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CHAPTER 23

The Belize Ethnobotany Project: safeguarding medicinal plants and traditional knowledge in Belize

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Abstract

The Belize Ethnobotany Project was initiated in 1988, through a collaborative effort of a number of individuals and institutions. This paper discusses some of the components of the project, and its accomplishments and challenges. A checklist of the flora has been produced and includes 3408 native and cultivated species found in Belize. The multiple-use curve is introduced as a way of determining the most appropriate sample size for ethnobotanical interviews/collections. Valuation studies of medicinal plants found in two areas of local forest are described and compared with values of traditional uses for farming, using a net present value analysis. Studies to determine sustainable levels of harvest of medicinal plants were also initiated in Belize and are ongoing. The link between conservation, drug development and local utilization of medicinal plants is discussed, and the various impacts on conservation considered. Our experience with the production of a traditional healer's manual is detailed, and the benefit-sharing program it resulted in is described. Various local efforts at developing forest-based traditional medicine products are discussed, as is the natural products research program based on Belizean plants. Other results of this project include the development of a medicinal plant forest reserve and a video documentation and teaching program. Ethnobotanical and related studies in Belize are continuing.

Keywords: *ethnobotany, medicinal plants, traditional knowledge, benefit-sharing, valuation*

I. Introduction

The Belize Ethnobotany Project (BEP) was initiated in 1988 as a collaborative endeavor between the Ix Chel Tropical Research Foundation and Belize Center for Environmental Studies, both Belizean non-governmental 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 carried out over 100 collection trips to various locales, and has gathered over 8000 plant specimens as of the end of 2000. The specimens have been deposited at the Belize College of Agriculture, the Belize Forestry Department Herbarium, as well The New

York Botanical Garden. (NYBG) and US National Herbarium. The BEP involves the cataloging of traditional knowledge provided by dozens of traditional healers and bushmasters of Mopan, Yucatec, and Kekchi Maya, Ladino, Garifuna, Creole, East Indian, and Mennonite descent. This paper provides an outline of some of the components and results of this project.

II. Checklist of the flora

In order to properly understand the ethnobotany of a region, it is essential to have a listing of its flora, with accurate botanical names. In view of this, a project was initiated in 1989 to produce a checklist of the flora of Belize. This was published in December 2000. The checklist is an aggregate of what is known about the plants of Belize (listing 3408 species) and their importance to people. The checklist, entitled *Checklist of the Vascular Plants of Belize, with common names and uses*,[1] encompasses all native and naturalized vascular plants, including ferns, gymnosperms, and cultivated plants, and is the foundation for much future work on the Belizean flora. This work recognizes 1219 genera and 209 families in Belize. The largest family is the Fabaceae *sensu lato* with 295 species plus eight subspecific taxa. The Orchidaceae is next, with 279 species, followed by Poaceae (248 spp.), Asteraceae (153 spp.), Cyperaceae (146 spp.), Rubiaceae (142 spp.), Euphorbiaceae (104 spp.), Melastomataceae (96 spp.) and Aspleniaceae (58 spp.). A total of 41 species in 24 families are endemic to Belize, comprising 1.2% of the flora. The taxonomic treatments are based on a thorough review of the literature, and the study and citation of approximately 17,000 specimens collected in Belize and examined at various herbaria, and includes the plants collected by the BEP.

Each species entry (see below) includes the currently accepted Latin binomial with author. Synonyms are included when they have been applied in the literature of Belize or the region. Following the synonym are references used to support the nomenclature and occurrence in Belize. Common names (Nv) used in Belize are reported next. The common names are in English, Spanish, and Maya, when known. Local and regional uses are reported from the literature and our fieldwork, and divided into 19 broadly defined categories, including medicinal uses, food, ornamental uses, poison, and product (a catch-all term for any use from a child's toy to a household implement). The growth form of each plant is also reported (e.g. erect shrub, small tree, climbing vine, creeping herb). The last entry, vouchers, are specimens collected in Belize and deposited in herbaria. A sample species entry is as follows:

