

# TROPICAL RAINFORESTS: Diversity and Conservation

Edited by  
Frank Almeda  
and  
Catherine M. Pringle

CALIFORNIA ACADEMY OF SCIENCES  
and  
PACIFIC DIVISION, AMERICAN ASSOCIATION  
FOR THE ADVANCEMENT OF SCIENCE  
San Francisco, California  
1988

## THE ORGANIZATION FOR TROPICAL STUDIES (OTS): A SUCCESS STORY IN GRADUATE TRAINING AND RESEARCH

DONALD E. STONE

Dept. of Botany, Duke University and the Organization for Tropical Studies,  
Durham, N.C. 27706

The seeds for a cooperative program in tropical studies date back to the late 1950s. This common base of interest leading to the establishment of the Association for Tropical Biology in 1962 and the Organization for Tropical Studies in 1963 is documented, and the history and development of OTS is covered through the administration of five executive directors. The research and particularly the education programs that account for OTS's preeminence in tropical biology are surveyed. The last section on OTS TODAY presents an overview of current programs and alludes to new challenges and action plans that are designed to continue the success achieved in the first 23 years.

The Organization for Tropical Studies, Inc., familiarly known as OTS, is a highly successful consortium of universities and research institutions that has been primarily responsible for the United States' literacy in tropical biology. This symposium presents a fine opportunity to reexamine the development of OTS (Hubbell 1967; Harmon 1970) and the basis for its success in anticipation of the 25th anniversary in 1988.

A few words about the design of the paper are in order because it is divided into five sections of unequal length and emphasis. Section I, entitled PRE-OTS, examines the events in the U.S. scientific community that coalesced widespread interests in tropical biology and catalyzed action leading to OTS as well as the Association for Tropical Biology. Section II, ADMINISTRATIVE HISTORY OF OTS, constitutes the bulk of the profile that has involved a "cast of thousands" over the years. Although it is not possible to detail the roles of all those involved in OTS, individuals whose association with OTS has been long and noteworthy are highlighted. Section III, on EDUCATION, and section IV, on RESEARCH, are abbreviated renditions of

the core programs whereby OTS has been successful and has made its most visible and lasting contributions to society. Many of the stories left untold here have to do with personal interactions and achievements of the thousands of students, faculty and researchers who have been influenced by their participation in OTS programs. Yet to come also is an objective evaluation of the impact that education and research programs have had on the national and international scene. Section V, OTS TODAY, carries events through the summer of 1986 and provides a thumbnail sketch of the consortium's aspirations for the future.

## PRE-OTS

### Independent Efforts in Tropical Studies

To understand why OTS has been successful in tropical education and research requires some knowledge of the roots from which the organization derives its strength (Table 1). The official birth of OTS was February 27, 1963, at the State Courthouse, Tallahassee, Florida. While this date marks the formal incorporation of the seven founding universities—Costa Rica, Florida, Harvard, Miami, Michigan, Southern California, and Washington—the seeds for a cooperative program in tropical studies date back to the late 1950s. Harvard was forced to cancel training and research programs at the Atkins Garden and Research Laboratory in Cuba with Castro's takeover in 1959, and Michigan had become frustrated in trying to establish a training center in southern Mexico. Michigan's efforts to develop a coordinated program in tropical studies started in 1957 when Theodore H. Hubbell was appointed to chair a Committee on a Proposed Center for Tropical Studies (Anon. 1965a). A plan was quickly drafted to establish a center in Chiapas, and by July 1958 a proposal was submitted to the U. S. National Science Foundation (NSF) and the Ford Foundation. Over the next several years the committee members made many trips to Mexico to arrange allocation of land for field sites with local, state and federal authorities, and details were worked out for curricula, logistics, and facilities (Anon. 1959). Tentative arrangements were made with the Universidad Nacional Autónoma de México, but firm agreements with Mexican authorities could not be reached and the idea of establishing a tropical center in Mexico was finally dropped in the spring of 1962. During this same period the Associated Colleges of the Midwest drew up a plan to establish an undergraduate, junior-year-abroad program in Costa Rica. The universities of Florida, Kansas and Miami all offered field biology courses in Latin America, and, in fact, Miami had opened negotiations with the Costa Rican government to acquire land for biological field station: (Hartweg 1963a). The University of Washington was added to the prospective fold because of its desire to find a tropical base for the forestry program.

TABLE 1. HISTORICAL EVENTS LEADING TO OTS INCORPORATION

### *Independent Efforts in Tropical Studies*

Atkins Garden and Research Laboratory in Cuba used by Harvard University: forced out by Castro's takeover in 1959  
 University of Michigan attempts to establish center in Chiapas, Mexico: efforts initiated in 1957 and abandoned in 1962 for want of firm agreement with Mexican government  
 Associated Colleges of the Midwest, University of Florida, University of Kansas, and University of Miami all had field biology programs in Latin America in the late 1950s and early 1960s

### *National Science Foundation-sponsored Conferences & Programs*

Miami, Florida, May 5-7, 1960: Conference on Tropical Botany  
 Fundamentals of Tropical Biology course in Costa Rica, 1961-1963, offered by the University of Southern California in conjunction with the University of Costa Rica  
 Costa Rica, April 23-27, 1962: Conference on Problems in Education and Research in Tropical Biology  
 Hodge & Keck Report, 1962: Biological Research Centers in Tropical America  
 Trinidad, July 2-6, 1962: Neotropical Botany Conference and founding of the Association for Tropical Biology  
 Jamaica, Dec. 17-21, 1962: meeting of representatives from Costa Rica Conference and Trinidad Conference

### *Formation of OTS*

Coral Gables, Florida, Jan. 31-Feb. 2, 1963: meeting of Organizing Committee  
 State of Florida, Feb. 27, 1963: incorporation  
 Miami, Florida, June 25-26, 1963: first formal Board meeting  
 San José, Costa Rica, Nov. 8-11, 1963: first annual Board meeting

---

### Miami Conference of 1960

The ferment of interest in tropical biology prompted NSF to examine the status of teaching and research on tropical plants, and on discovering that little information was available, a Conference on Tropical Botany was called at the Fairchild Tropical Garden in Miami, Florida on May 5-7, 1960. The Miami Conference was seminal in the development of a national awareness of the tropics, and the general conclusions that were drawn established the tone and framework for subsequent scientific efforts in training and research (NRC 1960). The conference concluded with the following recommendations:

"Tropical botany is now and will become increasingly important as an area demanding maximum cooperation between men of all nations concerned, because of man's dependence on the plants of his environment, the continuing and rapid growth of populations and the associated depletion of natural vegetation regions and resources.

"Field botanical research on tropical vegetation should be greatly augmented in the immediate future because the destruction of natural vegetation places a limit on the time available for the study of undisturbed tropical vegetation.

"The location and identification of tropical plants as resources for basic scientific study, for use in industry and medicine, for ornamental and agricultural horticulture, and the support of investigations and the training of students will benefit the country of origin and the country of utilization.

"Field stations in the tropics and subtropics are extremely important for botanical teaching and research. Existing field stations should be utilized to the fullest extent, and new field stations should be planned and supported according to demonstrated need.

"Practical taxonomic information is a recognized need for almost all botanical research, and local floras including all groups of plants should be prepared for tropical regions where botanical studies are conducted. At the same time, active support should be given to implement a coordinated program of monographs on tropical American plants.

"Existing textbooks of botany are based largely on conditions and plants of the temperate regions. The preparation of texts which encompass the tropics should be encouraged.

"While it is recognized that taxonomy is basic, plant geography, ecology with its application to land use, plant pathology, plant physiology, economic botany, anatomy, genetics, cytology, morphology, and other botanical disciplines have important roles in the development of knowledge of tropical botany."

#### Fundamentals of Tropical Biology Course

One of the first and most visible moves to address the deficiency in U.S. scientists trained in tropical biology came in 1961. The University of Southern California (USC), with the helping hand of James S. Bethel in Science Education at NSF (J. M. Savage, pers. comm.), received NSF and Organization of American States funding to teach Biology 505L, Fundamentals of Tropical Biology, in Costa Rica. This course, under the direction of Jay M. Savage and with the cooperation of faculty from the University of Costa Rica (UCR), was designed to provide "college and university teachers with a basic understanding of biological phenomena in the tropics through firsthand study in tropical environments" (Savage 1961). One can imagine

the excitement of the 15 U.S. and five Latin American participants. Here was a unique opportunity for educators to see firsthand what they had been lecturing about for years. This first course had the traditional classroom lectures and accompanying laboratories, and seven field trips exposed the participants to soaring volcanic peaks, treeless páramos, deciduous dry forests, and lush tropical lowland rainforests. The Fundamentals course was repeated under USC and UCR sponsorship in 1962 and 1963, and additional opportunities were afforded to a select group of college professors for short periods of full-time research (Savage 1963a). In the summer of 1963, twelve graduate students were added to the mix to determine if the program could serve equally well for the novice college professor and the young graduate. Among this set of participants was a UC Berkeley student by the name of Daniel H. Janzen, who subsequently went on to put his own stamp of genius on the OTS training programs.

#### Costa Rica Conference of 1962

The first course showed the way for introducing tropical biology to an eager community of U.S. scientists. In the spring of 1962 Savage, Rafael Lucas Rodríguez, and J. Robert Hunter, under the auspices of NSF, organized a key Conference on Problems in Education and Research in Tropical Biology. This conference was held in San José, Costa Rica on April 23-27 to consider: (1) the minimal basic requirements for education and research in tropical biology; (2) how existing demands for education and research, facilities and trained tropical biologists could be met; and (3) a program for coordinating the many individual projects in education and research in tropical biology (Savage 1962).

The five-day session was intense. The first two days were designed to orient the 31 participants to the tropics, to Costa Rica and to the purpose and format of the conference (R. L. Rodríguez); to summarize the present state of tropical biology (J. R. Hunter); and to outline an experimental program of education in tropical biology (J. M. Savage). These formal presentations were followed by panel discussions involving Costa Rican residents John DeAbate, Lester R. Holdridge, Alfonso Jiménez, and Joseph A. Tosi, Jr. The third day was devoted to field trips to survey sites for the education and research programs. The participants split into three groups: one going to a marine site near Mata Limón on the Pacific Coast; one to view Carlos Lankester's orchid garden in Cartago and vegetational associations along a 4,000-9,500 ft. elevational transect on Volcán Irazú; and the third to tour the Instituto Interamericano Ciencias Agrícolas (IICA) facilities at Turrialba. The background provided by the first three days of the conference and the expertise of invited participants were drawn on in the fourth day at the

"small conference sessions." Reports from these groups laid the cornerstones for OTS by developing the rationale and plan of action for meeting critical needs of teaching and research in tropical biology (Savage 1962). The four sets of recommendations that follow covered programs and facilities needed to engage in tropical education and research.

(1) Undergraduate, graduate, and postdoctoral education, chaired by Cornelius H. Muller, recommended: (a) the recruitment of undergraduates early in their careers so that a commitment to the tropics is inculcated; (b) a program of basic education in tropical biology for students at the graduate level; (c) a similar program for postdoctoral biologists without tropical experience; and (d) a coordinated effort to encourage and develop research as the base for graduate thesis preparation and recruitment of postdoctoral scientists into tropical research.

(2) Crucial problems in tropical research, chaired by Damon Boynton, identified seven broad areas of research priorities: (a) flora, fauna, and ecological associations, both recent and fossil, under tropical conditions; (b) biogeography and evolutionary biology including cytogenetics and allied subjects; (c) population and community dynamics, including man, under tropical conditions; (d) tropical climates, microclimates, and soils; (e) methodology for the determination of natural resources and the conservation thereof; (f) physiological and biochemical response of tropical plants and animals to variations in the environmental complex; and (g) geological features and processes pertaining to tropical biology.

(3) Facilities requirements for education, chaired by I. Duncan Clement, concluded that any proposed center must be a cooperative project organized on a hemispheric basis with headquarters in Costa Rica, but committed to developing facilities in other Latin American areas in the future. Minimal education needs include: (a) a basic central building with at least a dirty or wet laboratory and a clean teaching laboratory; (b) a working collection of local biota; (c) a working office laboratory and library; (d) a simple wood-working and metalworking shop; (e) adequate teaching equipment, especially projectors and screen, compound and dissecting microscopes and field glasses; (f) minimal field and collecting gear; (g) field vehicles; (h) adjacent animal quarters and plant-growing areas for simple behavioral and experimental studies; (i) simple field stations and permanent sites for study and observation; (j) adequate housing for staff and students; and (k) a permanent staff under the direction of a resident professional tropical biologist.

(4) Facilities requirements for research, chaired by E. Peter Volpe, recognized the ideal as a "multi-million dollar installation, involving the establishment of a centralized edifice and permanent field stations in select areas of Costa Rica." As minimal requirements the group listed the needs in three categories: (a) natural—areas with original, natural, or undisturbed

habitats; (b) human—permanent staff of knowledgeable individuals who can provide intimate knowledge of various aspects of Costa Rica; and (c) physical—field vehicles and laboratories equipped with microscopes, balances, photographic equipment, herbaria, stockrooms, etc.

