



WHAT'S UP?

The Newsletter of the International Canopy Network

2103 Harrison NW, Suite 2612 Olympia, WA 98502-2607

Nalini M. Nadkarni, Editor

Steve Rentmeester, Editorial Assistant

GETTING HIGH: CANOPY ECOTOURISM IN OREGON

For the past two years, Curry County, Oregon and Egret Communications have been working toward the development and operation of The Canopy Project, a combination of tourism, sustainable economics, education, and research. This initiative for building programs and infrastructure to guide visitors and conduct canopy research in the region's coastal rainforests, has received funding to move forward on preconstruction activities. Grants from the United States Forest Service and the United States Department of Commerce, Economic Development Administration plus local matching grants give Curry County more than \$700,000 to refine feasibility issues, develop preliminary architecture and engineering plans, and to take the project and proposed sites through environmental assessment.

The project, to be built and operated in Curry County by the non-profit organization "The Canopy Project", will mix on-site research, guided interpretive visits to the forest canopy, and nation-wide educational programs. The project proposes to build four key structures: a canopy walkway, a cantilevered structure for universal access into the canopy, a youth trail, and a center for interpretation and research. The research facilities will consist of office and laboratory space in the center facility and access to the canopy based on the planned infrastructure. Visitors would arrive at the center, learn from interactive exhibits, and then be transported in small groups to the forest access sites.

Curry County and the board of The Canopy Project plan to get preconstruction activities underway quickly. The first step of preconstruction will be to bring in outside experts to examine general design and economic feasibility issues. The project will focus on architectural and engineering issues starting this winter. Once those issues are resolved, specific



Photo: The proposed walkway in Curry County may be similar to walkways built in other parts of the world.

economic feasibility questions can be addressed. Project organizers hope to begin environmental assessment by early spring, 1998.

The project is designed to operate without outside assistance after initial investment, to use visitor revenues to support 50 family wage jobs, and to support research operations. The project, when complete, is forecast to generate \$17 million annually for the Curry County economy and to pump \$54 million a year into Oregon's tourism economy.

Sheree Cook, Curry County Commissioners, P.O. Box 746, Gold Beach, OR 97444 <currygov@harborside.com>

Terry Hanscam, President, The Canopy Project, 00243 Winchuck River Road, Brookings, OR 97415

Bob Harvey, Egret Communications, P.O. Box Q, Port Orford, OR 97465, <egretcomm@msn.com>

AMERICA'S URBAN FOREST-KEEPING OUR CITIES COOL

While forest canopies are important in maintaining species biodiversity, they are also critical in helping to keep our cities cool. Urban forests reduce demands for air conditioning and thereby reduce carbon dioxide emissions from fossil fueled power plants. In this article, we discuss how trees help keep our cities cool and how NASA technology is monitoring the "temperature" of our cities.

On a hot summer day, the shade of a tree can make our day tolerable by shading us from direct solar radiation. This is particularly important in urban areas where a large percentage of the surfaces are covered by concrete or asphalt. The temperatures of these artificial surfaces can sometimes be over 30° C warmer than vegetated surfaces. Materials such as asphalt store much of the sun's energy and remain hot long after sunset. This produces a dome of elevated air temperatures called the "urban heat island" and can increase temperatures by 5° C within the city. By absorbing the sun's energy, trees convert solar energy into latent heat, resulting in the transpiration of water from leaf stomata. Evaporation of water requires much more energy than heating air, so the energy that would normally heat the air is used to evaporate water.

How can we measure the effect trees have on keeping our cities cool? We could go out and measure the air temperature at various points throughout the city; but that would require thousands of measurements and coordinating many people to simultaneously record the temperatures. It would be difficult to accurately characterize the temperature variability over a large city. However, we can now use tools developed for exploring the universe to examining the role trees play in cooling our cities. In a study funded by NASA's Marshall Space Flight Center and Mission to Planet Earth, a series of flights over Huntsville, Alabama and Atlanta, Georgia are examining the heating and cooling patterns of the city. Infrared scanners, mounted on the NASA Learjet, produce aerial photographs. These digital images are a representation of the heat emitted from the ground. Analyzing these images with a computer allows us to measure the "thermal infrared" energy reflected from trees. By having the images in a computer we can also combine the data with topographic maps. Typically these airborne scanners have a temperature resolution of about 0.2 to 0.5° C. While the ground resolution varies with the height of the aircraft, a 5 m resolution is easily attainable and provides good detail of the forest canopy. In the cities we

have studied, early September temperatures ranged from 45-50° C for parking lots to 24-30° C for a "tree island" in the parking lot.

Quantifying the effects of tree canopy cover on the urban environment provide a foundation for determining the benefits of planting trees and reinforce the need to maintain and develop urban forests. Analysis of these data could also help urban design, by suggesting the inclusion of "tree islands" in asphalt parking lots, lining streets with trees, and shading the roofs of homes and businesses.

References using thermal imagery for forest canopy research:

- Lo, C. P., D. A. Quattrochi, and J. C. Luvall, 1997. Application of high-resolution thermal infrared remote sensing and GIS to assess the urban heat island effect. *International Journal of Remote Sensing*. **18**:2 287-304.
- Luvall, J. C. 1997. The use of remotely sensed surface temperatures from an aircraft based thermal infrared multispectral scanner (TIMS) to estimate the spatial variability of latent heat fluxes from a white pine (*Pinus strobus* L.) plantation. Pages 169-185 in *Scale in remote sensing and GIS*. Dale A. Quattrochi and Michael F. Goodchild, editors. Lewis Publishers, Chelsea, Michigan.
- Luvall, J.C., E.D. Schneider, J.J. Kay. *In Press*. Thermal remote sensing and its use for studying the thermodynamics of ecosystem development. *Landscape Ecology*.
- Quattrochi, D.A. and J.C. Luvall. *In Press*. Thermal infrared remote sensing data for analysis of landscape ecological processes: Review and prospects. *Landscape Ecology*.
- Luvall, J. C. and H. R. Holbo. 1991 Modeling forest canopy thermal response on a landscape scale using remotely sensed data. Pages 127-152 in *Quantitative Methods in Landscape Ecology*. M. G. Turner and R. H. Gardner, editors. Springer-Verlag, New York.
- Luvall, J.C., D. Lieberman, M. Lieberman, G. S. Hartshorn, and R. Peralta. 1990. Estimation of tropical forest canopy temperatures, thermal response numbers, and evapotranspiration using an aircraft-based thermal sensor. *Photogrammetric Engineering and Remote Sensing* **56**:1393-1401.
- Luvall, J. C. and H. R. Holbo. 1989. Measurement of short-term thermal responses of coniferous forest canopies using thermal scanner data. *Remote Sensing of Environment* **27**:1-10.
- Holbo, H. R. and J. C. Luvall. 1989. Modeling surface temperature distributions in forest landscapes. *Remote Sensing of Environment* **27**:11-24.
- Jeffrey C. Luvall, NASA's Global Hydrology and Climate Center, 977 Explorer Blvd., Huntsville, AL 35806, <jluvall@msfc.nasa.gov>, < http://www.ghcc.nasa.gov/atlanta>