Solanum nudum Dunal – Syn: *Solanum antillarum* O.E. Schultz – **Ref**: FG 10:131. 1974. **Local use**: PRD, MED, POIS; **regional use**: MED. **Nv**: diaper wash, lava paêal, lava pañal, maya washing soap, nightshade, sak-kol, yierba de barrer. – **Habit**: Shrub. – **Voucher**: *Arvigo 46, 503, 799; Atha 1021, 1334; Balick 1737, 2530, 2720, 3102; Bartlett 12962; Brokaw 31,368a; Dwyer 10802a; Gentle 2531, 4767, 6627, 6646, 8752; Lentz 2381; Lundell 435, 469; McDaniel 14339; Peck 808; Ramamoorthy 3022* MEXU!; *Ratter 4579, 4593; Schipp 312, 429, 959; Warrior 1862.*

III. The concept of the multiple-use curve

Essential to understanding the ethnobotany of a country is obtaining the confidence that the entirety of knowledge surrounding each plant has been collected. Establishing this confidence is dependent not only on interviewing as many individuals as possible, but on interviewing people from as many ethnic groups and regions within the country as possible. We have placed priority into obtaining as many 'collections' of ethnobotanical data from Belizean peoples as possible. For one group of plants, we obtained 143 interviews from individuals from four regions and five ethnic groups in Belize about their knowledge of 14 widespread medicinal plants. Using this, we could attempt to answer the question that ethnobotanists must constantly face – how many collections/interviews are sufficient to give the researcher an idea of the totality of a plant's uses in a particular area. In order to avoid problems often encountered by outside interviewers in foreign countries, Belizean nationals not only conducted all the interviews, but also aided in their conception and design.

To interpret and categorize the information, we have used the standards of ethnobotanical collections as established by The Royal Botanic Gardens, Kew. Kew's standards separate medicinal uses and treatments into 24 categories such as 'Circulatory System Disorders', 'Nutritional Disorders', etc. (Table 1). In using these

Table 1
Categories of medicinal uses of plants[a]

1. Unspecified medicinal disorders
2. Abnormalities
3. Blood-system disorders
4. Circulatory-system disorders
5. Digestive-system disorders
6. Endocrine-system disorders
7. Genitourinary-system disorders
8. Ill-defined symptoms
9. Immune-system disorders
10. Infections/infestations
11. Inflammation
12. Injuries
13. Mental disorders
14. Metabolic-system disorders
15. Muscular-skeletal-system disorders
16. Neoplasms
17. Nervous-system disorders
18. Nutritional disorders
19. Pain
20. Poisonings
21. Pregnancy/birth/puerperium disorders
22. Respiratory-system disorders
23. Sensory-system disorders
24. Skin/subcutaneous cellular tissue disorders

[a] Categories adopted from FEM Cook (1995) Economic botany: data collection standard. Royal Botanic Gardens, Kew.

categories, we have been able to establish, in this particular case, not only the totality of how medicinal plants are used, but how many interviews are necessary to capture that knowledge.

In attempting to describe the number of interviews necessary, we have applied the concept of a species-area curve to ethnobotanical collections. The species-area curve is used in ecological surveys as a method of estimating what area of forest must be inventoried before all species in that forest type have been located (Figure 1). We use the same concept to describe the rate at which ethnobotanical data are collected, going on the assumption that once asymptote of the graph has been reached, little information remains undiscovered (Figure 2). As is demonstrated by Figure 2, it is not uncommon to find new information about a plant's uses after as many as 100 interviews. This graph compares the rates at which the knowledge surrounding three species of medicinally useful plants was discovered. The graph shows that we can be confident that we have effectively captured all the manners in which *Vitex gaumeri* is used within the area. *Ruta graveolens*, as a new use is described at the 140th interview, demonstrates the importance of a large sample size. In addition, the slope of the *Bursera simaruba* line leads us to believe more interviews are necessary for a complete description of its uses.

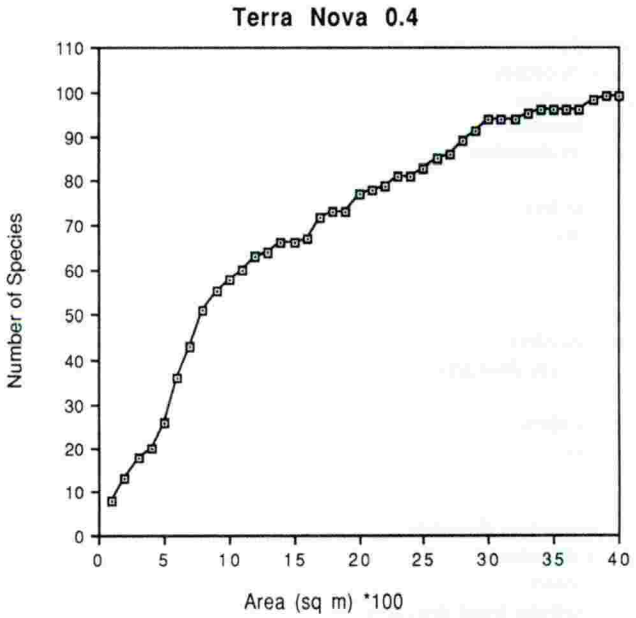

Fig. 1. Species area curve for 0.4 ha of forest at the Terra Nova Site, Belize, showing ca. 100 species per hectare.

