SECOND ANNUAL PROGRESS REPORT TO THE U.S.

AGENCY FOR INTERNATIONAL DEVELOPMENT

"USEFUL PLANTS AND TRADITIONAL HEALING SYSTEMS IN BELIZE"

(BELIZE ETHNOBOTANY PROJECT)

GRANT NO. 505-0035-G-OPG-8001-00

Submitted By

Michael J. Balick, Ph.D.
Philecology Curator of Economic Botany and
Director, Institute of Economic Botany
The New York Botanical Garden
Bronx, New York 10458-5126
(212) 220-8763

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Background and Rationale for Biodiversity Studies in Belize

The Central American nation of Belize, located south of the Yucatan Peninsula, comprises 22,963 km^3 of land area. Of this total, 21,323 km^3 is officially classified as forest land (Hartshorn et al., 1984). Approximately one-third of this is in forest reserves. However, conversion of forest lands for agriculture, logging and development is a serious threat to the nation's flora and fauna (Figures 1 and 2).

From a botanical perspective, a great deal remains to be discovered about the species composition of Belize's forests. According to Hampshire (1989), while 25,000 botanical speciments have been collected from Belize, a great number of these collections are from areas of easier access, e.g., the offshore cayes, areas near main roads, Mountain Pine Ridge, and areas around Orange Walk town. Areas that are poorly collected include the Maya Mountains, Sarstoon River, southern Toledo District, the Cockscomb Mountains, Thousand Foot Falls gorge, Pine Ridge ravines and Victoria Peak. Campbell (1989) in a synthesis of the state of worldwide tropical botanical inventory noted that Belize had the lowest number of herbarium collections (17) per 100 km^2 of any country in Central America, the next highest number being 22 in Nicaragua. At the upper end, Costa Rica had 236 collections per 100 km^2 and El Salvador had 268. Gentry (1978) estimated there to be 2,500-3,000 vascular plants in

ɜure 1. Destruction of natural forest for citrus plantations along the Hummingbird Highway.

igure 2. Destruction of Mangrove stands near Corozal for development of tourist facilities.

Belize. Our studies have shown this to be an underestimate.

Although this list is expanding with ongoing inventories by contemporary workers (Arvigo, Balick, Brokaw, etc.), there are thought to be over 150 endemic species in Belize (IUCN, 1982). Hampshire (1989) estimated that 4.6-6.0% of the Belizean flora is endemic. In contrast, less than 1% of the flora of Nicaragua (Sutton, 1989) or El Salvador (Hampshire, 1989) is thought to be endemic. The exact percentage of the endemic flora in neighboring Guatemala and Honduras is not known, but that for Costa Rica exceeds 10% (Gomez, 1989). Endemism is an important factor in the flora of Belize and, in our opinion, the estimate of percentage endemism will be increased only after more comprehensive studies are made of the poorly known regions of this country.

Introduction to the Project

On September 15, 1988, U.S. AID awarded a grant to The New York Botanical Garden (#505-0035-G-OPG-8001-00) to bring together a multinational research team to carry out a study of the biological diversity and ethnobotany of Belize. As stated in the project proposal, the study has six objectives:

1. Collect the diversity of plants found in Belizean forests that are known to be utilized for medicine, food, fiber, and for fuel.

2. Prepare plant specimens and distribute them to selected Belizean and foreign herbaria where they will be identified, described and curated.

3. Assess the most promising species for medicinal use based on their widespread utilization by well respected healers in the region.

4. Provide plant samples for testing to the National Cancer Institute, private industry and to academic pharmacological laboratories.

5. Prepare a manuscript for publication on Maya medical systems, including documentation of the plants used in herbal medicine, a discussion of the effectiveness of these plants in their cultural context, as well as results from pharmaceutical screening programs.

6. Promote and strengthen ties between Belizean and U.S. scientists in the area of traditional medicine, ethnobotany and the preservation of biological diversity.

Dr. Michael J. Balick, Director of The New York Botanical Garden Institute of Economic Botany is the Principal

Investigator (PI) on this project. His counterpart in Belize is Dr. Rosita Arvigo, Director of Ix Chel Tropical Research Center. The project is collaborating with local NGO's such as The Belize Center for Environmental Studies and the Belize Zoo and Tropical Education Center, as well as governmental agencies such as the Forestry Department of the Ministry of Natural Resources. As will be outlined later in this document, the project has attracted a significant number of volunteers and established strong linkages with a variety of Belizean institutions.

Information about the initiation of the project is summarized in the first annual report (March 30, 1989). The intention of this report is to provide a summary of the cumulative activities to-date. Detailed analysis of data as well as more detailed information are being presented in a series of papers published in scientific journals and will be submitted to U.S. AID as they are published. A copy of the first article in this series is presented as Appendix I in this report.

Activities over the duration of the grant are summarized under each of the specific objectives of the project.

Objectives

Objective 1. Collect the diversity of plants found in Belizean forests that are known to be utilized for medicine, fuel, fiber and for fuel.

Since the first fieldwork in November 1988, expeditions have been carried out to several dozen sites within Belize. The collection numbers, districts and dates of these trips are presented in Tables I and II. Table I presents a summary of additional expeditions undertaken by the team of Drs. Balick, Arvigo and Shropshire, while Table II presents a summary of fieldwork undertaken by Drs. Arvigo and Shropshire. The extensive fieldwork has been made possible through the acquisition of equipment and a vehicle, as well as the improvement of scientific facilities at Ix Chel Tropical Research Center, Cayo District, through the support of U.S. AID as well as private foundations and as a result of the project's very active participation in The New York Botanical Garden's plant collection contract with the U.S. National Cancer Institute (NCI). Private foundations that have helped to support our studies in Belize include the Metropolitan Life Insurance, Overbrook, and Rex Foundations. The equipment and facilities includes a full set of camping gear, mobile communications equipment, small botanical library, dormitory and lecture hall, a 1989 Izusu Trooper II, a trailer carrying a propane-fueled plant dryer for processing herbarium sheets and bulk samples (Figure 3), and all of the necessary drying ovens and other facilities for preparing the specimens and data at Ix Chel Tropical Research Center.

Figure 3. Dr. Gregory Shropshire with trailer modified into portable drying oven for processing bulk samples and herbarium vouchers.

TABLE I

PLANT COLLECTIONS MADE BY M. J. BALICK, R. ARVIGO AND G. SHROPSHIRE IN BELIZE DURING 1987-1991

Collection Nos.	District	Date of Fieldwork
1759-1868	Cayo	11/87 - 11/27/87
1869-1907	Cayo	6/8/88 - 6/11/88
1908	Belize	6/12/88
1909-1939	Cayo	6/13/88 - 6/15/88
1948-1969	Caye Caulker	1/30/89 - 2/2/89
1970-1989	Ambergris Caye	2/4/89 - 2/5/89
1990-1997	Cayo	2/7/89
1998-2088	Cayo	8/5/89 - 8/12/89
2089-2214	Corozal	11/12/89 - 11/21/89
2215-2220	Cayo	11/21/89 - 11/22/89
2221-2473	Cayo	1/22/90 - 1/26/90
2474-2571	Toledo	1/30/90 - 2/1/90
2572-2596	Cayo	1/20/90
2597-2731	Stann Creek	5/20/90 - 5/25/90
2732-2735	Cayo	8/22/90
3008-3010	Cayo	8/23/90
3011-3091, 3096	Stann Creek	11/26/90 - 11/30/90
3092-3109	Cayo	12/2/90 - 12/3/90
3110-3111	Cayo	12/4/90
3112-3157	Cayo	5/19/91 - 5/23/91

TABLE II

PLANT COLLECTIONS MADE BY R. ARVIGO AND

G. SHROPSHIRE DURING 1987-1991

Collection Nos.	District	Date of Fieldwork
1-39	Cayo	7/25/87
40-57	Cayo	8/10/87 - 8/25/87
58-65	Cayo	9/15/87
66-108	Cayo	4/17/88 - 5/20/88
109-112	Cayo	9/1/87
113-132	Cayo	5/18/88 - 7/1/88
133-171	Cayo	11/8/88 - 11/9/88
180-209	Cayo	2/16/89 - 3/15/89
211-255	Cayo	4/5/89 - 5/25/89
256-311	Cayo	6/15/89 - 1/24/90
312-404	Belize	3/23/90 - 3/30/90
405-431	Caye Caulker	4/19/90
432-467	Stann Creek	6/11/90-6/17/90
469-541	Orange Walk	5/10/91 - 5/16/91

As can be seen from Figure 4, collections have been made in Cayo, Belize, Stann Creek, Corozal, Orange Walk and Toledo Districts, but by far the most intensive activity has been in Cayo District. According to our original proposal, this was the area to be collected heavily in the first phase of the project, because of our relationships with so many knowledgeable local "bush doctors" (curanderos) and "bush men" (experienced woodsmen) who were willing to help us in this work. As can be seen by comparing Figures 4 and 5, we have covered representative ecological life zones consisting of subtropical moist forest, subtropical lower montane moist forest, subtropical lower montane wet forest, subtropical wet forest, tropical moist-transition to subtropical forest, and tropical wet-transition to subtropical forest.

A total of 1655 botanical collections have been made to date, each in duplicate sets of 4-6 sheets for distribution and study both within Belize and by taxonomic specialists at institutions around the world. These collections represent not only a sampling of biodiversity present in Belize, but also a compendium of information on local names and uses of the plants.

Approximately 50% of these materials were reported or observed by us to have uses in the local subsistence or cash economy. The pursuit of this type of information involves a great deal of investment in time spent building working relationships with local people knowledgeable about the uses

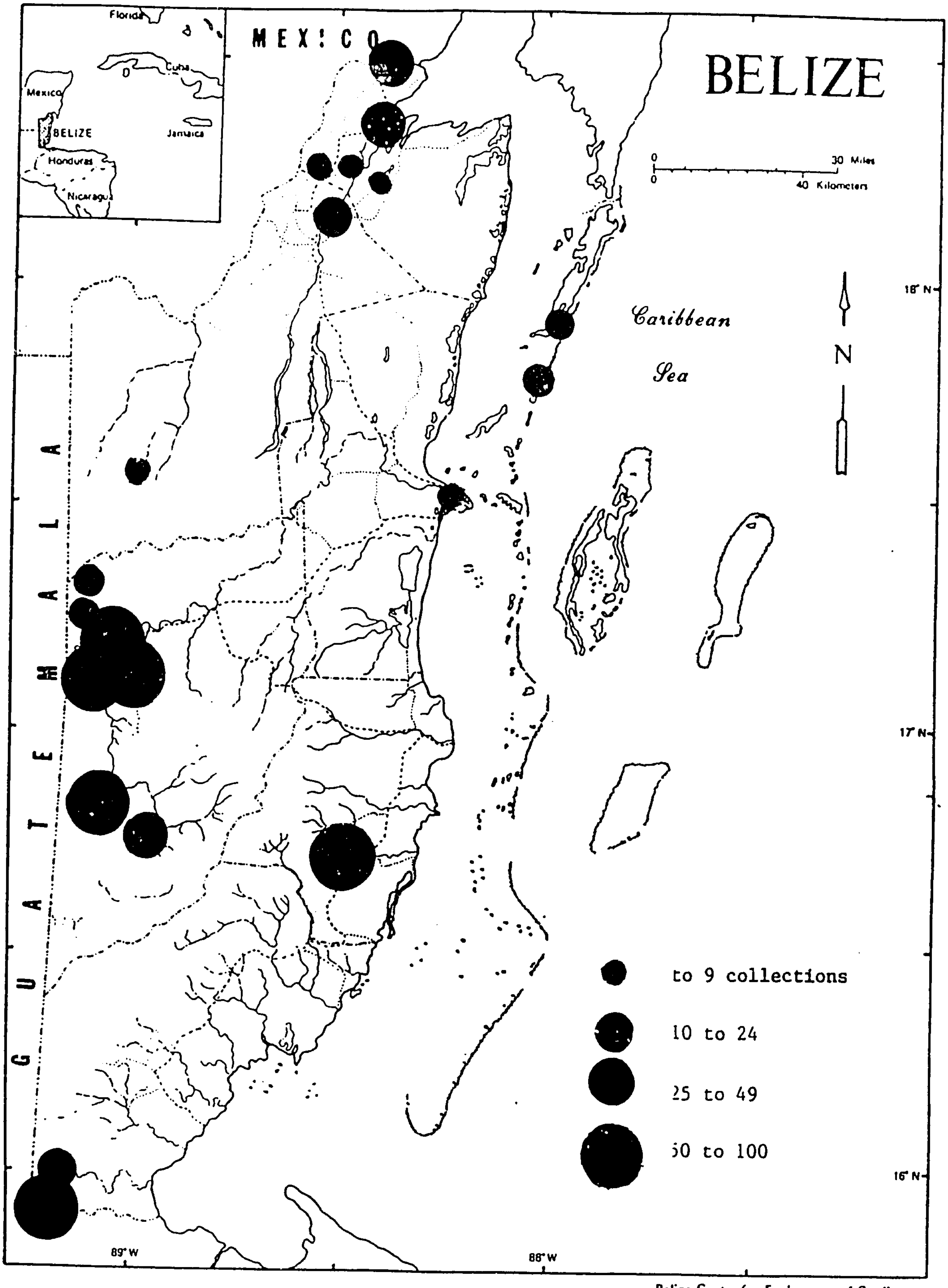


Figure 4. Collection sites during 1987-1991.

