Ethnobotanical and Floristic Research in Belize: Accomplishments, Challenges and Lessons Learned

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Abstract

Ethnobotanical and floristic research in Belize was conducted through the Belize Ethnobotany Project which was launched in 1988 as a multi-disciplinary effort of a number of individuals and institutions in Belize and internationally. The objectives of the project were the preservation of cultural and traditional knowledge, natural products research (through the National Cancer Institute), technology transfer, institutional strengthening and student training. This paper discusses the implementation of the project components, highlighting its accomplishments, challenges and lessons learned. A checklist of the flora has been produced, and includes 3,408 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 on the ecology, propagation and sustainable levels of harvest of medicinal plants were also initiated in Belize. Our experience with the production of a traditional healer's manual is detailed, and we describe details on the benefit-sharing approach utilized to recognize intellectual property that it contains. Various local efforts at developing forest-based traditional medicine products are described, as is the natural products research and teaching program based on Belizean plants. The authors will relate an example of how negative events can be transformed to have positive results. Specifically, in the case of conflict over the management of the region's first ethnobiomedical reserve, two competing groups claimed responsibility for its management. However, the conflict was eventually resolved and resulted in two such reserves being established, together representing over 50,000 acres of land set aside for conservation and use by traditional healers. The perspective of local participants and communities will also be presented, including a short video presentation.

Background and Introduction

Belize is a Central American country located on the Caribbean coast, south of Mexico and east of Guatemala. It has a of population 250,000 inhabitants spread over 8,867 square miles, giving a low population density of 28 persons per sq. mile. Over 70% of the country is under natural forest, and protected areas now cover 36 % of the land mass. Despite the small size of the country, its ecosystems are varied and its ethnicity diverse, giving rise to a rich culture with respect to traditional healing. The ethnic diversity ranges from groups of indigenous Maya and the Black Caribs (Garinagu), through the Creole descendants of African slaves, to the more recent Central American and Oriental immigrants. In some of these ethnic groups (especially the Maya and the Garinagu), the use of medicinal plants is spiritual and is linked to myths, rituals and religion. The knowledge acquired by healers has long ancestral origins that have been the result of an intimate relationship with nature. However, the influence of foreign cultures and the continued clearing of land

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for agriculture, industry and rural expansion are threatening these cultural and biological resources. Herb gatherers now claim that they have to travel longer and longer distances to obtain medicinal plants as the diversity and availability of medicinal plants are being destroyed. It is evident also that knowledge about the use of plants is itself in greater danger of extinction than the plants themselves.

It was against this backdrop that the Belize Ethnobotany Project was launched in 1988. The project has been a collaborative endeavor involving the Ix Chel Tropical Research Foundation, Belize Center for Environmental Studies, Faculty of Agriculture and Natural Resources of the University of Belize, Agriculture Research and Development Station in Central Farm, The Belize Zoo and Tropical Education Center, Belize Forestry Department, Belize Association of Traditional Healers, Traditional Healers Foundation of Belize, and the Institute of Economic Botany of The New York Botanical Garden. The most significant goal of the project was to conduct an inventory of the ethnobotanical diversity of Belize, a country with significant tracts of intact forest. The project carried out over 100 collection trips to various locales, and collected over 8,000 plant specimens by the end of 2000. The specimens have been deposited at the Faculty of Agriculture and Natural Resources of the University of Belize, the Belize Forestry Department Herbarium (BRH), as well The New York Botanical Garden (NY) and U.S. National Herbarium (US). The Belize Ethnobotany Project involved gathering of traditional knowledge provided by dozens of traditional healers and bushmasters of Mopan, Yucateca, and Kekchi Maya, Ladino, Garinagu, Creole, East Indian, and Mennonite descent. Another significant objective was to help increase respect for traditional knowledge and foster its teaching and use. Additionally, the project aimed at promoting conservation of knowledge and biodiversity, through various local initiatives including displays, seminars, post-secondary classes, youth camps, school competitions, field trips, and guest lectures. A major output of these local initiatives was the establishment of Terra Nova, one of the first reserves established in the world that is dedicated to the conservation of medicinal plants. This paper outlines other achievements of the project and highlights some outputs of the collaboration it has fostered.

