Tropical Resources Institute

TRI NEWS

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Message from the Chairman

When first asked to contribute to this issue of the TRI News, I began thinking of a host of relevant topics within the spectrum of issues dealing with the tropics that have neither been discussed nor have received much attention. It has been nearly fifteen years since I became aware of and actively involved with the conservation of tropical ecosystems. In that period of time, there have been countless conferences, projects and dollars invested in the problem of tropical deforestation. I would guess that every U.S. university with a natural resource program has made an effort to highlight the issue. Virtually all newspapers and popular periodicals have published some piece clamoring about the loss of this vast resource. There was certainly no shortage of publicity this past summer in the wake of melting thermometers, howling hurricanes and raging forest fires.

Unfortunately, the more I thought about it, the more discouraged I became. In spite of all the money, time, energy and rhetoric (which seems to be our most abundant commodity), the pessimist in me said we have very little to show for all this activity. I began to ask myself a myriad of questions that those of us working in the international forum are reluctant to ask, preferring to ignore them out of fear of the answers we will get. Has any real progress been made? The

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decline of existing tropical forests is certainly occurring as rapidly today as it was ten years ago when the U.S. government awakened to the problem. Have U.S.-based organizations made a significant contribution? Are there any examples of successful forest conservation ventures working both economically as well as culturally? Am I wasting both time and oxygen sitting here in my little office a thousand kilometers from the problem pretending to make a contribution?

But alas, the old Peace Corps spirit of optimism helps me rise to the occasion and with the inspiration of a recent piece in The Economist, ("Ecologists make friends with economists" , Oct. 15th), a few positive thoughts come to mind. There are at least three areas where I think substantial progress has indeed been made in the past few years. Obviously, compared to the magnitude of the deforestation problem, the improvement has been ever so humble, but there may be reason for a little optimism.

Conservation and Development:

International conservationists are finally getting off their soap boxes and starting to reject the traditional preservation strategy that has been the hallmark of the recent U.S. environmental movement. What is most ironic is the fact that this attitudinal change is a result of a south to north technological transfer. U.S. organizations, both academic as well as program oriented, have generally considered it their mandate to "go down there and show 'em how to do it." But on this front, we had much to learn. Environmental organizations from tropical nations, both public and private, have long recognized the need to put conservation activities in the context of economic development. They could not afford the luxury of anything else. Some of our "newly discovered" economically-oriented alternatives were around long before the term agri-silvo-pastoral was coined.

There are increasing numbers of exciting efforts that are beginning to incorporate this approach. The Worldwide Fund for Nature has programs in tropical forestry and "Wild Lands for Human Needs" which are based on conservation through sustainable yield. Conservation International's projects in Mexico, Bolivia, and Costa Rica are incorporating integrated strategies of land planning including forestry, agriculture and protected area management. In Africa, a number of conservation projects are now emphasizing wildlife management rather than preservation, including the creation of innovative strategies to market tourism and wildlife products. The mountain gorilla projects of Rwanda and Uganda are outstanding examples. International NGOs have been active participants in the International Timber Organization (ITTO), a commodity agreement which has sustained yield as a centerpiece. The agreement is the first of its kind to stress conservation of the traded resource within the context of a market strategy.

This new approach by conservation groups must continue to receive support. We are desperately searching for examples of economically viable conservation projects that can serve as demonstrations for decision makers. Additionally, conservation professionals will increasingly need advanced training in such areas as economics, business and anthropology.

Natural Forest Management:

Natural forest management is now recognized as a viable alternative to plantation forestry in the tropics. Until recently, there was a general consensus among foresters that managing existing primary or secondary stands of tropical forests was either silviculturally infeasible or economically unsound. However, there has been a recent rethinking of this philosophy. Publications by the Institute of Tropical Forestry, FAO, IUCN, WWF, the Dutch Development Agency, and Yale F&ES have suggested that under the right circumstances, such natural forest management is not only possible, but is indeed the best alternative. Research on gap-phase dynamics, ecology and utilization of lesser-known hardwoods, natural regeneration, stand development and silviculture continues to make important contributions to management.

In addition, traditional forest management strategies that have been practiced by indigenous populations for thousands of years are now being investigated and promoted. Work by Dr. Christine Padoch of the New York Botanical Garden on swidden agriculture in Peru, and Dr. Steve Swartzman of the Environmental Defense Fund with extractive reserves in Brazil, is creating interest within the international funding community and could eventually become the basis for development projects. ITTO recently announced funding support for a large extractive reserve and forest management project in the state of Acre, Brazil that came about as a direct result of increased interest in natural forest management.

Much more applied research in these areas is urgently needed. What is unique about this research approach is that it combines many areas of expertise including soils, basic ecology, wood technology, international marketing, and sociology. This sort of multidisciplinary interaction can facilitate the development of more innovative strategies. The body of knowledge created by forest ecologists' work on gap-phase regeneration, for example, directly led to the development of the strip shelterbelt

harvesting strategy in the Palcazu Valley, Peru. This is one of the most interesting forest management projects in the Neotropics. Natural forest management is an area where Yale F&ES and TRI can make significant contributions toward conservation of tropical ecosystems.

South/North Niche Partitioning:

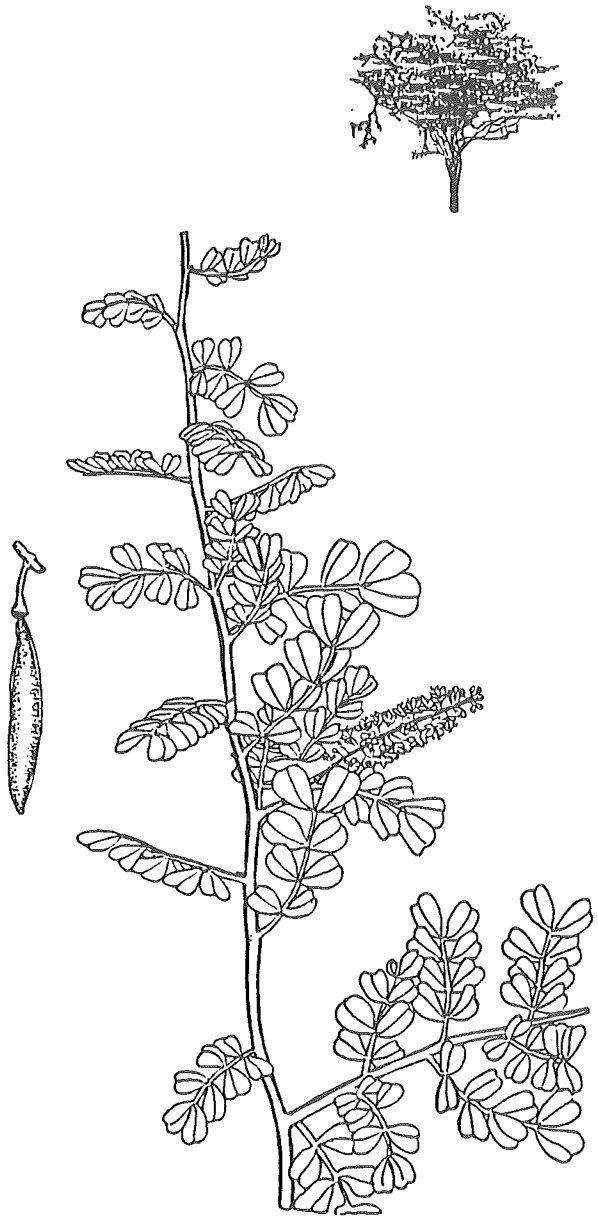
Although U.S. conservationists have made substantial contributions on a number of fronts, ultimately it will be up to local professionals in individual countries to develop locally appropriate solutions. What is actually happening, of course, is an exciting division of labor between organizations based in "developed" nations and those from the tropical world. The most important manifestation of this is the establishment of hundreds of new conservation NGOs throughout tropical nations. Because financial resources are often scarce, these NGOs have garnered support from colleague organizations in temperate nations. Many funding agencies are now considering direct support to these new organizations as they mature and establish a track record and project portfolio.