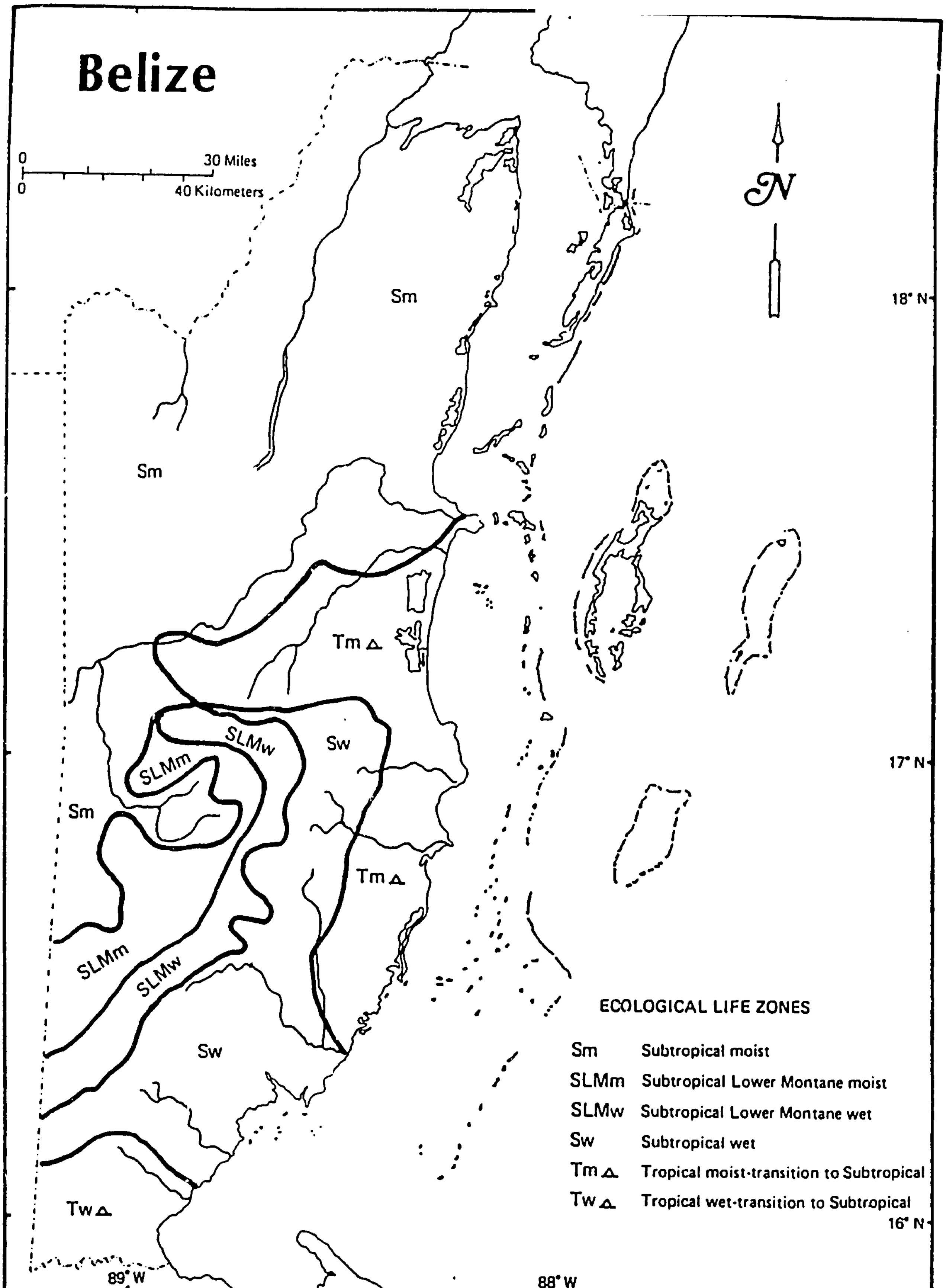
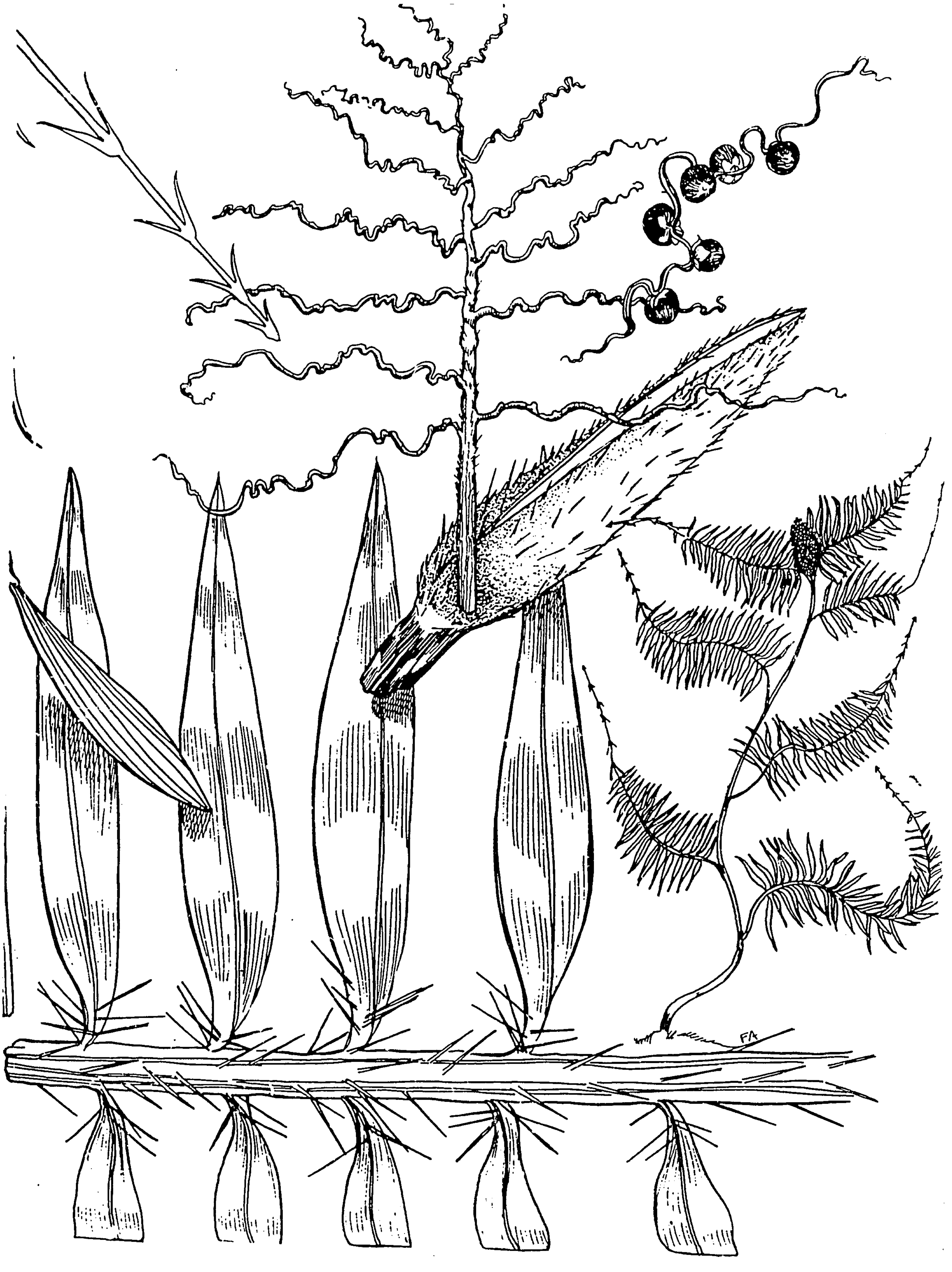


Figure 5. Distribution of forest types in Belize, from Hartshorn et al, 1984.

of the native flora. These collections also represent voucher specimens for ca. 1600 bulk samples of plants, each weighing 0.5-1.0 kg, collected for study by the National Cancer Institute Developmental Therapeutics Program, as described under objective 4. Sample herbarium labels, including ethnobotanical data and NCI bar code numbers are presented in Appendix II.

Dr. Balick's taxonomic specialty is the palm family (Palmae), and this family is a widespread and important element of the Belizean flora. It was decided to focus a portion of our effort on the production of a palm flora of Belize, with notes on distribution, local names and uses. In addition to the collection of herbarium specimens and ethnobotanical information, a volunteer artist, Ms. Fran Anderson, is drawing the plates, one of which is reproduced on the following page (Figure 6). This drawing depicts Desmoncus ferox, a common understory palm known as "bayal," used for making baskets and other woven handicraft items. This genus has been called the "New World rattan" and we have received inquiries from those interested in furthering its commercial use as a fiber crop.

Another aspect of this study is the assessment of the conservation status of the rarer elements of the Belizean flora. In March of 1988, an assessment of the conservation status of Schippia concolor, a rare neotropical palm endemic to Belize, was made at the request of Dr. Dennis Johnson and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funded by World Wildlife Fund-US. He is carrying out a study on the global conservation status of palms in collaboration with The International Union for the Conservation of Nature (IUCN). The report prepared for this purpose is presented in Appendix III. Through this study we were able to locate new sites for Schippia concolor, including one at the Ix Chel Tropical Research Center, and expand our information on the palm's range and abundance in Belize (Figures 7,8)

Finally, under objective 1, the project sponsored a field trip to Belize in January of 1990 that brought some nine volunteers to Belize to participate in general collecting and ethnobotanical inventory. The group collected in the Cayo district, in the areas near San Antonio and the Pine Ridge. One focus of the trip was on the dooryard gardens of local people, and two representatives gardens were studied, one in San Antonio and the other near Xunantunich. Over 200 numbers of plants were collected, and detailed maps prepared of the gardens of Cuc and Xix families. Figures 9 and 10 show maps prepared, and Table III is a summary of plant use within the twc gardens. Note that the Xix garden is richer in medical plant species as Mrs. Juana Xix is a very experienced herbalist, while the Antonio Cuc family is more dependent on the harvest and sale of local fruits. This is illustrated by the fact that 39% of the species in the latter garden were in the "food" category (including multiple use). These data are interesting for the fact that there is such a high percentage

Figure 7. Habitat of *Schippia concolor* in the Pine Ridge. Note that the plants in this site are subject to frequent fires.

Figure 8. Habitat of *Schippia concolor* along the Western Highway being destroyed.

