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THE ORGANIZATION FOR TROPICAL STUDIES

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The tropics are the last great frontier for human occupancy left on earth. Under the pressure of expanding populations they are everywhere being invaded and altered with fantastic rapidity. Just as our own ancestors saw the wilderness as an enemy to be conquered and tamed, so do the pioneers now settling the tropical regions. They know and care nothing about what they are destroying, what balances they upset, or what the future consequences of their actions may be.

For science, also, the tropics constitute a frontier and a challenge. The tropical biotas and ecosystems that are succumbing so rapidly to man's attack are enormously complex, of great scientific interest, and very poorly understood.

It is therefore urgent, for two reasons, that intensive, multidisciplinary studies of the tropical environments be undertaken while there is still time—first, for the advancement of science, and second, to provide a basis for the intelligent use and conservation of the resources of the tropics. Research on tropical ecology is at least as important for humanity as are studies of the oceans, and overwhelmingly more so than the exploration of space. To it should be devoted the same kind of large scale, coordinated effort that is now being expended or organized for space science and oceanography, on which are focused the efforts of many institutions, agencies, and individual scientists. The Organization for Tropical Studies has been established to promote such an endeavor.

Our ignorance of the tropics

The tropical zone includes more than one-quarter of the land area of the earth, besides vast expanses of ocear and sea. It is fundamentally distinguished from the other zones by its high and relatively uniform input of solar energy. However, the tropics are not all hot, of course, and many hot regions are not tropical. In this zone the variety of terrestrial environments is very great, ranging from hot lowlands to cool plateaus and snow-clad mountain peaks, from swamp and rain forest to savanna and desert. This diversity in habitat is reflected in the multiplicity and variety of tropical plants and animals. Probably four-fifths of all existing species live in the tropics.

The most salient feature of the tropi-

cal zone is its high total energy budget caused by the abundance of sunshine. Related to this, in ways not well understood, are the following characteristics of its terrestrial environments: (1) high species diversity; (2) greater total biomass per unit of area than in other regions; (3) multiplicity of biological niches or ways of making a living; (4) multiplicity of pathways for energy flow within the biological community; and (5) maximum frequency of adaptations for mutualistic relations between species and, among animals, for concealment, protective coloration, and mimicry. All these characteristics of tropical ecosystems are most pronounced in the hot, humid lowland terrestrial environments, making those environments especially important for ecological and evolutionary studies. The phenomena listed involve no special principles unique to tropical biology, but they are all somehow causally related to tropical conditions. Together they account for the most striking characteristic of tropical biotas — the high degree of community organization that is achieved whenever the water budget is sufficiently ample and stable to sustain massive photosynthesis throughout the year.

Although tropical biotic communities include the most highly organized, most complex, and most interesting of all biological systems, we know very little about their composition and how they work. If a complete systematic inventory were to be made of a piece of tropical lowland wet forest, for example, it would be no surprise to find that at least half the species composing it are undescribed. And if we do not even know its species composition in detail, how much greater must be our ignorance of the interplay among its species, of the structure and dynamics of the community which they make up, of the flow of energy and materials within that community, and of the factors which maintain its stability and lead to recovery after disturbance. Even the physical aspects of tropical environments — soils, microclimates, water relations, etc. — are poorly understood as compared with those of temperate regions. Scientific exploration of the tropics has only just begun.

The vanishing tropical wilderness

For most of us "northerners" the word "tropics" calls up visions of endless forests, dim, high-canopied and liana-hung, of dense jungles and impenetrable swamps, of palm-fringed strands, and of vast savannas with stalking lions and herds of countless grazing animals. In them man scarcely appears. These images, subconsciously retained from tales of exploration and adventure read in youth, color our thinking about the tropics even when we know better.

The reality is very different. No one who has not himself seen what is happening to the tropical regions can have any adequate appreciation of how rapidly they are being occupied and how drastically they are being altered. The forests, jungles, swamps, and savannas are still there, but not for long. In many regions they are already reduced to remnants, and most of the still remaining natural environments will be gone in a generation or two. Dr. Harrison Brown recently estimated that by the year 2000 world population will probably be 7½ billions, of whom some 6 billions will be living in the presently underdeveloped nations, nearly all of which are in the tropics.

Man's spread into the tropical regions is inevitable and accelerating. The forests are going to be cleared, the swamps drained, the grazing herds killed off, and great numbers of plant and animal species eliminated. The invasion of new territory is precipitous. Accommodation to man's use is by axe, fire, and bulldozer, with no long-term planning, no thought of consequences, and no inkling of the desirability of maintaining sound and enduring ecological relationships with the land. One need only read Archie Carr's "Ulendo" to get an idea of what is happening in Africa, and in tropical America every year sees greater inroads made on the forests. The pressure for new agricultural land is irresistible, and the tropical wilderness is everywhere doomed.