Threats to Medicinal Plant Diversity

Up until the early 1980's, 93% of Belize was classified as 'forest land,' but land clearing for the expansion of agriculture (i.e. mostly corn and grains, citrus and pasture), land prospecting, and the expansion of rural and urban communities has contributed and continues to contribute to the reduction of forests. A recent study indicated that approximately 250,000 acres of forest was cut down during the two year period 1989-1991, giving an average annual deforestation rate of 2.3 %. Very little or no deforestation occurred on private reserves and protected areas but high rates of deforestation were reported on private land and leased national lands. Presently the exact estimate of forest cover is unclear but estimates are generally around 70%.

Land clearing for agricultural development has occurred mostly on the fertile plains found along streams and rivers. In most cases the 66 ft. buffer zone, which is legally required to be left intact, is also cleared, and this is threatening the survival of contribo (*Aristolochia tribolata* L.), which grows only in this habitat. The full effect of riverine deforestation on medicinal plants is unknown at this time, but it is likely to destroy the habitat of medicinal plants such as greenstick (*Eupatorium morifolium* Mill.), provision bark (*Pachira aquatica* Aubl.), fig (*Ficus radula* Willd.) and callawalla (*Phlebodium* decumanum (Willd.) J.Sm.).

Many trees that are used for medicinal purposes are also used for timber, and continued logging of natural stands has significantly reduced their populations. Mohogany (*Swietenia macrophylla* King), which is a high priced lumber, is harvested and exported raw or used locally for furniture making. Cedar (*Cedrela odorata* L.), balsam (*Myroxylon balsamum* L.) Billy Webb (*Acosmium panamense* (Benth.) Yakolev), copalchi (*Croton niveus* Jacq.) and sapodilla (*Manilkara zapota* L.), which are all used in local medicine, are also logged heavily.

In recent times, the use and trade of medicinal plants and their products have increased in Belize. Rainforest Rescue and Rainforest Remedies, two locally registered companies, prepare dried products, salves and herbal extracts for the local and tourist market, and export some of their products to the United States. Agape Herbs, another local company, is also active in selling packaged forms of medicinal plants on both the local and export market. More recently, Arum Ltd., a subsidiary of a US cosmetic company, succeeded in the development of cosmetic products using locally available backyard plants. A number of individuals, especially in the city and district towns, make their living by selling medicinal herbs. These activities have given rise to herb gathering as a way of life for some locals and since the trade is often restricted to few species, the pressure on natural supplies is increasing.

The increased demand for medicinal plants has resulted in some herb gatherers (especially those concerned only with economic gain) practicing unsustainable harvesting. In the Cayo district, at least 10 instances have been seen or reported where whole balsam (*M. balsamum*), billiweb (*A. panamensis*), and copalchi (*C. niveus*) trees of varying sizes have been found cut down to facilitate the harvesting (or stripping) of bark from the stems and branches. In other cases, especially for older trees, harvesting of the complete circumference of bark at chest height, has resulted in ring barking and the death of large mature trees.

Over-harvesting or inappropriate harvesting of medicinal shrubs and vines have also been noted in the field.

The reduction in the number of backyard and home gardens also reduces the availability of medicinal plants. These reductions are occurring in urban, and to a lesser extent, rural areas. As Belize continues to develop, this trend is expected to continue. Aloe vera (*Aloe vera* L.), tree of life (*Kalanchoe pinnata* (Lam) Pers.), lemon grass (*Cymbopogon citratus* (DC.) Stapf) and oregano (*Lippia graveoles* HBk.) are some common examples of medicinal plants that are being affected by this trend.

Very little research has been carried out on the habitat, diversity, growth and development of medicinal plants. As a result, information in these areas is lacking, making it difficult to assess the effect of human and other actions on this biodiversity. Knowledge on cultivation and sustainable harvesting techniques is also lacking and therefore any commercial use of these plants may put a strain on natural supplies. The program of ethnobotanical and floristic research in Belize was therefore considered a high priority in the conservation and use of medicinal plants.