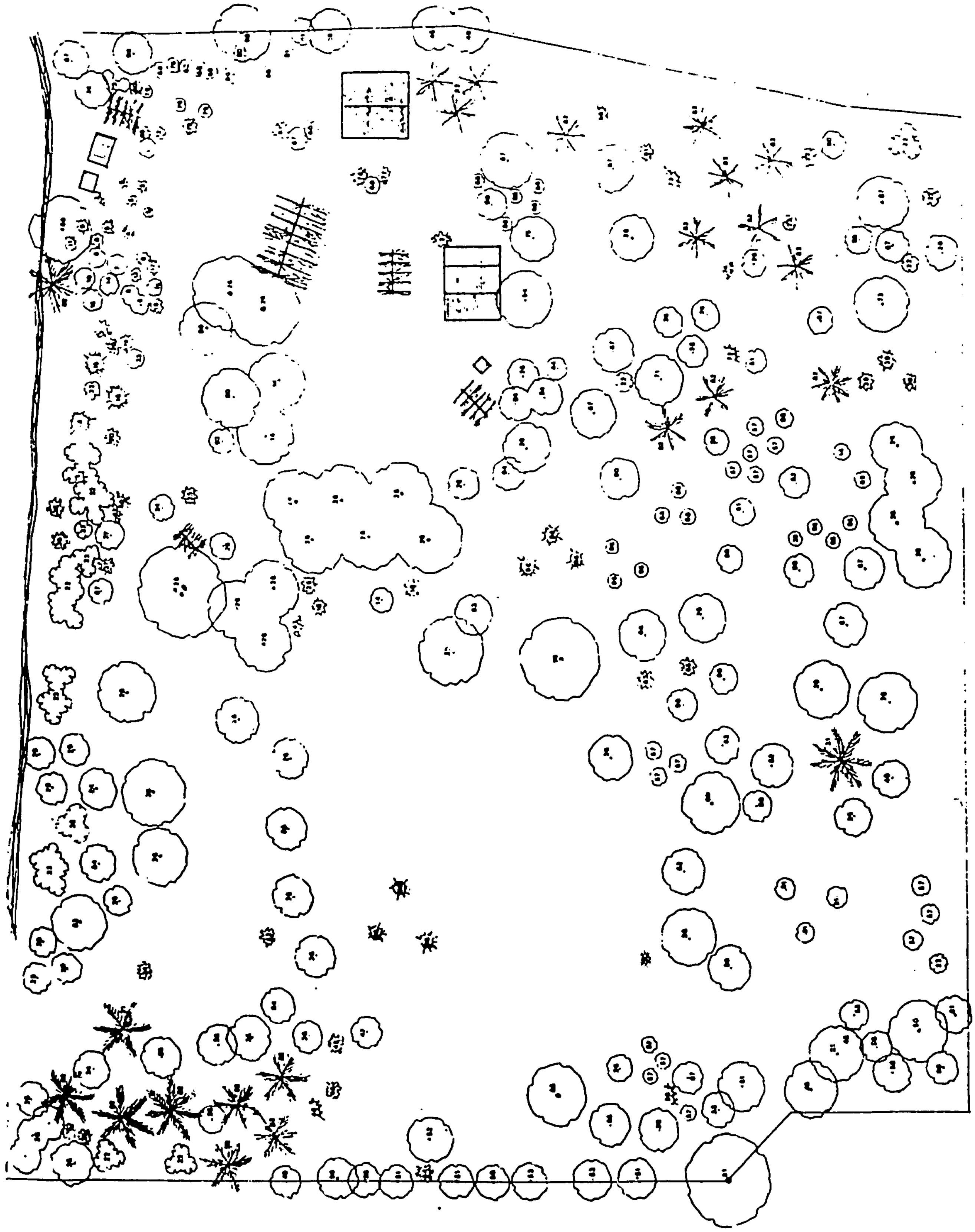

Figure 10. Map of dooryard garden of Antonio Cuc family, San Antonio.

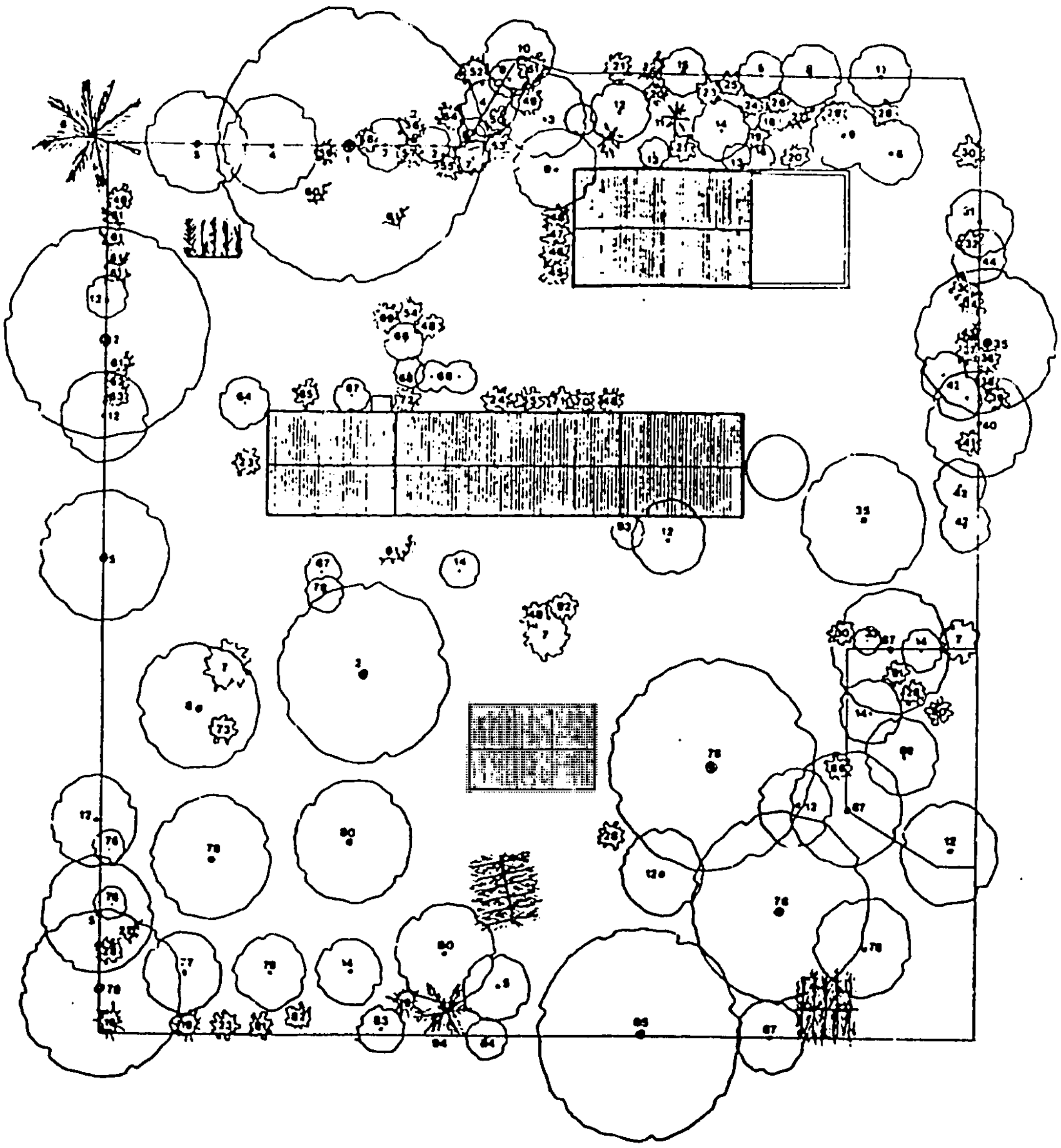

Figure 9. Map of dooryard garden of Isobel Xix family, Xunantunich.

TABLE III

PLANT USE BY CLASS

USE	XIX GARDEN		CUC GARDEN	
	Number	%	Number	%
Medicinal (only)	44	(47)	27	(33)
Food (only)	17	(18)	25	(30)
Medicinal & Food (multiple use)	7	(8)	7	(9)
Ornamental	20	(22)	14	(17)
Construction & Crafts	3	(3)	2	(2)
Fuel	1	(1)	3	(4)
Unreported use	1	(1)	4	(5)
Total species present	93		82	

of medicinal plants grown (or managed) within the household plots. In general, most home gardens emphasize the production of food and ornamental plants. The rich ethnomedical tradition of Belize is apparent from this study. Appendix IV contains the list of plants identified to date from this study, as well as their common names and uses.

Objective 2. Prepare plant specimens and distribute them to selected Belizean and foreign herbaria where they will be identified, described and curated.

As discussed under objective 1, a total of 1655 botanical collections have been made as of 6/30/91, each containing a detailed listing of information about the distribution, abundance, common names and uses of the Belizean flora. Each number is collected in a replicate set of 4-6, and distributed to: The New York Botanical Garden (NY); Herbarium of the Forestry Department of Belize (BRH); Ix Chel Tropical Research Center; botanical specialist; Missouri Botanical Garden MO; Harvard University Herbaria (GH); The Royal Botanic Gardens, Kew (K); and the Instituto de Biologia, Universidad Nacional Autonoma de Mexico (MEXU). Specimens sent to the latter two institutions depend on the collection of sufficient numbers of duplicates. If the material collected is a voucher for material sent to the National Cancer Institute, then one herbarium specimen is sent to the U.S. National Herbarium (US), as spelled out by the terms of the NCI contract.

The New York Botanical Garden is mounting the sets of herbarium specimens for the BRH and Ix Chel herbarium collections. These are then hand carried by Dr. Balick to Belize for presentation and use by our collaborators at these two institutions. The BRH herbarium staff recently requested assistance with financing the upgrading of the herbarium including instruction in proper curation procedures. Within the budget and time limitations of this project, some assistance is being given. It is hoped that U.S. AID will be willing to support the upgrading of the BRH herbarium as part of a future grant, as this is an extremely important facility for the study of the conservation and utilization of the flora of Belize.

Objective 3. Assess the most promising species for medicinal use based on their widespread utilization by well respected healers in the region.

There are several components to this objective, which has been broadened beyond the original focus of the study on the ethnomedical uses of plants. The Belize Ethnobotany Project has developed a collaborative network of healers, including both generalists and specialists in the hierarchy of traditional medicine. Because of the rich cultural composition of the country, a great deal of information is to be found within the context of this country-wide study. In order to understand the dynamics and scope of this knowledge, we have worked with a number of people from different backgrounds including Maya, Ladino, Creole, East Indian, and Mennonite. Each of these cultures focuses on different disease concepts and the utilization of an independent but convergent suite of plants. In some cases, plants are recognized by various cultures for a universal trait, such as the effectiveness of Neurolaena lobata for gastric problems. In other cases we have found the same plant being used for very different purposes. For example, the Maya use Pluchea symphytifolia in a vaginal steam bath while the Creole use it as a poultice for rheumatism. All of this information is being analyzed and synthesized for publication at a later date. Our central figures in this network of healers and bushmen who freely share information with our project include Mr. Ramon Badillo, Mr. Antonio Cuc (Figure 11), Miss. Barbara Fernandez, Mr. Thomas Green, Mr. Jorge Jimenez, Mr. Antonio Morales, Don Eligio Panti (Figure 12), Mr. Andrew Ramcharan (Figure 13), Mr. Neopolo Romero, Miss Hortense Robinson (Figure 14), Mrs. Juana Xix, as well as several other persons who have chosen to remain anonymous.

Another direction the assessment of promising plant species has taken is the economic evaluation of these resources in local markets. While most discussions

Figure 11. Mr. Antonio Cuc of San Antonio, Cayo District, peeling bark for a bulk collection.

Figure 12. Don Eligio Panti treating an infant with gastric problems.

Figure 13. Mr. Andrew Ramcharan collecting medicinal plants in Corozal District.

Figure 14. Miss Hortense Robinson collecting a species of Piper in the Cockscomb Jaguar Preserve.

concerning the value of biodiversity frequently cite the importance of plants as medicines, most of this information is based on the use of tropical plants in the pharmaceutical industry. It is generally agreed that ca. 25% of all the prescriptions written by doctors in the United States are for pharmaceuticals containing plant products or for pharmaceuticals that have their origin in plant products. This comprises a market worth at least five billion dollars annually within the United States, and even a greater amount worldwide.