What must be done

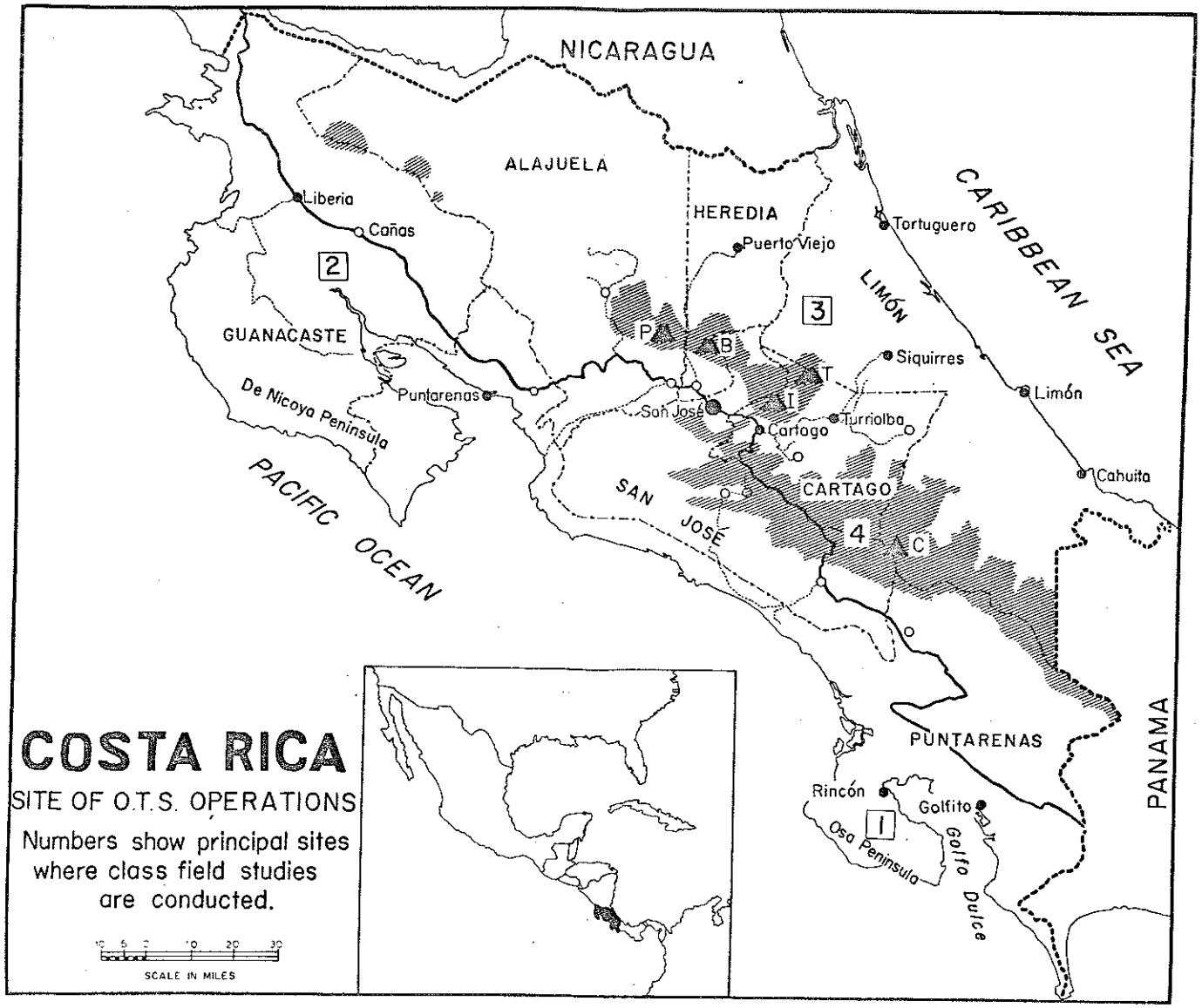
It is essential that research on tropical problems be greatly expanded and intensified, and without delay. We must learn all we can about the elaborate and complex natural tropical ecosystems while there is still time, and that time is short. Besides the importance of such knowledge for science, which will be great, it will be indispensable as a basis for rational planning for the productive long-term use of tropical lands. The present generation of scientists is responsible and morally obligated to see to it that the necessary studies are made.