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 (Balick *et al*. 2000), 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 8 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 Belize Ethnobotany Project.

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 nineteen broadly defined categories, including medicinal uses, food, ornamental uses, poison, and product (a catchall 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 paeal, 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.

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 fourteen 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 Royal Botanic Garden, Kew. Kew's standards separate medicinal uses and treatments into twenty-four categories such as "Circulatory System Disorders", "Nutritional Disorders", etc (Table 1). In using these 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.

Table 1. Categories* of Medicinal Uses of Plants.

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

*Categories adopted from Cook 1995

In attempting to describe the necessary number of interviews necessary, we have applied the concept of a species-area curve to ethnobotanical collection. 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 is 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 one hundred 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* Greenm. is used within the area. *Ruta chalapensis* L., as a new use is described at the one hundred and fortieth interview, demonstrates the importance of a large sample size. In addition, the slope of the *Bursera simaruba* (L.) Sarg. line leads us to believe more interviews are necessary for a complete description of its uses.

Valuation Studies

A great deal of attention has been given recently to the value of non-timber 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 *et al*. (1989) 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 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 $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 $564 and $3054 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 2 & 3. 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 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 suggests that the present value of medicine is $726 per hectare. Making a similar calculation for plot 2, with a 50-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 ex-

Figure 1. A species area curve for the Terra Nova reserve showing the diversity of species in measured quadrants.