Perhaps the greatest contributions made by American professionals beyond scientific research will be in raising public awareness of tropical issues, lobbying Congress and raising funds. One example of past accomplishments in these areas is the pressure brought to bear on the development banks to change their lending policies. The stateside political maneuvering of American conservation organizations achieved what could not have been achieved by representatives of tropical NGOs.

Where does this leave us? I must agree with my original statement that we don't have much to show for all the money and effort over the last fifteen years. I suspect that this is because we have not been committed enough. Given the magnitude of the problems we face, much more needs to be invested in the years to come. If the Tropical Forestry Action Plan has accomplished anything, it has informed us up front that this will certainly be expensive.. Undoubtedly, it will be more and more difficult to get public money from the States as the next administration confronts the level of U.S. fiscal problems. Yet, if we can show that our work makes economic sense as well as environmental sense, we might just achieve some results. Other strategies are doomed to failure.

John E. Earhart

World Wildlife Fund/
The Conservation Foundation



Haematoxylon campechianum

RESEARCH PROFILES

Seed Germination and Seedling Establishment in a Tropical Dry Forest

Guillermo Castilleja, Ph.D. Candidate
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Introduction

Central to theories of community maintenance and also to the design of management practices in mesic tropical forests is the concept that many forest tree species depend on gaps and other disturbances to regenerate. Low light levels and pathogens in the understory of the intact forest have been shown to have detrimental effect on the growing offspring of many tree species.

Gap-dependent regeneration is a concept that has received much publicity. So many studies Have been generated that it is easy to forget that the reference is to mesic forests, and that its scope is limited by the ecology it describes. To what extent this concept can be applied, or needs to be modified in order to understand regeneration pathways in dry forests, remains to be determined. In fact, there are no paradigms comparable to "gap dependency" when referring to the regeneration of dry forests.

When comparing wet and dry forests in the tropics some major differences arise. Dry forests tend to have a lower stature, biomass, and species diversity, and a more marked foliar and reproductive phenology following the fluctuations of moisture availability. Although we know that decreased rainfall is ultimately responsible for these structural differences, so far we have ignored the way in which many specific ecosystem functions in the dry forest are affected by water stress. Listing major differences between dry and wet forests does not unveil these specific functions, but it is useful in elaborating hypotheses that could lead to new paradigms of, among other things, forest regeneration.

One important difference between dry and wet forest is the thickness of the canopy. In most cases dry forests consist of only one canopy stratum (sometimes two), whereas the rule in wet forests is to have three or more. This reduction in canopy thickness, coupled with varying degrees of deciduousness, results in higher light levels at the ground level in the dry forest compared to the legendary understory of the wet tropical forest. One important consequence of this situation is depicted by the more abundant ground cover found in dry forests. Are seedlings part of this healthier "ground cover?" If so, this structural difference would already constitute a deviation from the gap-generation model. A further deviation would follow if gaps in dry forests resulted in environments particularly moisture-stressed due to increased evapotranspiration.

The purpose of my research is first, to describe the process of seedling establishment in a dry forest and second, to elucidate the roles of moisture and light regimes in the control of this process.

Study site

I have been conducting this study since 1984 in the Guanica State Forest, a subtropical dry forest in south-western Puerto Rico that has been protected from human disturbance for the last 50 years. Rain in Guanica (890 mm annually) is concentrated in a minor rainy season from May to June, and a major rainy season from late August to November. Except during the major rainy season, potential evapotranspiration usually exceeds precipitation. The dryness of the site is further increased by the calcareous nature of the substrate. Mean annual temperature is 25.1 degrees Celsius.

Three major vegetation types can be distinguished in the forest reserve. The driest cover is the xerophytic scrub located at low elevation on the south-facing slopes, while at higher elevations and on more gentle slopes is the deciduous forest, the most common type in Gaunica. Thirdly, occupying a comparatively small area are patches of semi-evergreen forest, seen in canyons and small valleys. The moisture gradient not only enriches Guanica's flora and fauna but also makes this an ideal place for studying micro-site effects. Up to two hundred woody species have been identified in the Guanica forest, and among them a variety of vegetative and reproductive strategies can be recognized.

Descriptive work

I decided to concentrate on the first stages of tree reproduction, i.e. seed germination and seedling establishment, both because they summarize ecological relations significant to community structure, and because they are the stages that are usually most relevant to silvicultural practices in dry forests. As practically nothing is known about regenerative pathways in dry forests, the first approach I took in my work was a descriptive one. Specific studies characterized the different stages during

this reproductive phase, i.e. seed dispersal, dormancy, germination, recruitment rates, and seedling early growth and mortality rates. The second approach was experimental and was aimed at determining the effects of micro-site on seedling establishment in a selected group of species.

Seeds from fifty-five species have been collected. Most fruits are produced at the end of both rainy seasons, although numerous species exhibit continuous fruiting. In general, seeds are small (less than 0.5 cm) with a thick coat, and they are dispersed by birds. Seed longevity is noticeably short for most species: post-dispersal seed predation accounts for a large number of dead seeds in the soil, but loss of viability after two or three months is also common. When seeds are placed on a moist substrate, germination occurs within a week. However, it is essential for most species that water remain available for imbibition (uptake of water and subsequent swelling) for at least a week. Increased coat permeability (by puncturing, or abrasion) reduces the mean germination time from 5 to 2 days. Truly dormant seeds are a minority and their dormancy mechanisms have yet to be studied. The emergent seedling is small, epigeal (growing above the surface of the ground), and with no apparent storage material to assist early growth. After the full expansion of the cotyledons, shoot growth is noticeably retarded compared with the rapid development of the hypocotyl into a long tap root.

