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Ethnopharmacological Studies and Biological Conservation in Belize

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In the last few decades, the discipline of ethnobotany has undergone great evolution in its methodology and focus, as well as its application. Traditionally, ethnobotanical studies were carried out by systematic botanists, whose goal was to produce lists of useful plants of a particular tribe or region. Most of these studies were presented in encyclopedic form. Ethnobotanical inventory is still very important, because such a small fraction of the total information that exists on the utility of plants has been cataloged. In the last few decades, however, the interdisciplinary approach has become more important in ethnobotanical research, involving the close collaboration of botanists, pharmacologists, anthropologists, chemists, nutritionists, economists, conservationists, policymakers, ecologists, and those in many other fields.

One result of this new approach has been the application of ethnobotany to public policy questions, for example, in the areas of health and ecosystem conservation. Ethnopharmacological studies initiated by Dr. Paul Alan Cox and colleagues in Samoa have resulted in the conservation of significant areas of endangered Samoan rain forest. Ethnobotanical studies in Madagascar, coordinated by Dr. Nat Quansah, take place in forest reserves and seek to establish a sustainable dynamic between the people's use of the area and the biological integrity of the protected ecosystems. This paper will discuss our current efforts in Belize, Central America, involving both ethnobotanical inventory and tropical forest conservation.

The Belize Ethnobotany Project

The Belize Ethnobotany Project (BEP) was initiated in 1988, as a collaborative endeavor between the Ix Chel Tropical Research Foundation and the Belize Center

for Environmental Studies, both Belizean nongovernmental organizations, and the Institute of Economic Botany of The New York Botanical Garden. The main goal of the project has been to conduct an inventory of the ethnobotanical diversity of Belize, a country with significant tracts of intact forest. The project has made dozens of expeditions to various locales and has collected some 3,660 plant specimens as of early 1994. The specimens have been deposited at the Belize College of Agriculture and Forestry Department Herbaria, as well The New York Botanical Garden and U.S. National Herbarium. A data base has been established at The New York Botanical Garden with planned distribution to several computer facilities within Belize. The BEP involves gathering of traditional knowledge provided by more than two dozen colleagues who are traditional healers of Mopan, Yucatec, Kekchi Maya, Ladino, Garifuna, Creole, East Indian, and Mennonite decent.

Through a contract with the U.S. National Cancer Institute (NCI), the project has provided some 2,600 bulk plant samples to the NCI for screening in their human cancer and HIV Developmental Therapeutics Program (DTP). Samples, each weighing approximately 500 grams, have been collected and dried at low heat and shipped to the NCI's testing facilities in Frederick, Maryland. While NCI scientists have expressed interest in some of the species collected to date, more nearly comprehensive studies have not identified a particular plant with a novel compound for advanced development in the DTP. In the future, however, as more and more of the species are put through the two HIV screens and forty human cancer screens, we expect that greater interest in some of the species will be shown.

Valuation Studies

A great deal of attention has been given recently to the value of nontimber forest products in the tropical forest. One method of ascertaining this value is to inventory a clearly defined area and estimate the economic value of the species found there. Peters, Gentry, and Mendelsohn (1989) were the first to elucidate the commercial value of nontimber forest products found within a hectare of forest in the Peruvian Amazon. This study did not include medicinal plants in their inventory, and at the suggestion of the authors, this aspect was evaluated in Belize. From two separate plots, a thirty- and fifty-year-old forest respectively, a total biomass of 308.6 and 1,433.6 kilograms (dry weight) of medicines whose value could be judged by local market forces was collected. Local herbal pharmacists and healers purchase and process medicinal plants from herb gatherers and small farmers at an average price of U.S. $2.80/kilogram. Multiplying the quantity of medicine found per hectare above by this price suggests that harvesting the medicinal plants from a hectare would yield the collector between $864 and $4,014 of gross revenue. Subtracting the costs required to harvest, process, and ship the plants, the net revenue from clearing a hectare was calculated to be $564 and $3,054 on each of the two plots. Details of the study can be found in the original article (Balick and Mendelsohn 1992). The lists of plants and their uses are presented in tables 24.1 and 24.2.