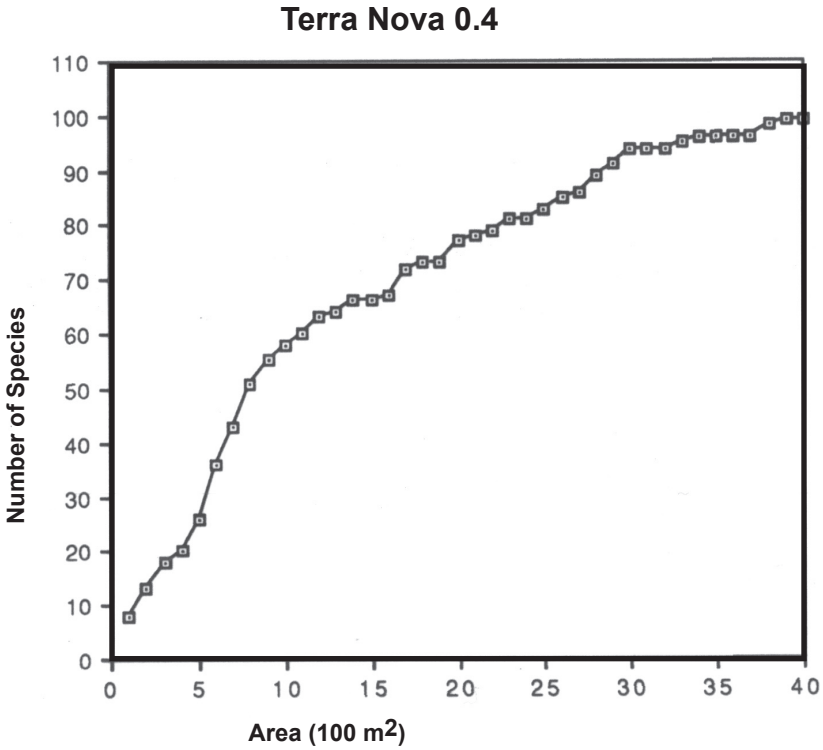
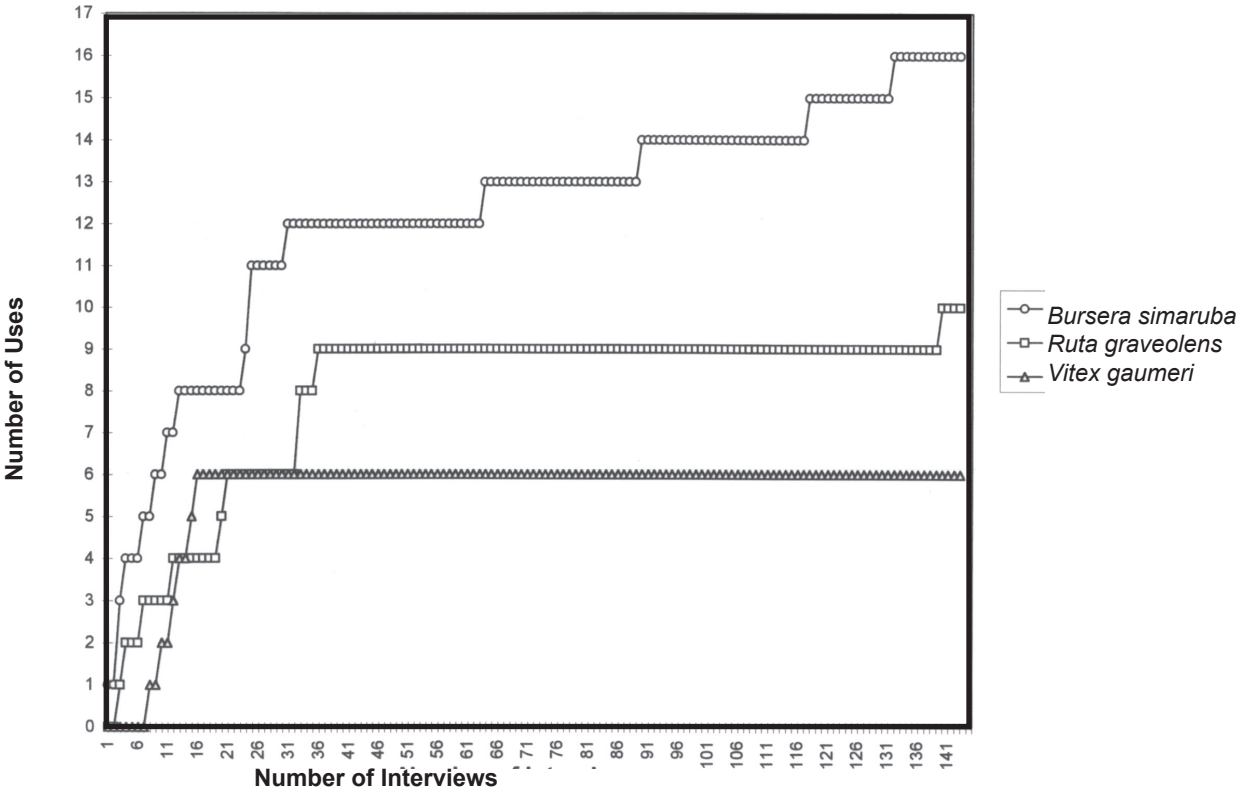


Figure 2. A multiple use curve showing the increasing number of medicinal uses learned with increasing numbers of interviews/collections of three commonly known plant species.



tractive 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. This is, in part, due to the biology of the individual species. As an aggressive tree species that propagates quite easily from stem cuttings, the number of individuals of *B. simaruba* in a disturbed setting will probably increase. The harvest of *Dioscorea* involves removal of the large tuberous root, thus ensuring the death of the plant, and it does not appear to be easily propagated upon root division, nor will it survive in a cleared, exposed patch of forest or field as easily as will *B. simaruba*.

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 forest for the harvest of non-timber forest products will increase relative to other land uses over time, as these forests become scarcer.

Table 2. Medicinal Plants Harvested From a 30-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,” chronic indigestion, 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.

*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 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 & 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.
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.

Rainforest Remedies: A Traditional Healer's Manual

One of the early requests received from the traditional healers 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 health care and in teaching their children. The result was *Rainforest Remedies: 100 Healing Herbs of Belize*, co-authored by Rosita Arvigo and Michael Balick, 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 of each book has been 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 $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 Johnson (1998).

Natural Products Studies

Initial studies in Belize were sponsored by the collection contract received from The National Cancer Institute (NCI). During the ten 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 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*. (1995). 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*, Benth. was identified as a source of phenophorbide a, a green pigment that inactivates cell surface receptors. According to the paper (Glinski *et. al*. 1995), "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 judgement 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.