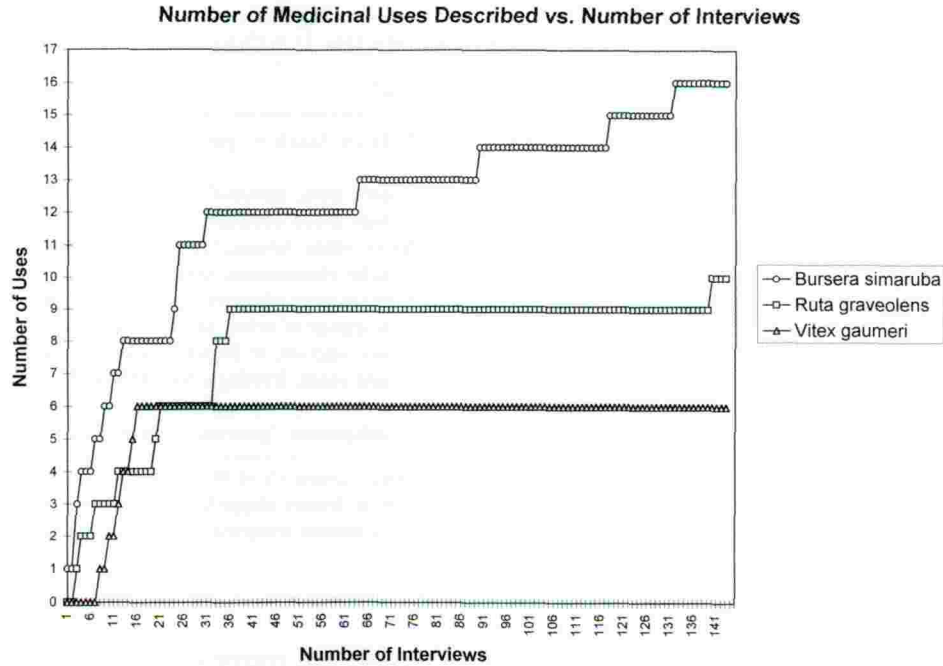

Fig. 2. Multiple use curve for three species of plants used in traditional medicine in Belize, with 141 interviews/collections.

IV. Valuation studies

A great deal of attention has been given recently to the value of non-timber 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 et al.[2] were the first to elucidate the commercial value of non-timber 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 30- and 50-year-old forest, respectively, a total biomass of 308.6 and 1433.6 kg (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 US$ 2.80/kg. 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 US$ 864 and US$ 4014 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 US$ 564 and US$ 3054 on each of the two plots. Details of the study can be found in the original article.[3] The lists of plants and their uses are presented in Table 2 and Table 3. Not enough

Table 2
Medicinal plants harvested from a 30-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* (Wild.) J. Smith	Ulcers, pain, 'gastritis', chronic indigestion, high blood pressure, 'cancer'
China Root	*Smilax lanceolata* L.	Blood tonic, fatigue, 'anemia', acid stomach ache, 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

[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.

information is available to understand the life cycles and regeneration time needed for each species, so 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 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 30-year rotation in plot 1, this suggests that the present value of medicine is US$ 726 per hectare. Making a similar calculation for plot 2, with a 50-year rotation, yielded a present value of US$ 3327 per hectare. These calculations assume a 5% interest rate.

Table 3
Medicinal plants harvested from a 50-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* (L.) Sarg.	Antipruritic, stomach cramps, kidney infections, diuretic
China Root	*Smilax lanceolata* L.	Blood tonic, fatigue, stomach ache, 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

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 US$ 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 from medicinal plants appears to be economically justified. It seems that 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 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 became 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 forests for the harvest of non-timber forest products will increase relative to other land uses over time, as these forests become scarcer.