Who is to do the work? Most of the world's scientists live in the temperate zones, where the great centers of education and research are located. Relatively few of them have had tropical experience and even fewer are now studying tropical problems. We must encourage biologists and other scientists now working in the temperate zones to extend their interests into the tropics, but this alone will not suffice. Much more scientific manpower will be needed, and this will have to be created by exposing young scientists to tropical environments in the formative stages of their careers and interesting them in the study of tropical phenomena. This means that training programs must be established in the tropics and that competent scientists experienced in various aspects of tropical research must be called upon to participate in them.

The Organization for Tropical Studies

Recognizing the urgent need for mobilization of forces for an attack on tropical problems, in 1962 nine North American universities and the University of Costa Rica joined in setting up the Organization for Tropical Studies (OTS). With later additions, it now includes 16 universities—California (all campuses), Connecticut, Costa Rica, Florida, Georgia, Harvard, Hawaii, Indiana, Kansas, Louisiana State, Miami, Michigan, Southern California, Texas A & M, Texas Tech, and Washington—and the Smithsonian Institution. The Organization is a nonprofit corporation of the State of Florida, with its central administrative office at the University of Michigan, its business office at the University of Miami, and an operating center at the University of Costa Rica. Each member institution has two representatives on its Advisory Council. The affairs of the Organization are managed by a 17-man Board of Directors, the members of which are elected for 3-year terms by the Advisory Council. The Board elects the officers and an executive committee composed of the officers, the immediate past president, and two other members.

For 1967 the officers are James S. Bethel, president (Washington), Stephen H. Spurr, vice-president (Michigan), William J. Argersinger, Jr., secretary



Costa Rica, showing the mountainous regions (shaded), the Caribbean and Pacific slopes and coastal plains, the two peninsulas, and the course of the Inter-American Highway (heavy line). From the Cordillera Central rise four great intermittently active volcanos that reach heights of 7,800 to 11,000 feet: Poas (P), Barba (B), Turrialba (T) and Irazú (I), the last of which erupted in 1962-63. Much of the crest of the Cordillera de Salamanca lies above 10,000 feet, with its highest point, Cerro Chiripó (C) attaining an elevation of about 12,400 feet.

The numbers indicate the areas most often used by OTS field classes: (1) the Osa Peninsula, with one of the finest examples of wet lowland tropical forest, and Golfo Dulce, with mangrove-bordered shores; (2) Guanacaste, relatively dry, with semideciduous forest and grazing land; (3) Guapiles, with wet lowland forest of different type than that on the Osa Peninsula; and (4) Cerro de la Muerte, with montane forests on the slopes and with páramo-like environments on the crests and peaks of the Cordillera de Talamanca.

(Kansas), and W. Henry Leigh, treasurer (Miami). Besides these men, the executive committee includes Reed C. Rollins, past president (Harvard), Herbert G. Baker (U.C., Berkeley) and Grover E. Murray (Texas Tech). Other members of the Board in 1967 are John De Abate (Costa Rica), Archie F. Carr (Florida), Roland Coulson (Louisiana State), Wayne C. Hall (Texas A & M), Mildred E. Mathias (UCLA), Charles D. Michener (Kansas), Hugh Popenoe (Florida), Jay Savage (Southern California), Howard J. Teas (Georgia), and Edward O. Wilson (Harvard).

Responsibility for operations rests upon the Executive Director, appointed by the Board. He is Stephen B. Preston, a member of the faculty of the School of Natural Resources of the University of Michigan. An Associate Director is being sought to share in handling the administration, and an Assistant to the Director has now been employed to supervise field operations in Costa Rica.

Purpose and scope of OTS

OTS is not a conservation organization. It is not dedicated to advising on how man can best succeed in the tropics. It was established to promote the study of science in the tropics, to conduct organized programs of graduate training and research on tropical problems, and to serve as a national and international agency for coordinating and facilitating the work of individuals and groups in the tropics. Its intent is to serve the entire scientific community, not merely the interests of its member institutions. Its central purpose is to acquire and disseminate a broad understanding of tropical environments by means of a sound program of basic research and teaching which is not

oblivious to the spread of human populations in the tropics or to man's complex relations to tropical environments. This program is focused primarily on three areas of study: (1) the composition and functional organization of tropical biotic communities, (2) changes in these through time, and (3) man's relations with the tropical environments.

To achieve these objectives fully, OTS would have to foster or conduct research and educational programs in many subject areas and in many tropical regions. In its present stage of development it could not possibly function on so ambitious a scale. Beginning modestly, in its first years the Organization restricted its subject matter to biology and its field of operations to Costa Rica. Now it is ready to enlarge its scope by expanding its teaching program to other areas of science, by increasing its research activities, and by extending its operations into other parts of the American tropics. Perhaps in the future it may be able to reach out into more distant parts of the tropical zone.

