Selbyana 20(1): 61–65. 1999.

FOREST CANOPIES 1998: GLOBAL PERSPECTIVES—A NEW BEGINNING FOR THE NEW MILLENNIUM

MARGARET D. LOWMAN

Marie Selby Botanical Gardens, 811 South Palm Avenue, Sarasota, FL 34236 USA.

I would like to begin with an enormous "thank you" to the chairs, the participants, the volunteers, and the staff of Selby Gardens who made this, the second international forest canopy conference, an event of global significance. Without all of the wonderful help and local supporters, a conference of this magnitude would not have been possible, nor would it have been so productive in terms of its research, conservation, and education mission.

The 1998 conference represented our last scientific get-together of the twentieth century, and perhaps the most notable achievement was the diversity of people attending, particularly young canopy scientists (60 graduate students), women (63), and the excellent representation from the international scientific community—more than 40 countries were represented. Such participation attests to the importance of canopy research. It is significant that—at the end of this century—we are united in "a common feeling" about the importance of forests. Therefore, instead of summary remarks at the end of the conference, the emphasis was on the beginning of a global initiative for research and conservation of world forests.

Canopy science is changing and expanding in many directions. Analogous to a patchwork quilt, it is composed of a variety of designs and materials:

1. Spatial scales from leaf to forest;
2. Low to high technological approaches;
3. Under-funded to well-funded projects;
4. Low to high levels of communication among scientists;
5. Small-scale versus large-scale studies;
6. Research on animals, on plants, or on both;
7. Mobile organisms versus sedentary creatures versus canopy processes under study; and
8. Low to high probabilities of implementing conservation in different regions.

Since the first canopy conference in 1994, new ideas have been forthcoming. The years between the two conferences saw the advent of larger and improved collaborative studies. Canopy cranes and other field sites offered more long-term opportunities for canopy researchers to share data and integrate ideas. Emphasis was placed on the role of indigenous people, since local people are the stewards of the forest over the long term, not the visiting researchers. The 1998 conference recognized and celebrated the youthful energy of the new canopy scientists—scientists who will provide the growth and leadership for the future. At this junction, an alarm must be sounded that there are still important forest regions where canopy research is either non-existent or inadequate because of the shortage of funds and training. This is a critical time to ensure that adequate funds are available for future scientists, particularly for graduate programs, long-term research, international communication, field sites, and publications.

The conference, divided into ten sessions, illustrated the breadth of canopy research in progress around the globe.

SESSION I: BIODIVERSITY IN FOREST CANOPIES

Chaired by Nigel Stork and Joachim Adis, Session I featured a keynote presentation on arthropod diversity by Neville Winchester. This topic was an update from the first canopy conference, when participants were unresolved about arthropod diversity, and many projects were in early stages. Thus the second conference opened with a continuing dialog on this important subject. Since arthropods represent the majority of known biodiversity in forest canopies and throughout the planet, this topic is key to forest conservation.

Neville's talk featured data from temperate rain forests in British Columbia, but he raised questions applicable to forests worldwide, namely about forest sustainability in relation to conservation of biodiversity. Alain Dejean continued on the arthropod theme in his comparisons of ant-plant relationships in two Atlantic forests; Dan Gruner focusing on herbivore diversity in Hawaiian forests; and Ulrich Simon on spider diversity in pine trees. Don Reynolds offered important data on fungal biodiversity, another component of forest canopies that in the future may approach the vast numbers of arthropods. In concluding, Nigel Stork emphasized the need for more long-term assessments of arthropods and other key species in forest habitats. He expressed hope that collaborative projects like the

new crane in Australia will facilitate more comprehensive studies of forest biodiversity.

Session II: Advances in South American Canopy Biology

Talita Fontoura and Servio Ribeiro chaired this session, the idea for which was suggested at the 1994 Canopy Conference. At that meeting, the enormity and diversity of South America and that continent's large number of institutions and research groups contrasted sharply with the relatively small number of papers presented. At the second conference, South American studies were well represented in both the oral session and posters.

