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Chapter 7
Linking Ethnopharmacology and Tropical Forest Conservation in Belize

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Introduction

In the last few decades, the discipline of ethnobotany has undergone a great evolution in methodology, focus, and 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, since such a small fraction of the total existing information has been catalogued. In the last few decades, however, an interdisciplinary approach has become more important in ethnobotanical research, involving the close collaboration of botanists, pharmacologists, anthropologists, chemists, nutritionists, economists, conservationists, policymakers, and ecologists, as well as those in many other fields.

One result of this new approach has been the application of ethnobotany to public policy questions, particularly 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 utilization of the area and the biological integrity of the protected ecosystems. This chapter will discuss 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, a Belizean nongovernmental organization headed by Dr. Rosita Arvigo, 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 carried out dozens of expeditions to various locales and had collected some twenty-seven hundred plant specimens as of early 1993, about 50 percent of which contained ethnobotanical data. The specimens have been deposited at the Belize College of Agriculture and Forestry Department Herbaria, the New York Botanical Garden, and the U.S. National Herbarium. A database has been established at the New York Botanical Garden and distributed to several computer facilities within Belize. The BEP involves gathering of traditional knowledge provided by over two dozen colleagues who are traditional healers of Mopan, Yucatec, Kekchi Maya, Ladino, Garifuna, Creole, East Indian, and Mennonite descent.

Through a contract with the U.S. National Cancer Institute (NCI), the project has provided some two thousand bulk plant samples to the NCI for screening in their human cancer and HIV Developmental Therapeutics Program (DTP). Samples, each weighing approximately five hundred 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 comprehensive studies have not identified a particular plant with a novel compound for advanced development in the DTP. However, in the future, as more and more of the species are put through the two HIV screens and forty human cancer screens, greater interest in some of the species will be shown.

Valuation Studies

A great deal of attention has been given recently to valuing 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), working within a hectare of forest in the Peruvian Amazon, were the first to elucidate the commercial value of nontimber forest products. This study did not inventory medicinal plants, 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

TABLE 7.1. Medicinal Plants Harvested from a Thirty-Year-Old Valley Forest Plot (No. 1) in Cayo, Belize

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

Note: Uses listed are based on disease concepts recognized in Belize, primarily of Mayan origin, and 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.

1433.6 kilograms (dry weight) of medicines, whose value could be judged by local market forces, was collected. Local herbal pharmacists and healers purchased and processed medicinal plants from herb gatherers and small farmers at an average price of U.S.$2.80/kilogram (1991). 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 7.1 and 7.2.

Not enough information is available to understand the life cycles and regeneration time needed for each species; 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 value of harvesting plants sustainably into the future 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, we calculated the value of medicine at $726 per

TABLE 7.2. Medicinal Plants Harvested from a Fifty-Year-Old Ridge Forest Plot (No. 2) in Cayo, Belize

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

Note: Uses listed based on disease concepts recognized in Belize, primarily of Mayan origin, and 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.

hectare. Making a similar calculation for plot 2, with a fifty-year rotation, yielded a value of $3,327 per hectare. These calculations assume a 5 percent 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 Guatamalan rain forests, 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, the protection of at least some areas of rain forest as extractive reserves for medicinal plants appears to be economically justified and a periodic harvest strategy is a realistic and sustainable method of utilizing the forest. Based on 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 of 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 1991 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

