded saw, a steam gun, a line winch (for moving to and away from the main units) and communications equipment. Inspection, cleaning, and repair of the balloons is facilitated by having internal lines which maintain a balloon in a spherical shape and by having external lines that permit the rotation of a balloon about one of several axes. The gross lift of a single balloon is about 760 pounds. Each main unit carries 100 pounds of liquid helium, which is freely suspended outboard of one corner of the triangular frame. This amount of helium is enough to reinflate all of the balloons once; the helium boil-off is used as makeup gas. The frames and all components are designed to be easy to disassemble and transport by cargo plane, truck, and/or ship to another site.

This access device can be used by canopy ecologists to facilitate long-term studies within the forest canopy. For instance, the routine collection of foliage from the tops of rainforest canopies will allow an analysis of the mineral content of the leaves, which can then be compared to the mineral content of the soil near the roots of the trees. The allocation of minerals throughout the forest canopy can be easily assessed.

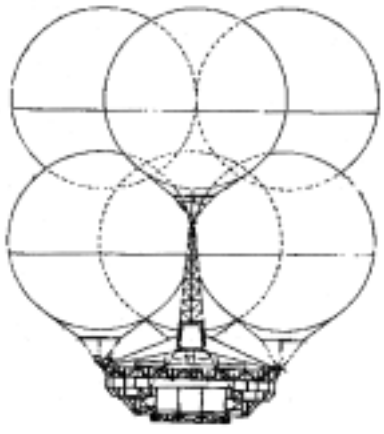

Figure 1: a side view of a main unit, stacked 3 over 3.

The "crown balloon" system has not been physically constructed. Most of the basic engineering has been completed and the engineering which remains is well-understood. It is difficult to foresee all of the potential applications. It is believed, however, that the system is needed and that once in use it will provide a reliable platform for work in many different environments. The Snow Water Corporation is eager to correspond with canopy researchers who have ideas for research applications or questions regarding this canopy access system.

Contact: Frank Hodgson, Snow Water Corporation; Phone: (800) 872-5244; <AKILO55@Yahoo.com>; <<www.AKILO.com>>.

Ecological restoration activities in a forested reserve of Costa Rica

Ecologically sound restoration of degraded or disturbed lands is of primary importance in rehabilitating the structure, function, and biodiversity of forested regions in the tropics. Dosel, S.A. and the International Canopy Network are collaborating on a program to begin rehabilitating small areas of disturbed forest near the Braulio Carrillo National Park in Costa Rica. The objectives of the program are: a) to begin the long process of reforesting overgrown pastures and agricultural lands with native tree species, and b) to blend the program's management and activities with an educational program that offers insight to both eco-travellers and local landowners/managers concerning the benefits of rehabilitating tropical rain forests. The candidate sites are located on a privately-owned reserve adjacent to the Braulio Carrillo National Park, a 45,000-hectare reserve consisting of pristine premontane rain forest.

We are seeking volunteers with backgrounds in forest ecology and ecological restoration to assist in the development of this project. We offer free room and board at the site (for two or four-week periods) for any experts interested in collaborating on such a project. With the understanding that it may take many years to begin seeing results, we wish collaborate with individuals or institutions willing to make a long-term commitment to the management plan and fundraising efforts. We encourage partnerships with the Universidad Nacional de Costa Rica and natural resource institutions/agencies in Costa Rica, and expect that this will be an opportunity for information and knowledge exchange among countries.

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A Summary of the European Science Conference on Tropical Forest Canopies

A conference of the European Science Foundation (ESF) Tropical Canopy Research (TCR) Program was held at St. Anne's College, University of Oxford, December 12-16, 1998. The aim of the conference was to bring together leading canopy biologists from within Europe, and key guest speakers from other countries, to give a state-of-the-art account of tropical canopy research within Europe, and to put this work in a global perspective. Each session of the conference started with a keynote address, giving an overview of the subject, followed by several papers based on new, fundamental research. Participation in the conference was largely by invitation: 54 delegates attended including leading canopy biologists from Australia, America, and Panama. The conference began with a keynote address by the Chairman of the ESF TCR. Keynote speakers included Prof. Nigel Stork, Prof. Nalini Nadkarni, Prof. Margaret Lowman, and Dr. Yves Basset. A total of 36 papers were presented. Invited papers addressed forest architecture, animals and plants in the canopy, hydrology and microclimate, physical parameters, environmental change, politics, and communication. Fourteen delegates presented posters at the meeting.