IV.A. Establishing sustainable harvest rates for locally used medicinal plants

In attempting to establish sustainable harvest rates of trees that produce bark of value in local traditional medicine, we performed a series of bark cuttings on approximately 40 individuals representing six species. With these individuals, we varied the width of bark cut, the length of the cut, and the alignment of the cut (north, east, south or west facing) hoping to establish the manner of cutting which removes the most bark with the least damage to the tree (see Figure 3). These trees were then marked and returned to every 6 months to monitor regeneration. As can be seen in the photos, the bark mends itself from the sides of the cut or in asymmetrical patterns, eventually entirely covering the cut area and becoming harvestable once again.

These preliminary cuts led us to the conclusion that the width of the cut is most influential in the rate of regeneration, the length of the cut being nearly inconsequential. As much as half of the circumference of the bark can be removed without permanently harming the tree, provided the removal is distributed in several cuts rather than one large cut. For example, the most sustainable and productive manner to harvest a tree with a circumference of 60 cm would be three 10-cm-wide

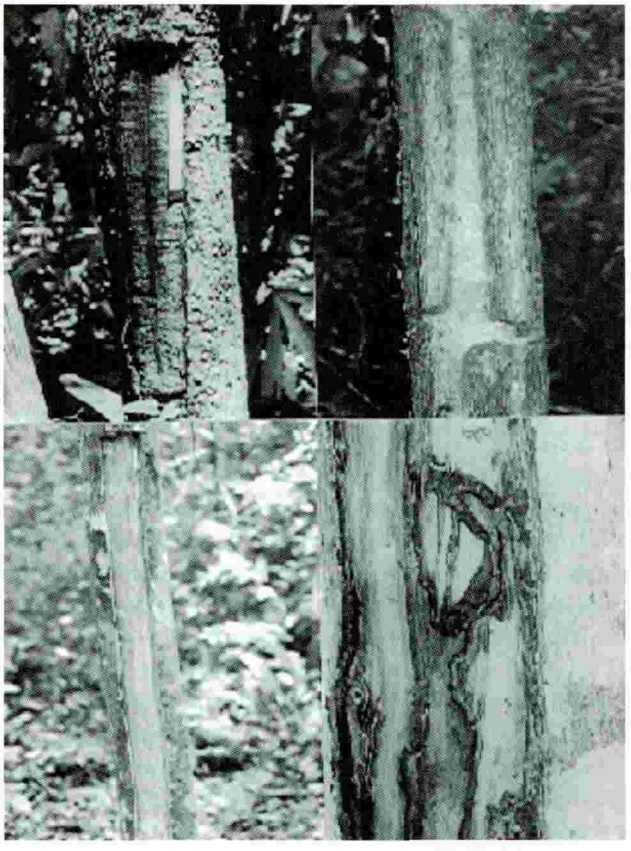

Fig. 3. Upper left and upper right: *Bursera simaruba*, bark regeneration over a 24-month period; lower left: *Simarouba glauca*, fresh cut for bark harvest; lower right: *Vitex gaumeri*, showing an irregular regeneration pattern after 6 months.

cuts, as long as desired, all 10 cm from the next cut. Having established the most efficient 'design' of the cut, we are now, through removing samples from several individuals of similar size of one medicinally valuable species, attempting to establish the exact rate at which bark regenerates. These studies are continuing at various sites in Belize, under the direction of Daniel Atha, in collaboration with Charles Peters and the primary author.

V. The link between medicinal plants, drug development and conservation

There is an often-stated assumption that the discovery of a new plant drug will help in conservation efforts, especially in tropical 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 4 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 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 US$ 80–90 million of global retail sales of pharmaceutical products has not been calculated, to the best of our knowledge. However, it can be argued that commerce in traditional plant medicines, consisting primarily of local activity such as that previously described, comprises a significant economic force. If it is assumed that three billion people use traditional plants for their primary healthcare, and each person utilizes US$ 2.50–5.00 worth annually (whether harvested, bartered or purchased), then the annual value of these plants could range between US$ 7.5 and US$ 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 10 times the size of the US herbal industry, which is about US$ 1.3 billion annually (M Blumenthal, personal communication, American Botanical Council).