Ecological and Propagation Studies

Medicinal plants in the wild have been nurtured and preserved by herb gatherers and traditional healers for many generations under an informal set of rules. However, as the demand for medicinal plants and their products increase, the pressure on wild populations intensifies. Assessing the ecological conditions under which medicinal plants grow and researching appropriate propagation methods and harvesting techniques while empowering commercial herb gatherers with these techniques is considered necessary to promote the sustainable harvest and possible cultivation of medicinal plants.

During the period 1992 to 1995, a series of field visits were conducted to observe the growing conditions and obtain planting material for propagation studies of selected medicinal plants. The plants studied were selected based on: common use and effectiveness as traditional medicine; habitat destruction or over-harvesting; commercial value in local markets; and potential for introduction as a cash crop in Belize. The outputs of studies on two such plants and a summary of the propagation results of others are hereby presented.

Contribo (*Aristolochia trilobata* L.), a trailing and twining herbaceous vine, grows mostly along the cool banks of rivers and streams. Although the main branches of the plant are found below the canopy, most of its vines trail the upper branches of the surrounding trees. Thickets are generally preferred for growth as they make available a network of branches and vines for the plant to trail on. Direct sunlight scorches the leaves of new plants indicating that there is little tolerance to direct sunlight. The plant

was noted to flower and produce seeds around between March and April each year. The appearance of adventitious roots on nodes that trailed on the ground gave an early indication of the possible of propagation by cuttings.

Nursery experiments confirmed that *A. trilobata* can be propagated by cuttings. Under average nursery conditions, cuttings that were greater than 6 mm in diameter gave establishment rates of 85-100 % while cuttings that were less than 3 mm in diameter had establishment rates of less than 50 %. Under the nursery conditions that prevailed, the use of rooting hormone did not have any effect on the establishment rates of the cuttings. It was also noted that cuttings that were 6 mm or more in diameter grew much faster and gave stronger plants even though bud burst took longer.

Based on the observations during the study period, the following constraints to the cultivation of *A. trilobata* were identified:

1. A caterpillar identified as *Battus polydamas polydamas* was observed on young *A. trilobata* plants in the nursery as well as on plants in the forest. In Belize, the caterpillar has not been reported as a pest on any other plant and as such was not previously recorded as a pest. On more than one occasions, this caterpillar was responsible for completely defoliating *A. trilobata* seedlings in the nursery.
2. *A. trilobata* preference for riverside type soils can seriously restrict its potential for commercialization. These soils are not extensive in Belize and most of them are already under grain production, citrus cultivation or pastures.

Gumbolimbo (*Bursera simaruba* (L.) Sarg.) appeared to be tolerant to a wide range of environmental conditions. It was found growing in clear open areas exposed to 100 % sunlight as well as among trees in the high forest. The soils on which it was found varied from deep heavy clays to shallow steep slopes. Hilly and rocky limestone landscapes were noted to support luxuriant growth of *B. simaruba* despite their shallow topsoils and the presence of hard limestone bedrocks very near the soil surface. Generally, once the internal drainage of the soil is good, the growth of the *B. simaruba* plant would be supported.

Local livestock farmers from time to time use *B. simaruba* for fenceposts by cutting fencepost-sized branches and planting them directly in the field during dry periods. However, *B. simaruba* cuttings were difficult to propagate when young tips and branches were used even if rooting hormone was used as a stimulant. Establishment rates were very low, ie. between 28 - 36% for cuttings less than 3 mm in diameter and in most cases, sprouting did not occur until after 2 - 3 months of setting the cuttings. In most of the cuttings that did not sprout, the below ground part rotted, and laboratory analysis indicated that the stem rot was caused by anthracnose (*Colletotrichum gleosporioides*). This infection was also confirmed on thick fence-post sized cuttings that did not establish in the field. It is apparent therefore why local livestock farmers planted the *B. simaruba* cuttings during the dry season instead of during the wet season when the chance of anthracnose infections increases under wet soil conditions.