The seedling population in this forest is quite sparse. I counted and measured all seedlings less than 25 centimeters in a total of 1000 square meters in each cover type (scrub, deciduous, and semi-evergreen). Compared with such wet forests as El Verde, where seedling density in the understory is around 15 seedlings/meter, seedlings in Guanica seem to be almost absent. The highest density is found in the deciduous forest, with 3 seedlings/meter, and the lowest in the xerophytic scrub with 2 seedlings/100 meters. The spatial distribution of seedlings under the deciduous cover is independent of the patchy light distribution at the ground level, and in the xerophytic scrub it is positively correlated with shade.

Low density of seedlings is partially explained by the low seedling recruitment rates. Seedling recruitment was followed every three months for two years using 50 1 x 1 meter plots randomly located in each cover type. In the two years that this experiment has been conducted, a total of three seedlings germinated and survived up to three months in all of the recruitment plots (150 plots). Paradoxically, seed input does not seem to be the limiting factor, as many of the recruitment plots are found directly underneath fruiting trees. During the rainy season of 1986 I visited these plots weekly to check for germination of seeds that I had previously seen in the plots and judged sound. Except for a total of five seedlings of *Bursera simaruba* found in the canyon forest (which all died after three weeks of drought), nothing in the plots germinated — in spite of the two torrential rains that fell during that period which maintained the upper inch of soil near saturation for at least four days following the storms.

Recruitment thus seems to be an infrequent event. Those few seedlings of less that 15 centimeters that became established were permanently tagged and censused every three months for a period of two years. In the site with the highest seedling density (the deciduous forest), relative annual growth rates are usually less than 10 percent. Interestingly, for some species no expansion of the apical meristem occurs for some months after the expansion of the cotyledons. In one case (*Gymnanthes lucida*) there was no expansion for one year. Yet, seedling mortality in the period covered by this study was less than 10 percent for most species, following a severe drought that lasted for three months. Herbivory does not affect seedlings significantly, even during caterpillar outbreaks following heavy rain storms at the beginning of the rainy seasons. This immunity to herbivory may be a consequence of the low density of seedling populations.

Field observations in combination with current research on seed imbibition suggest that moisture conditions relevant to seed germination play an important role in seedling recruitment. I am currently exploring this possibility by analyzing the frequency of periods suitable for germination according to three factors: seed imbibition rates, upper soil moisture retention, and precipitation patterns. My aim is to construct a model seed-scale, so that given a certain seed input, precipitation regime, and micro-climate, it can account for the rarity of germination in the dry forest.

Experimental work

In order to assess the importance of the micro-site in the establishment of seedlings, I conducted a series of experimental plantings in three stations representing characteristic environments throughout the forest. Treatments of a 3 x 2 factorial design included three levels of canopy cover: semi-evergreen, deciduous, and gap; and two levels of moisture: rainfed and rainfed plus weekly irrigation, with the amount of water necessary to simulate a wet year. On the two occasions that this experiment was run, rainfall was below average, creating a significant contrast between these two moisture regimes. In order to homogenize germination times and make comparisons meaningful, seeds of the tested species were treated to maximize imbibition. In these germination beds, root competition with adjacent vegetation and herbivory were precluded.

These experiments were initiated with the first spring rains and continued for a year. A total of eight species have been tested using this trial. Survival rates were consistently lowest when seedlings were exposed to no canopy cover and were only rainfed. Highest survival rates were shown by seedlings growing in the deciduous forest understory and subjected to a "wet year" regime. Seedlings growing under the semi-evergreen canopy showed high survival rates only during the first three months after germination, regardless of moisture treatment, but crashed afterwards probably as a result of insufficient light levels. Growth rates for the surviving seedlings were sorted according to the ecological status of the species. Two of the tested species, *Prosopis juliflora* and *Leucaena glauca*, are known to be the most common invaders of disturbed habitats in the forest, and they had their highest growth rates when growing in the gap treatments. Forest species, on the other hand, displayed healthier growth when shaded by the canopy of the deciduous forest.

Conclusion

Although the analysis of variance in these trials is not yet completed, preliminary results strongly suggest that the interaction of light and moisture is the determining factor in seedling survival. This analysis will help us understand how these two factors interact in specific environments and with specific species. However, at this point it is clear that "gap dependency" by itself does not govern seedling establishment in the deciduous forest, and that the moisture balance of the germination site is, if not more important, at least as significant a factor.

This outline of early establishment in the dry forest does not imply that this is the way in which this forest community maintains its structure. The fact that so many trees in the xerophytic scrub and deciduous forest seem to maintain themselves in one given site through successive sprouting, makes the regenerative pathways of the dry forest very complex. We are still a long way from depicting a functional model of regeneration of the dry forest so that what we know can be used by forest managers. Research is needed to close this gap.

According to a1986 report by Murphy and Lugo, deforestation rates in the tropics are particularly critical in the dry forest life zone where population pressure is the highest and forest productivity the lowest. Areas such as Haiti and the Sahel are representative of the dimensions of this crisis. A concerted effort in reforestation and taking conservation measures is urgently needed in those places. Financing institutions are now devoting more attention to such areas through funding reforestation, conservation projects and sounder development schemes. Silviculturalists are developing new techniques to manage the imminent problem of desertification, in Africa and elsewhere. It is time that tropical ecology joins the effort by expanding its area of concern into the regeneration of the dry forest.

Acknowledgements

Funding for this research has been provided by the Tropical Resources Institute at Yale School of Forestry and Environmental Studies, the Yale Council on Latin American Studies, the Enders Foundation, and the Mellon Foundation through a grant to F.H. Bormann and G.E. Likens.

Growth Allocation Of Co-Occurring Species With Similar Regeneration Strategies Under Contrasting Moisture And Light Regimes: A Comparison Between Two Genera Of Moist Temperate And Moist Tropical Forests

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Introduction

Deforestation in the moist tropics is a phenomenon which has been recognized by foresters for a long time, particularly in Asia (Brandis 1897). Only with the accelerated development in the Neotropics in the last twenty years has it become a prominent issue. Moist regions of temperate countries have also suffered periods of severe deforestation as land was cleared for agriculture, though many of these areas, through successional processes, have reverted to forest. These land changes have been well documented by Raup and Carlson (1941), Raup (1944), Rackham (1976), Peterken (1987) and others.

Natural forest management will play a significant role in both temperate and tropical regions where forest area is extensive and population low, and where there is an appropriate socio-political climate. Yet, much more research is needed to further refine the management techniques used in both regions. To hasten this process,

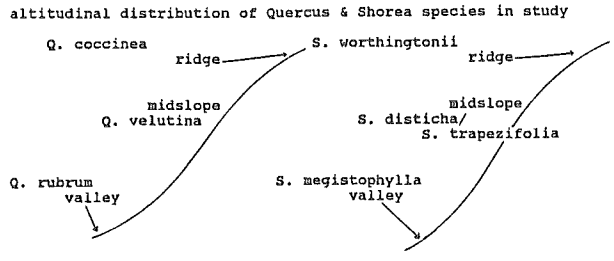
scientists are exploring the validity of applying silvicultural knowledge and expertise generated in the management of natural forest from the temperate zones to the tropics and vice versa.