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 8–12 years, and that programs initiated today must be viewed as having long-term benefits, at best. Exceptions to this are agreements such as that 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 on which to base 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. The conservation potential is minimal if the end-products are derived from synthetic processes, or from plantations developed outside of the original area of

Table 4
The economic value and conservation potential of plant medicines

Sector	Distribution	Market value	Pitfalls	Conservation potential
International Pharmaceutical Industry	Upper end of economic system	High – in the billions	• Over harvest • Synthesis (if no provision for benefits included) • Plantations established outside of area discovered	Low to high
National and International Herbal Industry	Full spectrum of economic system	High – in the billions	• Over harvest • Plantations established outside of area discovered	Low to high
Regional Traditional Medicine	Lower end of economic system	High – in the billions	• Over harvest-(sustainability)	Low to high

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 4 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 of 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.

VI. Rainforest remedies: a traditional healers' manual

One of the early requests received from the traditional healers we worked with was that the project prepare a semi-technical book on the uses of Belizean plants in traditional medicine, that could be used by local people, for their healthcare and in

teaching their children. The result was *Rainforest Remedies: 100 Healing Herbs of Belize*, co-authored by Arvigo and Balick,[4] with line art by Laura Evans. The book contains sections on the common and scientific names, plant family, a simple botanical description, and information on habitat, traditional uses, and research results. Included in the latter category is information on clinical trials that might have been undertaken as well as any contraindications (cautions) known for the use of this particular plant medicine. The book was published by Lotus Press, Twin Lakes, Wisconsin, and distributed in the United States as well as Belize. A portion of the sales price is donated to a traditional healer's fund established by the Ix Chel Tropical Research Foundation and The New York Botanical Garden, and has benefited the healers who collaborated with the authors on this book. Proceeds are distributed twice yearly, in July and December, through the 'Traditional Healers Foundation'. The total value distributed as of 2000 was over US$ 20,000. The manual has gained widespread acceptance amongst people in Belize interested in traditional healing, as well as tourists looking for information on the use of local plants in medicine. A second edition of *Rainforest Remedies* was published in 1997. A summary of the program, and how the individual healers used their royalty payments, is presented in Johnston.[5]

VII. Development of a forest-based traditional medicine industry

One of the primary dilemmas in a development of a program of extraction of non-timber forest products (NTFPs) has been the long history of over-collecting of the resources, with their resultant decline, as well as the export of raw materials to centers and countries far from their origin. Rattan is a classic example of this over-exploitation, 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 commercialized 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, a 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 both local herbalists and for commerce. To address this latter possibility, the Belize Ethnobotany Project worked with the Belize College of Agriculture, Central Farms, in learning how to propagate and grow over two dozen different plants currently utilized in traditional medicine in Belize. Individual students took on particular species and carried out various agronomic experiments on propagation and growth. 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*.

VII.A. An ethnobiomedical forest reserve

In June 1993, the Government of Belize designated a 6000 acre (2428 ha) 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. The initial philosophy behind the development of this forest reserve was that 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.

The reserve was designated specifically for the extraction of medicinal plants used locally as part of the primary healthcare network. Accordingly, we refer to this type of extractive reserve as an 'ethnobiomedical forest reserve', a term intended to convey a sense of the interaction between people, plants and animals, and the healthcare system in the region.

The reserve was initially championed by a local group of traditional healers known as the 'Belize Association of Traditional Healers'. Conflict arose during the early years of the reserve, with a second group of individuals forming a healer's association, curiously enough, having the same name as the initial group, and demanding control over the management of the reserve and, at one point, the utilization of the assets in the initial group's bank accounts that were raised to implement the reserve. The new group, having political support from a newly elected government at that time, took over management of the reserve (but not the bank accounts), and for several years, there was no activity in the reserve. In addition, loggers encroached upon the reserve during that time and, with no guards in the area, were able to log a portion of the mahogany in the protected area. It has been said locally that one of the members of the second group was selling phony deeds for 'retirement home' subdivisions in the reserve to Belizeans living in the United States, a scam that quickly fell apart when these people returned to Belize and wanted to inspect their 'property'. Finally, the management of the reserve was given to a third group that is currently looking for funds for the reserve's preservation and operation. In this case, conflict over the ethnobiomedical forest reserve was initially quite destructive, but in the end, members of the second group requested that another medicinal plant reserve be set up near the village of San Antonio and named as a memorial to Don Elijio Panti, one of the elders involved in this project. Demarcation and surveying of the Panti reserve are now just beginning. Despite the painful and often comical drama associated with the establishment of the first reserve, the final result has been that at least double the land area is now set aside for use by the traditional healers in these two reserves.