Further information on the germination rates of seeds and establishment rates of cuttings for various medicinal plants is presented in Table 4. The results obtained from these experiments are considered valuable as the cultivation of medicinal plants is encouraged as a means of supply. Cultivation is better than collecting from wild populations especially for species that are rare, endangered or over-exploited. Cultivation also has pharmaceutical advantage as cultivated plants can be genetically improved, variations in composition can be minimized and higher yields can be obtained with improved agronomic practices. Large scale cultivation, though, may promote monocultures, increase the use of agrochemicals, and reduce the genetic diversity of species. As a result, it is recommended that cultivation should be promoted under mixed cropping or agroforestry systems.

Terra Nova - An Ethnobiomedical Forest Reserve

In June 1993 the Government of Belize designated a 6,000 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. The initial philosophy behind the development of this forest reserve was to serve the following:

- **In-situ conservation of medicinal plants to complement the activities of traditional healers**; this would include identification and labeling of medicinal plants, rescuing plants threatened by forest clearing elsewhere and transplanting them at Terra Nova, and regulating the harvesting of medicinal plants in line with sustainable practices.

- **Support ethnobotanical research and training**: research on ecology, growth and development, sustainable harvesting methods, value of the forest resource, cataloguing of economically important plants, determination of active principles, and conducting training and youth camps.

- **Ecotourism**: with proper facilities and infrastructure Terra Nova would eventually be used for eco-trails, nature walks, guided tours, seminars and workshops. This would create a synergistic effect translating into economic return for the surrounding community as well as for Terra Nova.

Table 4. Germination and Establishment Rates of Various Medicinal Plants Propagated by Cuttings and Seed.

Plant	No. of Seeds per Cuttings Set	No. of Seeds per Cuttings Established	Average No. of Days to Germination	% Germination per Establishment
Cuttings Set				
Aristolochia trilobata L.	33	17	-	52
Bursera simaruba (L.)Sarg	50	16	-	32
Simarouba glauca DC.	15	0	-	0
Mentha spicata L.	15	15	-	100
Seeds Set				
Myroxylon balsamum L.	6	0	n/a	0
Strychnus panamensis Seem.	15	10	63	67
Pachira aquatica Aubl.	4	3	29	75
Ricinus communis L.	38	18	31	47
Senna spectabilis DC.	40	39	7	98

The reserve was designated to 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 to be used locally as part of the primary health care 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 health care system in the region. The reserve was initially championed by a local group of traditional healers known as the Belize Association of Traditional Healers (BATH). During the period February 1993 to May 1994, BATH obtained financing for specific activities (such as surveying the reserve) and intended to raise additional funds through joint scientific projects and by encouraging individuals or organizations to adopt-a-tree or adopt-an-acre. In less than a year, BATH was able to: survey and mark the boundaries of the reserve; upgrade the access road; begin fencing; construct a campsite; transplant over 500 seedlings of various medicinal plants; conduct a youth camp; support plant collection and research on harvesting; and employ a caretaker/warden.

In the second year of the management of Terra Nova by BATH, a project proposal was written and submitted to USAID to further develop Terra Nova as an ecotourist destination. A little over US $ 30,000 was approved by USAID and BATH was awaiting approval of the co-management plan that was submitted to the Ministry of Natural Resources. This was when controversy over the management of the reserve arose, with a second group of individuals forming a healer's association, curiously enough, having the same name as the initial group ie BATH, and demanding control over the management of the reserve and, and one point, the utilization of the assets in the initial group's bank accounts that were raised for the reserve. The new group, having political support from a newly elected government at that time instigated the withholding of the co-management plan and frustrated the efforts of the original BATH. The directors of the original BATH, being vision oriented instead of conflict oriented, resigned to make way for the new BATH who took over management of the reserve. USAID withdrew their funding and for several years there was no activity in the reserve. Loggers encroached upon the reserve during that time, and with no guards in the area, were able to log a portion of the mahogany and other valuable species in the protected area. In addition, it has been said locally that the main director of the new 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."