Kluwer Academic Publishers will publish the conference proceedings in a two-volume special edition of the journal *Plant Ecology*. Kluwer will also published the proceedings as a book, to be edited by Dr. A. Davis, Dr. M. Speight, and Prof. K.E. Linsenmair, provisionally titled: 'Tropical Forest Canopies: Ecology and Management'. The conference will be reviewed in the leading journal *Trends in Ecology and Evolution (TREE)*, in conjunction with coverage of 2nd International Canopy Conference, held at the Marie Selby Botanical Gardens in Florida one month before the ESF meeting. Representaion in *TREE* will ensure that the results of the meeting receive widespread international publicity.

The ESF Oxford Canopy Conference was the first of its kind to be held in Europe, and only the third on a global scale. It represents a major step forward in the international organization of canopy research. It is hoped that the conference will act as a catalyst for future international collaboration in this field. The majority of the conference highlighted European research, and the large numbers of papers that were presented at the meeting and their high scientific content, is a good indication of the current activity in tropical canopy research within Europe, a great deal of it stimulated by the ESF TCR. Discussions at these meetings also led to the realization that organisms and processes that are studied by canopy researchers bear directly and indirectly on pressing environmental and social problems that humans must con-

front and understand in the new millennium. Such issues as the maintenance of biodiversity, carbon cycling, effects of global climate change, and sustainability of forest resources can and should be addressed in concerted ways by the canopy research community for at least three reasons: 1) scientific curiosity about fundamental biological questions; 2) provision of useful answers to issues of importance to other humans; and 3) increased access to funds that will promote field research, expanding the capacity to learn more about forest canopies and other aspects of the biosphere. Participants recognized the opportunity for governments to meet treaty and other political commitments through this process and this can unlock substantial funding through GEF, ESF, EU and other agencies. This conference thus set the stage for developing long-term collaborative canopy research. The organizers and participants have been planning a follow-up workshop to articulate a research agenda for canopy researchers, slated for November 20-24, 1999, in Oxford, U.K. This will be a joint effort by European canopy scientists (funded by the ESF) and North American researchers (a proposal is pending with the National Science Foundation's International Program).

Participants recognized that this field of inquiry should not be limited by what has gone before. Rather, discussions must focus on what is needed to deliver something that will make a difference to our understanding and sustainable use of the biosphere within 5, 10, 20, and 50 years. We view this collaborative workshop as a timely and "keystone" meeting that will provide representatives of the forest canopy research community the opportunity to discuss short- and long-term research directions and plan for their implementation. Below is an outline of the prospective meeting in Oxford. We invite ICAN members to comment on these matters before, during, and after the workshop.

Agenda Items for the ESF/NSF Meeting

I. Provide an overview of canopy research at the turning of the millennium; review results presented at recent canopy meetings; identify the "developmental stage" of this emerging science.

II. Present "case studies" of other fields that have already worked through early developmental stages (e.g., plant genome project, Hubble telescope, human genome project). Brief histories of these fields will be presented by representatives from these groups in order to learn if there are emerging trends or specific recommendations that can be applied to speed the development of canopy research.

III. Discuss links to allied fields with representatives from these fields (e.g., ecosystem ecology, climatology, sustainable forestry). What are the important questions being addressed by non-canopy disciplines for which a developing canopy research community could provide insights and data?

IV. Generate short-, medium-, and long-term goals for canopy research in the next millennium. Formulate scientific questions that should be addressed, including large-scale, long-term questions that require comparative approaches, harmonized methods, and potential manipulative experiments, as well as small-scale, individual-based research projects.

V. Develop strategies to address these questions. Assess levels of funding, infrastructure, administrative framework, research sites, and database needs to implement collective and individual research agendas.

VI. Determine who are the end users of answers to these questions (universities, government agencies, general public). What content and in what forms do they need these answers? How can we transfer technology and build local capacity to match the process to potential donor requirements?

VII. Generate action items, a time schedule, and assign tasks to individuals for future progress in this process.

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Hot off the Press!

Life in the Treetops; Adventures of a Woman in Field Biology.