However, it is our opinion that conservation activities as well as the study of biodiversity will be equally served by also assessing the value of the flora to the local market for their use in traditional medicine. In this context, we carried out an economic valuation study of two representative plots of forests in the Cayo District, in collaboration with Professor Robert Mendelsohn of the Yale University School of Forestry and Environmental Studies. The first part of this study consisted of putting a value on the standing biomass of medicinal plants available from the herbal pharmacists in the local markets, such as the Belize City market. Each of the major towns of Belize has a local market, and the herbal practitioner has a place within this market system. Table IV provides information on the medicinal plants harvested from the first plot. These comprise species that have an existing market and, therefore, a cash value in the herbal pharmacies of Belize.

TABLE IV

MEDICINAL PLANTS HARVESTED FROM SECONDARY FOREST IN CAYO, BELIZE

COMMON NAME	SCIENTIFIC NAME	USE*
Bejuco Verde	Agonandra racemosa (DC.) Standl.	Sedative, laxative, "gastritis," analgesic
Callawalla	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 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.

From: Balick and Mendelsohn, in manuscript.

Through this study, we were able to determine the value of the harvest of medicinal plants from from one hectare of secondary forest in Belize at several levels: to the farmer; the herbal pharmacist; and the herbal physician. The latter category includes the people who practice traditional medicine in Belize dispensing not only herbal remedies but also diagnosing illnesses and prescribing specific treatments. The details of this study are presented in a paper which has been submitted to a scientific journal for publication. For the purposes of this report, it is interesting to point out that the present value (PV) of plant medicines contained within one hectare of 30 year old secondary forest in Belize is US $4,822. This is compared with calculations by other workers for milpa in Guatemala (PV =288/HA) and tropical pine timber plantations (PV=$3,184). Valuation studies such as these are being carried out in Iquitos, Peru and the Napo region of Ecuador by NYBG Institute of Economic Botany staff in collaboration with Professor Mendelsohn and his students. At the conclusion of these studies, we will have excellent comparative data for both Central America (Belize) and the two South American sites. This kind of information is extremely important for resource planners, as well as scientists and conservationists. To the best of our knowledge, the Belize study is the first calculation of the economic value of native medicinal plants in the local market The publication of the data will poirt out the importance of this resource, nct only within the context of Belize, but throughout the tropics as well, where hundreds of millions of people depend on an ever-diminishing tropical forest resource for up to 80% of their primary health care. We are actively seeking additional funds from the U.S. Agency for International Development and other foundations to continue to expand this aspect of the study in other parts of Belize.

As a result of this economic assessment, we have held discussions with staff from the Belize College of Agriculture (BCA) on the importance of building a germplasm bank of locally used medicinal plants within Belize. At this facility, we will seek to collect, propagate and grow locally native medicinal plants. Based on our November 1990 meeting, we have selected seven species for introduction in these trials. The selection of these species has been based on the following criteria: common use and effectiveness as traditional medicines; commercial value and local markets; increasing scarcity due to habitat destruction or over-harvest; and the potential for introduction as a cash crop in Belize. These species include <u>Aristolochia grandiflora</u>, <u>Bursera simaruba</u>, <u>Myroxylon balsamum</u>, <u>Neurolaena lobata</u>, <u>Pimenta dioica</u>, <u>Sweetia panemensis</u> and <u>Simarouba glauca</u>. It is proposed to implement this germplasm bank at a BCA facility, near Central Farms. One acre will be dedicated to the germplasm bank and planted according to a standard field plot design. A complementary, but somewhat smaller facility will be developed at the Ix Chel Tropical Research Center. An introductory curriculum on local medicinal plants will be developed for the second year students at BCA, and several of the publications to be jointly authored by Drs. Balick and Arvigo will be used as the course textbooks. At the present time we are undertaking some preliminary experiments on the propagation and cultivation of these species, but the full-scale effort must await additional funding.

Finally, in order to obtain an overview on the importance of non-timber forest products in Belize, and their possible use in extractive production strategies in Belizean forests, the project funded a study by two Yale University School of Forestry and Environmental Studies master degree students, Robert M. Heinzman and Conrad C. S. Reining in late 1989. This report involved the collaboration of the Belize Environmental Center and the Ix Chel Tropical Research Center. The 38 page document they produced as a result of their fieldwork in Belize is presented as Appendix V of this report. Their study identified a number of non-timber forest products in Belize that have contemporary economic value. This list includes allspice (Pimenta dioica), chicle (Manilkara chicle, M. achras), cohune (Orbignya cohune), various plants for construction and thatch, copal (Protium copal), logwood (Haematoxylon campechianum), izote (Yucca species) and xate (Chamaedorea species). Heinzman and Reining also calculated the value of production from the e re forestry sector in Belize, both timber and non-timber products, to be ca. six million dollars in 1989. Of this total, two products, chicle and izote comprise one-third of the total. By comparison, forest-based tourism produced $29,593,343 in foreign exchange in 1989, approximately 15% of all foreign receipts in Belize that year. Clearly the ecotourism (including scientific research) sector of the economy has benefitted significantly from the maintenance of biodiversity, as well as the continued production of studies that interpret biodiversity to the scientific community and interested public. We feel strongly that these types of studies are essential in convincing government and the private sector of the value of maintaining biodiversity. Heinzman and Reining's report will be included as a full chapter in the forthcoming book by Drs. Balick and Arvigo on the ethnobotanical wealth of Belize. This book project is further discussed under objective 5.

Objective 4. Provide plant samples for testing to the National Cancer Institute, private industry and to academic pharmacological laboratories

The bulk of the material collected has been provided to the National Cancer Institute through the previously mentioned contract with that organization. A dozen or so samples have been provided to other investigators such as Dr. Charlotte Gyllenhaal at the Pharmacology Department of the University of Illinois at Chicago, who is researching anti-cancer compounds. As previously mentioned, ca. 1600 bulk samples, each weighing 0.5 - 1.0 kg, have been provided to the National Cancer Institute (Figure 15).

The NCI has extracted these samples in both organic and aqueous solvents, and has screened them in *in vitro* systems, against HIV and cancer models. The protocol used by the NCI, as provided by Dr. Gordon Cragg, is as follows: The dried plant samples are stored at -20^{o}C for a minimum of 48 hours immediately after arrival at the NCI. This period of freezing is a requirement of the US Department of Agriculture as a precaution to reduce risk of release of alien pests. Each sample is labelled, either in the field or on arrival at the repository, with a bar-code label designating a unique NCI collection number. After freezing, samples are logged into a raw materials database and sent to the Natural Products Extraction Laboratory for grinding and extraction. A small portion of each sample is removed and kept as a voucher. The rest of the sample is then ground and extracted by slow percolation at room temperature with dichloromethane/methanol (1:1 mixture), followed by a methanol wash. The combined extract and wash are concentrated *in vacuo* and finally dried under high vacuum to

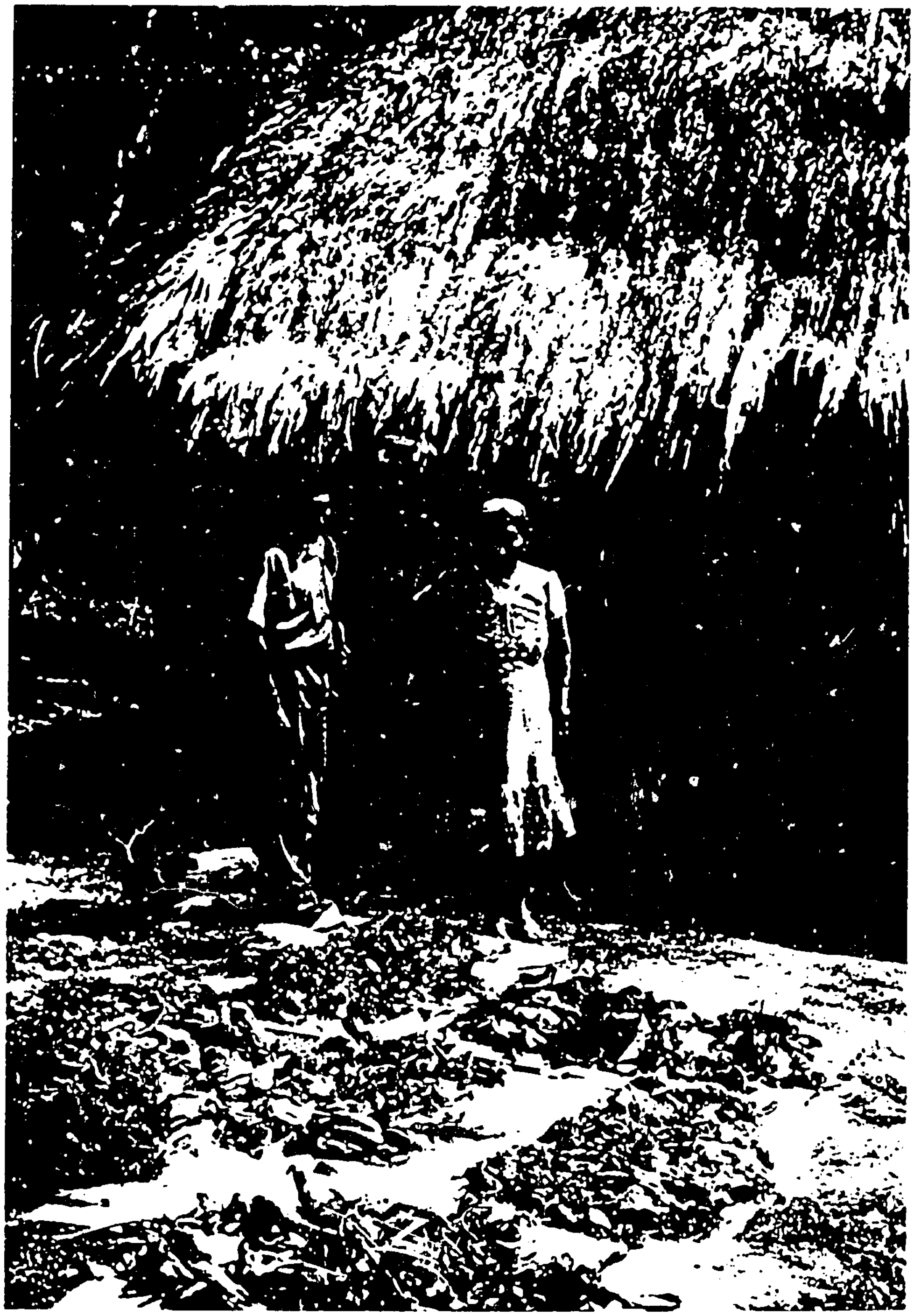

Figure 15. Bulk samples being dried under the supervision of Antonio and Juanita Cuc.

give an organic extract. After the methanol wash, the residual plant material is extracted by percolation at room temperature with distilled water; lyophilization of the percolate gives the water extract. All extracts are returned to the natural products repository for storage at -20°C until requested for testing.

In the *in vitro* anti-HIV screen, human T lymphoblastic cells infected with the AIDS virus are incubated for six days with varying concentrations of the extract (Weislow et al. 1989). Untreated infected cells do not proliferate and die rapidly. Infected cells treated with extracts containing effective antiviral agents will proliferate and survive at moderate extract concentrations, whereas high concentrations of extracts generally will kill the cells. The degree of activity is measured by the level of protection provided by extracts at sub-toxic concentrations. Extracts are formulated for testing by dissolving in dimethyl sulphoxide and dilution with cell culture medium to a maximum concentration of 250 ug/ml.