TABLE 24.1 *Medicinal Plants Harvested from a Thirty-Year-Old Valley Forest Plot (No. 1) in Cayo, Belize*

Common Name	Scientific Name	Use[a]
Bejuco verde	*Agonandra racemosa* (DC.) Standl.	Sedative, laxative, "gastritis," analgesic
Calawalla	*Phlebodium decumanum* (Willd.) J. Smith	Ulcers, pain, "gastritis," chronic indigestion, high blood pressure, "cancer"
China root	*Smilax lanceolata* L.	Blood tonic, fatigue, "anemia," acid stomach, rheumatism, skin conditions
Cocolmeca	*Dioscorea* sp.	Urinary tract ailments, bladder infection, stoppage of urine, kidney sluggishness and malfunction, mucus loosener in coughs and colds, febrifuge, blood tonic
Contribo	*Aristolochia trilobata* L.	Flu, colds, constipation, fevers, stomach ache, indigestion, "gastritis," parasites

[a]Uses listed are based on disease concepts recognized in Belize, primarily of Maya origin, that may or may not have equivalent states in Western medicine. For example, kidney sluggishness is not a condition commonly recognized by Western-trained physicians but is a common complaint among people in this region.

TABLE 24.2. *Medicinal Plants Harvested from a Fifty-Year-Old Ridge Forest Plot (No. 2) in Cayo, Belize*

Common Name	Scientific Name	Use[a]
Negrito	*Simarouba glauca* DC.	Dysentery & diarrhea, dysmenorrhea, skin conditions, stomach and bowel tonic
Gumbolimbo	*Bursera simaruba* (L.) Sarg.	Antipruritic, stomach cramps, kidney infections, diuretic
China root	*Smilax lanceolata* L.	Blood tonic, fatigue, "anemia," acid stomach, rheumatism, skin conditions
Cocolmeca	*Dioscorea* sp.	Urinary tract ailments, bladder infection, stoppage of urine, kidney sluggishness and malfunction, mucus loosener in coughs and colds, febrifuge, blood tonic

[a]See note for table 24.1.

Not enough information is available to understand the life cycles and regeneration time needed for each species, and therefore, we cannot comment on the frequency and extent of collection involved in sustainable harvest. However, assuming the current age of the forest in each plot as a rotation length, we calculated an estimate of the present value of harvesting plants sustainably into the future by using the standard Faustman formula: $V = R/(1 - e^{-rt})$, where R is the net revenue from a single harvest and r is the real interest rate; t is the length of the rotation in years. Given a thirty-year rotation in plot 1, this suggests that the present value of medicine is $726 per hectare. Making a similar calculation for plot 2, with a fifty-year rotation, yielded a present value of $3,327 per hectare. These calculations assume a 5% interest rate.

These estimates of the value of using tropical forests for the harvest of medicinal plants compared favorably with alternative land uses in the region such as milpa (corn, bean, and squash cultivation) in Guatemalan rain forest, which yielded $288 per hectare. We also identified commercial products such as allspice, copal, chicle, and construction materials in the plots that could be harvested and added to their total value. Thus, this study suggested that protection of at least some areas of rain forest as extractive reserves for medicinal plants appears to be economically justified. It seems that a periodic harvest strategy is a realistic and sustainable method of utilizing the forest. On the basis of our evaluation of the forest similar to the second plot analyzed, it would appear that one could harvest and clear one hectare per year indefinitely, assuming that all the species found in each plot would regenerate at similar rates. More than likely, however, some species, such as *Bursera simaruba*, would become more dominant in the ecosystem while others, such as *Dioscorea*, could become rare.

The analysis used in this study is based on current market data. The estimates of the worth of the forest could change based on local market forces. For example, if knowledge about tropical herbal medicines becomes even more widespread and their collection increases, prices for specific medicines would fall. Similarly, if more consumers become aware of the potential of some of these medicines or if the cost of commercially produced pharmaceuticals becomes too great, demand for herbal medicines could increase, substantially driving up prices. Finally, destruction of the tropical forest habitats of many of these important plants would increase their scarcity, driving up local prices. This scenario has already been observed in Belize with some species. It seems that the value of tropical forest for the harvest of nontimber forest products will increase relative to other land uses over time, as these forests become more scarce.