UNIVERSITY OF NORTHERN BRITISH COLUMBIA SITE OF CANOPY RESEARCH ON INTERIOR WET-BELT FORESTS

The University of Northern British Columbia (UNBC) has been awarded a 5 year research grant by the Government of the Province of British Columbia (Forest Renewal B.C.) to investigate canopy dynamics in "wet-belt" forests of northern interior British Columbia. This work, which focuses on factors influencing the development of arboreal lichens in "wet-temperate" forests of northern interior B.C., includes experimental study components examining how alternative forest harvesting techniques influence "old growth" attributes and the retention/recruitment of canopy epiphyte communities. Project funding from Forest Renewal British Columbia (\$750,000 Can.) extends through the spring of 2002.

A major focus of this project is on the cold wet forests of the Interior Cedar-Hemlock (ICH) and Engelmann Spruce-Subalpine Fir (ESSF) zones of the Northern Rocky Mountains. These forests share a number of characteristics that shape canopy epiphyte community response and have major implications for human usage and economic activity in this region. Some of these characteristics include:

- Natural disturbance regimes in which fire is infrequent.
- Severe limitation to forest regeneration associated with heavy snowpack, cold wet soils, and competition effects.
- Extensive areas of mountain caribou habitat which rely on arboreal lichens in old-growth forest as a primary winter food item.
- Increasing interest in alternative sources of economic activity in local communities such as eco-tourism, alternative forest harvesting techniques, and activities associated with protected areas.

One outcome of this increased focus on northern "wet-belt" forests is a growing demand for information on ecological attributes and canopy processes, and a bridging of this information to local communities. In particular, there is considerable interest on the design and implementation of non-clearcutting silvicultural systems that allow for the greater retention/functioning of natural ecological process. We will include an assessment of changes in canopy function in areas where alternative forest harvesting techniques are being implemented.

Project work in 1997 has focused on the examination of growth rates and productivity measures in arboreal lichen

communities from sub-alpine spruce-fir forest stands in the northern Cariboo Mountains. The starting point has been the determination of standing biomass and measurement of turnover rates in arboreal lichen communities, using single rope access techniques. A canopy microclimate station is being used to detail profiles of canopy microclimate across tree crowns and within aggregate tree clumps at different heights within the canopy. We use impedance measures as surrogates for lichen thallus moisture content (using small clips placed on lichen thalli across which AC pulses are applied). This instrumentation will provide a detailed understanding of wetting and drying patterns within the canopy which seem to be a primary constraint to growth and productivity. In conjunction with measures of canopy turnover, these measurements will provide a comprehensive picture of canopy dynamics in existing forest stands, in stands modified by alternative forest harvesting techniques and natural gap-dynamic processes.

Project personnel include project co-investigators Darwyn Coxson from the UNBC and Susan Stevenson from Silviflora Research; Jocelyn Campbell, a graduate; and Janet Marsh. It is anticipated that additional positions available on this project in 1998 will include a graduate student research fellowship (M.Sc. or Ph.D. level) and a research assistant position.

For a project overview contact:
<<http://www.unbc.edu/wetbelt/#whatiswetbelt>>

*Darwyn Coxson, Department of Biology, University of Northern British Columbia, Prince George, B.C. V2N 4Z9,
<darwyn@unbc.ca>*

RAINFOREST: PAST AND FUTURE

James Cook University, Cairns, AUSTRALIA
24th - 28th April 1998

Co-hosted by the Cooperative Research Centre for Tropical Rainforest Ecology and Management in Australia, and the Smithsonian Tropical Research Institute in Panama.

The symposium program includes an exciting mix of researchers from around the world and across a range of disciplines to discuss the origin, maintenance and conservation of tropical forest communities. Early bird registrations close 31 January 1998. Registration Fees: Full time delegate \$250; Student delegate \$150.

*Ms Kerry Moore, Ph: + 61 7 4042 1254
<Kerry.Moore@jcu.edu.au>*

SECOND INTERNATIONAL FOREST CANOPY CONFERENCE
FOREST CANOPIES 98: GLOBAL PERSPECTIVES

Marie Selby Botanical Gardens, Sarasota, Florida, U.S.A.
November 4-8, 1998
(Tentative Schedule of Events and Sessions)

Co-Chairs

Meg Lowman, Director of Research and Conservation Dept., Marie Selby Botanical Gardens, Sarasota, Florida
Francis Hallé, Professor de Botanique, Institut de Botanique, Montpellier, France

WEDNESDAY - November 4, 1998

Canopies for Kids

Lynne Cherry, Author

H. Bruce Rinker, Millbrook School, NY

Valerie Renard and Raúl Rivero, Marie Selby Botanical Gardens

A special pre-conference day where public school science students from the Sarasota area participate in hands-on activities with scientists and their equipment.

Methods Workshop

Bart Bouricius and Phil Wittman, Canopy Construction Associates, MA

Gilles Ebersolt, Radeau des Cimes, Paris, France

A special pre-conference session running concurrently with the children's day whereby conference participants can discuss, observe, experience, and experiment with different canopy access techniques.

Opening Night

Neil Rettig and Kim Hayes (National Geographic Society USA)

Tim Scoones (Oxford Scientific Films, London)

Reception for conference participants followed by National Geographic preview of new TV film "Heroes of the High Frontier."

THURSDAY - November 5, 1998

Each session lasts for 1 hour and 45 minutes. During this time, it is envisioned that chairs will plan for one 25 minute presentation that serves as a review of the subject, 4 fifteen minute presentations, and a 20 minute discussion period at the end of each session.

Opening Remarks - 8:30 a.m.

Mark Bierner, Executive Director, Marie Selby Botanical Gardens

Session I. - Biodiversity in Forest Canopies - 8:45 a.m.