By Margaret D. Lowman. 1999. Lowman is the director of research and conservation at the Marie Selby Botanical Garden in Sarasota, Florida, USA. Her book is an autobiography depicting the experiences of a pioneer forest canopy researcher. Lowman describes the mysteries of the treetops - their inhabitants, their flowers and fruits, their growth and mortality, their medicines and foods, as well as the intricate patterns of diversity that reside within forest canopies around the world. She also writes about the various canopy access techniques used in conjunction with her scientific research. ISBN: 0-300-07818-8. Contact: *Yale University Press, P.O. Box 209040, New Haven, CT 06520; <<www.yale.edu/yup/>>.*

RESEARCH REPORTS

HERBIVORY AND PATTERNS OF GENETIC DIVERSITY IN *TABEBUIA* TREES: CONTRASTING THE CERRADO VEGETATION WITH THE WETLANDS OF PANTANAL MATOGROSSENSE, BRAZIL

We studied herbivory rates on the crowns of two species of *Tabebuia* (Bignoniaceae) with distinct life histories and different savanna habitats. *Tabebuia aurea* is a pioneer tree, and occurs as extensive monodominant stands in open wetlands. A contiguous population, covering about 1200 km^2 in the Brazilian Pantanal Matogrossense, is the most impressive example. This species occurs as sparsely distributed individuals in the Brazilian arboreal savanna, referred to as the "cerrado". *Tabebuia ochracea* is a persistent tree species of the cerrado, where it occurs in small patches among other tree species.

We formulated three hypotheses were to investigate the role of herbivory in the ecology and evolution of populations of these species: a) *T. aurea* is genetically more homogeneous than *T. ochracea*; the population genetic structure of these species reflects their different life history strategies; b) the monodominant population of *T. aurea* in the Pantanal is genetically more homogeneous than the population in the cerrado; herbivory rates in the Pantanal are kept low by high environmental disturbance and unpredictability; c) *T. ochracea* is highly polymorphic and the species is adapted to withstand severe herbivory; *T. ochracea* performs better in the cerrado than *T. aurea* due to higher insect herbivore damage on the latter species.

We studied insect-chewing (by chrysomelid beetles and leaf-mining Lepidoptera) on two leaf cohorts in 1996. We assessed variability in leaf size and leaf specific area (LSA). Herbivory rates were correlated with individual mean genetic distance within the population (from an UPGMA dissimilarity analysis) to test the hypothesis that resistance from herbivory increases with increasing differentiation among individuals. In addition, herbivory per branch was correlated with mean bud growth. In the three populations, levels of herbivory were compared among branches within individuals, individual trees within populations, and among populations within landscapes.

Tabebuia aurea in the cerrado showed the highest phenotypic variability in leaf area, and *T. ochracea* showed the highest variance in LSA. The mean genetic dissimilarity index was approximately double for *T. ochracea* than *T. aurea*, and the latter was genetically more diverse in the cerrado than in the Pantanal. Herbivory rates varied significantly within trees in all populations, but patterns of herbivory among trees were also variable. For both leaf cohorts, herbivory was greater in the cerrado than in the Pantanal, and greater on *T. aurea* than on *T. ochracea*.

In the cerrado, insect damage to leaves was negatively correlated with genetic distance, which means that individuals of *T. ochracea* (with higher population genetic variability) were less attacked than individuals of *T. aurea*. Stem growth between the two leaf flushes did not vary significantly among species, populations, or sites. However, growth rates were negatively correlated with individual leaf area lost. The results support the hypotheses that polymorphism in genetics and herbivory exists in these populations.

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DO ANTS CONTROL GALL MIDGES IN NEOTROPICAL CANOPIES?

One explanation for the high within-community diversity of arthropods in the tropical forest canopy is that continuous stochastic local disturbances in nature prevent any long-term equilibrium "climax" state. These so-called *stochastic non-equilibrium models* assume that the presence of a species at a vacant site is important. This may represent an advantage against all species that arrive later. Niche overlaps are assumed to be very common within species-rich communities. As a result, neither successional stages nor a climax community can emerge. This concept contrasts with to the so-called *deterministic equilibrium models* that are based on the ecological niche. Each organism maintains a defined position in its environment and, driven by competition, the system runs through defined successional stages, eventually achieving a structurally predictable equilibrium (Linsenmair 1990).

The purpose of our study was to cause local disturbances and make sites "vacant" by fogging the canopy of a widely distributed Amazonian tree species. Our data provide a first insight into the composition and interaction of the arthropod guilds in the neotropical canopy, particularly in the patterns and dynamics of recolonization by species of common arthropod groups.