Study Proposal

A key problem in forest types of both regions is the establishment of advanced regeneration where this is required for future regrowth. The red oaks (family *Fagaceae*; genus *Quercus*; section *erythrobalanus*) of eastern North America and the beraliyas (family *Dipterocarpaceae*; genus *Shorea*; section *doona*) of Sri Lanka have this problem. Moreover, 90 percent of the hardwood timber on the international market is provided by these two genera, which are experiencing extremely heavy exploitation in forests. This study attempts to examine their regeneration strategies in an effort to link physiology with ecology, by conducting controlled growth chamber experiments concurrently with field experiments of seedlings. It proposes to determine the occurrence and significance of physiological specialization of seedlings among three species of red oak (*Quercus coccinea, Q. rubra, Q. velutina*) and four species of beraliya (*Shorea disticha, S. megistophylla, S. trapezifolia, S. worthingtoni*) with response to different soil moisture and light regimes. For each genus, the study species co-occur together in the same forest type but on different sites. A summary of the common characteristics of both genera is shown in figure 1. This study provides a unique opportunity to compare two genera with similar regeneration strategies which occur in markedly different forest types. It allows one to ask the question: Are physiological traits that govern species seedling distribution and performance along light intensity and quality and/or soil moisture gradients the same between genera that have similar growth patterns?

FIGURE 1.

A summary of characteristics that certain species of Quercus & Shorea have in common.



The hypotheses and objectives of the study are listed below:

Hypotheses

* A moisture gradient determines species distribution along the slope, starting in the seedling stage.

* Light is a major factor influencing moisture regimes across a particular site. This factor and the shade tolerance of the species determine its performance.

Objectives

1. Determine, at the end of the growing season, whole plant carbon gain and allocation to roots, stems and leaves.

2. Determine a time series of events for above ground plant growth rates and component growth rates.

3. Determine a time series of shoot architecture over the growing season by measuring stem height, number of branches, number of leaves, flush rate, number of internodes, leaf area, leaf orientation, leaf life.

4. Test whether population structure and growth rates of individuals in established seedling population, whose soil and light conditions have been measured, confirm the predictions of species performance in the experiments using the controlled growth chamber environment.

5. Relate the anatomy and physiology of each species to their growth performance in the different soil moisture and light regimes.

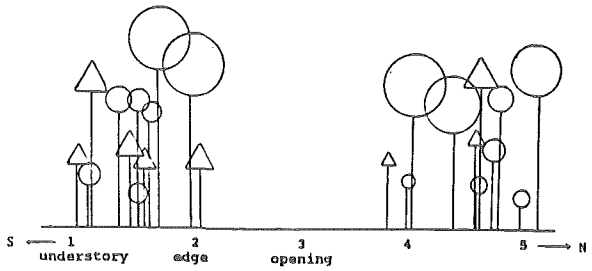
Field Experimental Design

Experiments were started in the fall of 1987 on the beraliyas at the Sinharaja Man and the Biosphere Reserve in Sri Lanka, and in the spring of 1988 on the red oaks at the Yale-Myers Forest in northeastern Connecticut, U.S.A.

Three circular gaps have been created in each forest along the gradient from bottomland (wet) to midslope, to ridgetop (dry). Each gap was made large enough to get the maximum diversity of microclimates across the site. Within each gap, five plots have been laid out along a transect covering the range in microenvironmental regimes. Each plot has one spacing matrix, with four replications, each with twenty five newly germinated individuals for each species (see figure 2). Herbivores and pre-existing vegetation have been excluded. Environmental measurements (light intensity, soil moisture, temperature, relative humidity) for each plot are being made at seasonal intervals. Seedling size, architecture and

weight, and their components are being measured at one and a half month intervals.

FIGURE 2.



Growth Chamber Experimental Design

The controlled experiments are being conducted in growth chambers in order to compare seedling survival and growth between and within the species across an array of light and soil moisture regimes. These experiments were started at the same time and location as the field experiments. They are a series of matrix tests comprised of five light regimes, three watering levels, and one spacing level. The light regimes include both quality duration and intensity. Light quality has been altered by using a particular mix of paint pigments added to a varnish base and sprayed on a plastic film (Lee, 1978). Light conditions resembling those of a forest understory were then created. Light intensity was altered by the amount of paint spray applied to the film. Response of seedlings to time exposed to sunlight is also being examined by subjecting seedlings to different durations of full sunlight. This has been done by using different spacings between the slats of Venetian blinds that have been laid horizontally over the seedlings to artificially create forest understory sunflecks. The watering levels range from well watered (continuously moist) to water stressed (periodically dry). The same microenvironmental and seedling measurements are being made in the growth chambers as for the field experiments.

Leaf Anatomy and Physiology

Seedlings of each species will be grown in different controlled environments. Two light intensities, full sun and deep understory shade, and two moisture regimes, water stressed and non-stressed, will be created to represent the different environments. Leaves from each species will be sampled from the different growing environments and various anatomical characteristics measured: cuticle thickness; upper and lower epidermal cell size and number of layers; palisade cell size and number of layers; whole leaf thickness; stomata frequency, location and size; leaf hair frequency and size.

Leaf samples from seedlings in the different environments will also be sampled for tissue water content, water potential, conductance and maximum carbon dioxide assimilation.

Results

Results should determine the degree of physiological specialization or non-specialization of species that co-occur in the same forest type. They would also provide a better understanding of the maintenance of species rich forests and shed further light on similarities and differences in dynamics between temperate and tropical forest systems.

Findings will also provide a better understanding of the establishment of advanced regeneration and hence allow for a further refinement of the silvicultural systems used. They also will connect directly with current studies on natural populations that are concerned with predicting *Quercus* and *Shorea* seedling growth and performance in different environments (Sander, et al. 1977, 1984, Ashton 1987). Preliminary information will be provided for their establishment in plantations.

Acknowledgements

Funding for research has been provided by Monsanto Agricultural Company, Hoest-Celanese Corporation, the World Wildlife Fund and the Tropical Resources Institute of the Yale School of Forestry and Environmental Studies. Physical support (accommodation, equipment and transport) has been provided by the Botany Department of the University of Peradeniya and the Forestry Department of Sri Lanka, and by the Yale-Myers Forest in Connecticut.