Nigel Stork, Executive Director, Center for Rain Forest Conservation
Queensland, Australia

Jack Longino, Evergreen State College, WA and ALAS Project,
Costa Rica

Session II. - Advances in South American Canopy Biology - 11:00 a.m.

Julio Voltolini, University of Taubaté, SP, Brazil

Talita Fontura, University of Santa Cruz, Bahia, Brazil

Session III. - Canopy - Atmosphere Dynamics, Including Trace Gas Exchange - 2:00 p.m.

Manuel Lerdau, State University of New York, NY

Gary Lovett, Institute of Ecosystem Studies, NY

Methods Workshop - 4:00 p.m.

Continued demonstrations of techniques for canopy access at the
Banyan tree, Marie Selby Botanical Gardens

Dinner Under the Banyans - Selby Gardens' Trustees Invited

Speaker, *Tom Lovejoy*, Director of Science, Smithsonian Institution,
Washington, DC.

FRIDAY - November 6, 1998

Session IV. Global Perspectives in Forest Conservation and Management - 9:00 a.m.

Kathryn Saterson, Biodiversity Support Program, World Wildlife
Fund

Jorge Illueca, United Nations Environmental Program

Session V. - How Can Canopy Scientists Integrate their Research with Global Policy-making? - 11:00 a.m.

Muriel Brathwaite, The World Bank (retired)

Meg Lowman, Marie Selby Botanical Gardens

Roundtable Lunch Discussion Groups 1:30 p.m. (box lunches)

1. Canopy Access Methods and the Development of Safety Protocols

Robbie Oates, Canopy Construction Associates

Tom Ness, New Tribe Outfitters

2. Canopy Crane Workshop

Joe Wright, Smithsonian Tropical Research Institute

Tamiji Inoue, Kyoto University, Japan

3. CITES and the Future of Research Collections

John Beckner, Marie Selby Botanical Gardens

John Kress, Smithsonian Institution, Washington, D.C.

4. Biology of Mistletoes

Gerhard Glatzel, Institute of Forest Ecology, Vienna Austria

Session VI. Epiphytes and Vines in Forest Canopies - 3:15 p.m.

Bruce Holst, Marie Selby Botanical Gardens

Wilhelm Barthlott, University of Bonn, Bonn, Germany

Public Lecture, **The High Frontier:** Mark Moffett, National Geographic Society - 8:00 p.m.

SATURDAY - November 7, 1998

Session VII. - Canopy Ecophysiology -9:00 a.m.

Steve Mulkey, University of Missouri, St. Louis, MO

Kaoru Kitajima, Smithsonian Tropical Research Institute

Session VIII. Canopy-Forest Floor Interactions -11:00 a.m.

D.A. Crossley and Mark Hunter, Institute of Ecology, University of Georgia, Athens, GA
Tim Schowalter, Oregon State University, Corvallis, OR

Roundtable Lunch Discussion Groups - 1:30 p.m.**1. Databases in Canopy Research and International Applications**

Nalini Nadkarni, Evergreen State College, Olympia, WA
Geoffrey Parker, Smithsonian Environmental Research Center, MD

2. Integration of Science and Story in Secondary Education

Kathryn Lasky, Author, Cambridge MA
Lynne Cherry, Executive Director, Authors Scientific Trust, Washington, DC

3. Canopy Walkways and Integrated Studies

Meg Lowman, Marie Selby Botanical Gardens
H. Bruce Rinker, Millbrook School, NY

Session IX. Ecology and Behavior of Vertebrates in Forest Canopies 3:15 p.m.

Hans Winkler, Austria
Dave Shaw, Wind River Canopy Crane, OR

Banquet, Marie Selby Botanical Gardens lawn - 7:00 p.m.

Invited Speakers:
Bruce Babbitt, Secretary of the Interior, USA
Al Gore, Vice-President of the USA

SUNDAY - November 9, 1998**Session X. Temperate Forest Canopy Research 3:15 p.m.**

Steve Sillett, Humboldt State University, Arcata, CA
Neville Winchester, University of British Columbia, Canada

Final Remarks - 11:00 a.m.**Field Trips - all afternoon****MONDAY - November 10****Field Trip to Peru, departure to Miami and Iquitos****Ongoing throughout conference:**

Canopy Film Festival Canopy Photographic Exhibit
 Poster Sessions

Travel Grants

Any scientists from developing countries who are currently engaged in canopy research are eligible to apply for travel funds. Interested participants should send a 2-page curriculum vitae, plus a tentative title of a presentation, to Meg Lowman.

Tentative Registration Schedule

AUGUST 1997 - preliminary brochures distributed
 JANUARY 1998 - registration forms available
 JUNE 1998 - Abstracts from speakers due for publication in conference booklet
 NOVEMBER 1998 - speakers submit written papers to be included in a proceedings volume

Meg Lowman, Research & Conservation Department, Marie Selby Botanical Gardens, 811 South Palm Avenue, Sarasota, FL 34236 USA, FAX (941) 951-1474

USGS LAUNCHES NEW ELECTRONIC CLEARINGHOUSE FOR BIOLOGICAL DATA

Dr. Dennis B. Fenn, Chief Biologist, announced that the U. S. Geological Survey's Biological Resources Division (USGS/BRD) has initiated a new Internet-based clearinghouse that can be used to search for biological data and information from a variety of sources. This clearinghouse is part of the National Biological Information Infrastructure (NBII), a cooperative effort led by the USGS to increase access to biological data and information maintained by a variety of Federal and State government agencies, universities, museums, libraries, and private organizations. The NBII Clearinghouse also functions as a part of the National Spatial Data Infrastructure (NSDI) Clearinghouse <<http://www.fgdc.gov/clearinghouse/index.html>>, as many of the biological databases described in the NBII Clearinghouse employ geospatial references.

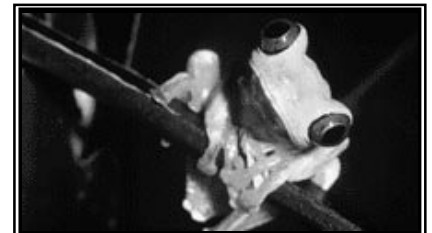
Through the NBII Clearinghouse, <<http://www.nbii.gov/clearinghouse.html>>, Internet users can search through standardized descriptions of biological databases or information products. These descriptions (metadata) include subject matter; how, when, where, and by whom the data were collected; whom to contact for more information; and how to access the database or information product. Users can search the NBII Clearinghouse using the following criteria: name of the investigator or author, subject-matter keywords, spatial coordinates of the study/project, and species or other taxonomic group.