Two tree crowns of a widely distributed Amazonian tree, *Goupia glabra* (Celastraceae; height 38 and 45 m) near Manaus, Brazil, were fogged in intervals of 6 or 24 months

(1991-1994) with 1% natural pyrethrum. Between 898 and 2850 arthropods (50-158 ind/m2) were collected per fogging event during the dry and rainy seasons in the 18 trays installed below the canopies of two trees. Hymenoptera (≤51%, mostly Formicidae) and Diptera (≤58%), dominated the samples. A total of 95 ant species occurred on a single tree. Most ants were permanently foraging in the canopy and their recolonization after fogging seems to follow stochastic pathways (Adis *et al.* 1997, 1998).

At fogging intervals of six months, the number of ants collected decreased continuously (from 45% to 12% of the total catch), whereas the amount of Diptera and other Hymenoptera increased (from 12% to 58% and from 6% to 12%, respectively; Fig.1). This tendency was also observed after a fogging interval of two years (1992-94), if only few ants had returned to forage in the tree canopy. Data indicate a biotic interaction between predaceous ants and the gall-building Cecidomyiidae, as well as between Cecidomyiidae and the parasitic Hymenoptera. This was not known from previous studies in tropical tree canopies.

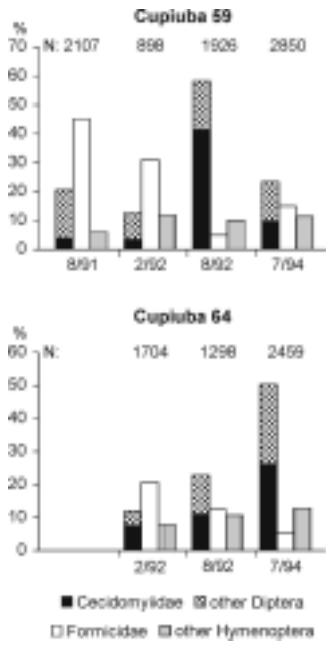

Figure 1. Percentage of Diptera, Cecidomyiidae, Formicindae, and other (mainly parasitic) Hymenoptera of the total number of arthropods (N) obtained by canopy fogging between 1991 and 1994 from two Cupiuba trees (*Goupia glabra*) at Reserva Ducke near Manaus (from Adis *et. al.* 1998, modified)

To our knowledge, there are no field data showing the specific predation by ants. Some investigations have suggested that: 1) the population density of leaf-mining larvae of Diptera and Lepidoptera is being non-selectively controlled by ants; and 2) an exclusion of ants can have a direct effect on the attack of parasitoids if ants interfere with searching by the adult parasitoid. Herbivores tended by ants have been shown to suffer less parasitoid attack than untended herbivores (Memmott *et al.* 1993).

In comparison, Stork (1988, 1991) obtained a low number of ant species (n=10-32; 3% of the total arthropod species) from ten Bornean canopies in a lowland floodplain forest, but a high number of species of other Hymenoptera (n=37-267; 23% of the total arthropod species). The families of Nematocera known to parasitise the galls of Cecidomyiidae in Central Amazonian tree canopies (Eulophidae, Eurytomidae, Pteromalidae, Torymidae; Adis *et al.* 1998) represented 40% of the Chalcidoidea species and 46% of all specimens obtained on Borneo. The Diptera on Borneo amounted to 22% of the arthropod species and specimens collected. The Cecidomyiidae, Ceratopognidae, Chironomidae, and Sciaridae represented 91% of the specimens and 69% of the species of all the Nematocera obtained. At Manaus, specimens of these groups amounted to 89% of the total Nematocera. The Cecidomyiidae represented 47-62% of the Nematocera specimens collected and at least 13 species. On Borneo, 26 species of Cecidomyiidae represented 15% of the total Nematocera specimens.

The data from tree canopies on Borneo suggest that a small number of ant species might result in reduced predation of Cecidomyiidae galls by ants, which would favor an interaction primarily between the parasitic Hymenoptera and the Cecidomyiidae. Field experiments might elucidate the general interactions between Formicidae, Cecidomyiidae, and parasitic Hymenoptera. At Manaus and at the Rio Orinoco, twigs of trees with Cecidomyiidae galls could be protected from ant attacks (e.g. by mesh bags). On Borneo, carton nests of non-competitive ant species could be added to the canopy and the response of gall-building Cecidomyiidae monitored.