Topics ranged from epiphytes in the Araceae family in Rio de Janeiro (André Mantovani), interactions between ants and gall midges (Joachim Adis), insect fauna on tree crowns in French Guyana (Yves Basset), herbivory on *Tabebuia* in Brazil (Servio Ribeiro et al.), to the flora of the Andean montane forest (Percy Nuñez Vargas) and the phenology of Mexican cloud forests (Guadelupe Williams-Linera). The chairs noted the obvious lack of presentations on vertebrates from South America, despite the fact that many research publications exist on this topic, and hoped that mammologists and herpetologists would be forthcoming at the next canopy conference.

Session III: Canopy-Atmosphere Dynamics

Session III was chaired by Manuel Lerdau and Gary Lovett. Lovett introduced the topic of canopy-atmosphere dynamics, and Carol Wessman presented a keynote talk on the value of scaling up studies from local landscapes with remote sensing. Subsequent talks featured topics of trace gas exchange between canopy and atmosphere (Manuel Lerdau); modeling carbon exchange in a temperate forest stand (Julian Hadley); the impact of epiphytes on temperature in tropical rain forests (Martin Freiburg); transpiration studies from the Venezuelan crane (Dieter Anhuf); and climate variability in forests of Argentina (Olga Scarpati). The topic of this session was suggested at the first canopy conference for inclusion in the 1998 symposium, because of the exciting progress being made using different technologies to access the canopy-atmosphere interface.

Session IV: Epiphytes and Vines in Forest Canopies

Bruce Holst and Wilhelm Barthlott chaired this session, which featured speakers from eight countries. Concentrating on spatial and temporal aspects of epiphyte communities, the session demonstrated that epiphytes in natural habitats have surpassed the stage of inventoried description and moved on to the analysis of communities with temporal and spatial analyses of populations.

Wilhelm Barthlott presented an introduction to the epiphytic plants of the world, illustrating their pantropical distribution, restriction to several plant families, and characteristic features. Jurgen Nieder, in describing the distribution patterns of vascular epiphytes with their concentration in the wet tropics, speculated that epiphytes might approach 10% of global plant diversity. Frans Van Dunne showed the first results of the sampling of epiphytes in a secondary montane forest in the Colombian central Cordillera. Nalini Nadkarni explained an experimental approach to measuring colonization of epiphytes in the Monteverde cloud forest; her data showed that re-colonization of denuded branches required more than five years. In addition, her team is transplanting epiphyte mats from moist cloud forest sites to drier valley forest sites, to simulate global warming; the initial results show massive die-off of epiphytes. Juliana Prósperi emphasized the structural role of lianas and hemi-epiphytes, describing lianas as typical colonizers of gaps and disturbed habitats, and hemi-epiphytes which are usually found in more stable situations.

Other topics addressed population dynamics of vascular epiphytes in a humid montane Mexican forest (Peter Hietz); phenology of phorophytes on Barro Colorado Island, Panama (Joe Wright); an overview of lianas in Uganda (Gerald Eilu); and community ecology of epiphytes in Rio Surumoni, Venezuela (Monica Carlsen). All participants agreed that improved canopy access methods are allowing epiphytes to be studied more comprehensively.

Session V: Global Perspectives in Forest Conservation and Education

This session, chaired by H. Bruce Rinker and M.V. Subba Rao, included case studies of diverse management practices for forest resources in Mexico, the Philippines, Nepal, India, Cameroon, Peru, and other nations. Topics included tropical rain forest fragments and their associated anthropogenic influences, especially seed dispersal strategies in Mexican pasture landscapes (Javier Laborde); biodiversity issues on private and public lands in the Philippines (Alito Baguinat); exploitation of *Shorea robusta* in the Terai region of Nepal (Shambhu Prasad Sah); the decline of species and habitat diversity in the

Eastern Ghats, India caused by agriculture and other human pressures (M.V. Subba Rao); and epiphyte conservation by villagers in Cameroon (Bernard Nkongmeneck). One of the poster sessions supported Session V by illustrating examples of forest recovery in tropical regions and educational models for attitude changes toward world forest resources. The session concluded that researchers and educators pursuing creative solutions to the continued exploitation of world forests might result in long-term solutions for conservation problems.