Metadata descriptions in the NBII Clearinghouse are developed according to the NBII's biological metadata standard, <<http://www.nbii.gov/current.status.html>>, which also serves as a biological "enhancement" or "profile" of the Federal Geographic Data Committee's Geospatial Metadata Content Standard. The mission of the USGS/BRD is to work with others in providing the scientific understanding and technologies needed for sound management and conservation of the Nation's biological resources.

Anne Frondorf, (703) 648-4205, <Anne_Frondorf@nbs.gov>

ICAN'S SLIDE LIBRARY

This tree frog was photographed by Nalini Nadkarni in the Costa Rican rainforest. ICAN is developing a slide library, which will be available for loan.



If you have slides of the canopy please consider donating a copy at <canopy@elwha.evergreen.edu>.

Research Report: Effects of Hurricane Hugo on Canopy INVERTEBRATE COMMUNITY STRUCTURE AND FOLIIVORY

INTRODUCTION

Hurricane Hugo struck eastern Puerto Rico in September, 1989, defoliating much of the tropical forest and blowing down trees over large areas of the Luquillo Experimental Forest LTER site. This disturbance to the forest canopy altered abiotic conditions, and initiated canopy refoitation and vegetation succession in areas of treefall. Invertebrates associated with the forest canopy are affected by changes in temperature, moisture, and host conditions, depending on tolerances to heat, dessication and altered biochemistry on exposed plants. Few studies have documented responses of canopy invertebrate communities to disturbance and ecosystem recovery.

This study of invertebrate responses to hurricane disturbance at El Verde Field Station began in February 1991, shortly after initiation of tree refoitation and seedling and sprout regeneration. Sampling of canopies in relatively intact stands and in large treefall gaps has continued, resulting in a database for 140 invertebrate taxa on six tree species, representing early and late successional species common to replicate plots, over a four year period, 1991-92 and 1994-95.

MATERIALS and METHODS

Six experimental blocks were established at El Verde Field Station in February 1991. Each block included paired 30-50 m diameter plots representing a treefall gap resulting from Hurricane Hugo and a relatively undisturbed plot in which no trees fell. Canopy coverage was < 25% in treefall gaps and > 75% in intact plots at the beginning of study. By 1994, canopies in both treatments were essentially closed, with *Cecropia* forming a canopy at 10-15 m in gap plots. Five tree species were selected initially on the basis of their representation of undisturbed forest (*Dacryodes*, *Manilkara*, *Sloanea*) and disturbed forest (*Cecropia*, *Casearia*) and their presence in all treatment plots for comparison. A third disturbance-adapted tree genus, *Prestoea*, was added in 1992.

One tree per species was sampled in each plot during the wet season and dry season in 1991-92 and 1994-95. Trees were sampled with an insect net with a closeable plastic bag, permitting collection of samples up to 10-12 m in canopies averaging 20 m in height. Invertebrates in samples were sorted by taxon; foliage was pressed, dried, weighed and measured for leaf area missing (LAM). Invertebrate number divided by foliage mass provided a standard unit (intensity).

Most of the 140 taxa occurred too infrequently for individual ANOVA to evaluate the significance of treatment, tree species, season, year and interaction effects and were grouped by higher taxonomic rank and/or guild. Monte Carlo methods were used to re-randomize the data for tree species, treatment, season and year, and run the ANOVA. Only LAM showed a significant seasonal trend, so, data were pooled by tree species, treatment, and year for subsequent analyses.

RESULTS and DISCUSSION

Tree species significantly affected abundances of 45% invertebrate groups analyzed. Several herbivore taxa occurred, or were significantly most abundant on only one or a few of the six tree species. Some predacious and detritivorous taxa also showed significant differences in abundance among tree species. Hurricane treatment significantly affected abundances of 25% of the invertebrate groups (Table 1). Defoliators, detritivores and aquatic insects generally were more abundant and sap-suckers and molluscs were less abundant in intact forests, compared to treefall gaps. Predators showed more variable responses. Hence, functional organization of the community shifted from dominance by defoliators to dominance by sap-suckers, which exploit nutrient translocation to rapidly growing tissues.

Significant annual variation in abundances occurred in 49% invertebrate groups. Successional trends were not apparent for most of these groups. However, two taxa of scale insects (*Ceroplastes* and *Coccus*), showed distinct declines in abundance over the study period.

LAM differed significantly among tree species (probably reflecting different palatibilities), disturbance treatment (reflecting changes in defoliator abundances), year, tree species x treatment and tree species x year. When season was included in the analyses, this factor and tree species x year were the only significant factors. LAM peaked during the wet season on all six tree species each year, except during 1995, perhaps reflecting delayed effects of the severe drought during 1994. LAM increased significantly on *Cecropia* from 1991 through 1995, consistent with the hypothesis that herbivory should increase as host abundance increases. LAM was higher overall in intact stands, where defoliator abundance also was higher.

Table 1. Mean (\pm standard error) intensities for canopy arthropod taxa and guilds that showed significant responses to canopy opening by Hurricane Hugo at the Luquillo Experimental. Data are means for six tree species in six replicate blocks sampled seasonally during 1991-92 and 1994-95 (N=124 for intact stands and 132 for gaps).

Taxon or Guild	Intact (No/kg foliage)	Gap (No/kg foliage)	Taxon or Guild	Intact (No/kg foliage)	Gap (No/kg foliage)
Defoliators	100	64	Predators*	290	470
Lepidoptera	35	15	Oxyopid spiders	12	5
Curculionidae	12	4	Araneid spiders	14	22
			Predaceous Diptera	4	1
Sap-suckers	170	220	Detritivores	140	76
Protopulvinaria	5	14	Collembola	41	24
Stem coccoid	6	5	Fungivorous Diptera	25	5
Mirid 1	7	12			
Molluscs	1	4	Aquatic insects	14	8
			Culicidae	6	5
			Leaf Area Missing (%)	5	4

CONCLUSIONS

Most variation in arthropod abundances was related to tree species. The significance of tree species likely reflects different biochemical characteristics of the trees affecting associated herbivores and their host-specific predators.

Hurricane Hugo significantly affected canopy arthropod communities, favoring sap-suckers and molluscs and reducing defoliators, detritivores, and aquatic insects during this period. Predacious beetles also were significantly less abundant in gaps during the first year.