The OTS educational program

Because the training of more investigators was seen as the most urgent need and the essential first step toward its objectives, the Organization began by concentrating on its educational program. Graduate level courses in tropical biology were established, all stressing ecology and all conducted almost wholly in the field. Up to now, all courses have been given in Costa Rica, a country chosen primarily for its suitability for work in biology. It has extremely diverse environments easily accessible for class study within a short range of the center at the University of Costa Rica, located at San José. Since 1963 two 8-week sessions have been held each year, one in February and March (the dry season), the other in July and August (the season of heavy rains). Three courses have usually been offered in each session, one introductory and two advanced.

The introductory course deals with the principles of ecology as they operate in the tropics. Its core is a series of class exercises involving both plants and animals, each focused on some particular question concerning the interrelations and adaptations of organisms in tropical communities. Each student also selects an individual problem of limited scope, which he studies under the guidance of one of the instructors. The course is usually restricted to 20 students, but in 1966 the summer session was given as two sections of 17 students each. The course, or each of its sections, has two full-time professors aided by several visiting professors each of whom spends 2 weeks working with the students in the field.

The two advanced courses offered in each session are limited to 10 students; one stresses botany, the other zoology. The topics change each session and cover various aspects of tropical biotas and ecology. The courses given thus far have included forest ecology, insects, monocotyledons, epiphytes, vertebrates, and grasses, with emphasis on ecology, behavior, and evolution. Students work on joint projects and investigate restricted problems of their choice. Each of these courses has at least one full-time professor and two or more visiting scientists who stay with the course for not less than 2 weeks.

In all these courses students and professors are in the field together for about 7 of the 8 weeks of the session. The time is spent in from three to five contrasting lowland and highland environments, and the field observations and experiments are accompanied by many staff lectures given in the situations being studied. The Organization does not have a permanent teaching staff and sees no need for one. The instructors are selected from institutions throughout the Americas on the basis of competence, desire to participate, and the ability to teach an interesting and demanding course under sometimes difficult field conditions. OTS has been fortunate in attracting distinguished scientists to its teaching staff, and some former graduate students who took the courses have returned in the role of instructors.

The teaching program is being expanded into other fields than biology as rapidly as possible. In the summer of 1967 a course in tropical geography entitled "Tropical Lands and Their Utilization: the Costa Rican Example" will be given for the first time. Other new courses are being planned in tropical forestry, human ecology in the tropics, and tropical marine biology. Offerings in limnology, geology, meteorology, anthropology, archeology, and other subjects are contemplated. Not all these courses will be taught in Costa Rica; choice of site will be determined by suitability of the region, availability of the required facilities, relative costs, and other considerations. At present OTS has no field stations of its own, but uses rented or donated space for its classes at haciendas, in small towns, or at field laboratories owned by governmental or private agencies. Negotiations are under way for the use of facilities at sites in Guatemala and Honduras in addition to those available in Costa Rica. Marine biology courses will be given at some tropical marine laboratory. In the event that the Organization must provide its own field quarters in some environments, such installations will be kept simple and inexpensive.

Financial support for the educational program comes from several sources. Member universities have assigned off-campus duty to professors to teach OTS courses and have paid travel and subsistence costs to enable some of them to observe course operation or to plan new courses. The universities have also supplied secretarial help and have furnished field vehicles, microscopes and other equipment, and library materials on a gift, loan, or rental basis. By far the greater part of the cost of the program, however, has been covered by generous grants from the National Science Foundation. These grants have been used for faculty and administrative salaries, travel and subsistence of faculty and students, and purchase of supplies and some permanent equipment.

Limitations on the amount and permissible uses of NSF funds have hitherto prevented the Organization from accepting as many Latin-American students as would be desirable. In the summer of 1967, however, with support from AID-ROCAP, a Spanish-language section of the introductory course will be added, in which will be enrolled members of the faculties of the associated Central American universities (CASUCA) and some Spanish-speaking students from the United States. It is hoped that further enlargement of the Spanish-language program, both in coverage of fields and in availability to Latin-American students and investigators, will be made possible by grants from appropriate sources.