The session concluded on the fifth day with the resolve to establish permanent headquarters in San José, Costa Rica and to act immediately on implementing recommendations for programs and facilities to further education and research in tropical biology. The participants voted to constitute themselves as a permanent body devoted to implementing the action plan of the small conference sessions. An executive committee was formed from the six members of the Conference Steering Committee (viz. J. DeAbate, L. R. Holdridge, J. R. Hunter, A. Jiménez, R. L. Rodríguez and J. M. Savage) and seven persons were elected from the delegates at large: F. S. Barkalow, Jr., I. D. Clement, N. E. Hartweg, W. H. Leigh, G. Mann, C. H. Muller, and F. W. Went. Hunter was subsequently elected chairman and Clement and Went were appointed as official representatives to meet with participants of the forthcoming Neotropical Botany Conference in Trinidad.

#### Hodge and Keck Report

Concurrent with the USC/UCR training program, NSF conducted its own field survey of the Biological Research Centers in Tropical America. In light of the 1960 Miami conference findings, Walter H. Hodge and David D. Keck (1962) set out to ascertain the sites where "basic biological research and/or research training may be conducted and where the participation of foreign scientists is invited." In their coverage of fifteen Latin American countries and six West Indian islands, Costa Rica and UCR in particular were identified as prime locations for tropical studies with the following complimentary remarks:

"The most up and coming University in Central America and one with a number of cooperative programs with U.S. institutions, and the site of two NSF summer training institutes. The new campus has modern buildings and facilities for most kinds of biological work carried out mainly in departments of botany, biology, entomology and microbiology. Because of its facilities—including an ample library, and the proximity of a wide variety of nearly [nearby?] natural areas, a fine plant collection (of C. Lankaster in Cartago), and potential branch field stations in the country—this University has been recommended as the site of a permanent center for indoctrinating United States scientists and their students in tropical Biology. The University is much interested in all such programs."

### Trinidad Conference of 1962

The third in the series of conferences sponsored by NSF was held at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad on July 2-6, 1962 (Purseglove 1962). The 37 or so participants at the Neotropical Botany Conference discussed the report of the Costa Rica Conference and then heard nine botanical specialists outline major gaps in botanical knowledge of the Neotropics: opening session, John W. Purseglove; taxonomy and collecting, Bassett Maguire; ecology and conservation, Stanley A. Cain; morphology and anatomy, William L. Stern; plant physiology, Kenneth V. Thimann; cytogenetics, F. W. Cope; cryptogamic botany, George R. Proctor; economic botany, Louis O. Williams; and evolution, Herbert G. Baker. Following an enumeration by A. C. Smith of the facilities available in the Neotropics for teaching and research in tropical biology (after Hodge and Keck 1962), the Trinidad Conference concluded on July 6 with a resolution to "bring into being" the Association for Tropical Biology (ATB) (Purseglove 1962:43). Mixed opinions existed as to the impact and relation this new society would have to the proposals fostered by the Costa Rica Conference, but the Executive Committee of the Association was authorized "to co-opt one or two delegates... to achieve a meeting of minds, action and participation" (Purseglove 1962:46). Furthermore, I. D. Clement was designated as the liaison to invite Costa Rica Conference participants to join the ATB.

### Jamaica Meeting of 1962

The stage was set for a meeting of the two groups in Port Antonio, Jamaica on December 17-21, 1962. The mindset and expectations of the participants must have differed. To those from the Trinidad Conference, the ATB was viewed as "the central or parent organization to which others of more special interest" could become affiliated (Maguire 1966: 7,8). No doubt J. W. Purseglove, chairman, Tobias Lasser and B. Maguire conveyed this attitude when they met with J. DeAbate, J. R. Hunter and J. M. Savage from the Costa Rica Conference. In any case Purseglove reports that the Costa Rica Conference was dissolved and merged with the ATB (Purseglove 1964:2). Quite to the contrary, however, the two groups did not merge, and this meeting in Jamaica has to be regarded as the formal point of divergence. Savage's impression was that the wheels were already in motion for a Center or Organization for Tropical Studies (Savage, pers. commun.), and Purseglove's reference to merger applied to invitations extended to individual membership in ATB. Certainly this latter explanation is consistent with the events, for just prior to the Jamaica meetings a "Proposal for the Establishment of a Center for Tropical Studies" in Costa Rica was being circulated by the University of Michigan (Anon. 1962).

The Jamaica meeting marks the close of preliminary discussions leading to the formation of OTS. The botanical community has to be given credit for publicizing the problems and challenges of working in the tropics, in the course of reaching this point. All of the persons who attended two or more of the conferences were plant scientists. Fourteen participants were present at both the 1960 Miami Conference and the 1962 Trinidad Conference (Baker, Cain, Clement, Fosberg, Hodge, Keck, Howard, Maguire, Mathias, McVaugh, Purseglove, Smith, Went, and Williams), three individuals (Bethel, Holdridge, and Noggle) attended one of these meetings as well as the 1962 Costa Rica Conference, and two peripatetics (Clement and Went) were present at all three sessions (see NRC 1960, Savage 1962, Purseglove 1962). OTS stands solidly on these botanical foundations; however, the vitality of the consortium derived from the melting pot of scientists from the seven founding institutions.

### Coral Gables Meeting of 1963

The formal steps to establish OTS were initiated by Norman E. Hartweg as Chairman of the Michigan CenTrop committee. On December 3, 1962, he wrote invitational letters to representatives of nine institutions to convene at the University of Miami in Coral Gables, Florida on January 31 - February 2, 1963 (Hartweg 1963b). This meeting touched on the high points leading to the proposal for establishment of the Organization for Tropical Studies and outlined the organization and facilities that would be needed to implement the educational programs. "It was there that the bullet was bitten and concrete steps taken" (Rollins 1986) to establish OTS by drawing up by-laws and submitting the charter to the State of Florida (Hartweg 1963a).

At the time of the Coral Gables meetings, several of the schools were uncertain about making a formal commitment to OTS membership and, in fact, the Associated Colleges of the Midwest and the New York Botanical Garden later declined membership. Many other potential members were never given the opportunity to make this choice because the invitations to attend were only sent to a subset of institutions that participated in the Costa Rica and/or the Jamaica conferences. The University of Kansas, for example, was not represented at this meeting, but because of intense interest it submitted a formal request for membership in the spring of 1963.

## ADMINISTRATIVE HISTORY OF OTS

### The Early Years of OTS

The first formal Board meeting was held in Miami on June 25-26, 1963 (Savage 1963b). At this time the University of Kansas was accepted as a

charter member<sup>1</sup>, to bring the membership to eight, and a six-person Executive Committee was elected with N.E. Hartweg as President and Chairman; J. DeAbate, Vice President; J. M. Savage, Secretary; W. H. Leigh, Treasurer; and J. S. Bethel and Reed C. Rollins, Members at Large. By the OTS Charter of February 1, 1963 (Hartweg 1963a), and persisting to this day, "at least one director designated by a member institution shall be a scientist and not more than one director shall be an administrative officer of the member institution." The wisdom of this requirement is now self-evident, and it was such a group that charted the early course for OTS and developed some lofty expectations that have yet to be realized. For example, in the dealings with NSF regarding funding for educational programs and facilities in Costa Rica, there was an implicit understanding or expectation at least that OTS would be designated as a "national laboratory" comparable to the Kitt Peak National Observatory or the National Center for Atmospheric Research (Bethel 1965, Hubbell 1965a,b). Unfortunately this status and the stability provided through core financial support never materialized (Bethel 1966). In its place OTS relied on a small dues commitment from its members, a \$2,500 initiation fee and \$2,000 annual dues thereafter, and program funds provided by an ephemeral assortment of government and private granting agencies.

The personal commitment of the Board members and the great promise of OTS overcame many obstacles in the 1963-1964 period, but finances limited development of the organizational structure. J. M. Savage was hired on an interim basis as Executive Secretary and J. DeAbate as Special Consultant to mobilize the Fundamentals course for the summer of 1964 (Savage 1963c). The youthful organization received a major setback when President Hartweg died in February 1964 (Savage 1964d). R. C. Rollins was elected president by mail ballot to step into the breach during this crucial phase of funding negotiations with Science Education at NSF. Savage operated out of Costa Rica in the spring of 1964 in order to organize the summer OTS course, and both he and DeAbate worked to strengthen ties with local institutions and to develop new ones in other Latin countries (Savage 1964a). Conversations were initiated at this time with UCR officials about construction of OTS facilities, and an agreement was being sought with the government Institute of Land Colonization (ITCO) to establish field sites for education and research (Salazar 1964). Apparently ITCO wanted the sites to be extensive so that they could serve as the nucleus for a future National Park System (Savage 1964b).

OTS's need for a full-time director was appreciated from the beginning of Rollins' reluctant ascendancy to presidency, and by July 1964, William

<sup>1</sup> The University of California was subsequently admitted on November 13, 1964 as the ninth and last charter member.

Hatheway, formerly with the Rockefeller Foundation in Mexico City, had been selected as the first Executive Director (Savage 1964c). With the University of Miami acting as fiscal agent at no cost to OTS, Hatheway moved to Costa Rica to head the operation. The departure of Savage prior to Hatheway's arrival in late September led to some communication problems regarding grant-writing responsibilities. Although the issues were satisfactorily resolved through President Rollins' coordination, it was a bad omen for the new Executive Director. Hatheway was, of course, plagued from the start by organizational work in anticipation of the two courses scheduled for the winter of 1965. Further, he was challenged by the perceptive comments of Charles D. Michener (1964) to orient the course away from the classroom and into the field. Hatheway proposed a revised curriculum that scaled back on short-term visiting faculty and lectures and placed greater emphasis on spending longer time at each field site with a few senior faculty. In particular, Hatheway felt so strongly that L. R. Holdridge's expertise in vegetation and tropical tree identification was indispensable to the Fundamentals course that Holdridge was proposed as the principal instructor, with Hatheway and D. H. Janzen serving as assistants (Hatheway 1964).

Holdridge's willingness to assume a major role in the 1965 winter Fundamentals course was predicated on his position as coordinator and a contract with OTS giving the Tropical Science Center (TSC) full authority to handle the course (Hatheway 1964). This latter proposal was reviewed with some skepticism by Rollins from the very beginning because he felt that under no circumstances could the fledgling OTS consortium afford to "become a satellite of the Tropical Science Center" (Rollins 1964a). Although this contractual arrangement was thought to have the tacit endorsement of UCR faculty such as R. L. Rodríguez, Rollins realized that dependence on TSC for course logistics and development would do nothing for building the OTS capabilities and would tend to weaken the involvement with UCR. Rollins (1964b) repeatedly warned Hatheway about forming too tight a link with TSC, but on January 5, 1965, a contract was signed with J. R. Hunter that gave TSC responsibility "for the entire conduct of the course including instruction, course materials, field trips, handling and accounting of funds and all other matters relating to this course" (Anon. 1965b).

Problems faced Hatheway from the beginning. The advertisements that were sent out for the winter courses attracted a lot of interest and applications, but the problems of foreign mail and the lack of timely communication with the course applicants created confusion and discontent (Michener 1965). The problems only magnified once the courses got under way. The Tropical Forest Ecology course led by Paul W. Richards was not covered by the contract, so this group avoided the sniping and friction that developed between Holdridge and some of his staff and students in the Fundamentals

course. Animosity was expressed over TSC's efforts to control all aspects of course activity, and particularly their insistence that the use of field sites and facilities in Costa Rica be cleared through them. Apparently TSC viewed OTS as a potential competitor and the paranoia extended to the development of "exclusive-use rights" contracts with companies and private land holders (Woodman 1965). The final straw came when UCR refused to process credits for the 1965 winter course on the grounds that TSC was not an academic institution (Janzen 1965).

Hatheway's inability to cope with the situation brought Rollins to San José for a confrontation on February 16-18. As a result of this meeting, Hatheway resigned (Hatheway 1965a) and returned with pleasure to field botany (Hatheway 1965b). At this point, President Rollins turned to DeAbate and Janzen for the organizational development of the 1965 summer course program, and at the March 21 meeting of the Executive Committee, Rollins' forceful action was endorsed and formal ties with TSC were severed (Savage 1965). This meeting brought the first OTS crises to a close and marked a turning point toward stability with the identification of Stephen B. Preston as interim Executive Director.

#### The Preston Era, 1965-1968

The summer of 1965 afforded a fresh start for OTS. The course programming was in the competent and energetic hands of D. H. Janzen, while J. DeAbate deftly cut the administrative red tape at UCR. Preston not only had the advantage of inheriting these two seasoned staffers, but he also benefited from the hindsight provided by W. H. Hatheway's trials and tribulations. In May of 1965, two months prior to assuming the OTS directorship, Preston had identified several "problem areas in OTS operation" in a special report requested by the Executive Committee (Preston 1965). One problem had to do with strained relations at UCR. Apparently DeAbate had been exceptionally aggressive and effective in negotiating for space and other privileges, and these efforts were resented by some faculty because he had dealt directly with the individual schools and departments, rather than channeling OTS requests through the upper echelon. The TSC brouhaha was recognized as an unfortunate event that left resentment on both sides. On the other hand, Preston was not ready to close out future options of establishing working relationships with TSC. Preston also surmised that the Costa Rican staff did not have a clear understanding of the thinking of the Executive Committee and had little knowledge of the activities of the member universities in relation to OTS, with the consequence that local operations were developed in a vacuum without institutional input. Preston concluded that the new executive director should spend a significant amount of time in the U.S. to

ensure liaison with the prime funding sources and majority of the consortium constituency.