After years of inactivity, a task force appointed by the government and including members from the old and new BATH recommended that the management of the reserve be given to a third party that is neutral, non-governmental, has national recognition and credibility as well as having a natural resource management mandate. A non-government NGO called the Belize Enterprise for Sustainable Technology (BEST) was identified and government signed a co-management plan with BEST in 1999. BEST is currently writing proposals and looking for funds for the reserve's preservation and operation. In this case, conflict over the ethnobiomedical forest reserve was initially was quite destructive, but in the end a neutral third party was identified and the government eventually approved a second medicinal plant reserve to be managed by the remaining members of the new BATH. This second reserve is comprised of over 50,000 acres and is located near in the uplands of a major watershed near the village of San Antonio. This new reserve was formally declared

in October 2000 and was established as a memorial to Don Elijio Panti, one of the elders involved in the Belize Ethnobotany Project. Demarcation and surveying of the Panti Maya reserve is now just beginning and an access road has been constructed. Despite the painful, and often comical drama associated with the establishment of the first reserve, the final result has been that about 10 times the land area is now set aside for use by traditional healers in these two reserves.

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 Franciose 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 was edited down 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 healer's 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." (Anon., no date) 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.

The collaborative efforts of those involved in the project resulted in the conduct of a strong educational program in schools, the launching of an annual youth camp and the publication of a quarterly newsletter. The educational programs in schools are conducted mostly by Ix Chel Tropical Research Foundation and the Traditional Healers Foundation. A special outreach program for primary schools begins with an annual public exhibit of useful plants, followed by classroom lectures and games and ending with a school competition focusing on "My Backyard Plants". The exhibit lasts for 5 days and over 1800 school children, mostly between the ages of 6-18, visit the display each year. The first exhibit was conducted in 1994 and has been conducted annually ever since. The school competition began in 1997 and in 2000, 6 schools participated in the program. Students are required to interview their elders and use the information to prepare an artistic manual entitled "My Backyard Plants". The competition is judged by the healers, and prizes, inclusive of television and video tape players, are awarded to the winning schools.

In 1994 the Belize Association of Traditional Healers (BATH) conducted a 7 day camp at Terra Nova medicinal plant reserve for 20 high risk urban youths. Activities included the planting of medicinal and timber trees, labeling the planted seedlings, documenting the uses of plants and exchange of stories and experiences with healers. Most of all, these high risk urban youths interacted with nature and were given an experience of life beyond city walls. As a result of the success of this first youth camp, 20-30 children between the ages of 10-14 years are now hosted annually for a one week camp at Ix Chel Farms by Ix Chel Tropical Research Foundation and the Traditional Healers Foundation.

The Traditional Healers Foundation also produces a quarterly newsletter called the "Tree of Life". This newsletter evolved from the "Plant Press" newsletter, which was first published in May 1992 by the same healers. This newsletter is free to members of the Traditional Healers Foundation, educational institutions and national government and non-government agencies in Belize. Circulation of this newsletter is over 1,000 and it is available to individuals for an annual contribution.

Conclusion and Lessons Learned

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 1980's has evolved into a complex, multidisciplinary and inter-institutional program aimed at better understanding the relationship between plants and people in Belize. In this final section we would like to conclude by discussing some of the lessons learned from the project.

It is now clear, based on our test of the multiple use curve in Belize, that a sample size greater than one or two collections is essential for a significant understanding of the plant resource and its use. Not only does the morphology of the plant show variation, depending on where it was

collected and its life stage, but the uses can vary into the dozens, as seen in this work. While we acknowledge the difficulty of making such high numbers of collections and interviews for every taxon or cultivar included in a work of this nature, it may be useful to focus such in depth interviews on certain aspects of the project—we suspect that medicinal plants will show some of the greatest variation in use.

Traditional cultures have multifaceted ways of managing their resources, and greater attention should be paid to this topic as part of ethnobotanical studies. This is especially important as, all too often, Western models of resource management, not known to be sustainable, are suggested for resources under traditional control. In some areas of the world, local people are going back to their traditional management of biological resources, having experimented with the Western model, and are observing greater success.