The results of these analyses have been most encouraging. Of the total information on 306 samples submitted to the PI on May 15, 1991, and subjected to the HIV screen, over 30 samples showed moderate or more substantial level of activity. Because of the sensitivity of information concerning potential therapies for HIV, there is great concern on the part of the NCI that preliminary information not be disseminated until individual compounds have been identified and tested for toxicity and overall effectiveness. In compliance with these wishes, the list of active plants is not yet available for inclusion within this report. However, we have been assured that this list will be made available, along with a complete analysis of the screening of Belizean plants for both anti-HIV and anti-cancer properties, for publication in the book on the ethnobotany of Belize. However, information from the initial analysis of the plants is presented in Appendix I, Table 1. It is interesting to note that this is the first testing of the ethno-directed sampling hypothesis which has been proposed as a result of our work with healers in Belize. As discussed in the paper, the ethno-directed sampling hypothesis consists of a cultural pre-screen--comprising indigenous information--and a botanical filter--the information gathered through the ethnobotanical process. The hypothesis suggests that the use of indigenous knowledge is a much more effective way of collecting a larger sample of biologically active plants than the control (e.g. the random collection of plants in the forest). As can be seen from Table 1, a preliminary set of data from the HIV screening program shows a fourfold increase in positive "hits" in the HIV screen using the "powerful plants" of the shaman, versus the control group of randomly collected materials (Figures

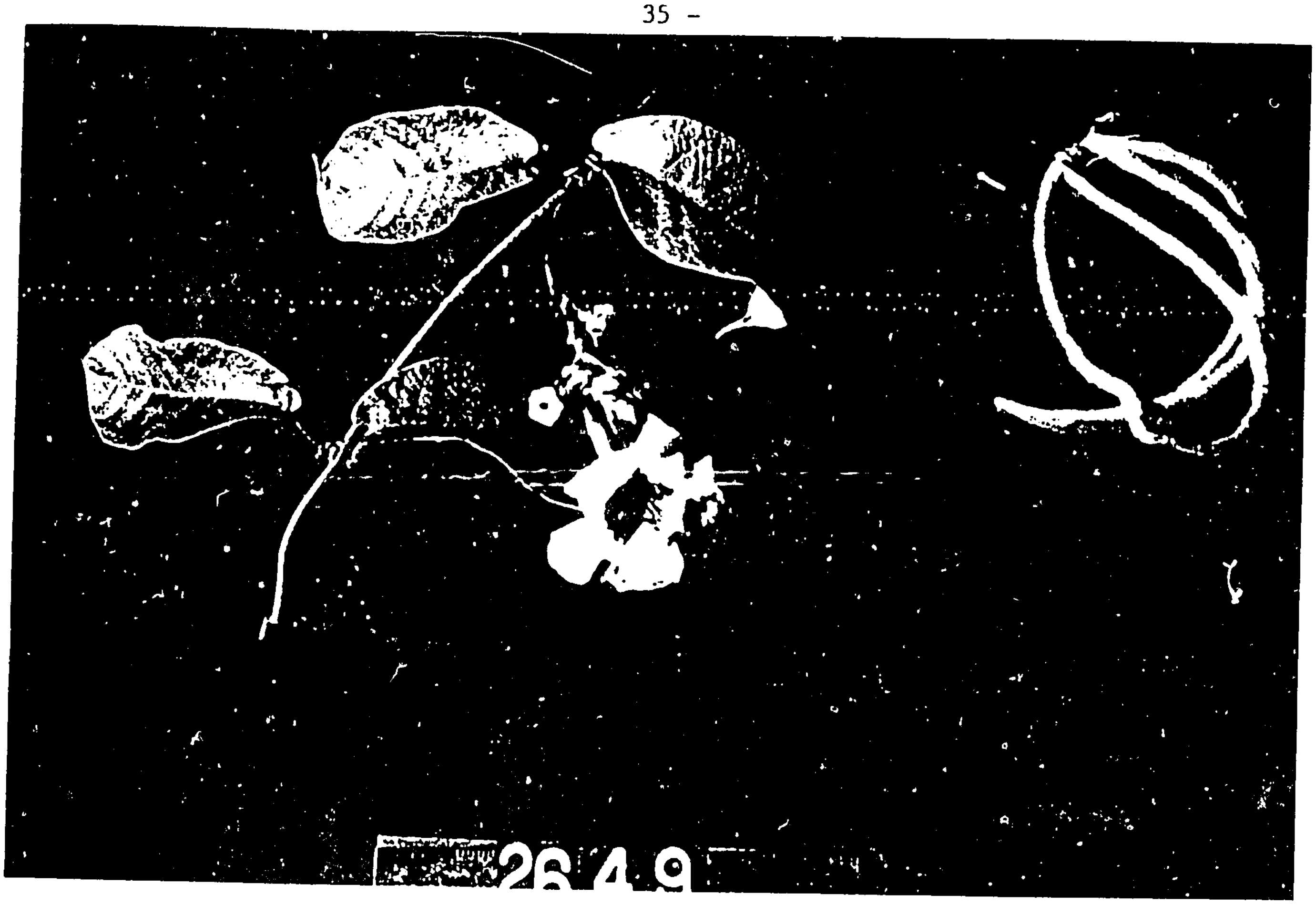

Figure 16. Randomly collected sample of the Apocvnaceae vouchered by herbarium sample and photograph.

Figure 17. Medicinal plant (Dioscorea sp.) in its understory habitat prior to collection for analysis.

16, 17). It is proposed to expand this experiment over a much larger area in Belize by gathering several hundred additional samples collected using the two systems. The initial work begun as a result of the present project certainly supports the ethno-directed sampling hypothesis, and supports the need for ethnobotanical information in modern developmental therapeutics programs.

Objective 5. Prepare a manuscript for publication on Maya medical systems, including documentation of the plants used in herbal medicine, a discussion of the effectiveness of these plants in their cultural context, as well as results from pharmaceutical screening of programs.

The activities of this objective are divided into three parts. These will be discussed in the order of their stages of completion.

The most advanced document is the manuscript for the book entitled, One Hundred Healing Herbs of Belize, by Drs. Arvigo and Balick. This book contains information on the local name, description, utilization and pharmacology (where known) of 100 of the most important Belizean plants used in primary health care. Black and white line drawings have been prepared by artist Laura Evans to illustrate this book. Representative illustrations prepared by Ms.Evans are presented as Appendix VI in this report. The book is a compilation of information obtained from the network of healers previously discussed, as well as information from the chemical and pharmacological literature, through the NAPALERT data base. This latter data base is a survey of the literature on the chemical composition and biological activity of the world's flora and has been provided to the project without cost. The book is designed to be used by local people interested in obtaining therapies from plants for primary health care conditions. We have made arrangements to publish this book in Belize. The funding of this publication is through a gift from the Rex Foundation, as well as the personal resources of Drs. Balick and Arvigo. We feel confident that this book will also be of interest to ecotourists in Belize, and will cover the publications costs within 2-3 years.

The second major publication resulting from this project is A Checklist of the Flowering Plants and Ferns of Belize, Their Common Names and Uses. At the present time, there is no reliable flora to the plants of Belize, except for various contemporary treatments of families such as the ferns. The Flora of Guatemala is generally accepted as being taxonomically out of date and in need of revision. A checklist is being prepared during the spring and summer of 1991, based on Spellman and Dwyer's checklist originally published in Rhodora, updated information from Flora Neotropica, various forestry manuals and papers, as well as the results of our firsthand research. At the present we are estimating an increase of ca. 10-20% in total records for the flora of Belize as compared to the Spellman and Dwyer list. The new checklist will be published and distributed by the PI and, it is hoped, eventually form the basis for a countrywide flora, including a series of florulas of specific sites.

Finally, the most ambitious publication project under this objective is the preparation of the book tentatively entitled Messages from the Gods; The Ethnobotanical Wealth of Belize. This book will compile the thousands of records, both published from firsthand research, that exist on the utilization of Belizian plants. It will also have individual chapters on home gardening systems, traditional healing practices of the various cultures, the extraction of non-timber forest products in Belize, the utilization of the Belizean flora in modern pharmacological research (including the previously discussed HIV and cancer work), and selected ethnographic information on the various cultures we have been working with. It is envisioned that this manuscript will take several more years of preparation and data analysis. A publisher (Columbia University Press) has expressed an interest in receiving this manuscript for publication in its series on tropical biology and resource management. The PI has already published two books with this series, and fully expects that this book will be accepted for publication with this publisher.

Objective 6. Promote and strengthen ties between Belizean and U.S. scientists in the area of traditional medicine, ethnobotany and the preservation of biological diversity.

This objective has been addressed through a variety of activities including seminars, workshops, and classroom lectures, joint expeditions, participation in the organization of the first and second traditional healers workshops, as well as frequent consultation with a variety of local government and non-governmental institutions. Drs. Balick, Arvigo and Shropshire have provided seminars in all of the communities that have been visited during the expeditions. As a formal part of each of our trips, we contact the mayor, teacher or village elder and ask them what would they like us to provide as part of our visit. Most often the response is a request for a lecture to the younger students of the schoc', or to community health care professionals. A number of these lectures have been given over the last two years, and have been very well received (Figure 18). At the present time, there are many more requests for lectures outside of our study area than can possibly be met. For this reason, we are proposing that in a future project more time be spent teaching the importance of the local plant resources for primary health care, in addition to collecting the actual plants and field data. In addition, the PI's in this project have all lectured several

Figure 18. Mr. Andrew Ramcharan lecturing to students in Ranchito on the value of local plants in healing.

Figure 19. Helicopter provided by The Royal Air Force removing participants in Dolores expedition from base camp.

times at open seminars in Belize City, coordinated through the Belize Environmental Center. One of the most significant contributions has been Dr. Arvigo's participation in helping to organize the first and second traditional healer's workshops, held in Belize City during November 1989 and February 1991. Dr. Arvigo, working with her colleagues from other NGO's such as the Belize Rural Women's Association and Belize Environmental Center, helped to develop these workshops, which were a first for Belize. In 1989, 125 people attended, including approximately 30 healers. In 1991, 254 people attended, including approximately 80 healers. These meetings were a great success and have helped to instill a sense of pride and unity in the community of healers in Belize.

Each of the botanical expeditions is multinational in its composition, although one of the PI's is present on all trips. We have participated in a series of expeditions coordinated by the Belize Environmental Center as part of its environmental assessment program. Dr. Balick was the expedition ethnobotanist for the Dolores expedition (Figure 19), and Dr. Arvigo was the ethnobotanist for the Cockscomb Basin expedition. This series of expeditions has been crucial to the development of a conservation strategy for Belize.

Finally, the PI's frequently serve as a resource for many of the environmentally-oriented Belizean NGO's and governmental organizations on a variety of issues relating to biological diversity, its use and conservation. These organizations include the Belize Environmental Center, the Belize Zoo and Tropical Education Center, the Program for Belize, The Belize Audubon Society, The Forestry Department and The Ministry of Health. These requests range from providing the scientific name of a useful or important plant species to preparing formal reports on the potentially harmful effects of the repeated consumption of local toxic plants. In addition, through the demonstration plots of the Ix Chel Tropical Research Center, a variety of issues concerning organic farming and plant introduction are addressed.

It is planned that the next phase of this project will include formal training for one of the foresters from The Forestry Department in the Herbarium of The New York Botanical Garden. It is, in our opinion, essential to have a manager for the BRH herbarium who has had a short course of formal training in the management of a research herbarium. Some of the PI's programs in other countries such as Brazil, Ecuador and Colombia have included training components as part of their efforts to support the local scientific community, and we are currently seeking outside funding to support this objective in Belize.

Conclusion

The first two years of this project have been most productive, and a great deal of new information about the

biodiversity of Belize, as well as its utilization, has been gathered. None of this would have been possible without the collaboration and direct support of a broad constituency of individuals and institutions in Belize. These include: Lou Nicolait, The Belize Environmental Center; Sharon Matola and Amy Bodwell of the Belize Zoo and Tropical Education Center; Mr. Oscar Rosado, Mr. Earl Green and Mr. Richard Belisle of the Belize Forestry Department; Mr. Harriot Topsey of The Archeology Department; Mr. Fred Smith of The Ministry of Health; Ms. Lucia Engleton of The Belize Rural Women's Association; Ms. Lourdes Hales of Medicos Sin Fronteiras, and the British Army and the Royal Air Force in Belize. We recognize that, despite the best ideas and intentions, no project can move forward without direct support, and this is graciously acknowledged from the U.S. Agency for International Development; The National Institutes of Health/National Cancer Institute; The Overbrook Foundation; The Rex Foundation; and through the personal donations of Drs. Arvigo and Balick. We are extremely grateful for the continuing contributions by Dr. Gregory Shropshire who has consistently served this project, without compensation, as a crucial member of the team. We are also grateful to our field assistants, Rolando Cocom and Pablo Cocom, whose enthusiasm and long hours of very hard work have not gone unnoticed. Finally, we thank the staff of the U.S. Agency for International Development for their interest in and support of our endeavors. These include our past Project Officer, Stephen Szadek, as well as our present Project Officer, Jeffrey Allen, the former head of the AID mission to Belize, Mosina Jordan, and Drs. James Hester and John Wilson of the Bureau for Latin America and the Caribbean, Office of Development Resources, Environment, Energy and Science staff.