Leaf area missing, an indicator of herbivore activity, showed significant seasonal and annual trends, as well as differences among tree species and hurricane treatments. Generally, LAM peaked during the wet season each year, but reached highest levels during an extended drought in 1994. LAM also tended to be higher on the more abundant tree species in each disturbance treatment.

Timothy D. Schowalter, Department of Entomology, Oregon State University, Corvallis, OR 97331-2907;
<schowalt@bcc.orst.edu>

INQUIRES, SEARCHES, AND INVESTIGATIONS

I have been unable to find any papers on mechanical effects in tree canopies. One can imagine that when the wind blows, the canopies of neighbouring trees bash against each other damaging twigs and branches. In some forests, the canopies of neighboring trees do not intermingle leaving a gap between each tree. Is that caused by twigs and branches bashing against one another? Has anyone described such processes?

J.B. Wilson, Botany Department, University of Otago, P.O. Box 56, Dunedin, New Zealand, <Bastow@Otago.ac.NZ>

Responses:

- Assmann, E. 1970. *The Principles of Forest Yield Study*, Pergamon Press, Oxford.
- Blaise, F. 1992. Simulation de couvert vegetaux realistes en 3-D. Pages 207-212 in XVII International Congress for Photogrammetry and Remote Sensing. LW Fritz and JR Lucas, editors. International Archives of Photogrammetry and Remote Sensing, vol. 14, tome B3, Washington D.C.
- Blaise, F. and F. de Reffye. 1994. Simulation de la croissance des arbres et influence du milieu: le logiciel AMAPpara. in Actes du 2e colloque africain sur la recherche en informatique. J Tonkoano, editor. Ouagadougou (Burkina Faso), du 12 au 18 octobre 1994. Orstrom, Paris.
- Coutts, M.P. and J. Grace. 1995. *Wind and Trees*. Cambridge University Press, Cambridge, Massachusetts USA.
- Fournier M., P. Rogier, E. Costes, and M. Jaeger. 1993. Modelisation des vibrations propres d'un arbre soumis aux vents, en fonction de sa morphologie. *Annals of Scientific Forestry* **50**: 401-412.
- Franco, M. 1986. The influence of neighbours on the growth of modular organisms with an example from trees. *Phil. Trans. R. Soc. Lond. B* **313**:209-225.
- Hale, Betsy J. 1992. Branching patterns and crown development of hardwood saplings in even-aged mixed species stands in southern New England. Ph.D. Thesis. Yale University School of Forestry and Environmental Studies, New Haven, CT USA.
- Long, J.N. and F. W. Smith. 1992. Volume increment in *Pinus contorta* var. *latifolia*: the influence of stand development and crown dynamics. *Forest Ecology and Management* **53**: 53-64.
- Mitchell, K.J. 1969. Simulation of growth of even-aged stands of white spruce. *Yale University School of Forestry Bulletin* **75**.
- Mitchell, K.J. 1975. Dynamics and simulated yield of Douglas-Fir. *Forest Science Monograph* **17**:7-8
- Putz, F., G.G. Parker, and R.M. Archibald. 1984. Mechanical abrasion and intercrown spacing. *Am. Midl. Nat.* **112**: 24-28.

Responses from:

Akihiro Sumida, Gifu Univ., Laboratory of Forest Ecology, Yanagido, Gifu, 501-11, Japan, <asumida@cc.gifu-u.ac.jp>

Daniel S. Gruner, Department of Zoology/U Hawaii, 2538 the Mall - Edmondson Hall, Honolulu, HI 96822, <dgruner@hawaii.edu>

Dr. Andreas Brunner, Universitaet Freiburg, Waldbau-Institut, Tennenbacher Str. 4, D 79085 Freiburg, Germany, <brunnera@ruf.uni-freiburg.de> <http://omnibus.uni-freiburg.de/~brunnera>

Fredric Raulier, Centre de foresterie des Laurentides, Service canadien des forests, Region du Quebec, <fraulier@cfl.forestry.ca>

Graeme Pierce Berlyn, Yale School of Forestry and Environmental Studies, 370 Prospect Street, New Haven, CT 06511, <graeme.berlyn@yale.edu>

Michael G. Ryan, USDA Forest Service, Rocky Mountain Research Station, 240 West Prospect RD, Fort Collins, CO 80526-2098 <mryan@lamar.colostate.edu>

Steven B. Jack, J.W. Jones Ecological Research Center, Ichauway, Route 2, Box 2324, Newton, GA 31770 <sjack@jonesctr.org>

PUBLICATIONS OF INTEREST

Canopy Arthropods. N. E. Stork, J. Adis, and R. Didham, editors. 1996. The past twenty years have seen a revolution in the study and understanding of the diversity and the structure of the arthropod communities in the forest canopy. This has been enhanced by the development of new techniques to access the canopy and to sample arthropods. The rapid increase in the number of studies of the canopy has been fuelled by the recognition of the importance of the roll of forests, especially tropical forests in carbon and water cycles and hence global climate. As forests are cut down, altered and fragmented, the communities of organisms associated with them are also affected. Predictions of global extinction rates for all species based on forest loss range from 1 to 10 percent every ten years. Arthropods comprise the largest part of animal species richness and therefore, inevitably large numbers of arthropods may become extinct. This volume, for the first time, brings together a wide range of the most recent studies of arthropods living in forest canopies and comes from a truly international team of contributors. Chapman & Hall, London. Editors ISBN 0412749009.

Australia's Ever-Changing Forests III. John Dargavel. 1997. This volume contains 27 papers presented at the Third National Conference on Australia's Forest History. The first ten are concerned with concepts and aspects of forest age ranging from the Greek and Latin classics to current perceptions of 'old-growth'. The other papers span the continent and include three from New Zealand. Topics cover using the forests, transforming their ecology and the methods used by public agencies to study their history. Canberra: Centre for Resource and Environmental Studies, ANU. vi+370 pp. incl. bibliography. ISBN 0 86740 4884. <http://cres.anu.edu.au/publication/everchan.html>

JOBS, OPPORTUNITIES, WORK WANTED

LA SELVA MANAGEMENT: THE ADMINISTRATOR AND THE SCIENTIFIC DIRECTOR

The tasks formerly charged to the La Selva Director have been divided between two newly created, complementary posts. The Administrator and the Scientific Director of La Selva have primary responsibility for the operation of the field station and for leadership in planning and implementing its development. These positions carry considerable responsibility and require a flexible, creative approach and good communications skills to satisfy the needs of varied constituencies. Close teamwork between the two is essential.