The Link Between Medicinal Plants, Drug Development, and Conservation

An often-stated assumption is that the discovery of a new plant drug will undoubtedly help in conservation efforts, especially in rain forest regions. This notion is based on the profit potential and economic impact, as well as on the feeling that governments and people will somehow impose a greater value on a resource if it can produce a product with a multinational market. Table 24.3 is a summary of the distribution of value and potential of medicinal plants to support conservation efforts, viewed from three levels or perspectives: regional traditional medicine, the international herbal industry, and the international pharmaceutical industry. Within each level the distribution of economic benefits varies greatly. In traditional medical systems the economic benefits accrue to professional collectors who sell the plants to traditional healers, or to the healers themselves. The local and international herbal industries produce value for a broad range of people and

TABLE 24.3. *The Economic Value and Conservation Potential of Plant Medicines*

Sector	Distribution of Economic Benefit	Market Value	Pitfalls	Conservation Potential
International pharmaceutical industry	Upper end of economic system	High—in the billions	• Overharvest • Synthesis (if no provision for benefits included) • Plantations established outside area discovered	Low → high
National and international herbal industry	Full spectrum of economic system	High—in the billions	• Overharvest • Plantations established outside area discovered	Low → high
Regional traditional medicine	Lower end of economic system	High—in the billions	• Overharvest (sustainability)	Low → high

institutions, including collectors, wholesalers, and brokers, as well as companies that produce and sell herbal formulations. Proportionally, the bulk of the economic value in the international pharmaceutical industry is to be found in the upper end of the economic stratum, at the corporate level, as well as to those involved in wholesale and retail sales.

A comparison of the market value of these products reveals an interesting point—that the value of traditional medical products, which are used by billions of people around the world, comprises billions of dollars each year. Whether or not it is comparable to the $80–90 million of global retail sales of pharmaceutical products has not been calculated, to the best of our knowledge. It can, however, be argued that commerce in traditional plant medicines, consisting primarily of local activity such as previously described, comprises a significant economic force. If it is assumed that 3 billion people use traditional plants for their primary health care, and each person utilizes $2.50–$5.00 worth annually (whether harvested, bartered, or purchased), then the annual value of these plants could be in the range $7.5–$15 billion, a sum that is significant and comparable to the two other sectors of the global pharmacopoeia. It is roughly estimated that the international herbal industry is about ten times the size of the U.S. herbal industry, which is about 1.3 billion dollars annually (M. Blumenthal, personal communication).

Those who promote the linkage between conservation and the search for new pharmaceutical products often fail to point out that the time frame from collection of a plant in the forest to its sale on the pharmacist's shelves is eight to twelve years and that programs initiated today must be viewed as having long-term benefits, at best. An exception to this are agreements such as between Merck, Sharp and Dohme and INBio, the National Biodiversity Institute of Costa Rica. This agreement provides a substantial "up front" payment from Merck for infrastructure development at INBio and for the national parks system in Costa Rica and will, it is hoped, be a model for such North/South collaborations in the future. In

traditional medicine and the herbal industry, the yields are immediate and the economic impact to the individual, community, and region can be quite significant.

The potential for strengthening conservation efforts ranges from low to high, depending on whether or not the extraction of the resource can be sustainably managed over the long term or is simply exploited for short-term benefits by collectors and an industry that has little interest in ensuring a reliable supply into the future. Conservation potential is minimal if the end products are derived from synthetic processes or from plantations developed outside the original area of collection. To address this issue, the National Cancer Institute's Developmental Therapeutics Program seeks to ensure that the primary country of origin of the plant will have the first opportunity to produce the plant, if commercially valuable products should arise as a result of their program (G. Cragg, personal communication).

Finally, table 24.3 summarizes the pitfalls inherent to each level, including overharvest, synthesis with no provision for benefits, land tenure issues, and, as previously mentioned, plantations established outside the range of the species. In any attempt to plan for the maximum conservation potential of a discovery, these pitfalls must be kept in mind.

Further, harvest itself is not without pitfalls. One of the primary concerns about extraction is sustainability. A case in point is the extraction of a drug used in the treatment of glaucoma, pilocarpine. The source of pilocarpine is several species of trees in the genus *Pilocarpus* that occur naturally in the northeast Brazil: *P. pinnatifolius*, *P. microphylla*, and *P. jaborandi*. Leaves have been harvested from the trees for many decades, usually under subcontract from chemical companies. Limited attempts at sustainable management were undertaken in the 1980s, but for the most part, harvest continued in a destructive fashion. Extinction—at the population level in many areas—has been the fate of these plants. Finally, over the last few years, cultivated plantations of *Pilocarpus* species have been developed, which will reduce the value of the remaining wild stands, as well as eliminate any incentive there was for conserving them.