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CONTRIBUTE TO "WHAT'S UP?"

ICAN is accepting articles, meeting and workshop announcements, related web site addresses, and citations for our Fall newsletter. Contributions are due by November 15, 1999, and can be sent via e-mail attachment or snail mail. Articles up to 1500 words are accepted (WORD format preferred) and black and white graphics are welcomed (.jpg or .tif format preferred). Please contact the ICAN for details.

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FEATURE ARTICLE

MADEIRA— SIMULATING CANOPY ARCHITECTURE AND CARBON GAIN; AN ENVIRONMENTALLY SENSITIVE TOOL FOR STUDYING ABOVEGROUND WOODY PLANT COMPETITION

In the future, more simulation models will be needed as tools to investigate plant processes that either take too long to be analyzed in growth experiments or are impossible to be performed physically. The development of plant biomass and individual tree architecture, both driven by a physiological machinery, are understood only qualitatively. Simulation models allow for the study of sensitivity of one process or parameter to another, even if both are not immediately related to each other but may interfere. The effects of the environment on growth relative to the influence of the (unknown) genome determining branching patterns is an example. Computer experiments allow a researcher to exchange species-specific branching patterns among simulated plants that grow with identical or different physiology.

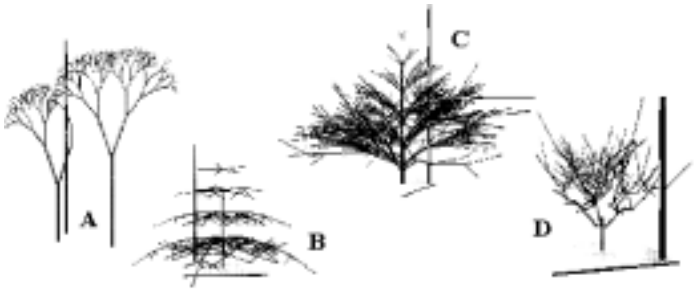

Figure 1. Plant growth forms generated by MADEIRA. (A) Two individuals of a theoretical plant branching dichotomously, however, close to certain *Tabebuia* species, (B) *Araucaria,* (C) *Acer campestre,* and (D) *Prunus spinosa.* All plants were generated from the physiological data set [1] but combined with species- or genera-specific branching patterns. Scale: 20cm.

These considerations formed the background for establishing the simulation program MADEIRA (Portuguese for "wood"). MADEIRA is based on measured annual light interception and measured annual carbon acquisition. It is a simple model to describe radiation extinction within the canopy, measured annual carbon allocation, and species-specific branching patterns. MADEIRA has been used to simulate architectures of plants of entirely different branching characteristics (Fig. 1) to produce acceptable images with a small amount of input.

Figure 2. (A,B): *Acer campastre* and *Prunus spinosa* after two years and after four years of growth, respectively. Both plants were generated using their typical data sets [1]. Clearly, *Acer* gains height and canopy space much faster. (C,D): *Acer* growing with its normal parameter as set in (A), (B), but *Prunus* now with a ten-fold higher seasonal carbon balance in sun leaves. Even in this situation *Acer* gained musch more canopy space after five years normal growth (D) while *Prunus* only doubled its height gain. Scale:20cm.

MADEIRA can also be used to study the significance of certain branching patterns relative to carbon gain of a plant (Fig. 2). *Acer campestre,* with its specific branching pattern, gained more height and canopy space in the same time as compared to the pioneer *Prunus spinosa*, even when *Prunus* was allowed to "grow" for a ten-fold annual carbon gain of its sun leaves at otherwise unchanged light extinction in the faster growing canopy. The message from this is clear: architectural development in the "normal" situation is more important for growth than the driving physiology, and is thus a decisive competitive factor. As a consequence of being overtopped by *Acer, Prunus* grows away from it (Fig. 3). This simulation, which produces some kind of "canopy shyness", is entirely based on the use of carbon within the plant, and it does not involve any phytochrome-mediated response. As a monospecific stand, *Prunus* forms a dense, even-sized scrub or hedgerow, as in nature (Fig. 4). When

Figure 3A: *Prunus* (left), *Acer* (center), and an artificial plant (right) after 5 years of growth (all starting conditions were identical).

Figure 3B:When growing in lateral competition, after twelve years of growth, *Prunus* (left) grows away from *Acer* (center). On the right, the theoretical plant has been detopped a few years before.