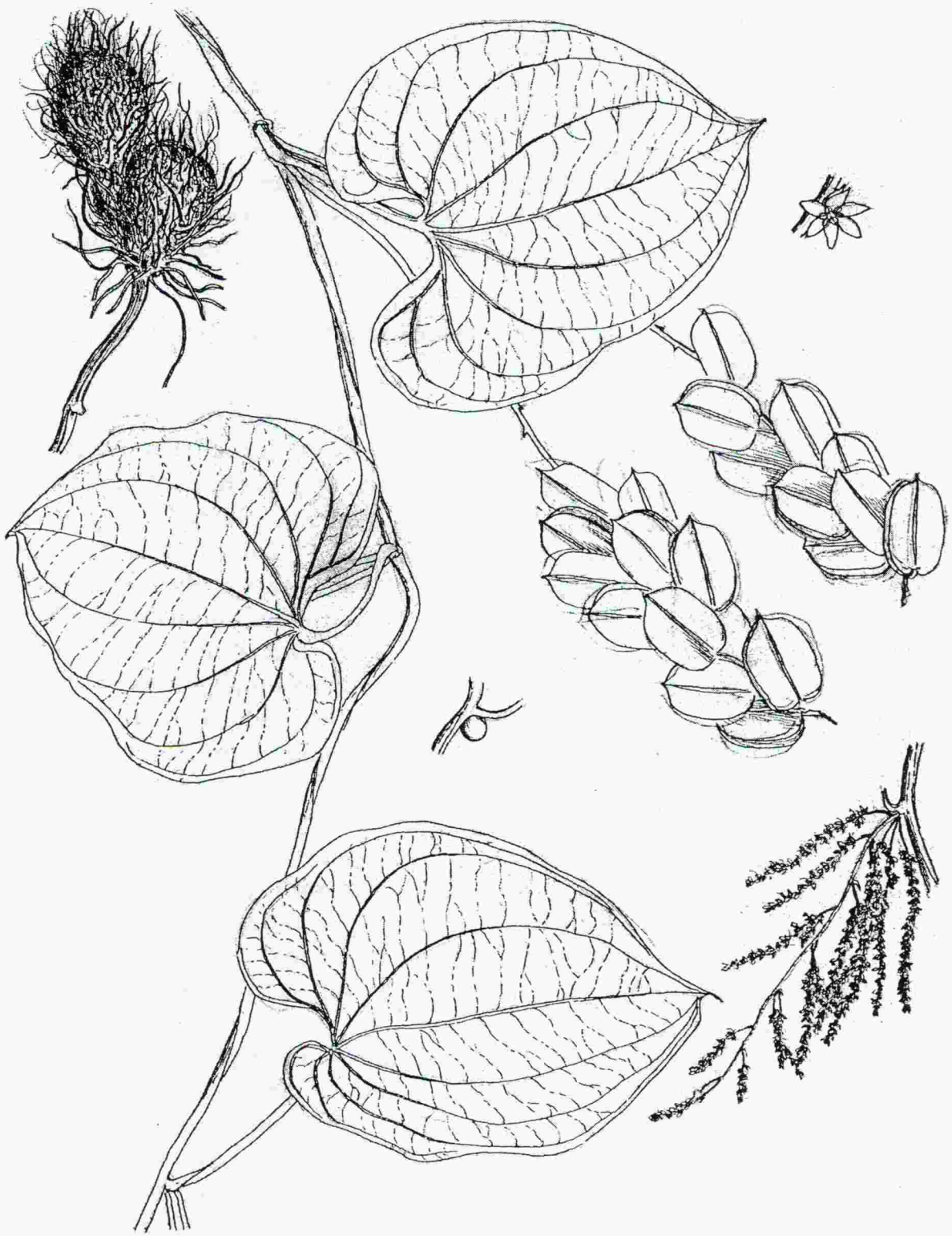

Figure 7.1. *Dioscorea* sp. Line art by the staff of Nanjing Botanical Garden, Nanjing, PRC.

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

There is an often-stated assumption 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 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 7.3 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 institutions, including collectors, wholesalers, brokers, and 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. Commerce in traditional plant medicines, consisting primarily of local activity such as previously described, comprises a significant economic force. If it is assumed that three 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 range between $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 annually (M. Blumenthal, personal communication).

An interesting perspective emerges when the tax yields to government are compared. Obviously, in traditional medical systems, taxes are neither assessed nor paid. The international herbal industry is subject to taxes such as at the point of sale and on corporate profits. Governments benefit most from taxes through commerce for therapies produced and sold by the international pharmaceutical industry.

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 from 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, hopefully, will be a model for such collaborations in the future. In traditional medicine and the herbal industry, the yields are immediate, and the economic impact on 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 of 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, should commercially valuable products arise as a result of their program (G. Cragg, personal communication).

Finally, Table 7.3 summarizes the pitfalls inherent in 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,* which occur naturally in Northeast Brazil: *P. pinnatifolius, P. microphylla,* and *P. jabo-*

TABLE 7.3. The Economic Value and Conservation Potential of Plant Medicines

Sector	*Distribution of Economic Benefit*	*Market Value (U.S. dollars)*	*Amount of Taxes Collected*	*Pitfalls*	*Conservation Potential*
International pharmaceutical industry	Upper end of economic system	High: in the billions	Substantial	Overharvest Synthesis (if no provision for benefits included) Plantations established outside of area discovered	Low → High
National and international herbal industry	Full spectrum of economic system	High: in the billions	Medium	Overharvest Plantations established outside of area discovered	Low → High
Regional traditional medicine	Lower end of economic system	High: in the billions	Small	Overharvest (sustainability)	Low → High

randi. 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 that will reduce the value of the remaining wild stands as well as perhaps eliminate any incentive there was for conserving them.

Development of a Forest-Based Traditional Medicine Industry

One of the primary dilemmas in the development of a program of extraction of nontimber forest products has been the long history of overcollecting 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 realized from its production as high-quality furniture. Two locally developed brands of commercialized traditional medicine are now being marketed in Belize. These brands are Agapi and Rainforest Remedies, and both are entrepreneurial ventures. A key difference in these types of endeavors is that the value-added component of the product is added in the country of origin of the raw material. As both of these product brands develop, and as new brands and products appear based on the success of the original endeavors, greater demand for ingredients from rainforest 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 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 over two dozen different plants currently utilized in traditional medicine in Belize. 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 six-thousand-acre parcel of tropical forest as a 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 area is developed, programs in traditional medicine, scientific research, and ecological tourism could 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. Scientists from Grinnell College, the New York Botanical Garden, Ix Chel Tropical Research Foundation, and members of the Belize Association of Traditional Healers have initiated long-term ecological studies with this goal in mind.

A unique feature of this reserve is that it is planned for use 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 re-

serve an "ethnobiomedical reserve," a term intended to convey a sense of the interaction between people, plants, and animals and the health care system in the region.

It will be many years before this first ethnobiomedical 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 (a serious threat) and agriculture, as well as sociological and political factors, could endanger the long-term existence of the reserve.

Conclusion

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 plants 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 protocols for valuable native plant species; progress toward an encyclopedia of the useful plants in the region as well as several major publications on the ethnobotany and floristics of the country; development of a teaching curriculum based on the appreciation and utilization of native plant species; the establishment of a program of pharmacological investigation linking a U.S. government agency with a network of traditional healers; and the establishment of a forest reserve. The Belize Ethnobotany Project has shown that ethnopharmacological investigation and ethnobotanical surveys can lead directly to the conservation of valuable ecosystems and, hopefully, contribute 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 and philanthropic support have subsided.

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