It is essential to integrate activities involving both biodiversity and cultural conservation into a project structure. All too often little is left behind after the completion of a project, and ethnobotanists have a responsibility to the people they work with to ensure the continuation of some aspects of the study. For example, helping to put elders who are the endangered repositories of traditional knowledge in front of children, such as in the classroom, who might become interested in this work. In Belize, through a variety of mechanisms discussed in this paper, we have been able to make contributions to preservation and utilization in these important areas.

We have found that ethnobotanical interviews using simple hand held videos are effective in gaining a greater understanding of what people are attempting to communicate to the interviewer. Present technology allows for the acquisition of very small "mini DVD" system video cameras that can be positioned in a way so as not to disturb the flow of the conversation, at least in many cases. At the same time these materials serve as a record of the conversations and interactions, and, in our experience, a much-appreciated gift to the family of the elders we have worked with. Tragically, a few hours of videotape conversations may be one of the few tangible legacies possessed by the family of a person learned in traditional knowledge.

Despite the electronic age, books, manuals, and floras are important research outputs and project goals. We as a community seem to be fascinated by the electronic tools available to us, while at the same time forgetting that they may not be available in all circumstances to the people who might best use them—for example as a manual that could be kept on a person's shelf for ready references, in the case of a volume on primary health care. We have been told in the North that published books are headed for imminent extinction, a message that does not seem to be the case in the South.

In the initial stages of project design, it is essential to give more attention to constructing a project that is truly interdisciplinary in nature, at least if that is the goal. All too often lip service is given to the word "interdisciplinary" without realizing it is a way to bring groups together that do not even speak the same professional language, to bring different perspectives to the same question and to provide a much more scientifically valid and rigorous conclusion.

The conduct of formalized training programs for local ethnobotanists further strengthens the capacity of a country to carry out ethnobotanical work long after a project concludes. Local scientists have been sent on training internationally, and local ethnobotanists and healers received field training on the collection and preservation of herbarium and bulk specimens. The knowledge gained by these individuals has remained in-country and are already being used in local and new foreign initiatives.

To complement the formalized training programs, local institutions were assisted in developing programs and improving infrastructure. Infrastructural development, including the donation of seven herbarium cabinets to the Faculty of Agriculture and Natural Resources and the Forestry Department has allowed these two institutions to properly care for the thousands of mounted herbarium specimens that have been donated by the project. In addition, a video was produced on the experience of one apprentice participating in a program launched during the project. In this case, a teacher's guide was also produced and copies of the video and guide were distributed to numerous primary schools in Belize. The teacher's guide recommended that teachers allow students to interview their elders and produce an artistic class project booklet entitled "My Backyard Plants". This activity has now evolved into an annual school competition that is judged by local healers, and prizes (usually a TV-VCR combination) are awarded to the school that produces the best booklet.

A common trend amongst ethnobotanists is to publish scientific papers and reports and refer to the local healers who collaborated as informants. Giving healers this unknown identity is an insult to them as in most cases it is their knowledge or intellectual property that guided the research. By including traditional healers (who provided quality information for research) as co-authors or even acknowledgement using their names, both foreign and local scientists received more respect from the healers and changed, in a very small way, the 'modus operandi' of scientific relationships, including publications.

Incorporating benefit sharing as a foundation for research is probably the most important lesson learned from this project. The commitment to benefit sharing took many forms but probably the most significant was an early commitment to nine healers who provided information for the publication of the health care manual "Rainforest Remedies". As mentioned, since the launching of the book in 1993, over

$20,000 US has been distributed to the healers whose knowledge is contained in the book. More authors and scientists need to consider this approach, respecting the intellectual property of indigenous people. In addition, the manual itself was a form of benefit sharing, as it was the first output requested by the healers. They felt that it would be useful as a primary health care manual for their patients and students. It was truly is a good foundation upon which to build mutual respect.

Finally, we learned to enjoy our fieldwork, getting to know our new colleagues, learning about the natural history of Belize, and, simply, just having fun.

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