The operational details proved time-consuming for Preston during his first year at the helm, and the hoped-for liaison with member institutions was limited. The time was ripe for the administrative restructuring proposed by T. H. Hubbell (1966) to strengthen and improve the organization. Among other things he recommended that the central office of OTS be moved from San José to the U.S. (Preston's home base at the University of Michigan), and that an assistant executive director be added to the staff to handle the operations of the San José office in the absence of the executive director. These recommendations were later adopted and to this day serve as the organizational framework for OTS.

Preston's interim directorship was stretched to three and one-half productive years, overlapping with the dynamic and forceful presidencies of J.S. Bethel and Stephen H. Spurr. During part of this period the University of Michigan provided Ross N. Pearson on release time to serve as Associate Director of Education, and the University of Washington assigned Dale W. Cole to handle duties of the Associate Director of Research. Jorge R. Campabadal was hired as an assistant during Preston's second year, but in a matter of months he proved his organizational skills and was elevated to Resident Director, a position he held for nearly 11 years that spanned the terms of six presidents (Table 2) and four executive directors (Table 3).

The late 1960s were a time of action and growth on all fronts (Argersinger 1967). Ford Foundation and NSF support between 1967-1970 funded over 90 pre- and postdoctoral pilot research projects. This was also a time when field sites were being sought for long-term training and research programs. Discussions were held with the United Fruit Company about use and possible management of the Lancetilla Botanical Garden in Tela, Honduras, and with Roberto (Bobby) Dorion, President of El Salto, S.A., about establishing a teaching and research center on the 10,000-acre sugar farm near Escuintla in western Guatemala. Preliminary consideration was even given to establish a Northern South American (Andean) OTS Center, and Thomas C. Emmel was sent on a reconnaissance (Teas 1969). A purchase option was taken in 1967 to buy La Selva from L. R. Holdridge, and arrangements were made with G. David Stewart of COMELCO ranch to lease space at Palo Verde for construction of a field station. As early as 1966 a multi-investigator research project was designed to compare the ecosystems of tropical lowland forest communities. When the proposal was submitted for funding to NSF in 1967, Palo Verde and La Selva were identified as the long-term study sites. This was also the period that the OTS emblem was designed under the guidance of Thomas E. Moore at the University of Michigan and formally adopted by the Board of Directors at the meeting of November 8, 1968.

TABLE 2. OTS PRESIDENTS 1963-1988

Tenure of President	Domain of Board Meetings
1963-1964 Norman E. Hartweg	June 25-26, 1963. Nov. 8-11, 1963.
1964-1965 Reed C. Rollins	Nov. 13, 1964. Nov. 12, 1965.
1965-1967 James S. Bethel	Nov. 11-12, 1966. Nov. 10-11, 1967.
1967-1968 Stephen H. Spurr	Nov. 7-9, 1968.
1968-1971 Mildred E. Mathias	Nov. 14-15, 1969. Nov. 13-14, 1970.
1971-1973 Joseph M. Reynolds	Nov. 11-13, 1971. Jan. 12-13, 1973.
1973-1974 Stephen B. Preston	Nov. 9-10, 1973. Nov. 8-9, 1974.
1974-1980 Jay M. Savage	Nov. 14-15, 1975. Nov. 12-13, 1976. Nov. 11-12, 1977. Nov. 10-11, 1978. Nov. 16-17, 1979. Apr. 12, 1980.
1980-1985 Thomas M. Yuill	Mar. 27-28, 1981. Mar. 19-20, 1982. Apr. 15-16, 1983. Mar. 23-24, 1984. Mar. 29-30, 1985.
1985- Peter H. Raven	Mar. 21-22, 1986. Mar. 20-21, 1987.

#### The Spencer Era, 1968-1972

The protracted interim directorship of Preston came to a close with Jack T. Spencer's appointment-elect in October 1968. Spencer had been a former program officer at NSF and was thus familiar with the fledgling OTS programs. He was also aware of NSF's encouragement for OTS to establish a financial office (Teas 1969) in order to untangle the financial records being kept at Michigan and the University of Miami (Spencer 1986), and this became part of the transition in leadership when the North American Office (NAO) moved in December 1968 from Michigan to the Miami campus (Spencer 1969). Almost from the start, however, the limited free space that could be provided by the University was inadequate to house the expanding headquarters, and by the spring of 1970 NAO moved off campus and rented quarters in a nearby office building in South Miami.

The year 1969 stands as one of the most intense periods in the development of OTS infrastructure (Marts 1969): formal guidelines were drawn up for most OTS business and program activities; a provisional indirect cost rate (47%) was established with NSF; a five-year development plan was drafted; formal advisory committees were constituted for earth sciences, geography,

TABLE 3. OTS ADMINISTRATION 1963-1986

Administrator and Title	Term of Appointment
*Jay M. Savage, Executive Secretary	Sept. 1963-Aug. 1964
*John DeAbate, Special Consultant Deputy Director Acting Executive Director	Nov. 1963-Oct. 1964 Nov. 1964-Mar. 1965 Mar. 1965-June 1965
*William H. Hatheway, Executive Director	Sept. 1964-Apr. 1965
*Stephen B. Preston, Executive Director (NAO)	Jun. 1965- Dec. 1968
Norman J. Scott, Asst. to Director (CRO)	July 1966-Jan. 1967
Jorge R. Campabadal, Asst. to Director (CRO) Resident Director (CRO)	Mar. 1967-Nov. 1967 Nov. 1967-Jan. 1978
Ross N. Pearson, Assoc. Director Education (NAO)	Sept. 1967-Aug. 1969
Dale W. Cole, Assoc. Director Research (NAO)	Spring 1968-Spr. 1970
*Jack T. Spencer, Executive Director (NAO)	Jan. 1969-June 1972
John P. Brand, Assoc. Director Education (NAO)	Sept. 1969-Aug. 1970
Benjamin H. Waite, Asst. Dir. Acad. Affairs (CRO)	Jan. 1971-Jan. 1973
*Kenneth J. Turnbull, Exec. Director (NAO)	July 1972-Feb. 1976
Robert G. Wilson, Sta. Director (Las Cruces)	Apr. 1973-June 1986
David P. Janos, Sta. Mgr. (La Selva)	Jan. 1975-Aug. 1975
Mario Baudoin, Sta. Mgr. (La Selva)	Nov. 1975-Aug. 1976
*Donald E. Stone, Interim Exec. Director (NAO) Executive Director (NAO)	Apr. 1976-Nov. 1976 Nov. 1976-Present
James E. Crisp, Sta. Mgr. (La Selva)	Dec. 1976-Aug. 1977
Lucinda A. McDade, Sta. Mgr. (La Selva) Scientific Coordinator (NAO)	Sept. 1977-Feb. 1978 June 1985-Present
Flor M. Torres A., Act. Asst. Resident Dir. (CRO) Chief of Operations (CRO)	Feb. 1978-Mar. 1978 Mar. 1978-Dec. 1983
Robert L. Sanford, Jr., Sta. Mgr. (La Selva)	Apr. 1978-Aug. 1978
Thomas S. Ray, Jr., and Catherine C. Andrews, Sta. Co-Mgrs. (La Selva)	Aug. 1978-June 1979
Philip J. DeVries, Sta. Mgr. (La Selva)	July 1979-Dec. 1979
David B. Clark & Deborah A. Clark, Sta. Co-Directors (La Selva)	Jan. 1980-Present
Charles E. Schnell, Interim Chief of Oper. (CRO) Chief of Operations (CRO) Resident Director (CRO)	Dec. 1983-July 1984 Aug. 1984-Dec. 1984 Jan. 1985-Present
Luis Diego Gomez, Sta. Director (Las Cruces)	July 1986-Present

\*Chief Executive Officer



marine science, meteorology, and terrestrial biology; and *ad hoc* committees were formed to consider Spanish language teaching, institutional membership, the North Andean Center, physical facilities, policy for station use, and ecosystem control. Fortunately this was a peak year for NSF support, and the future looked bright with a strong administrative staff and Mildred E. Mathias as the articulate, persuasive president, with needed leadership qualities (Marts 1969). In 1969 OTS had 25 institutional members (Spencer 1969), but a maximum of 17 enjoyed the rights of voting. The basis for this disfranchisement stemmed from the charter member's interest in regulating growth while ensuring their "full involvement" (Marts 1969). A three-tiered system was in place in which all institutional representatives were part of the Advisory Council. The Council in turn elected a 17-person Board of Directors, and from this group an 8-person Executive Committee was chosen. Discontent amongst the new memberships led Stephen H. Spurr to propose a re-evaluation of the Charter and By-Laws with the idea of combining the Advisory Council and Board of Directors. This action was taken, to the relief of many, at the next annual Board meeting (Marts 1970) and full voting rights were granted to all institutional representatives (Mathias 1986). On other fronts, two years of formal negotiations with El Salto, S.A., led to the signing of a contract (July 11, 1969) that provided OTS with a base of operation in Guatemala in exchange for a monthly payment of \$100. Ten courses were scheduled for 1969, but the expenditure ceiling imposed by NSF trimmed the final offerings to seven. This ceiling also limited the NSF-funded Ecosystem Comparison study that got off the ground in mid-1968.

By 1970 OTS gave a peak number of nine courses. Operations of as many as five simultaneous field courses required masterful logistic planning by Resident Director Campabadal. Behind the scenes NSF was keeping close tabs on course structure, student body, and finances. Alice Withrow, program officer in the NSF Education Directorate, was a vigorous mother hen who "ruled the roost on the educational funding for OTS" (Spencer 1986). Stringent limitations were placed on the use of NSF funds for supporting foreign students, and Foundation involvement seemed excessive at times. Friction between Withrow and the OTS administration made life difficult, but even so the courses were establishing a reputation of excellence and "Doña Alice" was immortalized in the name of the OTS bus. This was also the time when the impressive collection of course handouts was deemed worthy of editorial synthesis and Charles E. Schnell, graduate student at Harvard University, was retained to assemble "The Book" of biological and environmental data about the OTS study sites in Costa Rica (Schnell 1971). The course programming made use of the Smithsonian Tropical Research Institute facilities in Panama, of Discovery Bay in Jamaica, San Andres Island, Colombia and of Finca El Salto in Guatemala. The moratorium placed on

institutional membership during all of 1969 was lifted, and membership grew to 27. Meanwhile the OTS staff had reached the robust number of seven in NAO and thirteen at the Costa Rican Office (CRO) (Spencer 1970). La Selva, which was acquired in 1968, was provided with funds by the Ecosystem Comparison study for a land survey and establishment of field facilities. Plans were on the drawing board in 1970 for a 20x40 ft. research laboratory, and a new concrete footbridge was completed to the Arboretum. Ground was broken on February 18 for a field station building at Palo Verde, and an agreement was established with Robert G. Wilson at Las Cruces to use the newly constructed Stanley Smith Science Building that was designed to fit OTS needs.

In spite of the obvious strengths of the education programs and the great potential of the comparative ecosystem research program, the OTS horizon was clouded by financial insecurity. The limited income from institutional dues was insufficient to cover the administrative costs, and heavy reliance was placed on indirect cost recovery from the NSF grants. The national forecast called for a reduction in educational training funds from NSF, without an obvious substitute, but at the same time the expanded research programming in which OTS served as the recipient institution for individual investigators promised sufficient funds from indirect costs to maintain the administrative structure. With hindsight we can say now that OTS was skating on thin ice. Virtually all of its funds were coming from a single source, namely NSF, and there was no endowment and little reserve. Furthermore, Spencer's attempt to institute station and vehicle rental fees at break-even levels was rebuffed by many investigators. For the sake of harmony and with the hope of fostering increased usage of the facilities, station rates were reduced to cover only the food costs. The expectation or hope was that the indirect costs from grants would cover the deficits.

The national crisis in Federal support for higher education peaked in the summer of 1971 with the resignation of the chief of the Education Directorate at NSF (Spencer 1971). Eight OTS courses were offered this year, but the projections for 1972 and 1973 looked foreboding. At the peak of course offerings in 1970, slightly in excess of \$400,000 was provided by NSF for the education programs, whereas only \$261,000 was granted for the 1972-1973 period. This ominous sign forced the Executive Committee to rule for a "stretch-out" of the funds and reduce course programs to four in 1972 and two in 1973. The problems of education funding were ameliorated to some extent by the success OTS was having on other fronts. A research laboratory building was added to La Selva, and construction of the Palo Verde field station was far enough along in the summer of 1971 to handle two courses. This same timeframe marks the building of the Comparative Ecosystem study (see section on Research). The infusion of major research funding through

OTS stimulated a tremendous amount of start-up activity, with the College of Forestry under J. S. Bethel's deanship at the University of Washington taking the lead to install baseline forest plots and environmental monitoring equipment. It was at this time also that Kenneth J. Turnbull was identified as the team captain for future research efforts on the Ecosystem Comparison project.

The research theme played an increasingly prominent role during 1971 with the completion of laboratory facilities at Palo Verde and La Selva for the Ecosystem Comparison study, and with the attraction of numerous graduate students and young faculty through the OTS Pilot Research Program funded by NSF and the Ford Foundation. There had been a long-felt need for better communication between the visiting scientists and local community, and by 1971 a critical mass of resident researchers prompted Benjamin H. Waite, the Assistant Director for Academic Affairs, and post-doctoral fellow Paul A. Opler to organize a monthly seminar series at UCR. The emerging prominence of the tropical programs led to an invitation from the International Biological Program (IBP). Howard T. Odum, chairman of the IBP Tropical Biome planning committee, proposed that IBP and OTS co-sponsor an integrated research program directed at tropical forests. The proposal was given serious consideration, but was finally rejected ostensibly because OTS's comparative ecosystem research program encompassed a broad range of interests that were directed to "validation" of models, rather than the creation of a new one "de novo" for the Tropical Biome (Spencer 1971). The high point of OTS's venture into ecosystem research was marked by a formal series of seminars presented to the Board of Directors at their annual meeting in November 1971 at Turrialba.