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Ethnobotany and the identification of therapeutic agents from the rainforest

Michael J. Balick

Institute of Economic Botany, The New York Botanical Garden, Bronx, New York 10458, USA

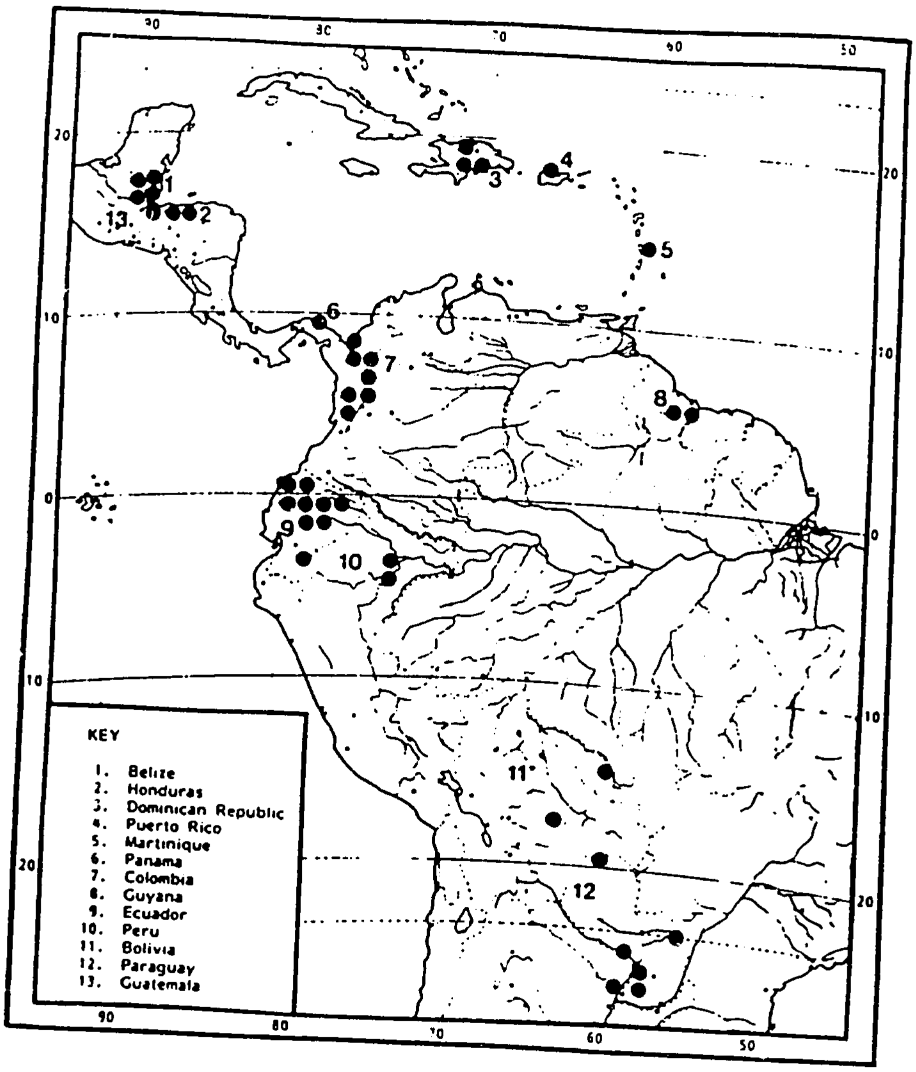
Abstract. Many rainforest plant species, including trees and herbaceous plants, are employed as medicines by indigenous people. In much of the American tropics, locally harvested herbal medicines are used for a significant portion of the primary health care, in both rural and urban areas. An experienced *curandero* or herbal healer is familiar with those species with marked biological activity, which are often classified as 'powerful plants'. Examples are given from studies in progress since 1987 in Belize, Central America.

The Institute of Economic Botany of The New York Botanical Garden is collaborating with the National Cancer Institute in Bethesda, Maryland (USA) in the search for higher plants with anti-AIDS and anticancer activity. Several strategies are cited for identification of promising leads from among the *circa* 110 000 species of higher plants that are present in the neotropics, the focus of this search. Recommendations are offered for the design of future efforts to identify plant leads for pharmaceutical testing.

1990 Bioactive compounds from plants. Wiley, Chichester (Ciba Foundation Symposium 154) p 22–39

Of the 250 000 species of higher plants known to exist on earth, only a relative handful have been thoroughly studied for all aspects of their potential therapeutic value in medicine. Yet the plant kingdom has yielded 25% or more of the drugs used in prescription medicines today (Farnsworth 1988). This paper is focused on the unstudied portion of the plant kingdom, particularly on strategies for increasing the efficiency of the search for new therapeutic agents, given the rate at which natural vegetation, especially in the tropics, is being destroyed.

The New York Botanical Garden Institute of Economic Botany (IEB) began its research programme in 1981. One focus of this programme is the search for plant species with new applications in agriculture, industry and medicine. In October 1986, the National Cancer Institute (NCI) awarded the IEB a contract to collect 1500 plant samples from the neotropics annually for its anticancer and anti-AIDS screening programmes. Because the number of species of higher plants in the neotropics is estimated to be 110 000, we decided to test several approaches to determine which system of collection could generate the largest proportion of leads or 'hits' in the *in vitro* screens. By early 1990, IEB scientists or collaborating scientists from other institutions had collected plants in twelve countries as well as in the Commonwealth of Puerto Rico (Fig. 1).



IG. 1. Collection sites from 1986–1990 for the National Cancer Institute-sponsored plant collection programme.

Collection strategies

The random method

This method, as shown in Fig. 2, involves the complete collection of plants found in an area of tropical forest. In most cases, only plant species in fruit or flower are collected, as determination of sterile specimens can be time consuming, difficult, or occasionally impossible. Large numbers of species can be collected in this way, depending on the season and the number of fertile plants present in the area.

Targeted plant families

The second strategy is to target for collection those plant families known to be rich in biologically active compounds, such as alkaloids, glycosides, steroids or flavonoids. Fig. 3 illustrates an area of tropical forest but in this example plants from four botanical families are the focus of the collection because they are known to produce biologically active compounds: Apocynaceae, Euphorbiaceae, Menispermaceae and Solanaceae. Naturally, there are many other families rich in biologically active compounds.

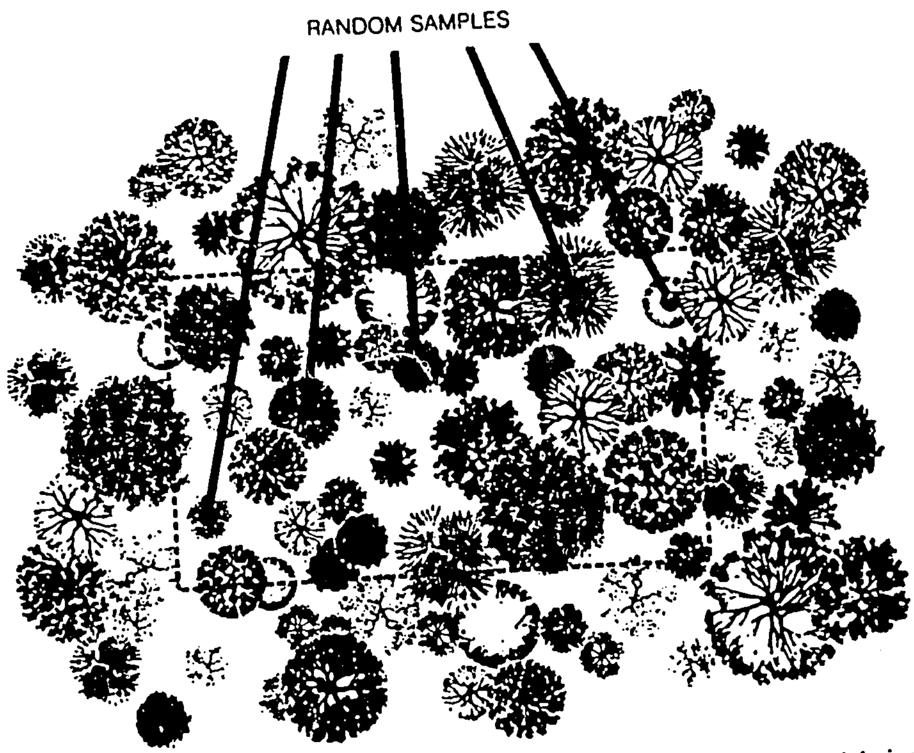


FIG. 2. Strategy for random collection in tropical forest. Diagrammatic aerial view of forest showing marked plot where plant species are collected.

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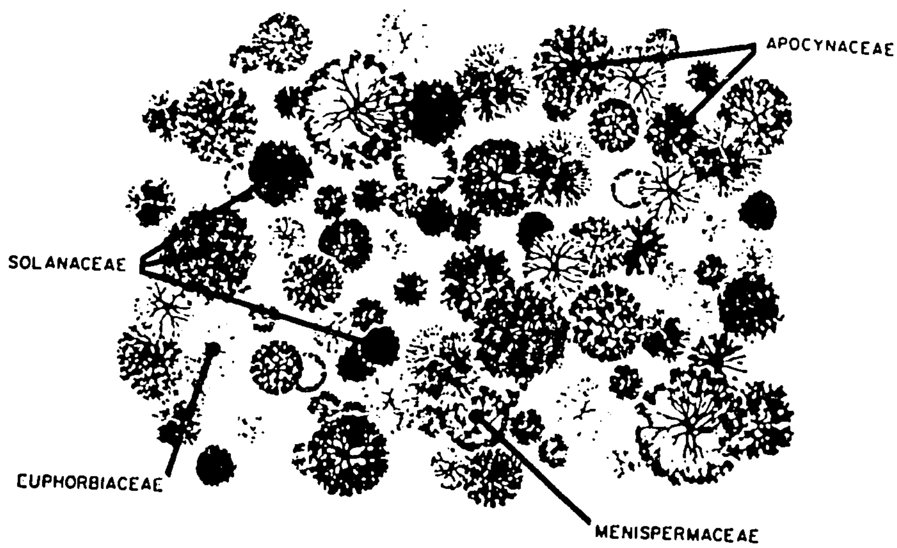

FIG. 3. Strategy for plant collection in tropical forest by plant family on the basis of known presence of bioactive compounds in certain families.

The ethnobotanical approach

This approach employs local people's knowledge about the medicinal uses of the plants and their environment. These people, working with an ethnobotanist, select the species of plants that are used medicinally in the area. Fig. 4 depicts an aerial view of the same area of tropical forest as Fig. 3 in which four genera of plants are used for medicinal purposes: *Bursera*, *Protium*, *Simaruba* and *Strychnos*. This strategy is the most difficult and intellectually challenging one, as it involves identifying people who are knowledgeable about the medicinal uses of their flora, and securing their cooperation in identifying the species they use or know.

It is the ethnobotanical strategy that I will focus on in this paper. Most of my work for the NCI programme involves the ethnobotanical strategy, primarily working in Belize. The co-principal investigator on this project, Dr Douglas C. Daly, has carried out both random collections and ethnobotanical studies in Bolivia, Colombia, Ecuador, Martinique and Peru. Plants from other areas illustrated in Fig. 1 have been collected using the random approach by 23 collaborating botanists.