Session VI: How Can Canopy Scientists Integrate their Research with Global Policy-Making?

Tom Lovejoy opened session VI (chaired by Lovejoy and Meg Lowman) by urging scientists to take a stand and enter into the policy-making arena, because their views are integral to sound conservation and land management. The keynote talk by Jeff McNeely (read by Michael Brown) addressed the role of canopy scientists in global policy-making and posed questions in need of answering. Case studies explored partnerships between scientists and policy-makers in the Peruvian Amazon (Stephen Timme), an innovative sustainable development idea using canopy farming of orchids in Costa Rica (Koen Verhoeven), the use of canopy ecology to implement conservation education for secondary schools (Bruce Rinker), an update on the Costa Rican biodiversity program (Lovejoy), and a summary of the ICAN (International Canopy Network) to foster global communication of forest canopy issues (Nalini Nadkarni). This session forced scientists to recognize the need to disseminate their results to the public and to policy-makers in clear, simple, and well-publicized venues, if they are to succeed in promoting forest conservation.

Session VII: Canopy Ecophysiology

Session VII was chaired by Steve Mulkey and Kaoru Kitajima. Since the first canopy conference, canopy cranes have facilitated major advances in studies of physiological ecology by providing access. The new Australian crane project and the energetics above and within tropical rain forest canopies were presented (Stephen Turton); an ecophysiological explanation for epiphyte distribution in Panama was hypothesized (Gerhard Zotz); carbon and energy exchange was measured in a Costa Rican lowland forest (Stephen Oberbauer); and the ecophysiology of canopy leaves was quantified for canopies in Panamanian lowland forest (Kaoru Kitajima).

Session VIII: Canopy-forest Floor Interactions

Dac Crossley, Mark Hunter, and Tim Schowalter, who chaired Session VI, noted that processes in the forest canopy cannot be isolated from processes on the forest floor. Soil provides resources that support growth and reproduction of canopy trees and other organisms. Forest canopies, in turn which modify forest floor conditions, are sources of material that returns to the forest floor. This interaction between canopy and forest floor can be viewed as a feedback loop. Understanding the interaction requires collaboration between canopy and forest floor ecologists. Barbara Reynolds and Mark Hunter reported canopy herbivore effects on rate and timing of nutrient fluxes from canopies and general stimulation of nutrient cycling in forests. Depending on site and nutrient levels, they found that herbivores account for 25–50% of the variance in throughfall chemistry. Their documentation of nutrient mobilization by herbivores contrasts with Lovett's laboratory experiments demonstrating immobilization of nutrients in herbivore feces by soil microbes. These differing results indicate a need for research on factors affecting the fate of nutrients transferred to the forest floor as a result of herbivory.

Lance Risley described herbivore effects on the light but steady rain of foliar material to the forest floor throughout the growing season. Although greenfall biomass is small compared to autumnal fall of senescent foliage, greenfall has significantly higher concentrations of nitrogen and decomposes significantly faster than senescent foliage litter. Methods for classifying diversity of ground vegetation in managed boreal forests were described by Sari Pitkänen who found understory diversity positively related to site fertility and tree diversity and negatively related to tree age and diameter. These results demonstrated the value of overstory conditions in regulating understory vegetation. Andreas Floren described changes in arboreal arthropod communities in disturbed versus primary tropical forests in Borneo, with ants the most abundant in the primary forest and least abundant in the early successional forest.

Timothy Schowalter closed the session by summarizing how the canopy can influence forest floor interactions. He cited the results of a student study demonstrating that canopy herbivory causes reduced root tissue density, creating massive depletion of carbohydrates and potential effects on root exudates and rhizosphere processes.

Session IX: Ecology and Behavior of Vertebrates in Forest Canopies

Session chairs Hans Winkler and Dave Shaw advanced the paradigm that—through observation and study of canopy vertebrate evolution, ecology, and behavior—forest canopy biology can be better understood. Forest canopy vertebrates provide a window into the nature of a forest. The abundance of gliders and parachuting vertebrates in southeast Asian forests, and their lack thereof in other tropical regions, was the subject of speculation (Timothy Laman). Cheryl Knott discussed how orangutan males differ from females in their ability to negotiate through the canopy in southeast Asia.