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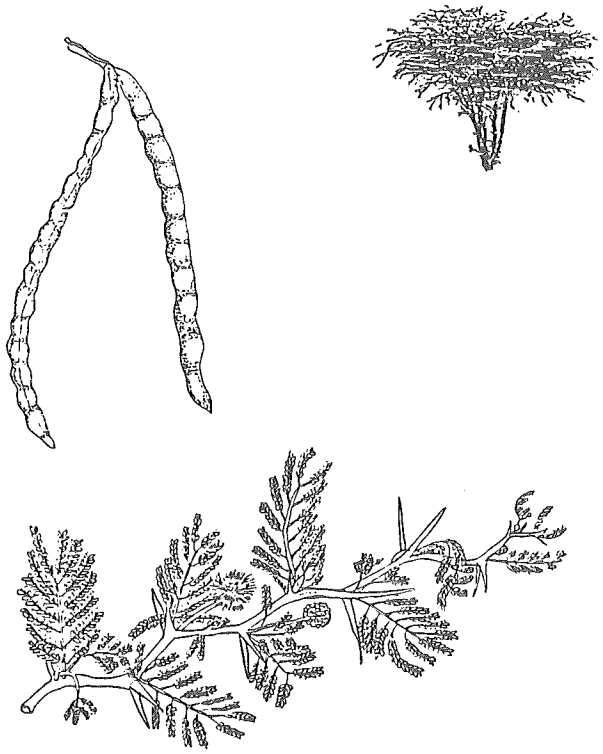
COOPERATORS

The Tropical Science Center & The Monteverde Conservation League, San Jose, Costa Rica

The Tropical Science Center(TSC) is a Costa Rican non-profit association founded in 1962 by a group of citizens and scientists concerned about the rational use of Costa Rica's natural resources. It was created in order to conduct and support scientific research and educational activities which explore the relationship between humankind and the biological and physical resources of the tropical environment. Located in San Jose, the Center serves as an umbrella for members and associate researchers to pursue professional and scientific interests throughout the region.

The association's major activities include: ecological research in tropical forest environments, land-use surveys and planning, preparation of environmental impact assessments for development projects in tropical areas, and training courses for practicing natural resource managers. In the past, the association has supplied trainers and material support for courses conducted by both the Organization for Tropical Studies (OTS) and The Centro Agronomico Tecnico de Investigacion y Ensenanza (CATIE) in Turrialba, Costa Rica.



Acacia tortuosa

Since 1972,TSC also has been involved actively in the administration of the Monteverde Cloud Forest Reserve. This 10,000 hectare reserve is located along the continental divide in the Cordillera de Tilaran in northern Costa Rica. The reserve's lush tropical forest is the only known refuge of the Golden Toad (*Bufo periglenes*) and it is one of the few remaining sanctuaries for the Resplendent Quetzal (*Pharomacrus mocinno*), considered by many to be the most beautiful bird of the American tropics. The Center shares administrative responsibility for the Cloud Forest Reserve with the **Monteverde Conservation League.**

The Conservation League is based in the Monteverde community adjacent to the reserve and consists mainly of resident biologists and local conservationists. It was formed recently in an effort to add new impetus to the fund-raising efforts of the reserve. Monies generated in this effort are dedicated to the expansion of the reserve to include the minimum area needed to ensure the survival of large mammals such as tapirs, jaguars, and mountain lions and of altitudinally migrating birds and butterflies.

TRI interns Tony Cummings and Dave Tobias spent this past summer living and working in the reserve. Tony's efforts focused on a vegetative assessment of lands that had only recently been acquired by the reserve in order to determine both the quantity and quality of habitat. His efforts were directed toward proving the assumption that habitat heterogeneity in the newly acquired areas allowed for increased biological diversity in these areas and in the reserve as a whole. The report on his findings will be available early next year. Dave prepared a report on the tourist carrying capacity of the reserve.

For more information on the Tropical Science Center, write to them at Apartado 8-3870, 1000-San Jose, Costa Rica, Central America. To contact The Monteverde Conservation League, write to Apartado 10165, San Jose, Costa Rica, Central America.

COOPERATOR NOTES

These Cooperator Notes offer a few details about the general focus or specific research and educational activities of various organizations. We welcome any submissions by our readers on their research or their institution's activities. Please send information to Peter Jipp, Editor, TRI News, Yale School of Forestry and Environmental Studies, 205 Prospect Street, New Haven, CT 06511, or call (203) 432-5118.

The **World Resources Institute** (WRI) has recently announced its merger with the International Institute for Environment and Development-North America. With their merger, IIED-NA changes its name to **The Center for International Development and Environment** (CIDE). Thomas H. Fox, previously the director of IIED-NA, retains this position in CIDE. Under the new arrangement CIDE becomes a major center within WRI, focusing on policy advising, applied research and technical program support for developing country governments and non-governmental organizations. WRI is a center for research and policy affairs focusing on environmental, resource and energy issues of global concern and their relationship to sustainable development. Additional information is available through the World Resources Institute, 1735 New York Avenue, N.W., Washington, D.C. 20006 or by calling Lani Sinclair at (202) 638-6300.

The **Food and Agriculture Organization** of the United Nations (FAO) has issued three new publications:

1. "Nitrogen Fixing Trees for Wastelands"
2. "Community Forestry: Lessons from Case Studies in the Asia and Pacific Region"
3. "TIGERPAPER, the latest issue of the regional conservation quarterly.

Free copies of these publications are available from: Y.S. Rao, Regional Forestry Officer, Regional Office for Asia and the Pacific, Maliwan Mansion, Phra Atit Road, Bangkok 10200, Thailand.

Under the direction of Dr. Adrian Marshall, the **South-East Asian Rain Forest Research Programme** continues to expand it's important work with tropical rain forest recovery following disturbance. Current research initiatives include: study of microclimate and colonization in gaps of varying sizes in evergreen dipterocarp rain forest in the Danum Valley, Sabah, East Malaysia; chemical and volumetric analysis of rainfall and runoff through stream monitoring, and; long-term effects of selective logging operations on vertebrate populations. Work in progress also covers entomological and edaphic components of the study area. To receive the Programme's newsletter, contact Dr. Adrian Marshall at the Institute of South-East Asian Biology, c/o Department of Zoology, University of Aberdeen, Aberdeen, AB9 2TN, Scotland.

The **Island Resources Foundation** , based on St. Thomas, USVI and in Washington, D.C. has awarded the 1988 Euan P. McFarlane Fellowship to Mr.Yves Renard of Saint Lucia. At the age of 34, Mr. Renard is already a major figure of influence in the region, having served as president of the Caribbean Conservation Association since 1986. He is also currently the IUCN Councillor for the region. The award program has been established to provide recognition for young West Indians who have demonstrated initiative, resourcefulness and leadership in promoting the conservation of natural and historical resources and the enhancement of the environment in the Eastern Caribbean. For information on eligibility or to submit a nomination, write to: Dr. Edward Towle, President, Island Resources Foundation, Red Hook Center Box 33, St, Thomas, Virgin Islands 00802. Nominations should be postmarked no later than March 31, 1989.

The **University of Ibadan** in Nigeria offers a Wood Products Engineering undergraduate degree programme and opportunities for advanced studies in Forest Resource Management. Professor G.K. Falade directs the on-going research efforts at the university. Current and recently completed projects include: potential uses of water hyacinth (*Eicohornia crassipes*) as raw material for biogas digestion and composite board production; studies on solar heated kiln designs for both agricultural and wood products, and; the feasibility of manufacturing laminated veneer lumber from lesser known Nigerian woods. Additional information is available from: Mrs. Kehinde T. Olatunji, Faculty Officer, Faculty of Technology, University of Ibadan, Ibadan, Nigeria.