In July 1987, I travelled to Belize at the invitation of Dr Rosita Arvigo, a nature-cure physician and doctor of naprapathy (a traditional medicine regimen, using manipulation, diet and massage). An accomplished Western herbalist, Dr Arvigo had been studying with an elderly Maya *curandero* or herbal healer, Don Eligio Panti, for four years. Dr Arvigo wanted to collaborate with an ethnobotanist, to document the Maya pharmacopoeia, as utilized by

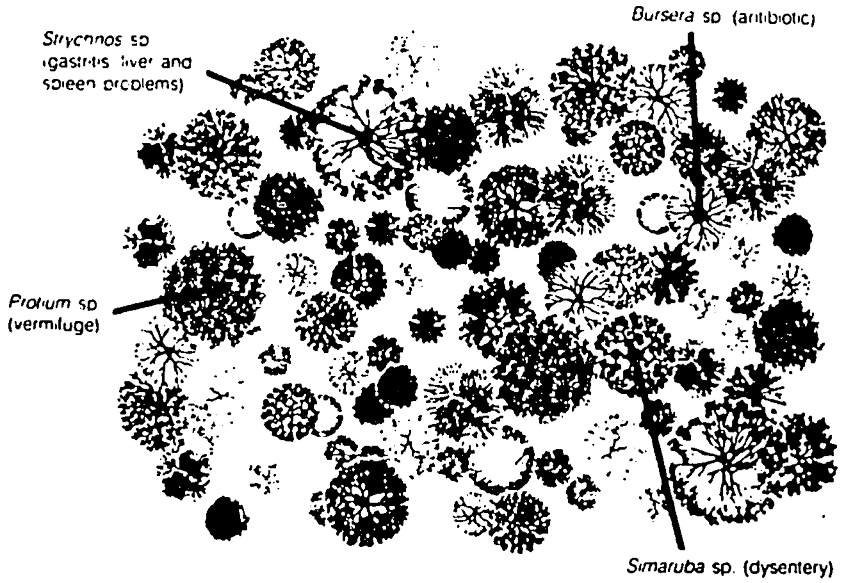

FIG. 4. Strategy for collection in tropical forest based on ethnobotanical uses, in this case for medicines. Examples of useful plants taken from studies with the Maya in Belize.

Don Eligio Panti. After a few days with Don Eligio, and further discussions with Dr Arvigo, I recognized the opportunity to document botanically the *materia medica* of this *curandero* and agreed to return to Belize to work with Dr Arvigo, Dr Gregory Shropshire and Don Eligio Panti. This collaboration developed into the 'Belize Ethnobotany Project', a country-wide survey of the plants used by herbal healers, bushmen and other people knowledgeable about the uses of the native Belizean flora. Belize is a small country with some 180 000 people, but it is culturally diverse and the population includes Mopan Maya, Kekchí Maya, Mennonite, Ladino, Creole, Garifuna and North American groups. All of these people use plants to varying degrees, and comparative ethnobotanical studies are underway.

Traditionally, the major focus of ethnobotany has involved the preparation of lists of plants used by people. In the last few decades, an interdisciplinary approach has developed and ethnobotanists have joined with social scientists and researchers from other fields to gather information concerning useful plants (e.g. Berlin et al 1974, Davis & Yost 1983, Denevan & Padoch 1987, Vickers & Plowman 1984). These interesting collaborations have generated new perspectives on the study of the relationship between plants and people.

The ethno-directed sampling hypothesis

The ethnobotanical approach to collecting plants, as defined above, involves recognition of the activity as a process involving two components. The first component is the *cultural pre-screen* by local people of plants in their environment. This is usually thought of as a trial and error process occurring over hundreds or thousands of years. Another perspective, which is the one held by some of the *curanderos* we work with in Belize, is that the selection of useful plants is at least partially directed by supernatural forces. The second component is the *ethnobotanical filter*, in which the information about specific plant usage is acquired and introduced into the body of scientific knowledge through the ethnobotanical research. The *ethnobotanical filter* scans all the plants present in a region and captures those species of pharmacological use in order to, in the present case, provide samples to a drug development screening programme. The ethno-directed sampling hypothesis therefore maintains that the combination of indigenous knowledge about medicinal plants and the ethnobotanist's collection and documentation of this knowledge will yield a higher number of biologically active compounds for the screening programme on a per sample basis as compared to a group of plants collected at random. This will result in a higher probability of producing useful therapies from a group of medicinal plants. The pharmacological literature contains many references to the value of ethnobotany and indigenous knowledge in the development of therapeutic agents from plants (Cox et al 1989, Elisabetsky 1986, Farnsworth 1984, Svendsen & Scheffer 1982), although there are, to the best of my knowledge, no actual investigations carried out with a random collection as a control group. Later in this paper I shall discuss the data that we have received from the NCI's study in relation to the ethno-directed sampling hypothesis.

The *in vitro* anti-HIV screen

The first priority for the plants collected in the NCI sponsored programme is screening against the human immunodeficiency virus (HIV), the causative agent of AIDS. Plants are air or heat dried (below 65 °C) in the field and packaged in 0.5–1.0 kg samples, which are sent to The Frederick Cancer Research Facility Natural Products Repository in Frederick, Maryland for extraction and study. Voucher (herbarium) collections are made in the field and accompany the bulk samples to the US for distribution and study by botanists. Duplicate specimens are deposited in herbaria in the country where the plant was collected.

The dried plant samples are stored at −20 °C for a minimum of 48 hours immediately after arrival at the NCI. This period of freezing is a requirement of the US Department of Agriculture as a precaution to reduce risk of release of alien pests.

Each sample is labelled, either in the field or on arrival at the repository, with a bar-code label designating a unique NCI collection number. After freezing, samples are logged into a raw materials database and sent to the Natural Products Extraction Laboratory for grinding and extraction. A small portion of each sample is removed and kept as a voucher. The rest of the sample is then ground and extracted by slow percolation at room temperature with dichloromethane/methanol (1:1 mixture), followed by a methanol wash. The combined extract and wash are concentrated *in vacuo* and finally dried under high vacuum to give an organic extract. After the methanol wash, the residual plant material is extracted by percolation at room temperature with distilled water; lyophilization of the percolate gives the water extract. All extracts are returned to the natural products repository for storage at −20 °C until requested for testing.

In the *in vitro* anti-HIV screen, human T lymphoblastic cells infected with the AIDS virus are incubated for six days with varying concentrations of the extract (Weislow et al 1989). Untreated infected cells do not proliferate and die rapidly. Infected cells treated with extracts containing effective antiviral agents will proliferate and survive at moderate extract concentrations, whereas high concentrations of extracts generally will kill the cells. The degree of activity is measured by the level of protection provided by extracts at sub-toxic concentrations. Extracts are formulated for testing by dissolving in dimethyl sulphoxide and dilution with cell culture medium to a maximum concentration of 250 µg/ml.

Random versus ethnobotanical collection

To test the ethno-directed sampling hypothesis, two groups of plants were collected and sent to the NCI for screening against HIV. The random collection included plants from Honduras and Belize. The ethnobotanical collection was composed of species identified by Don Eligio Panti as 'powerful plants'. The 'powerful plants', according to Don Eligio, are species with substantial therapeutic value which are frequently used in his practice for a variety of purposes. The results from screening the two samples are presented in Table 1. It should be emphasized that these results are preliminary, and that data from only a small number of samples are available for analysis. However, these data have been analysed using the Fisher exact probability test, a methodology useful for handling data from small sample sizes (Siegel 1956). The results of this test show that $P = 0.101$; while providing no firm proof, this is a strong indication that the null hypothesis (that there is no relationship between ethnobotanical

TABLE 1 Preliminary testing of plants in an *in vitro* anti-HIV screen

	Collection method	
	Random collections	*Ethnobotanical collections*
Total species tested	18	20
Per cent (number) active	6% (1)	25% (5)

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collections and active compounds) should be rejected. Therefore, although the results from these two data sets do not conclusively prove the ethno-directed sampling hypothesis, they do support its validity. We expect that at the end of the five-year collection period, information on 7500 plant samples will be available, representing a minimum of 2000–4000 species, which can then be classified according to medicinal and non-medicinal uses and further analysed for their effectiveness in the anticancer and anti-AIDS screens. At that time we will also be able to detect trends by plant family, as discussed in the second collection strategy.

The conservation imperative and medicinal plants

Each year large areas of rainforest are destroyed through conversion to agricultural land or for other purposes. These habitats contain plant and animal species that are found nowhere else on earth. Most conservation activity focuses on the rainforest as an important and biologically rich habitat, and as a potential source of new products, such as medicines that could be introduced into commercial use. Rarely is the perspective taken that the forests contain a wealth of medicinal plants currently used by local people. It is estimated that up to 80% of the world's population uses plant medicines as an important component of primary health care (Farnsworth et al 1985) and certainly our fieldwork in Belize and elsewhere in Latin America supports this assertion. Therefore, since adequate hospitals and Western-trained doctors are not found in much of the tropics, the destruction of the rainforest will also destroy the primary health care network involving plants and traditional healers. Although no census has ever been taken, it is likely that there are thousands, if not tens of thousands, of traditional healers practising throughout the neotropics. Very often these people are elderly and, because of the forces of acculturation present in their society, many have no apprentices to carry on their work. One effect of deforestation is to reduce dramatically the supply of medicinal plants available to the traditional healer. Fig. 5 gives an idea of the situation facing Don Eligio Panti in the collection of plants he uses in his medicinal practice. In 1940, in an early stage of Don Eligio's practice, he walked for ten minutes from his house to the secondary forest site where he collected medicinal plants used to treat his patients. In 1984, when he began working with Dr Arvigo, it took them thirty minutes to reach a site that had sufficient quantities of these same species. In 1988, when I accompanied Dr Arvigo and Don Eligio Panti to the nearest collection site, it took us seventy-five minutes to reach an area where the plants could be found. Clearly, the added time and effort involved in the collection of medicinal plants is an increased burden for the traditional healer, therefore reducing his or her effectiveness in offering primary health care services to the community. Thus, in addition to building a case for conservation activities based on the *potential* use of the forest as a source of medicinal plants for our society,

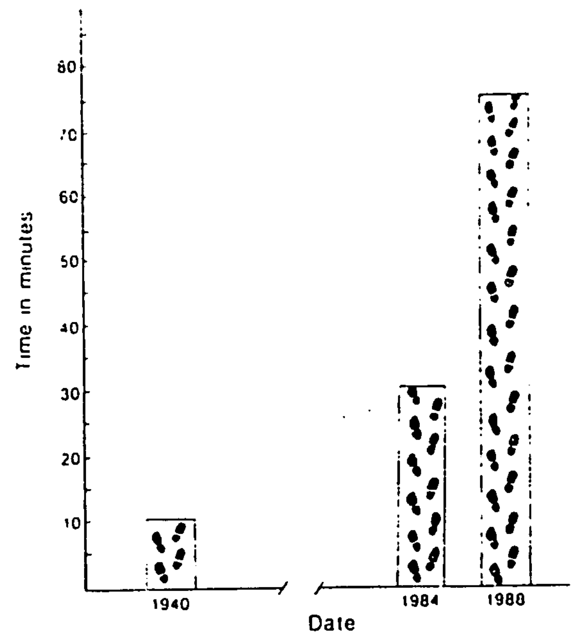

FIG. 5. Time required for Don Eligio Panti to reach secondary forest site for medicinal plant collecting. Note substantial increase from 1984 to 1988, indicating high level of forest destruction in the San Antonio region of Belize.

there is also great strength in the contention that conservation of these species is essential to the survival of the existing health care network in many tropical countries involving traditional medicine. Otherwise, as effective therapies are identified and developed from tropical forest plants over the next 5–10 years, the original habitats in which the species are found may no longer exist, and the plants so desperately needed as a supply of raw material will have become extinct.

Conclusion

As tropical forests are destroyed and tribal peoples acculturated, our ability to discover new pharmaceutical agents and bring them into everyday use is being seriously compromised. The lull in natural products research over the last few decades combined with the reduction in global plant biodiversity has resulted in an urgent race against time. Given the relatively small number of scientists qualified to address this problem, it is clear that choices in the allocation of time and resources must be made. The ethno-directed sampling methodology allows the researcher to obtain a higher number of leads in a pool of plant samples as compared to a group of plants selected at random. The broader utilization of this methodology could streamline the discovery and development of drugs from natural products.