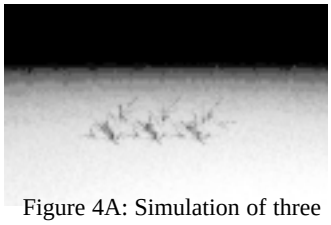

Figure 4A: Simulation of three years of growth of 3 neighboring *Prunus spinosa* individuals.

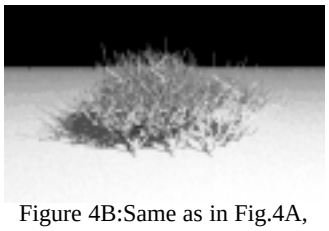

Figure 4B:Same as in Fig.4A, but after nine years of growth

running a competition experiment (Fig. 5), *Acer* "wins" due to its more economical branching features despite having established later, protected from browsing by the thorns of the pioneer.

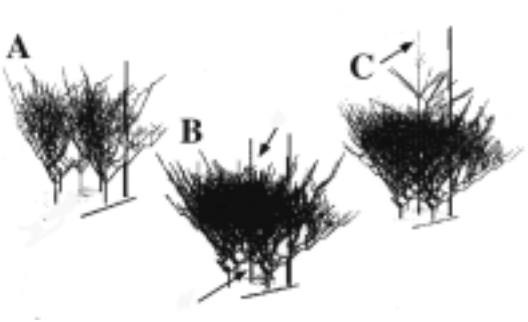

Figure 5: Simulation of a competitive situation among the thorny pioneer *Prunus spinosa* and the mid-successional *Acer campestre* (denoted by arrows), as found in nature. (A) Four individuals of two-year-old *Prunus* (e.g., emerging from suckers) begin to ward off predators, once sufficiently dense; (B) after eight years, seedlings of *Acer* may establish in their shade protected from browsing; (C) four years later the tip of *Acer* overtops the canopy of *Prunus*, *Prunus* is eventually outshaded by *Acer.*

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BOARD OF DIRECTORS BIO-SKETCH

In order to acquaint ICAN members with the Board of Directors, the next several issues of What's Up? will feature a brief introduction into the visions of the ICAN Board.

Dr. Nalini M. Nadkarni is ICAN's co-founder and President. She was born in Bethesda, Maryland, USA. She has a half-time teaching position at The Evergreen State College and carries out ecological research on forest canopies in Costa Rica and Washington State. Nalini became interested in tropical forest canopy research during a field course in Costa Rica where she learned tree-climbing techniques from Don Perry. It was at this time that Nalini realized there was very little known about forest canopies, and decided to pursue forest canopy research as a Ph.D. dissertation topic.

Nalini co-founded the ICAN in 1994 with ICAN Secretary-Treasurer Joel Clement. Their vision was to create an organization that would help facilitate communication among forest canopy researchers, who were very isolated at that time. They also envisioned bringing about ways to communicate forest canopy information to the general public, particularly children. Nalini envisions the future of ICAN will remain a vibrant, informal, and supportive network that provides services to its members. She also hopes that forest canopy work will become a part of common knowledge and general environmental literacy among educators, policy makers, and the general public.

As for the future of canopy research, Nalini would like to see more coordinated and collaborative research, as research groups find more avenues of communication. She would also like to see major funding for concerted research efforts that require large amounts of research infrastructure (such as numerous canopy cranes, walkways, and other access mechanisms at a variety of field stations all over the world). Her most fervent goal is that one day a graduate program in canopy studies that would provide interdisciplinary training for students who wish to pursue canopy research would be established.

Photo: Denise Joines

Funding Opportunities

Lincoln Park Zoo Scott Neotropic Fund (SNF) supports field research in conservation biology throughout Latin America and the Caribbean. Awards of US$3,000-$7,500, are predominantly offered to Latin American graduate students. Initial support is for up to 12 months from the date of award. The annual application deadline is September 1st. Contact: *Lincoln Park Zoo Scott Neotropic Fund, c/o Director of Conservation and Science, Lincoln Park Zoo, Chicago, IL 60614, USA; <steveed@ix.netcom.com>; <<www.lpzoo.com>>.*

BP Conservation Program assists and encourages international teams of university students to undertake conservation research with long-term impacts. Projects must address a conservation issue of global importance and have a strong affiliation with the country where the project is located. Contact: *K. Gotto, BP Conservation Programme, Wellbrook Court, Griton Road, Cambridge CB3 OMA, UK; <bp-conservation-programme@bridlife.org.uk>.*