There were a lot of irons in the fire, but 1972 started out on a downbeat with Spencer's forecast of indirect cost income deficits for fiscal year 1972 and 1973 (Stone 1972a). Any shortfall in grant overhead that funded the OTS administration would deplete institutional funds and decrease program flexibility. Nevertheless, plans were moving ahead on phase III of the Ecosystem Comparison study, and a proposal was developed by Monte B. Lloyd's Research Committee for submission to the Ford Foundation on "A Coordinated Educational Program in Ecology for Latin American Students." There is a bit of *déjà vu* here because they also proposed, as we are doing again in 1986, to organize a course for Costa Rican decision makers that would use the country as a model system in showing the interplay between human demography, agriculture, land use, economic development, politics, and law.

The final steps to acquire Las Cruces were negotiated at this time, and Campabadal and Waite investigated the feasibility of OTS's renting cloud forest property at Monteverde. An undercurrent of friction surfaced between Spencer and the "young Turks" scheduled to coordinate the courses (Emmel

1986), and the Executive Committee was asked to take a stand on the control of course budgets and composition of the faculty. The fact that the Executive Committee came down on the side of the course coordinator was negative enough in itself, but the rift with the Executive Director was widened when the Executive Committee voted in effect to close the NAO: "The maximum possible amount of OTS function presently carried out by the North American office be shifted to San José, Costa Rica, and that those operations which must be carried out in the United States be shifted to a member institution by the end of fiscal year 1972, if possible" (Stone 1972a). This action precipitated the letter of March 27 in which Spencer went public with his side of the story and was followed up, at the request of President Joseph M. Reynolds, with an audit of the NAO records by OTS Secretary-Treasurer Donald E. Stone and Duke University Treasurer Stephen C. Harward. The financial review of April 10 and 11 determined that the current "undivided surplus" of \$29,000 would be reduced to \$10,000 by June 30. Harward and Stone recommended the adoption of a new accounting system that would give better checks and balances and insight into the financial picture. This report was presented at the Executive Committee meeting of May 1 along with S. B. Preston's poll of the member institutions about their reaction to the proposal to disband the North American office (Stone 1972b). The sum total of the actions and remarks by the Executive Committee precipitated J. T. Spencer's resignation.

#### The Turnbull Era, 1972-1976

There was a cloud over OTS when Kenneth J. Turnbull was asked to step in. The organization was solvent, but expectations and demands outstripped financial resources (Stone 1973). The 1972 period was the penultimate year for course support from NSF. The usufruct agreement with R. G. Wilson gave OTS title to Las Cruces along with new responsibilities and headaches. The opportunity to acquire land at Monteverde had to be shelved as did plans for building new quarters on the UCR campus, and B. H. Waite's position of Assistant Director of Academic Affairs was terminated.

The NAO staff was trimmed from eight to two and one-half in the fall of 1972, and in January 1973 the accountant and part-time secretary were moved to smaller quarters in Miami. More responsibilities were heaped on Campabadal and the CRO while Executive Director Turnbull maintained residence in Seattle, Washington and commuted frequently to Miami. Retrenchment created demands for reorganization on all fronts and Turnbull found himself under great pressure from the OTS community to meet expectations that had been developed during the first decade of operation. S. B. Preston's tenure as president during this period was crucial because he knew OTS well from his early association as executive director, and he had gained

the contacts and respect of the OTS constituency. Still, Turnbull was on the hot seat. M. E. Mathias served as the buffer with R. G. Wilson at Las Cruces where expectations were high for the development of the botanical garden because of a three-year matching grant that was in hand from the Stanley Smith Horticultural Trust. La Selva had expanded too in the five years under OTS ownership. Facilities and trails had been improved and usage by researchers and courses had increased substantially. Since communication between the resident researchers and the OTS Board was viewed as a problem, Gary S. Hartshorn, predoctoral candidate at the University of Washington, was designated as Chairman of the Field Research Committee and invited to attend the Executive Committee meetings.

The pared-down graduate education program continued to sparkle as OTS's crown jewel (Pfeifer 1973). Orley R. Taylor helped the cause with a balanced budget as course coordinator of the No. 73-1 Fundamentals course and Mary F. Willson and C. E. Schnell successfully handled the summer program. Various suggestions were proposed to offer OTS-affiliated courses with member institutions taking the lead in the organization and financing. While this outlet might have picked up some of the slack in education, no sustained cooperative programming developed. The Comparative Ecosystem program was also under fire at NSF. The OTS umbrella proposal involving investigators with diverse research projects was judged inappropriate for the Ecosystem Program at NSF, and future proposals would have to be submitted to the General Ecology Program for review on a project-by-project basis.

The first *Ecología de Poblaciones* course, organized by F. Gary Stiles, Douglas C. Robinson, and Sergio Salas, was co-sponsored with UCR in the winter of 1974, and Tropical Parasitology and the Fundamentals course were offered in the summer. A decision, prompted by a persuasive presentation by researcher Gordon W. Frankie, was made by the Executive Committee to increase the buffer around La Selva, and in 1972 a narrow strip (Annex A) was added on the east side; and then again in 1974 some \$22,500 was obligated to acquire 87 ha on the south boundary (Annex B). Construction of a two-story annex to the central station building was undertaken to move some of the long-term researchers out of the dormitory into semi-private quarters and to provide screened laboratory workspace. These activities were visible signs of progress in the programs and facilities in 1974. Even the financial picture seemed to end on a positive note when Treasurer William E. Wright reported that a recent NSF audit gave OTS a "clean bill of health" (Langenheim 1974). Efforts to further streamline the NAO administration resulted in the closing of the Miami office on December 13 and consolidating the records at Seattle with Turnbull and a full-time secretary and accountant.

The year 1975 started on a high note with a planning conference and symposium on The Ecology of Conservation and Development in Central

America and Panama (Chavarría 1976) organized by Charles F. Bennett on behalf of OTS and the Consejo Nacional de Investigaciones Científicas y Tecnológicas (CONICIT), presided over by Rodrigo A. Zeledón. Warnings from NSF about financial accountability had surfaced earlier, but by midyear OTS was asked to present a formal statement of accounting procedures. Price Waterhouse & Co. was retained for this purpose in anticipation of an annual certified audit (Langenheim 1975). The second of three installments fell due on Annex B at La Selva and the annual \$12,000 match of the Stanley Smith Horticultural Trust (SSHT) grant for Las Cruces was straining the system. Further pressures were created when NSF's William E. Sievers of the Research Resources program made a site visit to the three OTS field stations in November 1975, and concluded that only La Selva had sufficient ongoing research to be competitive for future funds. This pronouncement came as a shock to the Executive Committee and led the members to table a motion calling for continuation of the SSHT matching grant. The Board of Directors subsequently voted to reduce expenditures at Las Cruces to the contractual obligations with R. G. Wilson and related minor costs, and left open the option of canceling the SSHT grant if OTS matching funds could not be waived.

The year 1975 ended on a financial downbeat that was not fully appreciated by the Executive Committee until President Savage initiated a series of conference calls in January 1976 and followed these up with a letter to the Board on March 19 (Savage 1976a) and a meeting at the University of California at Los Angeles on March 30 and 31 (Douglas 1976). The bottom line was that OTS had accumulated debts in excess of \$200,000 and a "cash flow" problem was triggered by NSF's unwillingness to release any more funds until the financial difficulties had been solved. As noted above, OTS had been "borrowing from Peter to pay Paul" for some years and the cycle was abruptly halted by NSF action. The fact that expenses exceeded revenue was no doubt exacerbated by OTS's inadequate accounting procedures and the consequent inability to monitor cash flow among the NAO (Seattle), the CRO (San José), and the subcontracts being administered for researchers at: USC, Los Angeles; UC, Berkeley; University of Texas, Austin; Texas A&M University, College Station; University of Michigan, Ann Arbor; and Florida State University, Tallahassee (see section on Research). Warnings to this effect had been raised by NSF as far back as 1974 and were detailed to the OTS administration in a meeting in Washington in May 1975 and a followup report (Ellis 1976). When the Executive Committee became aware of the gravity and protracted nature of the situation, Turnbull was asked for his resignation and a three-person management committee, consisting of President Savage, Vice-President C. F. Bennett and Treasurer J. Knox Jones, assumed interim administrative control and responsibility for developing a reorganization plan.

### The Crisis of 1976

A quick fix for OTS's de facto bankruptcy was not in sight. NSF Grants Officer Gaylord L. Ellis had invited OTS representatives to a meeting on March 15 at which NSF concluded that "it would be necessary for OTS to come up with a formal management plan which would provide assurance of their ability to deal with creditors without the possibility of being forced into bankruptcy and also indicate implementation of procedures demonstrating that the organization is being operated on a sound fiscal and administrative basis" (Kruithoff 1976). The discouraging outcome of this meeting was reported to the Executive Committee in a conference call on March 17, and the stark reality of survival was seriously questioned. Savage and Bennett estimated that a minimum of 20 institutions would have to be willing to accept an annual dues increase from \$2,000 to \$5,000 and the creditors would have to grant OTS time to repay the debts. Failing this, the alternative plan for bankruptcy would have to be activated (Savage 1976b). The prospects seemed slim, but the first thing that had to be done was to re-establish credibility with NSF. At this point I approached Duke Chancellor John O. Blackburn, Treasurer S. C. Harward and Graduate Dean John C. McKinney with the request to provide financial expertise in order to evaluate the crises and to consider having Duke serve as fiscal agent of OTS, if this seemed desirable. Approval of Duke involvement came with the letter of March 19, in which President Terry Sanford told NSF Director Guyford Stever that the University "would be willing to assume leadership in developing a plan to put OTS back on sound financial footing" (Sanford 1976).

The pressure for urgent action continued to mount with the ongoing operation in Costa Rica. Contractual obligations for La Selva land purchases totaling nearly \$14,000 were coming due; the annual Las Cruces obligation of \$3,600 could not be overlooked; and \$20,000 in unpaid bills had accumulated (Campabadal 1976a). Some of the creditors were forestalled by selling off several vehicles in Costa Rica, but even a subsistence level of operation was estimated to cost \$5,000 monthly (Campabadal 1976b). The UCLA meeting of March 30-31 tallied the OTS liabilities at \$215,890 and reviewed a reorganization plan that proposed to establish the president as the chief executive officer and shift the day-to-day operations of OTS to the resident director in Costa Rica. Fiscal management would be controlled by contractual arrangements with a member institution whereby 50% of an administrative manager's salary would be covered. UCLA, USC, and Duke were mentioned as possible fiscal agents. UCLA was ruled out because of the perceived bureaucratic inflexibility of state institutions, leaving USC and Duke to approach NSF about the ground rules for reorganization. The Duke administration took responsibility for setting up a meeting with NSF officials for

April 14. President Savage was accompanied by Clark McCartney, a Grants and Contracts officer from USC, and Duke sent Treasurer S. C. Harward and myself. The NSF administrators indicated that a six-month interim La Selva maintenance grant would be considered if Duke University assumed responsibility as fiscal agent of OTS and if the following conditions were met by the referenced target dates: (1) by April 24, 1976 the President of OTS shall provide NSF with written evidence that the OTS creditors will delay for one year the [request for] payment of OTS debts; (2) by May 1, 1976 Duke University shall submit to NSF a proposal for the operational support of the OTS Costa Rican field station facilities, including a brief statement of Duke's contributions toward the management of the research activities; and (3) by May 14, 1976 OTS shall submit evidence of the willingness of OTS member institutions to increase annual membership dues to \$5,000 per institution (Savage 1976c). Shortly after the meeting I was appointed interim Executive Director and given the challenge of putting OTS back on its feet. With good fortune the conditions were met on schedule, albeit with the loss of Illinois and Texas A&M, and W. E. Siever's Research Resources program at NSF recommended a six-month grant of \$80,000. These funds permitted OTS to stabilize its administration and the La Selva field facility. The road back to financial health was relatively rapid, but painful, because the repayment of debts had to be squeezed from institutional dues and other non-governmental sources of income. This last financial crisis had its good points in re-acquainting member institutions with OTS, but there were some scars left as well. Turnbull in particular resented the fact that his efforts on behalf of OTS were not appreciated (Turnbull 1976). He was particularly bitter about the official NSF records, disclosed through the Freedom of Information Act by Science Trends, that failed to acknowledge the Foundation's lapses in proper financial management which he felt had contributed to the crisis (Anon. 1976).

### The Stone Administration, 1976-

The survival of OTS during the crisis of 1976 and its growth and development over these past ten years are events of great importance, but they are obviously far too close for me to assess objectively. Nevertheless, I will relate my historical tie to OTS and some of the documented facts that provide background for a future exposé.