Major areas of responsibility include administrative leadership and supervision of the support staff; marketing and service to course participants, researchers, and public educators; scientific management of a multidisciplinary facility aimed at supporting outside users; involvement in teaching and research; and consensus-building activities that support the OTS mission.

La Selva Administrator. Oversees management of La Selva; supervises the heads of operations, accounting, marketing, and administration, as well as the secretarial and the community outreach staff. Represents OTS with local entities such as the national park, the school district, the municipality, and conservation groups.

La Selva Scientific Director: Provides scientific oversight and management; interfaces with current and prospective researchers, students, and educational programs to optimize use of facilities, interaction among projects, and access to information.

Shared tasks: Both positions implement OTS policy at La Selva and engage in activities to enhance development, operation, and funding for the station, coordinating with each other and other OTS staff.

Supervision: Both positions report to the Associate Executive Director (AED) to develop work plans and overall policies, and to foster a smooth-running operation that effectively employs available resources in supporting OTS goals.

Both positions are based at the field station, near Puerto Viejo de Sarapiquí, Costa Rica.

Amy Barbee <abarbee@ACPUB.DUKE.EDU>

RECENT CITATIONS IN CANOPY SCIENCE

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

Remote Sensing

- Estreguil, C. and E.F. Lambin. 1996. Mapping forest-cover disturbances in Papua New Guinea with AVHRR data. *Journal of Biogeography* **23**:757-773.
- Gholz, H.L., P.J. Curran, J.A. Kupoec, and G.M. Smith. 1996. Assessing leaf area and canopy biochemistry of Florida pine plantations using remote sensing. Pages 3-22 in H.L. Gholz, K. Nakane, and H. Shimoda, editors. *The use of remote sensing in the modeling of forest productivity*. Kluwer Academic Publishing. Dordrecht, The Netherlands.
- Nilson, T. and J. Ross. 1996. Modeling radiative transfer through forest canopies: implications for canopy photosynthesis and remote sensing. Pages 23-60 in H.L. Gholz, K. Nakane, and H. Shimoda, editors. *The use of remote sensing in the modeling of forest productivity*. Kluwer Academic Publishing. Dordrecht, The Netherlands.
- van Leeuwen, W.J.D., A.R. Huete, C.L. Walthall, S.D. Prince, A. Begue, and J.L. Roujean. 1997. Deconvolution of remotely sensed spectral mixtures for retrieval of LAI, fAPAR and soil brightness. *Journal of Hydrology* **188-189**:697-724.

Plant Physiology

- Liu, X., D.S. Ellsworth, and M.T. Tyree. 1997. Leaf nutrition and photosynthetic performance of sugar maple (*Acer saccharum*) in stands with contrasting health conditions. *Tree Physiology* **17**: 169-178.
- Picchioni, G.A., P.H. Brown, S.A. Weinbaum, and T.T. Muraoka. 1997. Macronutrient allocation to leaves and fruit of mature, alternate-bearing Pistachio Trees: magnitude and seasonal patterns at the whole-canopy level. *Journal of American Society for Horticultural Science* **122**:267-274.

Ecosystem Ecology

- Binkley, D., and P. Hogberg. 1997. Does atmospheric deposition of nitrogen threaten Swedish forests? *Forest Ecology and Management* **92**:119-152.
- Carreira, J.A., A.F. Harrison, L.J. Sheppard, and C. Woods. 1997. Reduced soil P availability in a Sitka spruce (*Picea sitchensis* (Bong.) Carr) plantation induced by applied acid-mist: significance in forest decline. *Forest Ecology and Management* **92**:153-166.
- Erismann, J.W., G. Draaijers, J. Duyzer, P. Hofschreuder, N. van Leeuwen, F. Romer, W. Ruijgrok, P. Wyers, and M. Gallagher. 1997. Particle deposition to forests: summary of results and application. *Atmospheric Environment* **31**:321-332.
- Heaton, T.H.E., B. Spiro, and S.M.C. Robertson. 1997. Potential canopy influences on the isotopic composition of nitrogen and sulphur in atmospheric deposition. *Oecologia* **109**:600-607.

- Herwitz, S.R. 1993. Stemflow influences on the formation of solution pipes in Bermuda eolianite. *Geomorphology* **6**:253-271.
- Kabat, P., A.J. Dolman, and J.A. Elbers. 1997. Evaporation, sensible heat and canopy conductance of fallow savannah and patterned woodland in the Sahel. *Journal of Hydrology* **188-189**:494-515.
- Pratt, G.C., E.J. Orr, D.C. Bock, R.L. Strassman, D.W. Fundine, C.J. Tawarowski, J.D. Thornton, and T.P. Meyers. 1996. Estimation of dry deposition of inorganics using filter pack data and inferred deposition velocity. *Environmental Science and Technology* **30**:2168-2177.
- Ruijgrok, W., C.I. Davidson, and K.W. Nicholson. 1995. Dry deposition of particles: implications and recommendations for mapping of deposition over Europe. *Tellus* **47B**:587-601.
- Ruijgrok, W., H. Tieben, and P. Eisinga. 1997. The dry deposition of particles to a forest canopy: a comparison of model and experimental results. *Atmospheric Environment* **31**:399-415.
- Tuzet, A., J-F. Castell, A. Perrier, and O. Zurfluh. 1997. Flux heterogeneity and evapotranspiration partitioning in a sparse canopy: the fallow savanna. *Journal of Hydrology* **188-189**:482-493.

Plant and Animal Relations

- Kerdelhue, C., M.E. Hochberg, and J-Y. Rasplus. 1997. Active pollination of *Ficus sur* by two sympatric fig wasp species in West Africa. *Biotropica* **29**:69-75.
- Mack, A. 1997. Spatial distribution, fruit production and seed removal of a rare, dioecious canopy tree species (*Aglaia aff. Flavida* Merr. et Perr.) in Papua New Guinea. *Journal of Tropical Ecology* **13**:305-316.
- Warren, J.M., D. Z. Emamdie, and Kalai. 1997. Reproductive allocation and pollinator distributions in cauliflorous trees in Trinidad. *Journal of Tropical Ecology* **13**:337-345.