The International Foundation for Science (IFS) is an international non-profit organization mandated to promote high quality research on the management, use, and conservation of biological resources and their environment. IFS provides small grants to scientists in and from developing countries or to those employed in a developing country institution. Contact: *IFS, Grev Turegatan 19, 114 38 Stockholm, Sweden; Phone: (46) 8-545-818-00; <info@ifs.se>.*

Informal Science Education (ISE) Supplements. This program funds projects that provide rich and stimulating contexts and experiences for individuals of all ages, interests, and backgrounds to increase their appreciation for and understanding of science. This Supplement can be used for any activity that falls within the definition of an informal education activity such as media productions, exhibits, or youth-based activities. Contact: *<<www.nsf.gov/EHR/ESIE/resawrd/Ise-supl.htm>>.*

Center for Field Research Grants (CFR). CFR accepts proposals for Earthwatch field grants for multi-year studies in the biological, physical, and social sciences. Projects may be fielded in any country where it is safe and feasible to involve international volunteers. At least 20 volunteers must be employed, spread throughout the year. Grants for $10,000 - $130,000 per year, cover the costs of maintaining volunteers and research staff in the field and other project expenses. Contact; *<<www.earthwatch.org/cfr/cfr.html>>.*

Websites of Interest

State of the World's Forests 1999. The latest edition of this biannual publication from the United Nations Food and Agriculture Organization (FAO) offers one of the most comprehensive and up-to-date reviews of new developments in forestry and the condition of forests worldwide. Topics include: current figures on global forest cover, current efforts to assess forest resources, recent trends in forest management; and current and projected forest products production, consumption, and trade. This information is aimed at policymakers, academics, and the informed public. The report is offered in .pdf format; *<<www.fao.org/fo/sofo/sofo99/default.htm>>.*

New York Botanical Garden: Recently Added Online Resources. The New York Botanical Garden is in the process of cataloging its numerous specimens and has recently placed several searchable databases online. Search options allow users to search for specific taxa. Some of the resources are: Catalog of North American Bryophytes, <<www.nybg.org/bsci/hcol/bryo/>>; Catalog of North American Gymnosperms, <<www.nybg.org/bsci/hcol/gymn/>>; Catalog of Costa Rican Fungi, <<www.nybg.org/bsci/hcol/cric/>>; Catalog of NewWorld Macrofungi, <<www.nybg.org/bsci/hcol/fung/>>; and Ericaceae of Ecuador, <<www.nybg.org/bsci/hcol/eric/>>.

Missouri Botanical Garden: Moss Home Page. This webpage offers a large selection of resources for the study of mosses. These include a searchable species database; a searchable bibliographic database of bryological literature; a bryological glossary; moss checklists of Thailand, China, and Chile; and LATMOSS, A catalogue of neotropical mosses;<<www.mobot.org/MOBOT/tropicos/most/>>.

Botanical Society of America Online Image Collection (BSA). The BSA's entire slide collection, totalling 799 photos, is now available online. Users can access the images by browsing topical slide sets or via a keyword search engine. Images are offered as thumbnailed JPEGs which link to medium-resolution images. High-resolution images are also available; <<images.botany.org/bsa/>>.

Deforestation: Tropical Forest in Decline. This presentation examines the extent of tropical deforestation in developing countries, its causes and consequences, and the prospects for more sustainable land-use alternatives. The paper has been prepared as a contribution to the general public's better understanding of the complex social, economic, and environmental issues that surround tropical deforestation; *<<www.rcfa-cfan.org/English/issues.12.html>>.*

Publications of Interest

Ecology and Management of Tropical Secondary Forests: Science, People, and Policy. M.R. Guariguata and B. Finegan (eds.). 1999. Proceedings from a conference held at Centro Agronómico Tropical de Investigación y Enseñanza (CATIE) and the Center for International Forestry Research (CIFOR). Contact: *Unidad de Manejo de Bosques, CATIE, Costa Rica; <umbn@computo.catie.ac.cr>*.

Trees of the World. T.K. Bose, P. Das, and G.G. Maiti. 1998. This book is a comprehensive volume illustrating and discussing native and introduced trees growing in India and Asia. Each species is described in detail, including distribution, morphology, and habitat. Contact: *The Regional Plant Resources Centre, Bhubaneswar - 751015, Orissa, India; <<www.vedamsbooks.com/forestry.htm>>*.