Development of a Forest-Based Traditional Medicine Industry

One of the primary dilemmas in development of a program of extraction of nontimber forest products (NTFPs) has been the long history of overcollecting of the resources, with a resultant decline in these resources, as well as the export of raw materials to centers and countries far from their origin. Rattan is a classic example of this overexploitation, with people in producing countries who are closest to the resource receiving the smallest percentage of the profits involved in its production into high-quality furniture. At least three locally developed brands of commer-

cialized traditional medicine are now being marketed in Belize. These brands include "Agapi," "Rainforest Remedies," and "Triple Moon," and are all entrepreneurial ventures. A key difference in these types of endeavors is that the "value-added" component of the product is added in the country and region of origin of the raw material. As these particular product brands develop, and as new brands and products appear based on the success of the original endeavors, greater demand for ingredients from rain forest species will result. This could potentially contribute to preservation of tropical forest ecosystems, if people carefully manage the production or extraction of the plant species that are primary ingredients in these unrelated products. In addition, it is expected that small farmers will cultivate some of the native species, for sale to both local herbalists and for commerce. To address this latter possibility, the Belize Ethnobotany Project has been working with the Belize College of Agriculture (BCA), Central Farms, in learning how to propagate and grow more than two dozen different plants currently utilized in traditional medicine in Belize. Mr. Hugh O'Brien, professor of horticulture at BCA, has coordinated this effort, which has included the following genera: *Achras, Aristolochia, Brosimum, Bursera, Cedrela, Croton, Jatropha, Myroxylon, Neurolaena, Piscidia, Psidium, Senna, Simarouba, Smilax, Stachytarpheta,* and *Swietenia.*

An Ethnobiomedical Forest Reserve

In June 1993 the government of Belize designated a 6,000-acre parcel of tropical forest as a government forest reserve, for the purpose of providing a source of native plants used locally in traditional medicine. This forest is rich in medicinally important plant species, as well as serving as a wildlife corridor joining nearby conservation reserves. As this forest reserve is developed, programs in traditional medicine, scientific research, and ecological tourism should create a synergistic effect to translate into economic return for the surrounding community, as well as provide an interface where scientists and traditional healers can work together to develop state-of-the-art management strategies for the sustainable extraction of important plant products.

A unique feature of this reserve is that it has been designated specifically for the extraction of medicinal plants used locally as part of the primary health care network. Accordingly, we propose to call this type of extractive reserve an "ethnobiomedical forest reserve," a term intended to convey a sense of the interaction among people, plants, animals, and the health care system in the region.

It will be many years before this first ethnobiomedical forest reserve can be considered successful. A great deal of work must go into developing the management plan and finding the financial and human resources to implement it. Land use pressures surrounding the reserve, specifically logging and agriculture,

as well as sociological and political factors, could endanger the long-term existence of the reserve. However, in Belize there is a great deal of optimism about this reserve, in view of its innovative nature, and much support for it at the grass roots level.

What began as a simple ethnobotanical inventory in the late 1980s has evolved into a complex, multidisciplinary, and interinstitutional program aimed at better understanding the relationship between plant and people in Belize. Some of the initial results beyond ethnobotanical inventory include: refinement of the valuation methodology for the study of traditional medicines; development of nursery protocol for valuable native plants species; progress toward creation of an encyclopedia of the useful plants in the region, as well as of several major publications on the ethnobotany and floristics of the country; development of a teaching curriculum based on the appreciation and use of native plant species; the establishment of a program of pharmacological investigation linking a U.S. governmental agency with a network of traditional healers; and the establishment of a protected forest reserve. The BEP is planned to last through 1997 and perhaps branch out in other directions along the way. The BEP has shown that ethnopharmacological investigation and ethnobotanical surveys can lead directly to the conservation of valuable ecosystems and contribute, it is hoped, to their maintenance over the long term. One of the great priorities in ecosystem conservation today is developing economically sustainable strategies for maintaining such reserves over the long term (measured in hundreds of years) long after initial enthusiasm as well as philanthropic support have subsided.

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