Both Monika Preleuthner and Hans Winkler studied more than 180 species of birds at Suromoni, Venezuela, using the canopy crane, and found that canopy birds tended to be frugivores or omnivores, and were behaviorally more diverse than the birds of the forest interior. In a simpler forest, Dave Shaw and Catherine Flick found that five species of resident songbirds were stratified within the canopy of coniferous old growth in Oregon. Angela Parrodo-Rosselli and Jaime Cavelier, in studies of seed dispersal of canopy trees by frugivorous birds, found that trees with larger fruits had lower seed dispersal rates. T. Ganesh studied flower use by arboreal mammals and pollination of a bombacaceous tree in the wet evergreen forests of India, concluding that it was a predator-pollinator system in a syndrome of a mammal-pollinated species. Elizabeth Kalko discussed bat communities in Panama and Brazil, which are more diverse than previously thought before canopy access facilitated more accurate surveys.

Session X: Temperate Forest Canopy Research

Steve Sillett and Neville Winchester chaired Session X, which included studies from four continents, and was suggested as a topic worthy of more extensive discussion in the exit surveys of the last symposium. Robert van Pelt and Laura Fagan summarized studies of temperate old-growth forest canopies in North America; Peter Gleissner dealt with branching patterns in South American trees; Hal Heatwole and Meg Lowman summarized eight years of research on eucalypt herbivory and crown dieback in Australia; and Hemant Badola discussed growth of *Quercus* in India.

Roundtable Discussions and Workshops

Lunchtime, roundtable discussions provided a relaxed format for exchange of ideas on topics nominated by participants at the 1994 conference. A roundtable on canopy walkways produced a consensus on gathering all researchers and projects from different walkways worldwide in one database, to be shared via the ICAN web site. Safety protocols and other aspects of construction and maintenance of walkways were discussed. Canopy research databases were the topic of another workshop, at which the pros and cons of databasing different sized projects were debated. Participants concluded that the potential power of this emerging mathematical field has not been well-utilized in canopy science, and ideas for the future were outlined.

At a methods workshop, a continuation of a successful workshop held at the 1994 conference, scientists asked questions, tried new methods, or watched arborists and vendors demonstrate new canopy-access tools. The canopy luge (or sled) was slung from the Selby Gardens Banyan trees, so that participants and local students could simulate canopy sampling from this innovative French-designed device.

Other workshop topics included a discussion on the Convention on the International Trade of Endangered Species (CITES) and the future of research collections, the integration of science and story in secondary education, the biology of mistletoes, and a canopy crane workshop. The latter discussion group met twice during the conference, and representatives from each working crane were present. It was agreed that funding was needed for different ICCN members to visit each crane site, that protocols for measurements were needed quickly, and that possible funding from the United Nations would be investigated. Although the workshops were excellent venues for discussion, extensive exchanges of ideas also took place between sessions, during meals, on the grounds of Selby Gardens, and during the pre-dinner receptions.

Francis Hallé summarized the sentiments of the 1998 conference with these words:

It really does not matter whether you are from a poor tropical country or from a rich one, whether you work in a tropical rain forest or in British Columbia, whether you use a crane or a walkway, a balloon or a single rope to reach the canopy. It really does not matter whether you study big trees or bryophytes, ferns or orchids; or orangutans, mites, birds or bats; whether you specialized in taxonomy, phylogenetics, or physiological processes; whether you speak a perfect

English, with a Californian accent, or you have to fight all the time against the language—just what I'm doing at the moment—having just a few words, and a horrible foreign accent . . . .

What really matters is, at the end of this century, the birth and growth of a common feeling that trees and forests are of paramount importance for us all, and that, for the future of mankind, trees and forests deserve to be carefully studied and protected with love.

Therefore, instead of offering concluding remarks, I prefer to say that this marvelous canopy conference has to be considered as a starting point. The next canopy conference will take place in Australia in a few years; I just want to say "Hello, see you there . . . ."