Silvics of North America: Volume 1 Conifers; and **Volume 2 Hardwoods.** U.S. Department of Agriculture. 1990. These two volumes are essential resources for foresters, arborists, and tree enthusiasts. Contact: *<<willow.ncfes.umn.edu/silvics_manual/Table_of_Contents.htm>>*.

Announcements

Second International Forest Canopy Conference Proceedings. Part II of the proceedings of the Second International Forest Canopy Conference, held at the Marie Selby Botanical Gardens last November, entitled: *Forest Canopies 1998: Global Perspectives*, was published in Selbyana 20(1). This issue includes 13 papers presented at the conference, a post-conference summary by Meg Lowman, and a list of participants. Part I of the proceedings was published in Selbyana 19(2) last December, and Part III is scheduled for publication in December.

Selbyana encourages all conference participants to submit papers resulting from their work presented at the conference, as well as other work related to tropical plants with emphasis on epiphytes and their forest canopy habitat. Contact: *Tom Roberts <trobert6@virtu.sar.usf.edu>; 941-955-7553 x 10, <http:\\www.selby.org>*.

Volume 3, Issue 1 of Conservation Ecology is now complete and available online. This issue includes a special feature on Adaptive Management. Contact: *<<www.consecol.org/Journal/vol3/iss1>>; Australia <<//life.csu.edu.au/consecol/>>; Brazil <<www.bdt.org.br/cons_ecol/>>; Sweden <<conservation.beijer.kva.se/>>*.

Meetings of Interest

The 2nd Annual Earth Technologies Forum. Washington D.C., USA. September 27-29, 1999. Three days of conference sessions will include discussions of global climate change policy and technology issues. There will be a focus on both the international and domestic implementation of issues such as emissions trading, credit for early action to reduce greenhouse gas emissions, and voluntary programs to reduce emissions. Contact: *Ms. Erika Fischer; Phone: 703-807-4052; Fax:703-243-2874; <<www.earthforum.com>>*.

Technology in the Wildlife Profession: Research, Application, and Education. Nevada, USA. October 24-27, 1999. This symposium is sponsored by the GIS, Remote Sensing, and Telemetry Working Group of the Wildlife Society, and will take place during the 4th Microcomputer Applications in Fish and Wildlife Conference. This symposium will bring together presentations dealing with the use of GIS, GPS, remote sensing, and telemetry technology in the study, management, and politics of wildlife, and in wildlife education. Contact: *Scott Klopfer, Fish and Wildlife Information Exchange, 203 West Roanoke St., Blacksburg, VA 24061;Phone: 540 -231-7348; <sklopfer@vt.edu>; <<fwie.fw.vt.edu/ofwim/meet99.htm>>*.

Effects of Environmental Changes on Forest Growth. Maine, USA. October 26, 1999. This one-day intensive workshop is sponsored by NCASI and the International Forum of Forestry Research Organizations (IUFRO). Contact: *<<www.ncasi.org/events/NEForestry99.stm>>*.

Conference on Plant-Animal Interactions. Georgia, USA. January 4-8, 2000. The Society for Integrative and Comparative Biology (SICB) is hosting a coordinated pair of symposia: one on terrestrial systems, and one on marine systems. SICB is a dynamic organization dedicated to an interdisciplinary, "integrative and comparative" approach to biology. Contact: *Dr. Peter D. Smallwood, Department of Biology, University of Richmond, Richmond, VA 23173, USA; Phone: 804-289-8803; <psmallwo@richmond.edu>; <<www.sicb.org>>*.

Issues of Global Change: Conflicting Demands on Water, Air, & Land Resources in a Changing Global Environment. Lisbon, Portugal. October 16-18, 2000. Abstracts for oral and poster presentations are invited by January 28, 2000. Contact: *Gill Heaton, <gill.heaton@virgin.net>; <<www.elsevier.nl/locate/iep2000>>*.

RECENT CITATIONS IN CANOPY SCIENCE

[Editors note: Since there is no central journal on canopy science, it is useful to publish citations on canopy studies in recent scientific literature. Some of the papers listed below were obtained from ICAN subscribers sending in reprints; most were discovered through monthly literature searches (AGRICOLA, CAB, and FORESTRY ABSTRACTS)].

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CANOPY PLANTS

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