Friends of Trees has recently published its "1988 International Green Front Report", a compendium of noteworthy deeds, organizations, individuals, and publications concerning "Re-Greening the Earth." This is a well indexed and very inclusive reference text with a global perspective. Copies are available for $7.00 (U.S.) from Friends of Trees, P.O. Box 1466, Chelan, Washington 98816, U.S.A.

FUNATURA is a Brazilian non-profit organization founded in 1986 to "strengthen the role of the private sector in protecting Brazil's rich biological diversity and the Brazilian people's quality of life." With funding from the Nature Conservancy and the World Wildlife Fund, FUNATURA has developed an active program to identify and survey priority areas for conservation projects. Several areas have already been identified, and projects are underway in both the Cerrados Plain and Grande

Swietenia macrophylla

Sertao Veredas regions. Environmental education on both the local and national levels is another important component of FUNATURA's approach. Those interested in learning more about the projects should contact: Maria Tereza Jorge Padua, Presidente, Cx. Postal 02-0186, 70.001-Brasilia DF-Brasil.

Earlier this year we received a note from Dr. Jorge A. Jimenez, Director of the **Mangrove Management Project** on the Pacific Coast of Costa Rica. Dr. Jimenez' project involves a detailed study of *Rhizophora harrisonii* forest dynamics and responses to various silvicultural treatments. Contact Dr. Jimenez at Escuela de Biologia, Universidad Nacional, Heredia, Costa Rica for more information.

An International Workshop on Perennial *Sesbania* species **in Agroforestry Systems** will be held March 27-31, 1989. The Nitrogen Fixing Tree Association (NFTA) and the International Council for Research in Agroforestry (ICRAF) are co-sponsoring the event in Nairobi, Kenya. Questions regarding the workshop should be directed to Bill Macklin, Development Associate, NFTA, P.O. Box 680, Waimanalo, Hawaii 96795, U.S.A.

The Indonesian Institute of Sciences, and Wageningen Agricultural University, the Netherlands, have announced the **PROSEA First International Symposium** (May 22-25, 1989) in Jakarta, Indonesia. Plant Resources of South-East Asia (PROSEA) is an international interdisciplinary project begun in 1985 with the goal of compiling and publishing a multi-volume handbook to include all of the estimated 5000 species of economically useful plants from the region. Information on the Symposium's Programme Outline and registration materials are available from the Secretariat, PROSEA First International Symposium, P.O. Box 234, Bogor 16122, Indonesia.

Eastern Caribbean Natural Area Management Program (ECNAMP) based on St. Croix, USVI, has been instrumental in the development of a system of national parks and protected areas in the British Virgin Islands. Other important ECNAMP activities include: the Cottage Forest Industries project in Dominica, which seeks to provide alternatives to wasteful large-scale commercial logging; the development of a Consortium of Caribbean Universities for Resource Management; development of three biosphere reserves in conjunction with the Caribbean Institute for Resource Management, and; institutionalizing programs of natural heritage management in several target countries. For more detailed information write to ECNAMP, 6A Caravelle Arcade, Christiansted, St. Croix, U.S. Virgin Islands 00820 or call (809) 773-9854.

TROPENBOS is a global research programme to conserve and sustainably develop the tropical rain forest. This programme was initiated by the Netherlands government, and it became operational with the appointment in May, 1986 of Dr. M.S. Ross as director. One of the prime objectives of the TROPENBOS programme is to develop appropriate management plans for large and small areas of tropical forest which are both scientifically sound and acceptable to local and national communities. Included in the program plan are biophysical inventories, mapping, and socioeconomic studies. Additional information is available from: State Forest Service of the Netherlands, P.O. Box 20020, NL-3502 LA, Utrecht, The Netherlands.

TROPENBOS was highlighted in a recent issue of the The Common Property Resource Digest , which is the primary communication medium of the **Common Property Resource Network.** The Network seeks to disseminate information dealing with common property resources and to foster communication among natural resource professionals. The newsletter contains much useful information on upcoming conferences, available fellowships and publications. Copies can be obtained by writing the Common Property Resource Digest, 332e C.O.B., 1994 Buford Avenue, St. Paul, MN 55108, U.S.A.

TRI NOTES

Faculty, Staff and Student Activities

TRI wishes Katherine Snyder a fond farewell. She is leaving her position as Assistant Director at TRI to concentrate on her doctoral work in the anthropology department here at the university.

We welcome Stephen P. Broker (M.F.S. '83) and Betsy McGean (M.E.S. '86) who both joined us in November. Steve Broker is the new Director of Programs at the School of Forestry and Environmental Studies. He is responsible for overseeing all aspects of special program development and implementation in the Tropical Resources Institute and various other school programs. One aspect of his work will be assisting in the preparation of proposals to foundations and other funding sources in order to maintain the TRI Internship Fund which supports student research projects in the tropics. For the past four and a half years Steve served as Associate Director of the Graduate Liberal Studies Program at Wesleyan University.

Betsy McGean replaces Katherine Snyder as Assistant to TRI Director William Burch. She will be working closely with Steve in the preparation of grant proposals and will also serve as liaison and advisor for students involved in the program. Betsy worked previously with the World Resources Institute on the implementation of the "Tropical Forest Action Plans." During the past year she worked with an Indian non-profit group in social forestry extension and wasteland reclamation.

TRI Director William R. Burch traveled to Peru this summer to sign memoranda of understanding with the School of Forestry, Agraria, La Molina and ONERN, the national research agency. TRI looks forward to developing closer ties with both of these organizations through research and internship opportunities.

Dr. Burch is the Principal Investigator on sub-contract to an ongoing Forestry/ Fuelwood Research and Development Project (F/FRED) of the Winrock International Institute for Agricultural Development. Entitled " The Social Sciences in Forestry Curricula," this curriculum development project is designed to integrate social sciences into forestry training programs in South Asia. The fall '88 issue of the Farm Forestry News, a quarterly F/FRED newsletter, includes an article by Prof. Burch entitled "Gods of the Forest." The piece highlights the fundamental connections between cultural perceptions of the natural environment evident in myth and folklore and the distinct resource management strategies they have engendered.

Prof. Clark S. Binkley worked this summer at the Center for International Trade in Forest Products (CINTRAFOR) at the University of Washington on a study of forest sector development in the Pacific Rim. This project, known as the Pacific Rim Assessment, aims to develop a detailed econometric model of forest products production, consumption, prices and trade in the developed and developing countries of the region. The work is being directed by Prof. Peter Cardellichio, who received his PhD from Yale in 1987. A CINTRAFOR working paper describing the timber supply component of the model will be available later this winter.