I first became involved with OTS as a student in the 1965 course in Advanced Botany on tropical monocots. This was during the period when the course participants consisted of graduate students and young faculty who were hoping to gain experience in tropical biology. I was on the staff at Duke University at the time and had already developed field research plans that included Costa Rica. My course exposure was enough to convince me that

the University should become a member of the consortium, and when it joined in 1968 I was appointed to serve as one of the institutional representatives. Active interest in the affairs of the organization led to my election to the Executive Committee in 1969 and continued through 1976. In December of 1975 I volunteered to write an OTS proposal for a newly created NSF program in Research Initiation and Support (RIAS). This experience deepened my understanding of the OTS operation at a very fortuitous time, and ultimately proved to be the funding salvation for the 1976 Fundamentals course. Henry A. Hespenehede of UCLA had agreed before the crisis to serve as coordinator, but OTS obviously was in no position to make any guarantees. Fortunately, Hespenehede was willing to wait until a firm commitment could be made. The favorable eleventh-hour decision by the NSF Science Education Directorate to fund our RIAS proposal (\$240,000/four years) breathed new life into the educational programming and complemented the interim La Selva grant to carry OTS through its bleakest hour.

Reconstructing the financial debacle was a first step in restructuring the OTS administration. S. C. Harward and I reviewed the NAO records in Seattle in late April 1976, and in June the files were trucked to quarters at Duke University in Durham, North Carolina. Picking up the loose ends and figuring out the bases for our financial obligations was like working a Chinese puzzle. Harward personally undertook the task of establishing a double-entry book-keeping system for OTS and reconstructing the financial past, while Beverly L. Stone assumed responsibility for deciphering the files and running the NAO. Since many of the day-to-day operational tasks had been transferred to Costa Rica, a review of finances sent Robert W. Hughes (Duke Sponsored Programs), Stanley D. Gunsher (NSF Cost Analysis), W. E. Sievers (NSF Research Resources) and myself to CRO in early May. As a result of this audit and a subsequent site-visit by Harward, the administration of OTS finances was centralized at NAO, and CRO expenditures were limited to an imprest fund that was replenished out of NAO on the basis of paid invoices. Duke predoctoral candidate Lucinda A. McDade was installed as station manager at La Selva to provide administrative control and direct feedback to NAO. The implementation of tighter financial control and stronger administrative directives gradually took their toll on the CRO, and in January 1978 Jorge R. Campabadal resigned as Resident Director. The international scientific community was both shocked and saddened by Campabadal's departure because he had seen OTS through 11 years of phenomenal growth. He was personally responsible for the on-site development of facilities at La Selva and Palo Verde, and he served as the master logistician to courses and researchers. Campabadal was a friendly bilingual voice of wisdom to nearly a thousand OTS course participants.

The year 1978 got off to a rocky start with Campabadal's resignation but ended on a good note. Secretary Flor M. Torres was elevated to Chief of Operations, and by November OTS had retired its past debts and established financial accountability with an annual certified public audit. The benign neglect of Las Cruces stimulated R. G. Wilson to look elsewhere for maintenance of the botanic garden, and various proposals were put forth to transfer title and management of the property to some responsible local organization. Harvard predoctoral candidate Thomas S. Ray, Jr. became the La Selva station manager and vigorously campaigned with Costa Rican government officials for extending Braulio Carrillo National Park by a corridor to connect with La Selva (Bentley 1978).

From 1979 onward, OTS has continued to build on its strengths of graduate education and research. Much of the credit for OTS successes in Costa Rica during this growth phase goes to Chief of Operations Torres, and by 1980 Station Co-Directors David B. Clark and Deborah A. Clark shared the excitement of new developments at La Selva. When Torres resigned in 1983 to join her husband in Switzerland, Charles E. Schnell was coaxed away from his professorship at the Universidad Nacional to head up the CRO, and more recently to assume responsibility as Resident Director of all OTS operations in Costa Rica.

At the time of this writing, OTS has overcome its administrative shortcomings and moved forward to establish a distinguished record. True to its mission, OTS has provided leadership in education, research, and the wise use of natural resources in the tropics. The next two sections highlight OTS's success that traverses the tenures of ten presidents (Table 2) and seven chief executive officers (Table 3).

## EDUCATION

The success story of OTS to date is based largely on its contribution to graduate education in tropical biology. True to its original purpose of training a cadre of scientists who were knowledgeable about tropical studies (Gomez and Savage 1983), OTS has taught over 1,600 participants since the first course in the summer of 1964. Nearly 100 courses have been offered in more than a dozen fields (Appendix 1), but Tropical Biology: An Ecological Approach, more familiarly known as the Fundamentals course, has been the mainstay that has entertained the greatest audience and has received the widest acclaim. It is in fact the bread-and-butter program that most institutions use to justify membership in the consortium. Interestingly, OTS retains neither resident faculty nor research scientists to maintain the programs. Instead, we have been able to rely on the unparalleled pool of scientific talent from the faculties within and outside the consortium, and to utilize their

talents through release-time arrangements with the home institutions for the short-term visiting faculty or by limited hiring engagements with the full-time coordinators not otherwise salaried.

The Fundamentals course has a truly unique design that evolved from a typical lecture, laboratory, and occasional field-trip experience into a program whereby the field served as the classroom, and lectures on ecological theory and organisms revolved around hands-on experience with a series of tropical ecosystems. The evolution of this intensive, interactive format was favored by the opportunities afforded in Costa Rica to witness firsthand a diversity of tropical habitats, as well as the disgruntlement expressed by the first course participants (Janzen 1986), but the intellectual nudge to actually do so has to be credited in part to visiting faculty such as C. D. Michener (1964) and graduate teaching fellow Stephen P. Hubbell (1965) who articulated the need for taking advantage of the wonderful field opportunities. With this encouragement and the natural history bent and enthusiasm of D. H. Janzen and Norman J. Scott as the principal contributors to the course between 1965 and 1970 (Appendix 1), a workable format was developed that raised the courses to a new level of excitement and excellence.

The course design has in fact remained largely unchanged to the present time. After a few days of orientation lectures in San José, the 20 or so budding scientists, who have been selected by competition from among the world's leading graduate institutions, head to the field for nearly eight weeks of "total immersion." While this schedule sounds like an arena for testing survival of the fittest, proper orchestration by the course coordinators and rotation of visiting scientists with expertise on the sites results in a highly intense, intellectually and physically exhausting training program that invariably produces student reviews stating that "this is the best graduate course ever experienced." No doubt part of the attitude is generated by the esprit de corps that emerges from the group interaction under such trying conditions. Also one has to credit course design. From two to twelve days are spent in four to five contrasting tropical ecosystems selected from a rich assortment of pristine and disturbed sites throughout Costa Rica (Fig. 1 and Janzen 1983). Dawn-to-dusk work ethics combine theory in lectures with research-oriented field problems for both individuals and groups. Writeups, analyses, presentations, and discussions are all part of the intense dialogue. There is no escape for students or instructors alike: habitats, organisms and ideas are everywhere and in an overwhelming abundance and diversity.

The value of an OTS course goes far beyond the immediate gains of a tropical experience, eight graduate credits, and a foot in the door on tropical research. The collegiality developed here often leads to tight personal bonds that have significant professional implications down the line. The highly select student body and faculty of each course come from a wide range of

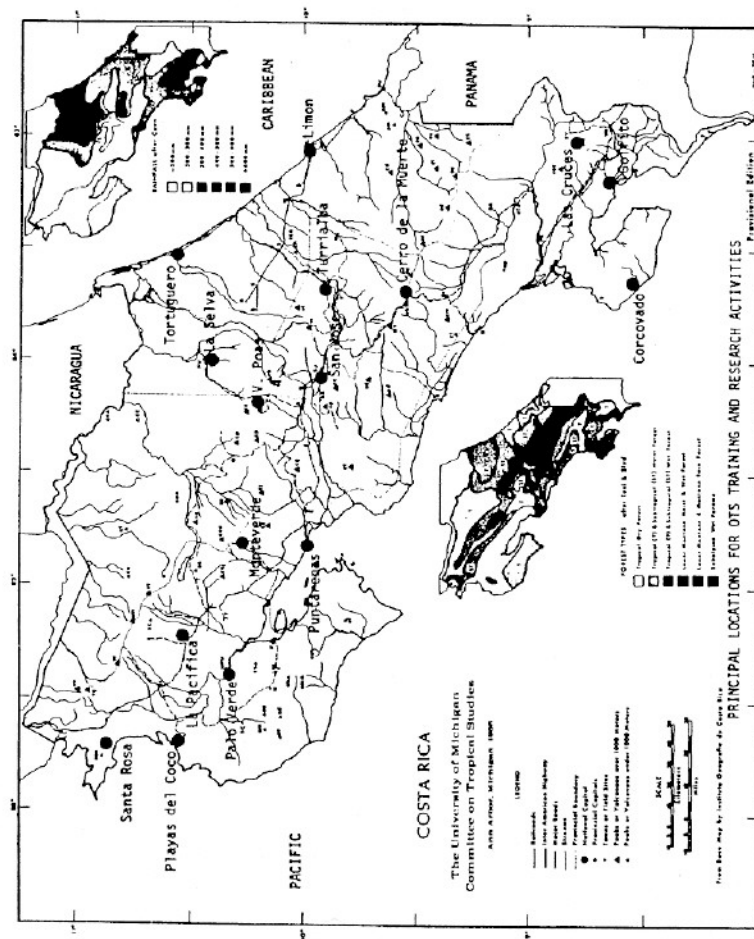


Fig. 1. Organization for Tropical Studies training and research sites.

top-flight institutions, and the opportunity for exchanging ideas and scientific techniques is unparalleled. Furthermore, this interchange between "tomorrow's leaders" constitutes a vast scientific network that has already had a substantial impact on Costa Rica and the United States in raising the level of scientific understanding about tropical biology. OTS alumni and faculty occupy distinguished positions throughout the academic community, and are in key decision-making jobs in governmental agencies as well as many of the advisory and consulting groups that affect government policy. We have every reason to believe that the influence of OTS training programs will continue to grow as new efforts are launched to link the academic knowledge of tropical systems with the decision maker's domain of natural resources.

## RESEARCH

Where education stops and research starts is a moot point. The OTS courses have a strong problem-solving component, and the participants are primed to conduct research as part of their graduate programming. The initial, and in some ways most important, link OTS has forged with research is through the "pilot study" awards to young postdoctoral investigators and graduate students. Between 1967 and 1970 the Ford Foundation and NSF provided \$250,000 to support 91 projects whose diversity exceeded even that of the courses (Appendix 1). When the NSF award ran out in 1969 and the Ford grant in 1970, OTS was without pilot research funding until 1976 when the NSF program in Research Initiation and Support (RIAS) breathed new life into post-course research projects. RIAS support (\$240,000) terminated in 1980, but the slack was picked up by the Jessie Smith Noyes Foundation that has provided block funding (\$442,500 to date) to OTS for competitive research fellowships for graduate students and a small number of postdoctoral scientists. Hundreds of young researchers have thus been afforded the opportunity to bridge the gap between the courses and nascent research programs in the tropics.

Efforts by OTS to establish a formal research program date back to June 1968 when a two-year \$450,000 NSF grant was awarded to conduct "An ecological study of a wet and dry forest ecosystem in Costa Rica." The primary stimulus for this venture came from Dean J. S. Bethel and his colleagues in the College of Forestry at the University of Washington and J. M. Savage, University of Southern California (Baker 1986). With La Selva as the wet forest research center and Palo Verde as the dry forest site (Fig. 1), the overall scientific goals were to inventory the biological and environmental parameters and then conduct a host of multidisciplinary studies that were centered on three research themes—primary productivity, plant reproductive biology, and insect dynamics (Spencer 1970:48-63).

The establishment and inventory of La Selva and Palo Verde was tremendously difficult because of the inaccessibility of the sites and the harsh climatic conditions. This aspect of the program was generally successful in that it laid the foundation for La Selva's preeminence as a biological field station. Boundaries were established and surveys were completed of the geology and soils at La Selva and Palo Verde. Coarse topographic surveys were done for La Selva and a 200-meter grid system was installed by H. Riekerk. Also, three intensive study areas of four hectares each were marked off into 20m x 20m plots wherein all trees were identified and the diameters measured by W. H. Hatheway and G. S. Hartshorn. During late 1970 a weather tower was erected at La Selva and dendrometers were installed on about 50 select trees. An automatic monitoring system was designed by L. J. Fritschen to capture and integrate weather and tree growth data by using battery-operated data-loggers that stored the information on magnetic tape. This pioneering effort to employ sophisticated instrumentation in the tropics was fraught with technical problems and the results were expensive and limited.

The research component of the Comparative Ecosystem study extended over three NSF umbrella grants between 1968 and 1976 and a series of individual awards involving a changing cast of scientific participants. In the first phase J. S. Bethel coordinated the studies on primary productivity with foresters from the University of Washington: biometeorology, L. J. Fritschen; soils, mineral cycling and plant nutrition, D. W. Cole, S. P. Gessel, J. G. McCoil; cell and tree growth, J. S. Bethel, K. J. Turnbull; and plant community interaction, W. H. Hatheway. The studies on plant reproductive biology were shared by H. G. Baker (University of California, Berkeley) and G. W. Frankie (Texas A&M University). The program in the dynamics of insect populations was developed by D. H. Janzen of the University of Chicago and assisted initially by A. M. Young.

Research accomplishments during the first two years of the ecosystem grant were varied and coordination between the research teams met with limited success. At the time of the renewal request, funding through the umbrella proposal was narrowed to the primary productivity group and the plant reproductive biology team. Janzen and several other investigators continued to lend their names in support of the ecosystem umbrella while submitting separate proposals through OTS. In 1970, for example, Janzen was funded by NSF for a study on "Plant-insect interactions," Emmet T. Hooper (University of Michigan) and Theodore H. Fleming (University of Missouri, St. Louis) for "Small mammal faunas of two tropical rain forests," and Monte B. Lloyd (University of Chicago) for "Tropical forest litter community." This independent mechanism for handling grants was continued until 1976 for Janzen's research on the "Effects of herbivory and seed predation on tropical plants" and Donald R. Strong's (Florida State University)

work on "Hispid beetles and their Zingiberales hosts in Tropical America."