Canopy Animals

- Adis, J., W. Paarmann, C.R.V. da Fonseca. 1997. Knockdown efficiency of natural pyrethrum and survival rate of living arthropods obtained by canopy fogging in Central Amazonia. Pages 67-81 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Casas, J. and M. Aluja. 1997. The geometry of search movements of insects in plant canopies. *Behavioral Ecology* **8**:37-45.
- Cunningham, J.C., K.W. Brown, N.J. Payne, R.E. Mickle, G.G. Grant, R.A. Fleming, A. Robinson, R.D. Curry, D. Langevin, and T. Burns. 1997. Aerial spray trials in 1992 and 1993 against gypsy moth, *Lymantria dispar* (Lepidoptera: Lymantriidae), using nuclear polyhedrosis virus with and without an optical brightener compared to *Bacillus thuringiensis*. *Crop Protection* **16**:15-23.
- Hammond, P.M., N.E. Stork, and M.J.D. Brendell. 1997. Tree-crown beetles in context: a comparison of canopy and other ecotone assemblages in a lowland tropical forest in Sulawesi. Pages 184-223 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Harada, A. Y. and J. Adis. 1997. The ant fauna of tree canopies in Central Amazonia: a first assessment. Pages 382-400 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Kitching, R.L., H. Mitchell, G. Morse, and C. Thebaud. 1997. Determinants of species richness in assemblages of canopy arthropods in rainforests. in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Mawdsley, N.A. and N.E. Stork. 1997. Host-specificity and the effective specialization of tropical canopy beetles. Pages 104-130 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Paarmann, W. and K. Kerck. 1997. Advances in using the canopy fogging technique to collect living arthropods from tree-crowns. Pages 53-66 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Paarmann, W. and K. Kerck. 1997. Studies on the biology of a canopy-dwelling carabid beetle collected by canopy fogging in the rainforest of Sulawesi (Indonesia). Pages 433-441 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Payne, N.J., J.C. Cunningham, R.D. Curry, K.W. Brown, and R.E. Mickle. 1996. Spray deposits in a mature oak canopy from aerial applications of nuclear polyhedrosis virus and *Bacillus thuringiensis* to control gypsy moth, *Lymantria dispar* (L.). *Crop Protection* **15**:425-431.
- Prinzing, A. 1997. Spatial and temporal use of microhabitats as a key strategy for the colonization of tree bark by *Entomobrya nivalis* L. (Collembola: Entomobryidae). in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Recher, H.F., J.D. Majer, and S. Ganesh. 1996. Eucalypts, arthropods and birds: on the relation between foliar nutrients and species richness. *Forest Ecology and Management* **85**:177-195.
- Recher, H.F., J.D. Majer, and S. Ganesh. 1996. Seasonality of canopy invertebrate communities in eucalypt forests of eastern and western Australia. *Australian Journal of Ecology* **21**:64-80.
- Riede, K. 1997. Bioacoustic monitoring of insect communities in a Bornean rainforest canopy. Pages 442-251 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Stork, N.E., R.K. Didham, and J. Adis. 1997. Canopy arthropod studies for the future. Pages 551-561 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Watanabe, H. 1983. Effects of repeated aerial applications of insecticides for pine-wilt disease on arboreal arthropods in a pine stand. *Journal of Japanese Forestry Society* **65**: 282-287.
- Watanabe, H. 1990. An estimation of an arboreal arthropod population in a dry evergreen forest in Northeastern Thailand in reference to primary consumption (grazing loss). Pages 174-179 in Proceedings IUFRO workshop on Pests and Diseases of Forest Plantations. Bangkok, Thailand.
- Watanabe, H. 1997. Estimation of arboreal and terrestrial arthropod densities in the forest canopy as measured by insecticide smoking. Pages 401-414 in N.E. Stork, J. Adis, and R.K. Didham, editors. *Canopy arthropods*. Chapman and Hall, London, UK.
- Watanabe, H. and S. Ruaysoongnern. 1989. Estimation of arboreal arthropod density in a dry evergreen forest in Northeastern Thailand. *Journal of Tropical Ecology* **5**:151-158.
- Watanabe, H., B. Prachaiyo, P. Sahunalu, and P. Dhanmanonda. 1984. Estimation of primary consumption (grazing loss) by leaf-eating insects in a dry evergreen forest in Northeastern Thailand. *Thailand Journal of Agricultural Science* **17**:119-128.

Canopy Structure

- Baldwin, V.C., Jr. and K.D. Peterson. 1997. Predicting the crown shape of loblolly pine trees. *Canadian Journal of Forest Research* **27**:102-107.
- Biging, G.S. and S.J. Gill. 1997. Stochastic models for conifer tree crown profiles. *Forest Science* **43**:25-34.
- Cade, B.S. 1997. Comparison of tree basal area and canopy cover in habitat models: subalpine forest. *Journal of Wildlife Management* **61**:326-335.
- Deleuze, C., J-C. Herve, F. Colin, and L. Ribeyrolles. 1996. Modeling crown shape of *Picea abies*: spacing effects. *Canadian Journal of Forest Research* **26**:1957-1966.
- Gilmore, D.W. and R.S. Seymour. 1996. Alternative measures of stem growth efficiency applied to *Abies balsamea* from four canopy positions in central Maine, USA. *Forest Ecology and Management* **84**:209-218.
- Gilmore, D.W., R.S. Seymour, and D.A. Maguire. 1996. Foliage - sapwood area relationships for *Abies balsamea* in central Maine, USA. *Canadian Journal of Forest Research* **26**:2071-2079.
- Harrington, C.A. and D.S. DeBell. 1996. Above- and below-ground characteristics associated with wind toppling in a young *Populus* plantation. *Trees* **11**:109-118.
- Hilbert, D.W. and C. Messier. 1996. Physical simulation of trees to study the effects of forest light environment, branch type and branch spacing on light interception and transmission. *Functional Ecology* **10**:777-783.
- Ito H., A. Sumida, Y. Isagi, and K. Kamo. 1997. The crown shape of an evergreen Oak, *Quercus glauca*, in a hardwood community. *Journal of Forest Research* **2**:85-88.
- Jose, S. and A.R. Gillespie. 1997. Leaf area-productivity relationships among mixed-species hardwood forest communities of the Central Hardwood Region. *Forest Science* **43**:56-64.
- Kikuzawa, K., H. Koyama, K. Umeki, and M.J. Lechowicz. 1996. Some evidence for an adaptive linkage between leaf phenology and shoot architecture in sapling trees. *Functional Ecology* **10**:252-257.
- Kozlov, M.V., B.J. Wilsey, J. Koricheva, and E. Haukioja. 1996. Fluctuating asymmetry of birch leaves increases under pollution impact. *Journal of Applied Ecology* **33**:1489-1495.
- Monserud, R.A., A.A. Onuchin, N.M. Tchebakova. 1996. Needle, crown, stem, and root phytomass of *Pinus sylvestris* stands in Russia. *Forest Ecology and Management* **82**:59-67.
- Osawa, A. and N. Kurachi. 1997. A light-weight CCD camera technique for estimating three-dimensional distribution of foliage density in tree crowns. *Ecoscience* **4**:183-190.
- Pereira, J.M.C., M. Tome, J.M.B. Carreiras, J.A. Tome, J.S. Pereira, J.S. David, and A.M.D. Fabiao. Leaf area estimation from tree allometrics in *Eucalyptus globulus* plantations. 1997. *Canadian Journal of Forest Research* **27**:166-173.
- Sumida, A., H. Ito, and Y. Isagi. 1997. Trade-off between height growth and stem diameter growth for an evergreen Oak, *Quercus glauca*, in a mixed hardwood forest. *Functional Ecology* **11**:300-309.
- Takenaka, A. 1997. Structural variation in current-year shoots of broad-leaved evergreen tree saplings under forest canopies in warm temperate Japan. *Tree Physiology* **17**:205-210.
- Ter-Mikaelian, M.T., R.G. Wagner, C. Shropshire, F.W. Bell, and C.J. Swanton. 1997. Using a mechanistic model to evaluate sampling designs for light transmission through forest plant canopies. *Canadian Journal of Forest Research* **27**:117-126.
- Ter-Mikaelian, M.T. and R.G. Wagner. 1997. Distance-independent models for predicting photosynthetically active radiation transmission through young forest plant canopies. *Canadian Journal of Forest Research* **27**:127-130.
- Wu, R. and R.F. Stettler. 1996. The genetic resolution of juvenile canopy structure and function in a three-generation pedigree of *Populus*. *Trees* **11**:99-108.