This past September, Professor John Wargo presented a paper on Biosphere Reserves to the Man and the Biosphere Secretariat of UNESCO in Paris. Prof. Wargo has developed an evaluation methodology to determine threats to the reserves and to gauge the potential of the current institutional structure to manage reserve resources to meet the multiple use objectives of Biosphere Reserves.

Professor William Reifsnyder has recently completed the editing of proceedings of a conference held last year on the application of meteorology to agroforestry systems planning and management. The conference was held in Nairobi, Kenya, and it was sponsored by the International Council for Research in Agroforestry (ICRAF), the World Meteorological Organization and the United Nations Environment Programme. Dr. Reifsnyder contributed a paper on "The Control of Radiation in Agroforestry."

Professor Steve Beissinger began work on two projects in Venezuela this summer with two Yale F&ES masters students. An experimental study of diet choice in the Snail Kite *(Rostrahamus socibilis)* was undertaken by Tim Donnay. This two-year project is funded by the Smithsonian Institution. The llanos of Venezuela is one of two known locales where this snail-eating hawk broadens its diet to include other foods, particularly freshwater crabs. This summer marked the fourth year of Beissenger's studies of this population. The other project, carried out by Jim Waltman and funded by the Roger Tory Peterson Foundation involves the nesting biology of the Green-rumped Parrotlet *(Forpus passerinus)*. This small parrot of little known genus has been induced to nest in boxes resembling fenceposts (a common natural nest site) that have been specifically designed for study purposes. Pilot studies of behavior and natural history are being completed, and experimental work will begin in the near future. Few parrot species can be studied in the detailed manner that will be possible with this species. Results and techniques should be transferable to species with small populations and those of economic interest to the pet trade.

Psidium guajava

Guest Lectures

The Yale School of Forestry and Environmental Studies and TRI have entertained a number of distinguished visitors during the course of the year.

April 22: Her Royal Highness Princess Chulabhorn Mahidol of Thailand made a presentation on "The Application of Science and Technology in Rural Development." Her Royal Highness holds a Ph.D. in Organic Chemistry from Mahidol University, and in 1987 she was Visiting Professor of Organic Chemistry at Ulm University in Germany and Visiting Professor of Agriculture at Tokyo University.

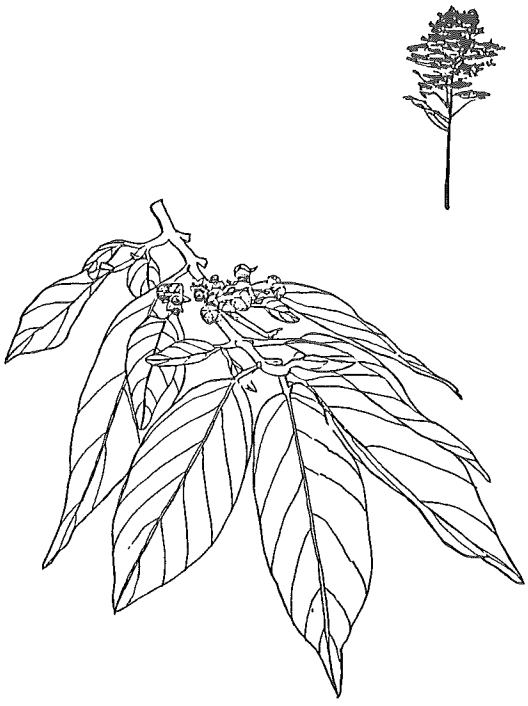
September 28: Mr. Massimo Sabbatini from Universita delgi Studi di Cassino, Italy presented a research seminar on "The Forestry Sector in Italy: Looking for an Economic Role."

October 27-28: Mr. Larry Fisher, the Southeast Asia Area Representative for World Neighbors, spent two days at the Forestry School. He lectured on "Farmer Education Programs in Indonesia and the Phillipines," and conducted a workshop entitled"Projects that Really Work." TRI concluded Mr. Fisher's visit with a TGIF fundraiser to benefit World Neighbors.

November 10: In an FES sponsored forum series entitled "Global Issues," a panel discussion moderated by Dean John Gordon on "New Directions in Agriculture" was convened. The multidisciplinary group of speakers included: Victor John Yannacone Jr., environmental attorney and trustee , Catherine Vedalia Riley Trust; I. Garth Youngberg, Executive Director of the Institute for Alternative Agriculture; A.S. Clausi, Senior Vice President(Retired) for General Foods Corporation; Richard L. Ridgway, Research Leader for the Insect Chemical Ecology Laboratory,USDA, and; David Graves, Legislative Assistant to Senator Thad Chochran (R-MS). Following the discussion, the Charles Valentine Riley Memorial Prize was awarded to Toshio Murashige, Professor of Horticultural Science and Plant Physiology, Department of Botany and Plant Sciences, University of California-Riverside.

November 12: Hosted by Professor Herb Bormann and supported by the Henry S. Graves Lecture Series, Mr. Kirk Smith lectured on the topic of "Biofuels, Airpollution, and Health: The Dark Side of Small is Beautiful." Mr. Smith is currently a research associate at the East-West Center in Honolulu, Hawaii.

December 12: Mr. Noel Brown, Director of the North American Office, United Nations Environment Programme (UNEP), presented a lecture on "Perspectives on Global Environmental Problems." Following the talk, Mr. Brown met informally with students at a reception in Sage Hall.



Colubrina arborescens

TRI Interns

The Tropical Resources Institute supported the diverse research initiatives of several masters students during the course of this past summer. The following is a list of the the students involved, the institutions with which they collaborated, and their project focus:

STUDENT	INSTITUTION	PROJECT
Jeff Bopp	Universidad Nacional Agraria La Molina, Peru	Secondary forest utilization in the humid tropics.
Alice Eichold	Center for Energy and Environment Research. University of Puerto Rico El Verde Field Site	Gas exchange characteristics and carbon gain of tropical tree species.
Cyril J. May	Beijing Forest University Peoples Republic of China	Three North Protection Forest System Project: Effectiveness of Problem Solving in China's Afforestation Effort.
Dave Tobias	Tropical Science Center San Jose, Costa Rica	Monteverde Cloud Forest Reserve: Tourist Carrying Capacity.
Kate Heaton Al Latourneau	Institute of Tropical Forestry Rio Piedras, Puerto Rico	Distribution of Dominant and Sub-Dominant Tree Species of Tabonuco Forest Type in the Bisley Watershed of the Luquillo Experimental Forest.
Tony Cummings	Tropical Science Center San Jose, Costa Rica	Vegetation Assessment for Maintaining Wildlife Diversity in the Monteverde Cloud Forest Reserve.
Jim Weigand	Centro Agronomico Tropical de Investigacion y Ensenanza (CATIE) Turrialba, Costa Rica	Established herbarium/CATIE project in silvicultual resources. Published "Small trees and Shrubs Found in the Atlantic Lowlands of Costa Rica.

