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Smithsonian Tropical Research Institute Fact Sheet

The Smithsonian Tropical Research Institute (STRI) is the world's premier research institute for basic science in the tropics, dedicated to increasing our understanding of the past, present and future of life in the tropics, and its relevance to human welfare. Research at STRI is conducted by an international staff of 40 scientists, and approximately 500 visiting scientists and students each year. STRI concentrates on basic research, principally in tropical forests and coral reefs, and its research addresses the relationships of organisms to their environment (ecology), and how organisms, communities, and species came to be in the forms we find them today (evolution). STRI maintains modern research facilities at its headquarters in the Republic of Panama, with a comprehensive library on tropical sciences; a network of research stations in the American tropics and Kenya that are protected under international treaties and are equipped for sophisticated studies; a 96-foot research vessel; and two construction-crane canopy access systems.

Scientific Research

The principal areas of STRI research are:

• ***Tropical Diversity and Its Origins***

Tropical biodiversity is at first bewildering due to the astronomical number of species. Recent intense sampling of insects in forest canopies, for example, suggests that the number of insect species is staggeringly large, perhaps reaching 10 million or more. Scientists do not know the names of most of these species, let alone their biology; yet these little-known organisms may harbor potential as biocontrol agents for pests of crop plants, or sources of new medicines and other compounds. Panama has one of the world's best-known tropical floras, which is now being screened for biomedical compounds.

• ***Marine Ecology and Evolution***

The Isthmus of Panama is an ideal setting for studying processes that generate biodiversity, because it is a barrier that isolated Atlantic from Pacific marine populations when it was formed about 3 million years ago. STRI studies how marine organisms become genetically different with time and how they become reproductively isolated via behavioral and molecular mechanisms. Understanding the processes that contribute to the differentiation of organisms is one of the great challenges of modern biology, and STRI's Molecular Biology program is involved in this effort. Using genetic information STRI is reconstructing "genealogical" trees for different organisms to understand patterns of change over long periods of time, and over the short-term how organisms respond to local environmental conditions.

• ***Ecology and Physiology of Tropical Forests***

Studies of forest ecology are the focus of STRI's Center for Tropical Forest Science (CTFS). CTFS now coordinates research in 14 nations, involving almost 6,000 tree species and 3 million individual trees, providing a global analysis that is fundamental to understanding forest dynamics, timber management and reforestation. The plant physiology program reveals the myriad ways that plants respond to environmental stresses, including changes in light and water levels. Growing concern over greenhouse gases and global warming has driven a major effort to understand how plants respond to elevated concentrations of carbon dioxide, including the first large-scale study of multiple tree species in the tropics. Tropical forest canopies are among the least-explored habitats on Earth because of their inaccessibility. STRI pioneered the use of

construction tower cranes to explore this environment, and they are now used around the world to explore this frontier. Together with Brazil's National Institute for Amazonian Research, STRI cooperatively administers the Biological Dynamics of Forest Fragments Project in the Amazon, the world's largest and longest-running study of habitat fragmentation.

• ***Ecological Interactions Among and Within Species***

How can so many species live together in a tropical forest? Just as competition within a human economy favors a division of labor, creating interdependence, so competition in nature likewise creates interdependence by favoring diversification and specialization. STRI focuses primarily on the two extremes of inter-relationships: pathogens and mutualists. For example, some ants are farmers that collect plants as compost, which is used to cultivate fungi as food. As with human agricultural systems, the ants' food crop is attacked by weeds and pests. In response, the ants have domesticated actinomycete bacteria—a major source of antibiotics for humans—that may help maintain a hygienic garden, an example of how basic research may have unforeseen applications, for new medicines or to control agricultural pests.

• ***Behavior and Adaptive Evolution***

Animal behavior is among the most fascinating aspects of tropical diversity, embracing the activities by which individuals are socialized, select mates, and modify their environments. Successful conservation efforts depend on understanding animal behavior—on how far the pollen of a rare orchid is carried by a bee, or how seeds are dispersed by mammals. STRI research has brought about a radical transformation in how we think about sex, because even this consummately cooperative activity involves a diverse array of behaviors by which mates attempt to manipulate one another. Reproductive incompatibility that might lead to the formation of new species can be brought about by infection with a bacterium that scientists have shown to be widespread among tropical insects. Research has revealed novel uses of language by which bees inform their comrades about the location of food, which enables them to dominate the local community.

• ***Archaeology, Anthropology and Human Ecology of Tropical Forest Societies***

Human populations play a crucial role in shaping tropical forest environments, and their manipulations vary with their social organization and technical expertise. The accumulated knowledge of tropical forest peoples allowed them to flourish in tropical environments, yet their knowledge and environments are rapidly disappearing. By studying the history and development of regional economies and social formation, STRI researchers identify the conditions that lead either to the depletion of local resources, or to their more sustainable use. Archaeological research shows the fundamental importance of innovations such as agriculture and ceramic technology developed by prehistoric tropical societies, and how and why these revolutionary advancements took place.

• ***Paleoecology***

STRI paleoecologists study the biological consequences of the closing of the Panamanian Isthmus over the last 11 million years, using rich marine fossil beds to provide high-resolution historical reconstructions. More recently, STRI has developed a century-long record of coral growth rates, showing that coral growth has been declining due to increasing turbidity of the water from increasing sediment of the runoff from the coast, itself a result of massive deforestation. STRI terrestrial paleoecologists focus on the climatic and vegetational history of lowland tropical forest from more than 200,000 to 500 years ago, including the profound environmental effects of prehistoric agriculture. Scientists have developed novel methods to precisely "read" the records of plant micro-fossils lodged in ancient lakes and deep-sea sediments, helping them to learn how ecosystems have responded to changes in climate and land use by humans. These long-term records may help us model potential ecosystem collapse due to future climatic disturbances, and the restoration of ecosystems following activities that promote sustainable development.

Publications

STRI research is reported in more than 250 scientific journal articles per year, including many in

the journals *Science* and *Nature*, as well as in numerous books and edited volumes.

Education, Outreach and Public Programs

A competitive fellowship program provides training opportunities to students world-wide, and STRI offers advanced graduate studies with affiliated institutions. A bilingual public education program interprets STRI research for the public, and also promotes conservation through lectures, a series of supplementary textbooks for science curricula in U.S. grade schools, and hands-on learning at Marine and Terrestrial Exhibition Centers. STRI research is frequently the focus of public television nature programs.