The OTS research program

The conduct and facilitation of research on tropical problems is as inte-

gral a part of the Organization's aims as is instruction. Because of the initial concentration on teaching the research program is not yet far advanced, but now that the educational program is well under way, research is being given increased attention. There are three ways in which OTS proposes to aid or sponsor research:

1) *Facilitation.* By giving access to OTS facilities and by furnishing advice and logistic help, the Organization can aid individual investigators or research groups whose projects, funded from other sources, will contribute to or are at least compatible with its objectives. Some projects have already been furthered in this way.

2) *Direct Support.* OTS has received funds from the Ford Foundation which will in part be used to support pilot projects or research undertakings of limited scope. Preference would be given to projects that would furnish information useful in the teaching program or that would contribute to more comprehensive studies sponsored by OTS. One main objective would be to provide experience and training in tropical research to promising young scientists of this and other countries.

3) *Major OTS Projects.* The Organization itself may select and sponsor a limited number of major, long-term research projects that will require for their accomplishment the cooperative efforts of specialists in several disciplines. OTS would establish the objectives of each such study, make the general plans, recruit the personnel necessary to do the work, and coordinate the various activities. Under the umbrella of the overall project, it would sponsor group or individual proposals to funding agencies for support of the whole or of segments of the research, would if desired administer the funds, and would serve as general coordinator and reviewer and provide the necessary continuity.

Several such projects are now being considered, and a few have reached the planning stage. One of these is an analytic comparison of the composition and dynamics of contrasting types of lowland forest ecosystems in Costa Rica. This investigation will necessarily take several years to complete and will have to be carried out by specialists representing a number of fields of study. A proposal covering the initial stages of this project is being submitted to the National Science Foundation. Other proposals to NSF and other agencies will follow.

OTS obviously can claim no proprietary rights over tropical studies. Some of its member universities have research programs under way in the tropics that were begun long before the Organization was conceived. The Smithsonian Institution, likewise a member, has its own program in tropical biology, and is itself doing much to coordinate the research of other agencies in this field. The objectives of OTS and of the International Biological Program are largely coincident so far as the tropics are concerned, and a large proportion of the studies that OTS might sponsor would also be appropriate for inclusion in the IBP. The policy of OTS is to cooperate in every feasible way with all agencies and undertakings the object of which is to increase knowledge of tropical ecology.

Help wanted

The purpose of this article is to make known to biologists generally the existence of the Organization for Tropical Studies and the opportunities it affords to students and investigators for work in the tropics. These opportunities are *not* reserved for the faculties and graduate students of member institutions; they are open to all qualified applicants. OTS is continually looking for persons qualified to teach in its field courses, and will welcome inquiries about possibilities. Anyone accepted is given an opportunity to familiarize himself with the course and the environments in which it will be taught before taking a class into the field.

Graduate students of any university who would like to gain tropical experience and are not afraid of hard work are encouraged to apply for admission to OTS courses. Selection of applicants is on a competitive basis. Round trip transportation and subsistence are furnished.

Investigators who would like to use OTS facilities in connection with their own projects, or who would like to participate in an OTS-sponsored project, are also invited to inquire about the possibilities.

Communications should be addressed to Dr. Stephen B. Preston, Executive Director, Organization for Tropical Studies, School of Natural Resources, The University of Michigan, Ann Arbor, Michigan.

The future of OTS

The universities that founded the Organization for Tropical Studies neither expected nor have received any benefits that have not been available to students and investigators of other institutions. Their justification for creating OTS lies in the accessions to knowledge expected from it, the increased breadth which its courses give to their own educational programs, and the service it can perform for all humanity. In the long run the universities have only three important assets to contribute to it: intellectual and organizational leadership, teachers and investigators, and students. The member institutions cannot heavily underwrite its costs.

The Organization should be viewed as an instrumentality for doing a task that is of vital importance, both in the national interest and for the future of all mankind. How well this country will fare in the future depends on how well the rest of the world fares. From this standpoint, and considering its breadth of scope, its multi-institutional and multidisciplinary character, and the importance and urgency of its mission, the Organization can be viewed as comparable with some of the national laboratories that are supported wholly by federal funds. Although it does not have this status, it confidently anticipates continuing support from both public and private sources.

The Organization for Tropical Studies, although very young, has already attracted widespread interest. Its potentialities for the promotion of science and human welfare are very great. Its program of graduate education for tropical research is unique, highly successful, and expanding. Its research program, now being initiated, will be successful in proportion to (1) the degree of acceptance of OTS by the scientific community as a principal agency for the conduct of research in the tropics, (2) the extent to which biologists and other scientists participate in its work, and (3) the amount of financial backing it is able to attract. The Organization hopes and believes that it will receive adequate support in all three of these areas and that it will in consequence be able to achieve the balance of activities necessary for the accomplishments of its objectives.