The second phase of the Ecosystem Comparison study was begun in 1970. The principal scientists from the first round remained affiliated, but there were some adjustments in personnel. K. J. Turnbull replaced Bethel as the team leader of the primary productivity studies and postdoctoral fellow Paul A. Opler became affiliated with Baker and Frankie on their plant reproductive biology project. This was also the period that Kamaljit S. Bawa, postdoctoral fellow at the University of Washington, received OTS Pilot Research support to work on the "Chromosome number and meiotic behavior" of rainforest and dry forest tree species. Considerable momentum and international interest was generated by OTS's fledgling attempt to engage in ecosystem-level research, but the task of keeping the projects on track proved to be difficult. The umbrella concept was fine in principle in that it gave core administrative and facilities support to field centers used by many. It proved less satisfactory, however, in developing the best possible scientific proposals for inclusion in the umbrella package, and it failed miserably in pulling the subprojects together in any semblance of an integrated ecosystem analysis (Cooper 1970).

Stimulated in part no doubt by the demise of funding for graduate education in the early 1970s, the research arm of NSF provided strong encouragement for OTS to develop sound, productive programs in tropical biology. At the same time it was clear that the research umbrella was unraveling at the fringes. The final phase of the Ecosystem Comparison support was granted in 1973 for a three-year period. Even at this time, however, new research teams were attracted to the fold: Lawrence E. Gilbert (University of Texas, Austin) focused on passion flower vines as the single primary producer for *Heliconius* butterflies; Gordon H. Orians (University of Washington) and G. S. Hartshorn (University of Washington) examined the role of tree-fall gaps in tropical forest dynamics; J. M. Savage (University of Southern California) and Ian R. Straughan (University of Southern California) investigated the community structure of the leaf-litter herpetofauna; and Henry S. Fitch (University of Kansas) launched into a study on the reproductive cycles, population, structure, biomass and food in vertebrate consumers. Even with these sound additions, the crux of the umbrella-proposal problems did not go away. The nagging uncertainty as to the best way to structure a coordinated research effort was still there, but even more damning was the paucity of published research papers by the primary productivity group. At the same time, the plant reproductive biology researchers flourished, particularly in the dry tropical ecosystem, and a long series of symposia contributions and papers have enriched our knowledge about tropical plant biology.

OTS's venture into managing ecosystem level research ceased during the financial crisis of 1976 and was not revived until 1984 (see next section). OTS's encouragement and facilitation of independent research in Costa Rica

and at OTS field stations in particular has been relatively unaffected over the years by the many trials and tribulations detailed above. Hundreds if not thousands of researchers have been assisted by OTS, and the scientific literature, some of which can be found cited in *Costa Rican Natural History* (Janzen 1983), is rich in acknowledgements to the many OTS staff who helped make the research possible.

#### OTS TODAY

OTS draws from the strength of its present membership of 40 institutions: 34 of which are U.S. universities, and the balance includes the Smithsonian Institution, the University of Puerto Rico, and four institutions from Costa Rica (Table 4). Each institution currently pays \$5,500 in annual dues (FY 87) and appoints two members to the Board of Directors. The board elects a 12-person Executive Committee (Table 5) and this group in turn hires and fires the Executive Director. The North American headquarters (NAO) has been located at Duke University in Durham, North Carolina since the last financial crisis in 1976. From here a seven-person staff initiates the planning, coordinates the programming, keeps the audited fiscal records, and handles the fund-raising for our various activities. Costa Rica is the logistic and operational base, and it was selected as such in the early 1960s because the country is small, about the size of West Virginia, exceedingly rich in habitats and biota, politically stable as a democratic republic and most supportive of the goals that OTS espouses (Hubbell 1967).

Costa Rica proved to be a wise choice on all counts, and particularly in regards to local support. The strength of our Costa Rican relations has grown over the years into a healthy, working relationship that operates at many levels. Our library, for example, invites use by local students writing reports on tropical biology, and the OTS courses in both English and Spanish have touched the lives of virtually all field biologists in Costa Rica. We are privileged to have the three graduate degree-granting institutions (ITCR, UCR, UNA) and the Museo Nacional as OTS members, and we enjoy their collegiality in education and research. José Andrés Masís, Director of the Planning Office of the Council of University Rectors (CONARE), currently serves on the Executive Committee of OTS as Vice President for Costa Rican Affairs and Chairman of the Costa Rican Institutions Committee (CRIC). Previously, this important position had been held by Rodrigo Gaméz, Director, Cellular and Molecular Biology Research Center, UCR; Rodrigo A. Zeledón, former course coordinator of 1964-2, longtime President of CONICIT and current Minister of Science and Technology; and Manuel M. Murillo, alumnus of the 1964-1 course and Director of the Center for Marine Sciences at UCR. These outstanding individuals have brought great insight and wisdom to the OTS



TABLE 4. OTS MEMBER INSTITUTIONS 1986-1987

University of Arizona	University of Michigan
Auburn University	Michigan State University
University of California (System)	University of Minnesota
University of California, Los Angeles	National Museum of Costa Rica
University of Chicago	Universidad Nacional Autónoma
City University of New York	University of North Carolina (System)
University of Connecticut	Pennsylvania State University
Cornell University	University of Puerto Rico
University of Costa Rica	Rutgers University
Duke University	Smithsonian Institution
University of Florida	Stanford University
University of Georgia	State University of New York,
Harvard University	Stony Brook
University of Hawaii	Instituto Tecnológico de Costa Rica
Indiana University	Texas A&M University
University of Iowa	Tulane University
University of Kansas	University of Utah
Louisiana State University	University of Washington
University of Maryland	Washington University
University of Miami	University of Wisconsin, Madison
	Yale University

in Costa Rica, and they are representative of the many friendships and working relationships OTS has established over the years.

The Costa Rican office (CRO) located in San José houses the Resident Director and a staff of twenty or so who worry about the logistics and operations of three field stations, the numerous training courses and scientific tour groups (Smith 1978), the hundreds of individual researchers and tourists who visit each year, and the far-reaching scientific and political issues that impinge on OTS's programs and well-being in Costa Rica. At times the San José office behaves like a spastic nerve center when simultaneous demands are placed on its limited resources. The 32-passenger bus and four-wheel drive vehicle fleet often have to be supplemented by outside rentals to carry the load, and the course field equipment and library reference books can only be divided so many ways before the office personnel and course instructors become frazzled. Mind you, all of this local logistic work is done under the constraints of another culture and at another pace. The fact that the office is outfitted with a copy machine and microcomputers with telecommunication capabilities does not speed up the purchase of nails or payment of bills.

The training and research activities of OTS are conducted at various sites throughout Costa Rica (Fig. 1), on both public and private land such as the

TABLE 5. OTS EXECUTIVE COMMITTEE 1986-1987

President	Peter H. Raven, Missouri Botanical Garden
VP Education	Barbara L. Bentley, SUNY, Stony Brook
VP Finance	Harold J. Michaelson, Smithsonian Institution
VP Development	Jay M. Savage, University of Miami
VP C.R. Coordination	José Andrés Masís, Council of Costa Rican University Rectors
Secretary	Richard K. Koehn, SUNY, Stony Brook
Treasurer	Richard A. White, Duke University
Members-at-Large	John J. Ewel, University of Florida Rodrigo Gámez, University of Costa Rica Gordon H. Orians, University of Washington G. Bruce Williamson, Louisiana St. University
Recent Past President	Thomas M. Yuill, University of Wisconsin, Madison

cloud forest reserve at Monteverde, the agricultural research center at Turrialba (CATIE), and many of the magnificent parks, but OTS's principal responsibility is to the management of field stations at Las Cruces, Palo Verde and La Selva. OTS got into the field station business before the park system was in place and at a time when only limited accommodations were available near the preferred study sites. Horror stories can still be heard about early course groups with Montezuma's revenge sharing a single stopped-up toilet in the town's best and only hotel. In 1968 OTS took steps to acquire La Selva, situated in the Atlantic lowlands of the Sarapiquí district; in 1969 a lease arrangement was worked out for a Pacific lowland dry forest site in Guanacaste Province, and the Palo Verde station was built at the base of limestone hills; and finally in 1983 an agreement was made to acquire Las Cruces Botanical Garden and Field Station in the coastal mountains of southern Costa Rica (Anon. 1972). Each of these field sites has contributed uniquely to the OTS programs, but for reasons discussed below, only La Selva Biological Station has come close to developing its potential as a world-class site for training and research (see also Clark 1988).

Why La Selva and not Palo Verde or Las Cruces? There are several contributing factors such as accessibility and inherent station management difficulties, but the bottom line is that research use of La Selva was sufficiently high

to maintain NSF's interest in providing continued funding for a tropical research site. La Selva is a truly biologically rich rainforest site, and one that should need no great deal of promotion. The fact of the matter is, however, that La Selva and OTS have been good for each other. In the early 1970s when NSF training funds for U.S. graduate students were phased out, OTS was able to lean more heavily on the development of La Selva as a center for tropical research. This move of course had positive repercussions in providing a site for graduate education, as well as carrying part of the burden for the OTS administration. At the same time La Selva benefitted from the intense but gentle research exploitation. The La Selva station and its environs became known as a tropical training center and as a site with great potential for research. The research usage has increased dramatically and in phase with the improvement of facilities: electric linepower was made available in 1978; a microwave telephone was added in 1979; a cable suspension foot bridge in 1982; large, central air-conditioned laboratories in 1983; and the list does not stop here. As research facilities improved more visitors were attracted, and this pressure in turn led to the need for better accommodations, a situation that has been addressed in 1986 by the completion of two new dormitories and a 72-person dining facility.

Facilities in themselves do not make great institutions, and the real credit to OTS has to be in its accomplishments in graduate training, research, conservation, and public service. While courses have ranged from forestry (Helms 1971) to pteridology (Mickel 1967), Tropical Biology: An Ecological Approach has continued to appeal to the broadest constituency. I should note here that a two-month OTS course for twenty students is not cheap; current direct costs are in the \$50,000-65,000 range and this doesn't even include transportation for getting the students to Costa Rica! Fortunately the Andrew W. Mellon Foundation has been our course benefactor since the NSF/RIAS support phased out in 1980. In 1986 OTS offered four courses: two in Tropical Biology, Jan-Mar. and June-Aug., Tropical AgroEcology, and Ecología de Poblaciones. Future programming will continue to seek ways to incorporate fundamental biological information into courses that have relevance to our host countries in the tropics.

For some years, OTS had no provision beyond courses to aid young researchers getting started in the tropics (see Research); they were on their own once the course was over. Starting in 1980 OTS received generous funding from the Jessie Smith Noyes Foundation to support three levels of tropical research fellowships: post-course mini-research projects with awards up to \$750; predoctoral pilot research projects in the \$500 to \$2,000 range; and both pre- and postdoctoral research projects that occasionally range over \$10,000. Although OTS restricts these competitive fellowships to field research within Costa Rica, the important point is that young researchers

have a way into the national competitive scene where research proposal success is tied closely to prior experience and preliminary data sets. Research generated by OTS alumni and their academic progeny far transcends our current sphere of influence. Both the OTS programs in Costa Rica and those of the Smithsonian Tropical Research Institute in Panama have had tremendous impact on tropical research productivity, as measured by a survey of the literature and presentations at national meetings (Clark 1985).

To a large extent OTS's role in tropical research has been to provide the training, opportunity, and facilities. About eight years ago it became evident that a center such as La Selva could not be passive like a hotel and wholly dependent on the researchers who happened to drop by. To develop the full research potential of the site and provide some control over the usage and research direction, four research areas were identified that are particularly suited to La Selva and the potential clientele (LSAC 1978): systematic biology; evolutionary biology; physiological plant ecology; and ecosystem level studies. With this research framework in place, we were then able to assess to what extent the past research activities had utilized La Selva and, more importantly, what would be required in order to exploit fully the research potential of the site. About the same time, during the late 1970s, a National Research Council committee chaired by Peter H. Raven was preparing a document on Research Priorities in Tropical Biology (NRC 1980). Among other things, the distinguished panel of biologists recommended that ecosystem level research be concentrated at four sites in the world—one in Asia, one in South America, one in Mexico, and the La Selva Biological Station in Costa Rica. Of these, La Selva was the only site where NSF has had a long record of financial support.

The pump was primed by the publication of *Research Priorities* in 1980 to move forward in a major way in the development of new research programming at La Selva. Electricity and telecommunications were in, but most important was the establishment of full-time professional management when David B. and Deborah A. Clark were hired in 1980 as Station Co-Directors. They have been on site these past seven years to oversee the dramatic development of research facilities at La Selva and to stimulate research through intellectual leadership. Beyond the literally thousands of individual research projects on all aspects of plant and animal ecology, La Selva now supports experimental and ecosystem level research in several key areas, such as the role of Bushmasters as top predators; the physiological ecology of gap and understory tree species; the dynamics of tree-fall gaps (Gaps project); the nutrient availability in tropical soils as affected by man and nature (Plots project); and the demography and seedling dynamics of canopy trees (Trees project) (see Clark et al. 1987).