Canopy Plants

- Aragon, G. and I. Martinez. 1997. Contribucion al conocimiento de los liquenes epifiticos de los montes de Toledo (Toledo, Espana). *Cryptogamie, Bryologie et Lichenologie* **18**:63-75.
- Arseneau, M-J., L. Sirois, and J-P. Ouellet. 1997. Effects of altitude and tree height on the distribution and biomass of fruticose arboreal lichens in an old growth balsam fir forest. *Ecoscience* **4**:206-213.
- Gradstein, S.R., P. Hietz, R. Lucking, A. Lucking, H.J.M. Sipman, H.F.M. Vester, J.H.D. Wolf, and E. Gardette. 1996. How to sample the epiphytic diversity of tropical rain forests. *Ecotropica* **2**:59-72.
- McCune, B., K.A. Amsberry, F.J. Camacho, S. Clery, C. Cole, C. Emerson, G. Felder, P. French, D. Greene, R. Harris, M. Hutten, B. Larson, M. Lesko, S. Majors, T. Markwell, G.G. Parker, K. Pendergrass, E.B. Peterson, E.T. Peterson, J. Platt, J. Proctor, T. Rambo, A. Rosso, D. Shaw, R. Turner, and M. Widmer. 1997. Vertical profile of epiphytes in a Pacific Northwest old-growth forest. *Northwest Science* **71**:145-152.
- Molina-Freaner, F. and C. Tinoco-Ojanguren. 1997. Vines of a desert plant community in Central Sonora, Mexico. *Biotropica* **29**:46-56.
- Moreno, I.M., and G. Aragon Rubio. 1996. Liquenes epifiticos de la vertiente norte del Puerto de la Quesera, Macizo de Ayllon (Centro de Espana). *Cryptogamie, Bryologie et Lichenologie* **2**:143-156.
- Popp, M., R. Mensen, A. Richter, H. Buschmann, and D.J. von Willert. 1995. Solutes and succulence in southern African mistletoes. *Trees* **9**:303-310.
- Renhorn, K-E., P-A. Esseen, K. Palmqvist, and B. Sundberg. 1997. Growth and vitality of epiphytic lichens: I. Responses to microclimate along a forest edge-interior gradient. *Oecologia* **109**:1-9.
- Sundberg, B., K. Palmqvist, P-A. Esseen, and K-E. Renhorn. 1997. Growth and vitality of epiphytic lichens: II. Modelling of carbon gain using field and laboratory data. *Oecologia* **109**:10-19.
- Tremblay, R.L. 1997. Distribution and dispersion patterns of individuals in nine species of *Lepanthes* (Orchidaceae). *Biotropica* **29**:38-45.

Miscellaneous

- Dahir, S. E. and C. G. Lorimer. 1996. Variation in canopy gap formation among developmental stages of northern hardwood stands. *Canadian Journal Forest Research* **26**:1875-1892.
- Ivanov, N., P. Boissard, M. Chapron, and B. Andrieu. 1995. Computer stereo plotting for 3-D reconstruction of a maize canopy. *Agricultural and Forest Meteorology* **75**:85-102.

INTERNATIONAL CANOPY NETWORK
SUBSCRIBER FORM

NAME: _____
ADDRESS: _____

PHONE: _____
FAX: _____
EMAIL: _____
VISA OR MC #: _____
EXPIRATION DATE: _____



\$ 30 Regular Subscriber please check below if you are a new subscriber:
\$ 20 Student Subscriber
\$ 50 Institutional/Corporate

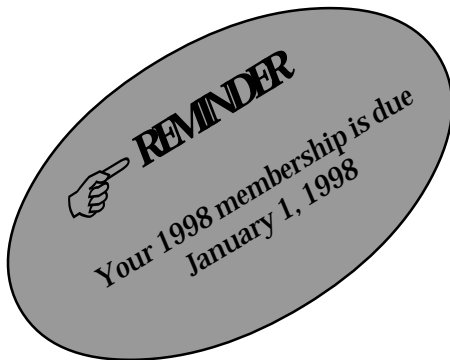
~Additional tax-deductable donations are welcomed~

PLEASE SEND A CHECK, MONEY ORDER, MC or VISA NUMBER TO:

**ICAN
2103 Harrison NW, Suite 2612
Olympia, WA 98502-2607 USA
Call in Visa or MC to (360) 866-6788
E-mail <canopy@elwha.evergreen.edu>**

INTERNATIONAL CANOPY NETWORK

*2103 Harrison NW, Suite 2612
Olympia, WA 98502-2607 USA*



This 80% Post Consumer, 100% Recycled Paper is Recyclable.