Partially Funded By TRI:

Jim Waltman	Cattle Ranch Fundo Pecuario Venezuela, Smithsonian Institution	Breeding behavior of the Green-rumped Parrotlet (*Forpus passerinus*).
Bob Heinzman Conrad Reining	USAID/Guatemala, Independent Project	Sustained Rural Development: Economy and Ecology of *Chamaedorea sp.* Palm Extraction.
Betsy Carlson Claudia Martinez	Ensenada de Utria, Colombia (INDERENA, Fundacion Natura) Independent Project	Characteristics of Mangroves in Utria. Resulted in a field guide for educational purposes.

BOOK REVIEW

Bruce Goldstein
MES Candidate '90

BIODIVERSITY. 1988. E.O. Wilson Ed. Washington, D.C.: National Academy Press.

Question: How many species became extinct in 1987?

Answer: a. 5
b. 150
c. 2,500
d. 17,500

Assuming that there are 5 million species on earth, the answer is 17,500, writes Harvard biology professor E. O. Wilson, editor of *BioDiversity*, the proceedings of a conference held in Washington, D.C. in September of 1986 under the auspices of the Smithsonian Institution and the National Academy of Sciences. Last year's loss is 1,000 to 10,000 above the natural rate, and the pace is accelerating.

The consequences of this extinction spasm will be grave, according to the 55 contributors to Wilson's volume. Environmental consultant Norman Myers states that humankind's destruction of natural habitat "may result in the greatest single setback to life's abundance and diversity since the first flickerings of life almost 4 billion years ago."

The authors, who range from field biologists and conservationists to philosophers and development specialists, agree with this grim assessment of humankind's fate in a biologically impoverished world. Stanford University biologist Paul Ehrlich writes that if people continue to eliminate the other species which support human life, civilization may collapse in a hundred years' time.

A broad diversity of participants was drawn to the Biodiversity Conference to gain a glimpse of a stark future. There were numerous press conferences and as many pilgrimages by biologists to Capital Hill to plead for more enlightened policies in research appropriations and development aid. According to Myers, the biodiversity crisis has reached a point where scientists no longer can afford to "abstain from advocacy to safeguard their scientific virginity."

The scientists expressed their greatest concern for tropical forests, which cover 7 percent of the earth's surface while providing habitat for over 50 percent of all species. Their concise essays summarize the state of the science in the estimation of the total number of species, the rate of decline, and the time it will take for the earth to recover after the passing of modern man.

Most of the writers agree that parks and preserves alone will not be adequate to protect a significant number of species. Changes in rainfall and temperature resulting from a global warming and forest destruction outside the preserve will alter the integrity of these refuges, and increasing human populations will lead to more frequent invasion by shifting cultivators and wood gatherers.

The dependence of human societies on the variety of species in tropical forests and other habitats is most vividly illustrated in an essay by Hugh Iltis, Director of the University of Wisconsin Herbarium. He describes his discovery of a commercially valuable tomato species during a botanical collecting expedition in the Peruvian Andes, and he argues that the wild relatives of commercially valuable species have often contributed to breeding programs by providing genes for desirable traits including resistance to insects and disease.

Other contributors give attention to the environmental services which wild nature provides to human society, such as watershed protection, recycling of rainwater into the atmosphere, and soil regeneration.

This groundwork is essential, but the value of the book lies in its willingness to go beyond a passive, fatalistic statement of our dependence on wild nature in the face of its imminent destruction. Writer after writer broaches the thornier question of what can be done to reverse the current trends, and particularly how biologists can contribute to saving the objects of their life's work.

Michael Robinson, Director of the National Zoo, advocates preserving natural systems by finding ways to draw enough valuable products from them to justify preservation in economic terms. He introduces a section of the book which examines the attempts of the Smithsonian Tropical Research Institute in Panama to farm the Green Iguana and the Paca, a large forest-dwelling rodent.

John Todd, President of Ocean Arks International, describes his attempts to restore an already degraded landscape by reassembling groups of native organisms which are the most efficient providers of valuable products, including fish and lettuce, and managing them with such services as sustained soil fertility and watershed protection.

John Spears, forestry advisor with the World Bank, advocates single-species plantations to save the tropical

jungles. He also advocates widespread planting of fast-growing trees, especially for commercial purposes, and more intensive agriculture to take the pressure off the forests.

Spear's approach contrasts with other papers promoting the techniques of traditional farmers, whose practices are better suited to their local area, while their use of genetically diverse seeds preserves the adaptability of major food crops.

These strategies are clearly dissimilar and mutually exclusive, but each could be part of an overall conservation strategy. A more fundamental division among some writers in the book hinges on whether biologists should attempt to place a value on biodiversity and find means of justifying biodiversity within the existing economic system. Many of the contributors, including Wilson, Ehrlich and Iltis, say that our long-term survival depends on an ethical evolution that extends our system of human rights to wild species and natural areas. None of the authors disagree with this notion, but some differ over what we should do in the meantime.

David Ehrenfield, biology professor at Rutgers University, believes that "by assigning value to diversity we merely legitimate the process that is wiping it out." Since economic criteria shift, says Ehrenfield, wilderness will eventually be destroyed and "we will be left with nothing but our greed when the dust settles."

Other writers find these ethical criteria unworkable. Michael Hanemann, an economist at Berkeley, says that a developed nation's attempt to export this idea to the developing world is not unlike "an aging rake urging chastity on a young man."

James Nations, research director at the Institute for Human Ecology, calls the present situation "the dilemma of deep ecology meeting the developing world." He urges a more practical, citing Cartwright, 1985 (Environmentalist, 5(3): 179-186) in "ensuring that people here and on the frontiers of the developing world receive material incentives that will allow them to prosper by protecting biological diversity rather than destroying it."

E.O. Wilson and others argue that society must invest more resources in training and funding biological research, from the classification of new species to the investigation of new drugs, crops and agricultural techniques. These are more than stop-gap measures; they may provide increased understanding of the natural world crucial in making the ethical decisions that many of the writers believe are our only long-term hope.

The entire volume is marked with a deep and fearful pragmatism. It marks not only a compendium of the best ideas in conservation biology, but a profound foreboding felt by life scientists for the future of the earth.

LITERATURE

Noted below are selected, recent additions to the TRI bibliographic database. Searches and printouts of the database will be available on demand. We also can provide copies of some items. We would welcome any papers or reports you could send for inclusion in this database. These publications will be listed in the next issue of TRI NEWS. If you do not have publications to send, please mail us citations of publications you judge to have special importance to tropical resources management.

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TRI Publications

TRI has published two working papers recently: **Effect of Rate of Growth and Development on Needle Photosynthate and Phloem Transport in Caribbean Pine (*Pinus caribaea*)** by Ambrose O. Anoruo and Graeme P. Berlyn ($7.50) and **Tropical Forestry and Biological Diversity in Indiaand the Role of U.S.A.I.D./ New Delhi** by Jeffery Y. Campbell ($ 7.00). For a complete list of TRI publications and how to order them, please contact Susan Brandi, Forestry Library, Yale F&ES, 205 Prospect Street, New Haven, CT 06511 U.S.A.

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