The first three programs of OTS that I have outlined—namely courses, fellowships, and research—constitute the core of our operation and the fabric that holds the consortium together, but I would be remiss not to recognize newly found directions that have evolved as a result of our efforts to interface with the real world. I am thinking here of two areas: conservation efforts related to Braulio Carrillo National Park, and public service projects that range from environmental education to contracts with the U.S. National Aeronautic and Space Administration (NASA). Our conservation efforts to date have been focused on La Selva and its environs for obvious reasons. One of the world's most prized tropical training and research sites was ever-so-securely being isolated by the colonization and resultant clearing of the Atlantic slope of Costa Rica by settlers looking for homesteads and by the large-scale loggers interested in profit. There was the virtual certainty of reducing La Selva to a small patch of forest surrounded by a sea of pasture. The whittling away of lush tropical rainforest reached a head in 1980 when a neighbor on the west flank threatened to log to the boundary of the 730-ha acre reserve. This challenge precipitated OTS's campaign to buy the adjacent 631 ha in 1981, and heightened our realization that immediate steps had to be taken to protect the vast Sarapiquí wilderness. While OTS is not a conservation organization per se, our interest in tropical training and research cannot overlook the need for suitable sites and the role they play in addressing natural resource issues.

Beyond the vested interest that OTS has in all tropical sites with potential for pursuing our broad-ranging programs, we have come to realize that obligations and opportunities exist to use our expertise in serving the welfare of mankind. Science for sustainable development is the catch-all for some of our newer projects. Included here is our work with NASA where they are trying to correlate data taken by satellites and airplanes with ground-truthing information provided by OTS on species composition and biomass along predetermined flight paths. Another example is the agreement with the Forestry Support Program of the U.S. Department of Agriculture to write a manual on agroforestry in Spanish that can be used to train Latin American technicians (OTS/CATIE 1986). Over the years OTS has sponsored or co-sponsored several scientific symposia, the most recent being in March 1985 on The Population Biology and Physiological Ecology of Mesoamerican Forests (Clark et al. 1987). OTS was intimately involved with the publication of the award-winning book *Costa Rican Natural History*, edited by D. H. Janzen (1983), and we have assumed responsibility for the Spanish translation. Perhaps the most important public service of OTS has yet to be realized. This responsibility has to do with efforts launched in 1984 in the field of environmental education. Our experience at La Selva in acquiring the neighbor's property in 1981, and the subsequent hassle with trespassers who

claimed historical right of passage, made us sensitive to the fact that land ownership is only as secure as local acceptance. To carry this idea a step further, a reserve or national park has a very limited half-life unless the local community has a vested interest in wanting and caring for it. For this reason OTS has initiated a variety of programs to reach the school children, teachers and parents in the Sarapiquí community adjacent to La Selva Biological Station and the Zona Protectora 'La Selva.' There can be no better investment for the long-term acceptance of Braulio Carrillo National Park.

The future may be limited by resources, but not by ideas and aspirations. Great opportunities are seen for course programs in agroecology and natural resources that involve greater participation of Latin American students. Exciting prospects also exist for tailoring some of the tropical programs for governmental decision makers who lack the basic ecological knowledge pertinent to passing judgement on key environmental issues. As the research at La Selva expands to encompass a greater diversity of approaches, we can expect this site to be in the vanguard of those seeking integration of the knowledge of population processes into a theory of how ecosystems work (Ehrlich 1986).

One might rightfully ask if the administrative foibles documented in the historical profile have prevented OTS from achieving its professed goals of providing leadership in education and research, and the wise use of natural resources in the tropics. I judge not, based on the following criteria. Foremost, no doubt, are the 1600 alumni and hundreds of OTS faculty who constitute the core of the New World expertise in tropical biology. The influence of the OTS programming is felt throughout the private and public sector. OTSers are omnipresent from consulting firms, to universities, to government offices. OTS-sponsored research, research facilitated by OTS, and research stimulated by OTS courses and programming is leaving a legacy of scientific reports as building blocks for human inquiry into the nature and functioning of tropical ecosystems. The very presence and activity of OTS has captured the scientific and public attention and has made us all very aware of the wonders and the fragility of the ecosystem we call Earth. In recognition of the role of OTS in "advancing the understanding and protection of threatened tropical ecosystems," the Tyler Prize Committee named OTS as co-recipient of the 1985 John and Alice Tyler Ecology-Energy Prize, and presented OTS President Peter H. Raven with a gold medallion and a \$75,000 check. I should note that \$50,000 of this prize was turned over to the Nature Conservancy for preserving the Zona Protectora. One would have to conclude that OTS has been successful in spite of itself because of the purity of its cause and the dedicated commitment of some truly outstanding individuals.

## ACKNOWLEDGMENTS

First, it is appropriate to note that I have had privileged access to the historical files associated with the North American Office of OTS. Beyond this primary source, useful critiques and comments have been provided by Beverly L. Stone and Lucinda A. McDade of NAO, Charles E. Schnell of CRO, and long-time associates of OTS who have served variously as students, course coordinators, faculty, Board of Directors and administrators: Herbert G. Baker, Thomas C. Emmel, Gordon W. Frankie, Daniel H. Janzen, Mildred E. Mathias, Stephen B. Preston, Reed C. Rollins, Jay M. Savage, and Jack T. Spencer. I am particularly appreciative of their comments and personal insights that helped me identify historical highlights. Choice of the facts to be emphasized and judgment about their meaning are, of course, mine.

## LITERATURE CITED

- Anonymous. 1959. Committee on a proposed Center for Tropical Studies. Preliminary draft, second part. University of Michigan, Ann Arbor.
- Anonymous. 1962. Proposal for the establishment of a Center for Tropical Studies. University of Michigan, Ann Arbor.
- Anonymous. 1965a. The Organization for Tropical Studies. Research News, Office of Research Administration. University of Michigan, Ann Arbor 15:1-4.
- Anonymous. 1965b. Inter-institutional contract between the Organization for Tropical Studies, Inc. (OTS) and the Tropical Science Center (TSC).
- Anonymous. 1972. Field stations of the Organization for Tropical Studies in Costa Rica. OTS, printed.
- Anonymous. 1976. Tropical Studies Center. Science Trends 36(13).
- Argersinger, W. J. 1967. Minutes of the OTS Board of Directors, San José, Costa Rica, November 10-11, 1967.
- Baker, H. G. 1986. Letter of May 11, 1986 to Donald E. Stone.
- Bentley, B. L. 1978. Minutes of the OTS Executive Committee, San José, Costa Rica, November 8-9, 1978.
- Bethel, J. S. 1965. Letter of September 15, 1965 to Reed C. Rollins.
- Bethel, J. S. 1966. Memo of June 7, 1966 to the OTS Executive Committee.
- Campabadal, J. R. 1976a. Letter of March 19, 1976 to Jay M. Savage.
- Campabadal, J. R. 1976b. Letter of March 22, 1976 to Jay M. Savage.
- Chavarría, M., ed. 1976. Simposio internacional sobre la ecología de la conservación y del desarrollo en el istmo Centroamericano. Rev. Biol. Trop. 24 (Suppl. 1):1-209.
- Clark, D. A., R. Dirzo, and N. Fetcher, eds. 1987. Ecología y ecofisiología de plantas en los bosques mesoamericanos. Rev. Biol. Trop. 35 (Suppl. 1):1-234.
- Clark, D. B. 1985. Ecological field studies in the tropics: Geographical origin of reports. Bull. Ecol. Soc. Amer. 66:6-9.
- Clark, D. B. 1988. The search for solutions: Research and education at the La Selva Biological Station and their relation to ecodevelopment. Pages 209-224 in F. Almeda and C. M. Pringle, eds. Tropical Rainforests: Diversity and Conservation. Mem. Calif. Acad. Sci. No. 12. California Academy of Sciences and Pacific Division, American Association for the Advancement of Science, San Francisco, Calif.
- Cooper, C. F. 1970. Letter of July 9, 1970 to J. T. Spencer.
- Douglas, C. 1976. Minutes of the OTS Executive Committee, Los Angeles, California, March 30-31, 1976.
- Ehrlich, P. 1986. Ecological understanding is not free. Amicus J. 7:6-8.
- Ellis, G. L. 1976. Letter of April 12, 1976 to Jay M. Savage.
- Emmel, T. C. 1986. Letter of May 1, 1986 to Donald E. Stone.
- Gómez, L. D. and J. M. Savage. 1983. Searchers on that rich coast: Costa Rican field biology, 1400-1980. Pages 1-11 in D. H. Janzen, ed. Costa Rican Natural History. University of Chicago Press, Chicago, Ill.
- Harmon, M. J. 1970. The Organization for Tropical Studies: Its history and activities in Central America. Term paper submitted to C. Stanifer, University of Kansas.
- Hartweg, N. E. 1963a. Summary of Coral Gables meeting of institutional representatives, January 31-February 2, 1963.
- Hartweg, N. E. 1963b. Letter of April 8, 1963 to W. Henry Leigh.
- Hatheway, W. H. 1964. Letter of December 7, 1964 to Reed C. Rollins.
- Hatheway, W. H. 1965a. Letter of February 26, 1965 to Reed C. Rollins.
- Hatheway, W. H. 1965b. Letter of May 21, 1965 to W. Henry Leigh.
- Helms, J. A. 1971. Education and research in tropical forestry. J. Forestry 69:414-417.
- Hodge, W. H., and D. D. Keck. 1962. Biological research centres in Tropical America. Pages 107-120 in J. W. Purseglove, ed. The Neotropical Botany Conference. Bull. Assoc. Trop. Biol. 1.
- Hubbell, S. P. 1965. Suggestions for improvements in the handling of the basic OTS course. Memo of March 24, 1965 sent to D. H. Janzen.
- Hubbell, T. H. 1965a. Recent developments in OTS affairs. Report of Sept. 6, 1965 to the Michigan Committee on Tropical Studies.
- Hubbell, T. H. 1965b. Minutes of the Third Annual Meeting of the Board of Directors, Universidad de Costa Rica, November 12, 1965.
- Hubbell, T. H. 1966. Memo of May 25, 1966 to the Executive Committee: Proposed actions to strengthen and improve the organization.
- Hubbell, T. H. 1967. The Organization for Tropical Studies. BioScience 17: 236-240.
- Janzen, D. H. 1965. Letter of January 26, 1965 to Charles D. Michener.
- Janzen, D. H., ed. 1983. Costa Rican Natural History. University of Chicago Press, Chicago, Ill.
- Janzen, D. H. 1986. Letter of May 15, 1986 to Donald E. Stone.
- Kruithoff, I. S. 1976. Memorandum to the NSF file: Meeting with

- representatives of the Organization for Tropical Studies (OTS), March 15, 1976.
- La Selva Advisory Committee (LSAC). 1978. Meeting of June 23, 1978. Reported in NSF Grant DEB 80-24887.
- Langenheim, J. H. 1974. Minutes of the OTS Board of Directors, San José, Costa Rica, November 8-9, 1974.
- Langenheim, J. H. 1975. Minutes of the OTS Board of Directors, Turrialba, Costa Rica, November 14-15, 1975.
- Maguire, B. 1966. Report of the President—Presidential year 1964-1965. *Bull. Assoc. Trop. Biol.* 5:3-11.
- Marts, M. E. 1969. Minutes of the OTS Board of Directors and the Advisory Council, Universidad de Costa Rica, November 14-15, 1969.
- Marts, M. E. 1970. Minutes of the OTS Board of Directors and the Advisory Council, Smithsonian Institution, November 13-14, 1970.
- Mathias, M. E. 1986. Letter of May 7, 1986 to Donald E. Stone.
- Michener, C. D. 1964. Letter of October 13, 1964 to Reed C. Rollins.
- Michener, C. D. 1965. Letter of February 12, 1965 to Reed C. Rollins.
- Mickel, J. T. 1967. An advanced course in pteridophyte biology in Costa Rica. *Amer. Fern J.* 57:145-161.
- National Research Council (NRC). 1960. Conference on tropical botany, Fairchild Tropical Garden, May 5-7. Publ. 822, National Academy Press, Washington, D.C.
- National Research Council (NRC). 1980. Research priorities in tropical biology. National Academy Press, Washington, D.C.
- Organización para Estudios Tropicales/Centro Agronómico Tropical de Investigación y Enseñanza (OTS/CATIE). 1986. *Sistemas Agroforestales Principios y Aplicaciones en los Tropicos*. OTS, San José, Costa Rica.
- Pfeifer, H. W. 1973. Minutes of OTS Executive Committee, San José, Costa Rica, June 21-22, 1973.
- Preston, S. B. 1965. Confidential report of May 17, 1965 to Reed C. Rollins: Problem areas in OTS operation.
- Purseglove, J. W., ed. 1962. The Neotropical Botany Conference. *Bull. Assoc. Trop. Biol.* 1:1-120.
- Purseglove, J. W. 1964. The Association for Tropical Biology, Inc. *Bull. Assoc. Trop. Biol.* 2:1-7.
- Rollins, R. C. 1964a. Letter of December 11, 1964 to William H. Hatheway.
- Rollins, R. C. 1964b. Letter of December 22, 1964 to William H. Hatheway.
- Rollins, R. C. 1986. Letter of May 10, 1986 to Donald E. Stone.
- Salazar, J. M. 1964. Letter of March 16, 1964 to John L. DeAbate.
- Sanford, T. 1976. Letter of March 19, 1976 to Guyford Stever.
- Savage, J. M. 1961. Final report on Advanced Biology Institute, Universidad de Costa Rica, July and August, 1961.
- Savage, J. M. 1962. Final report on the Conference on Problems in Education and Research in Tropical Biology, Universidad de Costa Rica, April 23-27, 1962.
- Savage, J. M. 1963a. Final report on Advanced Science Seminar, Universidad