VIII. Natural products studies

Our initial journeys to Belize were sponsored by the collection contracts received from The National Cancer Institute (NCI). During the 10-year span of two contracts with the NCI, thousands of bulk samples of plants were collected under the supervision of various local government agencies, for study by the NCI. Data on initial screening results were returned to these agencies, given to the individuals who, collaborated in the collections, and discussed during various traditional healers' meetings and seminars offered in Belize. While a number of samples had an interesting initial activity, no samples screened to date have been selected for further study by the NCI research team (Gordon Cragg, personal communication).

Other collaborations with natural product chemists have taken place during this period, based on plant materials collected in Belize. One interesting example is found in Glinski et al.[6] After discussing the interest in identifying bioactive compounds with healer Don Elijio Panti, he suggested a group of plants for testing in various screens by the Glinski group. One of these, *Psychotria acuminata*, was identified as a source of phenophorbide a, a green pigment that inactivates cell surface receptors. According to the paper,[6] 'our investigations suggest that the inactivation of cell surface receptors contributes not only to the antitumor effect of PDT [photodynamic therapy], but also to the systematic immunosuppression, a serious side effect of PDT'. It was found that an extract of this plant inhibited cytokinine and monoclonal antibody binding to cell surfaces, and this was attributed to the presence of phenophorbide a and pryophenophorbide a. This discovery was a contribution to the corpus of scientific literature about plant natural products chemistry and bioactivity – it was not focused on the development of a new drug. What is interesting and important to note, however, is that Don Elijio Panti was a co-author of this paper, published in *Photochemistry and Photobiology*, recognizing, in the judgment of the research team, that his discovery and utilization of the plant for many decades constituted a crucial and significant intellectual contribution to this paper. This is the standard that we and increasingly more of our scientific colleagues have attempted to adhere to in our ethnobiological studies.

IX. Video interviews, documentation and teaching programs

Videography was an important tool in documenting the work in this project. This aspect of the work was initially directed by Francoise Pierrot, who, working with the first author, interviewed a number of healers about their backgrounds, training, healing practices, philosophy, ambitions and goals. Around a dozen hours of interviews with six healers were edited into a 29-minute tape, *Messages from the Gods: conversations with traditional healers of Belize*. This was aired on local television, and the footage from which it was drawn deposited at various places in Belize and provided to the healers' families. We were quite pleased with the wide circulation of these tapes amongst family members of the healers. It was clear that this technology is a powerful tool in helping to develop respect for traditional

practices and values, as well as for the individual healers themselves. Following this experience, we decided to produce a second video, aimed at the source of future generations of healers children. A program was developed that included a video tape, *Diary of a Belizean Girl: Learning Herbal Wisdom From Our Elders*, for use in the middle schools of Belize. A teacher's guide, of the same name was written and published by a team led by Elysa Hammond, including Michael Balick, Charles Peters, Mee Young Choi, Don Lisowy, Glenn Phillips, Joy Runyon and Jan Stevenson. 'In this 23-minute video, Bertha Waight, a teenage girl from western Belize, talks about her desire to become a traditional healer like her mother Beatrice. She travels to meet several of her country's well-known healers, including Don Elijio Panti, Mr. Percival Reynolds, Miss Hortense Robinson, Mr. Polo Romero and Dona Juana Xix – in order to learn about the medicinal properties of many forest and field plants. The healers explain the use of different herbs in their medical practice to treat illnesses such as anemia, diabetes, diarrhea and migraine'.[7] She then takes her sister to a healer for the treatment of a headache, keeping a diary of her thoughts. Finally, she discusses her dream of becoming a healer, and a Western-trained health professional as well, with her friends.

This program and guide were distributed without charge to all of the middle schools in Belize, and for several years, a contest was held to determine the class that could make the best healer's manual, based on interviews with their elders. Competition was judged by the healers, and the prize that was offered was a television and video-tape player donated to the winning class.

X. Conclusion

In this paper, we have described only a portion of the project that has been ongoing in Belize for over a decade. What began as a simple ethnobotanical inventory in the late 1980s has evolved into a complex, multidisciplinary and inter-institutional program aimed at understanding better the relationship between plants and people in Belize. Some of the initial results beyond ethnobotanial inventory include: refinement of the valuation methodology for the study of traditional medicines; development of nursery protocol for valuable native plant species; progress towards 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 US governmental agency with a network of traditional healers; and, the establishment of a protected forest reserve. The BEP has also 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 reserves that involve human activity over the long term (measured in hundreds of years) long after initial enthusiasm and philanthropic support have subsided.

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