- de Costa Rica, June, July, August, 1962-1963.
- Savage, J. M. 1963b. Minutes of the Board of Directors Meeting, University of Miami, June 25-26, 1963.
- Savage, J. M. 1963c. Minutes of the First Annual Meeting of the Board of Directors, Universidad de Costa Rica, November 8-11, 1963.
- Savage, J. M. 1963d. Memorandum of January 7, 1963 to Leslie A. Chambers.
- Savage, J. M. 1964a. Final report on Advanced Science Seminar and Associated Activities in Education in Tropical Biology, June-August, 1964.
- Savage, J. M. 1964b. Letter of May 29, 1964 to Reed C. Rollins.
- Savage, J. M. 1964c. Minutes of the Second Annual Meeting of the Board of Directors, Universidad de Costa Rica, Nov. 13, 1964.
- Savage, J. M. 1964d. Letter of February 25, 1964 to Fellow Director.
- Savage, J. M. 1965. Minutes of the Executive Committee meeting, March 21, 1965, San Francisco, California.
- Savage, J. M. 1976a. Memo of March 19, 1976 to Chief Executive Officer, OTS member institutions: Members, OTS Board of Directors.
- Savage, J. M. 1976b. Memo of April 5, 1976 to Chief Executive Officer, OTS member institutions; Members, OTS Board of Directors.
- Savage, J. M. 1976c. Memo of April 19, 1976 to the Chief Executive Officer, OTS member institutions; Members, OTS Board of Directors.
- Schnell, C. E., ed. 1971. Handbook for Tropical Biology in Costa Rica. OTS, mimeographed.
- Smith, C. M. 1978. The impact of OTS on the ecology of Costa Rica. *Texas J. Sci.* 30:283-289.
- Spencer, J. T., ed. 1969. Annual report of the Organization for Tropical Studies, Inc., 1969. Vol. 1. Educational and research activities.
- Spencer, J. T., ed. 1970. Annual report of the Organization for Tropical Studies, Inc., 1970.
- Spencer, J. T., ed. 1971. Annual report of the Organization for Tropical Studies, Inc., 1971.
- Spencer, J. T. 1986. Letter of May 7, 1986 to Donald E. Stone.
- Stone, D. E. 1972a. Minutes of the OTS Executive Committee, San José, Costa Rica, March 12, 13, 1972.
- Stone, D. E. 1972b. Minutes of the OTS Executive Committee, Miami, Florida. May 1, 1972.
- Stone, D. E. 1973. Minutes of the OTS Board of Directors, Turrialba, Costa Rica, January 12-13, 1973.
- Teas, H. J. 1969. Minutes of the OTS Board of Directors and the Advisory Council, University of Miami, November 8-9, 1968.
- Turnbull, K. J. 1976. Memo of March 31, 1976 to the OTS Board of Directors.
- Woodman, J. 1965. Letter of March 16, 1965 to Norman J. Scott.

\*All unpublished memos, letters, and reports are bound in volumes referenced to this paper and deposited in Archives, Perkins Library at Duke University and are on reserve at the NAO.

## APPENDIX 1. OTS COURSES, 1964-1987

Year	Number and Title	Coordinator
1964	1 Tropical Biology: An Ecological Approach	J. L. Vial, Univ. Costa Rica
	2 Research Participation	R. A. Zeledón, Univ. Costa Rica
	3 Biology & Evolution of Tropical Plants	R. Ferreyra, Univ. San Marcos de Peru
1965	1 Tropical Biology: An Ecological Approach	L. R. Holdridge, Tropical Sci. Ctr.
	2 Tropical Forest Ecology	P. W. Richards, Univ. North Wales
	3 Tropical Biology: An Ecological Approach	D. H. Janzen, Univ. of Kansas
	4 Advanced Botany (Monocotyledons)	P. B. Tomlinson, Fairchild Tropical Garden
	5 Biology of Tropical Insects	J. Idrobo, Univ. Nac. Colombia C. W. Rettenmeyer, Kansas St. Univ.
1966	1 Biology of Tropical Vertebrates	E. T. Hooper, Univ. Michigan
	2 Biology of Tropical Epiphytes	C. H. Dodson, Univ. Miami
	3 Tropical Biology: An Ecological Approach	N. J. Scott, Univ. Costa Rica
	4 Biology of Tropical Grasses	C. Calderón, Smithsonian Instit. R. W. Pohl, Iowa State Univ.
	5 Tropical Biology: An Ecological Approach	L. L. Wolf, Syracuse Univ.
	6 Tropical Biology: An Ecological Approach	G. S. Daniels, UCLA
1967	1 Advanced Zoology (Insect Ecology)	D. H. Janzen, Univ. Kansas
	2 Tropical Biology: An Ecological Approach	R. J. A. Goodland, McGill Univ.
	3 Geography	R. N. Pearson, Univ. Michigan
	4 Advanced Botany (Pteridophytes)	J. T. Mickel, Iowa State Univ.
	5 Tropical Biology: An Ecological Approach	T. C. Emmel, Stanford Univ.
	6 Tropical Biology: An Ecological Approach	M. E. Mathias, UCLA R. L. Rudd, Univ. Calif. Davis
1968	1 Tropical Biology: An Ecological Approach	N. J. Scott, Univ. So. Calif.
	2 Problems in Tropical Forestry	T. C. Emmel, Univ. Texas
	3 Crop Plants in a Tropical Environment	T. Waggener, Univ. Washington C. O. Hesse, Univ. Calif. Davis V. W. Carlisle, Univ. Florida
	4 Reproductive Biology in Tropical Plant Ecology	H. G. Baker, Univ. Calif., Berkeley
	5 Tropical Biology: An Ecological Approach	N. J. Scott, Univ. Connecticut
	6 Tropical Biology: An Ecological Approach	T. C. Emmel, Univ. Florida
	7 Land & Life in the Tropics	J. J. Parsons, Univ. Calif. Berkeley
	8 Field Dendrology	J. S. Bethel, Univ. Washington
1969	1 Tropical Biology: An Ecological Approach	N. J. Scott, Univ. Connecticut
	2 Principles of Tropical Grassland Ecology	D. E. McCloud, Univ. Florida
	3 Introduction of Tropical Forestry	F. D. Johnson, Univ. Idaho
	4 Tropical Biology: An Ecological Approach	N. J. Scott, Univ. Connecticut
	5 Tropical Biology: An Ecological Approach	R. J. Goodland, McGill Univ.
	6 Advanced Population Biology	D. H. Janzen, Univ. Chicago G. H. Orians, Univ. Washington
	7 Tropical Marine Biology	G. J. Bakus, Natl. Acad. Sciences P. W. Frank, Univ. Oregon

## APPENDIX 1 (Continued)

1970	1 Tropical Biology: An Ecological Approach	N. J. Scott, Univ. Connecticut
	2 Tropical Limnology	D. G. Frey, Indiana Univ. E. S. Deevey, Dalhousie Univ.
	4 Regional & Economic Geography of Guatemala	S. B. Bonis, Inst. Geogr. Nac. Guatemala
	5 Field Course in the Geography of Costa Rica	C. L. Johannessen, Univ. Oregon
	6 Tropical Forestry	H. Riekerk, Univ. Washington
	7 Tropical Biology: An Ecological Approach	N. J. Scott, Univ. Connecticut
	8 Tropical Biology: An Ecological Approach	M. E. Mathias, UCLA T. E. Moore, Univ. Michigan
	9 Atmospheric Sciences	J. F. Griffiths, Texas A&M Univ.
	10 Tropical Marine Biology	G. J. Bakus, Natl. Acad. Sciences
	1971	1 Tropical Biology: An Ecological Approach
2 Habitat Exploitation & Diversity: An Ecological Approach w/Vertebrates		R. W. McDiarmid, Univ. So. Florida
3 Tropical Forestry		H. Riekerk, Univ. Washington
4 Recent Carbonate Sedimentation and Early Diagenetic Process		C. H. Moore, Louisiana State Univ.
5 Tropical Biology: An Ecological Approach		J. H. Vandermeer, Univ. Michigan
6 Tropical Biology: An Ecological Approach		E. G. Farnworth, Univ. Florida
7 Physical Landscape & Settlement Patterns		O. H. Horst, Western Michigan Univ.
8 Atmospheric Energy Considerations in a Tropical Environment	J. F. Griffiths, Texas A&M Univ.	
1972	1 Tropical Biology: An Ecological Approach	O. R. Taylor, Univ. Kansas
	2 Advanced Biology: Central American Pine Forests, Temperate "Islands" in a "Sea" of Tropical Vegetation	G. H. Orians, Univ. Washington
	3 Tropical Biology: An Ecological Approach	D. E. Gill, Univ. Maryland
	4 Geography: Man's Impact on Tropical Forest Ecosystems in Costa Rica, Past & Present	R. C. West, Louisiana State Univ.
1973	1 Tropical Biology: An Ecological Approach	O. R. Taylor, Univ. Kansas
	2 Tropical Biology: An Ecological Approach	M. F. Willson, Univ. Illinois C. E. Schnell, Johns Hopkins Univ.
1974	1 Tropical Biology: An Ecological Approach	C. R. Carroll, SUNY, Stony Brook
	2 Ecología de Poblaciones	F. G. Stiles, D. C. Robinson, and S. Salas, Univ. Costa Rica
	3 Tropical Biology: An Ecological Approach	D. E. Wilson, U. S. Fish & Wildlife
	4 Coral Reef Ecology	C. H. Moore, Louisiana State Univ.
1975	1 Ecología de Poblaciones	F. G. Stiles, Univ. Costa Rica
	2 Tropical Biology: An Ecological Approach	J. J. Ewel, Univ. Florida
	3 Tropical Parasitology	D. Pence, Texas Tech Univ.
1976	1 Ecología de Poblaciones	D. C. Robinson, Univ. Costa Rica
	2 Tropical Biology: An Ecological Approach	H. A. Hespenheide, UCLA

## APPENDIX 1 (Continued)

- 1977 2 Ecología Marina M. M. Murillo, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach D. R. Strong, Florida State Univ.  
 4 Tropical Biology: An Ecological Approach E. W. Stiles, Rutgers Univ.
- 1978 1 Tropical Biology: An Ecological Approach G. S. Hartshorn, Tropical Sci. Ctr.  
 2 Ecología de Aracnidos C. E. Valerio, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach D. P. Janos, Smithsonian Tropical Research Institute
- 1979 1 Tropical Biology: An Ecological Approach B. L. Bentley, SUNY, Stony Brook  
 2 Ecología de Poblaciones F. G. Stiles, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach D. E. Gill, Univ. Maryland
- 1980 1 Tropical Biology: An Ecological Approach R. J. Stout, Michigan State Univ.  
 2 Ecología de Poblaciones W. R. Soto, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach L. A. Real, No. Carolina State Univ.  
 J. Lanza, Bethany College
- 1981 1 Tropical Biology: An Ecological Approach M. V. Price & N. M. Waser, Univ. Calif., Riverside  
 J. C. Schultz, Dartmouth College  
 2 Ecología de Poblaciones W. R. Soto, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach G. W. Otis, Univ. Guelph
- 1982 1 Tropical Biology: An Ecological Approach G. B. Williamson, Univ. Miami  
 3 Tropical Biology: An Ecological Approach J. M. Wunderle, Jr., Univ. Puerto Rico, Cayey
- 1983 1 Tropical Biology: An Ecological Approach C. M. Simon, Univ. Hawaii  
 R. J. Stout, Michigan State Univ.  
 3 Tropical Biology: An Ecological Approach R. G. Zahary, CSU, Los Angeles
- 1984 1 Tropical Biology: An Ecological Approach D. J. Futuyma, SUNY, Stony Brook  
 3 Tropical Biology: An Ecological Approach W. A. Haber, Univ. Calif., Berkeley
- 1985 1 Tropical Biology: An Ecological Approach J. S. Denslow, New York Botanical Garden  
 2 Ecología de Poblaciones F. G. Stiles, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach R. J. Marquis, Univ. Illinois  
 4 Tropical Agricultural Ecology S. R. Gliessman, Univ. California, Santa Cruz
- 1986 1 Tropical Biology: An Ecological Approach F. E. Putz, Univ. Florida  
 2 Ecología de Poblaciones F. G. Stiles, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach C. K. Augspurger, Univ. Illinois  
 4 Tropical AgroEcology M. E. Swisher, Univ. Florida

## APPENDIX 1 (Continued)

- 1987 1 Tropical Ecology: An Ecological Approach R. J. Stout, Michigan State Univ.  
 C. R. Carroll, Univ. Calif. Nat. Reserves  
 2 Ecología de Poblaciones F. G. Stiles, Univ. Costa Rica  
 3 Tropical Biology: An Ecological Approach H. E. Braker, Univ. Calif., Riverside  
 D. H. Feener, Smithsonian Tropical Research Institute  
 E. W. Schupp, Univ. Iowa  
 4 Tropical Agricultural Ecology D. H. Boucher, Univ. Québec, Montréal  
 C. Staver, Cornell Univ.  
 5 Agroforestry G. S. Hartshorn, Tropical Science Center  
 R. F. Fisher, Utah State Univ.