Acknowledgements

I would like to acknowledge the input of Drs Elaine Elisabetsky and Douglas C. Daly in developing the terminology for the ethno-directed sampling hypothesis and to thank Dr Gordon Cragg for the very clear explanation of the screening programme carried out by the NCI. Dr Elaine Elisabetsky and Wil de Jong kindly provided help with the statistical analysis and Dr Charlotte Gyllenhaal provided bibliographic assistance. Drs Brian Boom, Elaine Elisabetsky and Douglas Daly offered comments on an earlier version of this paper. Bobbi Angell and Carol Gracie prepared the graphics presented in this paper. The fieldwork in Belize and Honduras was sponsored by the National Cancer Institute, the Metropolitan Life Foundation, and the US Agency for International Development. I am most grateful to the Philecology Trust for support of my research. Active collaboration of the Belize Forestry Department and Ix Chel Tropical Research Center, San Ignacio, Belize and the Fundacion Hondurena de Investigacion Agricola, San Pedro Sula, Honduras is acknowledged. Finally, thanks are due Dr Rosita Arvigo, Don Eligio Panti and Dr Gregory Shropshire for their interest in and continued collaboration on the Belize Ethnobotany Project. It is Don Eligio Panti's fondest wish that we will find a way to build a bridge between the medicinal plant knowledge of the ancient Maya and the therapeutic needs of Western medicine and contemporary society, and we are working toward this. This small contribution is dedicated to those thousands of traditional healers in the neotropics who, for the most part, toil under the most difficult circumstances and in the face of an onslaught of 'modern' culture.

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APPENDIX II

SAMPLE HERBARIUM LABELS, INCLUDING ETHNOBOTANICAL INFORMATION AND NCI COLLECTOR'S NUMBERS

The New York Botanical Garden
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Medicinal Flora of Belize Project

Pithecellobium keyense Britton MIMOSACEAE
-det. R. Barneby, 90

Off coast, Caye Caulker, south side of island. 17°45'N, 88°05'W. Common in sandy soil along beach.

Shrub to 2m; flowers green in bud, maturing white-green; fruits green.

n.v.: Xa-coy [Maya].
USE: Antirheumatic/analgesic (leaves). Drink decoction
Antidiarrheal/medicament for sore throat (fruit). Taste is astringent. Also commonly eaten by children
NCI Sample codes: stem(Q65S-603-R); roots(Q65S-604-S); bark(Q65S-605-T)
M. J. Balick 1951 January 30, 1989
with R. Arvigo, J. Davis, E. Gabourel, G. Shropshire

Fieldwork supported by the National Cancer Institute and the U.S. Agency for International Development

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POLYGONACEAE

Coccoloba uvifera (L.) L.
! Richard A. Howard, 90

Off coast, Caye Caulker. 17°45'N, 88°05'W. Common.

Tree to 7m with dbh 30cm; flowers white; fruit whitish, maturing red.

n.v.: Sea Grape [English].
USE: Comestible (fruit). Sold in the market
Antidiarrheal (bark). Drink decoction until cured
Antifungal for thrush (bark). Use infusion as mouthwash
NCI Sample codes: bark(Q65S-622-N)

M. J. Balick 1961 January 31, 1989
with R. Arvigo, J. Davis, E. Gabourel, G. Shropshire

Fieldwork supported by the National Cancer Institute and the U.S. Agency for International Development

APPENDIX III

An Assessment of the Conservation Status of Schippia concolor Burret in Belize, Central America

Michael J. Balick
The New York Botanical Garden
Bronx, New York 10458
(212) 220-8763

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Introduction

Schippia is a monotypic genus consisting of a single species, S. concolor. It was described by Burret (1933) from material collected in Belize by William A. Schipp. The type locality is listed as "19 mile Stann Creek Valley." There are two other sites where this species has been collected, Mountain Pine Ridge and 25 miles south of Belize City on the Western Highway. Johnson (1986) in his survey of the levels of endangerment of New World Palms suggested that Schippia concolor should be maintained in the endangered category, as recent attempts to study it in Belize resulted in only a single plant being seen.

In November 1987 I was asked by Dr. Dennis Johnson to investigate the status of Schippia concolor in Belize. This was to be concurrent with a similar effort by Dr. Hermilo Quero to carry out a similar evaluation in Southern Mexico. Fieldwork was undertaken during November while I was in Belize to study useful plants of the region.

Description of the Genus Schippia

Schippia is in the subfamily Coryphoideae, in the tribe Corypheae. It is in the subtribe Thrinacinae (Uhl & Dransfield, 1988). The most recent description of the genus Schippia is presented in Genera Palmarum (Uhl & Dransfield, 1987):

Schippia Burret, Notizblatt des Botanischen Gartens und Museums zu Berlin-Dahlem 11:867. 1933. Type: S. concolor Burret.

Moderate, solitary, unarmed, pleonanthic, hermaphroditic or polygamomonoecious palm. Stem slender, longitudinally striate, rough, with raised, close, oblique leaf scars. Leaves induplicate, palmate to very shortly costapalmate; sheath split basally, densely tomentose, disintegrating to form a thick fibrous network; petiole very long, narrow, adaxially channeled and abaxially keeled basally, biconvex distally, sparsely to densely tomentose, margins acute; adaxial hastula triangular or rounded, rather large, abaxial hastula a low rounded ridge; blade divided to below the middle into narrow, tapering, single-fold segments, with pointed, unequal, very shortly bifid apices, lighter colored beneath, appearing glabrous on both surfaces, midrib conspicuous, very short. Inflorescences solitary, interfoliar, much shorter than the leaves, branched to 2 (rarely 3) orders; peduncle moderate, dorsiventrally flattened; prophyll tubular, elongate, adaxially flattened, abaxially rounded, 2-keeled laterally, pointed, splitting unevenly apically, densely tomentose; peduncular bracts 3, ± like the prophyll but ± keeled dorsally; rachis about as long as the peduncle, glabrous; rachis bracts tubular, pointed, splitting adaxially, densely tomentose; other bracts membranous, pointed, small and inconspicuous; first-order branches adnate above the subtending bracts; rachillae short, narrow, spirally arranged, spreading, becoming smaller distally, bearing small triangular bracts each subtending a solitary flower. Flowers of two kinds, one hermaphroditic, the other lacking a gynoecium; calyx and receptacle forming a long pseudopedicel, calyx tubular basally with 3 triangular-lanceolate lobes; petals 3, distinct, much larger than the calyx, slightly imbricate; stamens 6, filaments distinct, elongate, anthers linear, sagittate basally, dorsifixed, versatile, latrorse, pollen elliptic, monosulcate, with punctate, tectate exine; gynoecium unicarpellate, ovoid, style elongate, tubular, open distally with stigmatic area around the rim, ovule basal, probably hemianatropous. Fruit globose with apical stigmatic scar; epicarp smooth, mesocarp thin, fleshy, endocarp smooth, membranous with anastomosing bundles. Seed globose with indistinct basal raphe, endosperm homogeneous; embryo nearly apical. Germination not recorded; eophyll simple. n=18

Schippia in Belize

In Belize, Schippia concolor often occurs in populations of Thrinax radiata Lodd. and Chrysophila argentea Bartlett. At first glance it is sometimes difficult to separate the species. The following key, modified slightly from Standley and Record (1936) can be used to separate the palmate-leaved species of palms in Belize:

Leaves palmate, with very numerous plaited segments.

1. Petioles armed with coarse stout prickles. . . . . Acoelorrhaphe wrightii.
1. Petioles unarmed.
   2. Leaf blades divided at the middle to the base.
   3. Trunk unarmed. . . . . Schippia concolor.
   3. Trunk armed with long spines. . . . . Cryosophila argentea.
2. Leaf blades not bilobed.
   4. Leaf blades with a well-developed rachis extending for about half their length. . . . . Sabal mauritiiformis.
   4. Leaf blades with a very short rachis or the rachis almost obsolete.

5. Fruit black; trunk with a network of fiber about the base of the leaves but without dense pads of "wool"; endosperm channeled. . . . . Coccothrinax argentea

5. Fruit whitish; trunk with thick pads of wool-like fibers about the bases of the petioles; endosperm smooth. . . . . Thrinax radiata.

During the period of fieldwork, both known habitats for Schippia concolor (Mountain Pine Ridge and the Western Highway) were visited. The type locality was not visited.

Schippia concolor was observed to be a common species on Mountain Pine Ridge. It was photographed near St. Augustine, at an elevation of ca. 500 meters. This is an open area of pine forest (Pinus carribaea) subject to frequent burning. Figures 1-2 shows the palm in this habitat. The bark of a number of species in this area is thick and corky, presumably to protect against or in reaction to fires. Figure 3 shows the thick "bark" on the stem of Schippia concolor. The fires seem to inhibit regeneration of the palms, as the seedlings observed under the individual mature trees (Figure 4) were quite young, and a complete assortment of palms at various life stages, as one might expect in a reproducing population, was not found in these fire-influenced habitats. In general, this species seems to be found in small populations, from ca. 2 or 3 to 50 plants in a single area.

The second site was along the Western Highway ca. 25 miles from Belize City. Here Schippia concolor is found in a dense forest formation that appears frequently inundated and not subject to fires. Figure 5 shows this palm and Figure 6 the forest habitat. No herbarium vouchers were made from this area.

The palm was also found growing on the grounds of the Belize Zoo and environs, ca. 15 km South of Belize City. The habitat was a more open area of forest than at the mile 25 site. However, as the Zoo is slated to be moved, in the future this habitat could be subject to disturbance.

Fruiting of Schippia concolor appears to occur in September. By November, only remnants of fruits, as well as a very few fruiting mature panicles were seen out of dozens of plants observed. One herbarium collection (M. J. Balick et al. 1845) was made at the base of the Mountain Pine Ridge reserve along the road from San Antonio at an elevation of ca. 230 meters (Figures 7, 8). This was in an area of undisturbed subtropical moist forest, and it was noted that the "bark" of Schippia concolor was not as corky as in the Mountain Pine Ridge area. Data from this collection is provided in Appendix 1. Herbarium specimens have been deposited at The New York Botanical Garden, with the Forestry Department, and at the IX Chel Farm field station; additional material will be distributed in the future. Both leaves and stem were collected and sent to the National Cancer Institute for screening for anti-cancer and anti-AIDS activity.

Schippia concolor was also discovered at IX Chel Farm, 10 km south of San Ignacio (Cayo District). This was in primary forest in association with Chrysophila argenta and Thrinax radiata. A collection was made (M. J. Balick et al. 1796), although no fruits or flowers were included. A description of this collection is also presented in Appendix 1. This represents a new locality for the species and further extends its range in Cayo District. Figure 9 shows the sites where Schippia concolor was either observed (documented by photographs) or collected as part of this study.

Assessment of Status of Endangerment in Belize

According to Hartshorn et al. (1984) Belize is not subject to the same rates of deforestation as other areas of the tropics, although pressures for farmland are increasing. The influx of tens of thousands of political refugees from neighboring countries in recent years has placed a great deal of stress on the forests along the Belmopan-Stann Creek road and south to Punta Gorda. Recently there has been consideration of implementation of large agricultural projects in other areas that could result in massive forest clearing. In addition, there is discussion of constructing new housing developments for the residents of Belize City, which was badly damaged by a hurricane in 1961. All of this could change the validity of Hartshorn et al's 1984 assessment.

While it is my opinion that no immediate threat to the existence of Schippia concolor in Belize exists at the present time, the fate of individual populations appears more questionable. The most protected populations are found in a forest reserve, Mountain Pine Ridge. It should be noted that, due to the frequent fires, the palms do not appear to be regenerating in sufficient numbers to maintain extensive populations over the long term. Another protected site is the IX Chel Farm, where the owners (Drs. Rosita Arvigo and Gregory Shropshire) are intent on preserving the forest where the species has been discovered. Over the past two years, this forest has been developed into a nature trail, known as the "Panti Trail" with many visitors annually coming to learn about the plants it contains. Palms in areas such as the base of Mountain Pine Ridge, or along the Western Highway are at far greater risk of destruction because of the pressures for development of this area. In conclusion, it would seem correct to say that some populations are in danger of extinction, but the genus as a whole in Belize is probably safe for the near future.

Acknowledgements

I am grateful to Dr. Dennis Johnson for his invitation to look at *Schippia concolor* in Belize, to Drs. Rosita Arvigo and Gregory Shropshire for their interest and companionship in the field, and to the Forestry Department of the Ministry of Agriculture, Forestry and Fisheries for granting permission to undertake fieldwork in Belize. The kindness of Mick and Lucy Fleming of C'- Creek and Lou and Robert Nicolait is also acknowledged.

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Figure 1. Schippia concolor near St. Augustine, in pine forest.

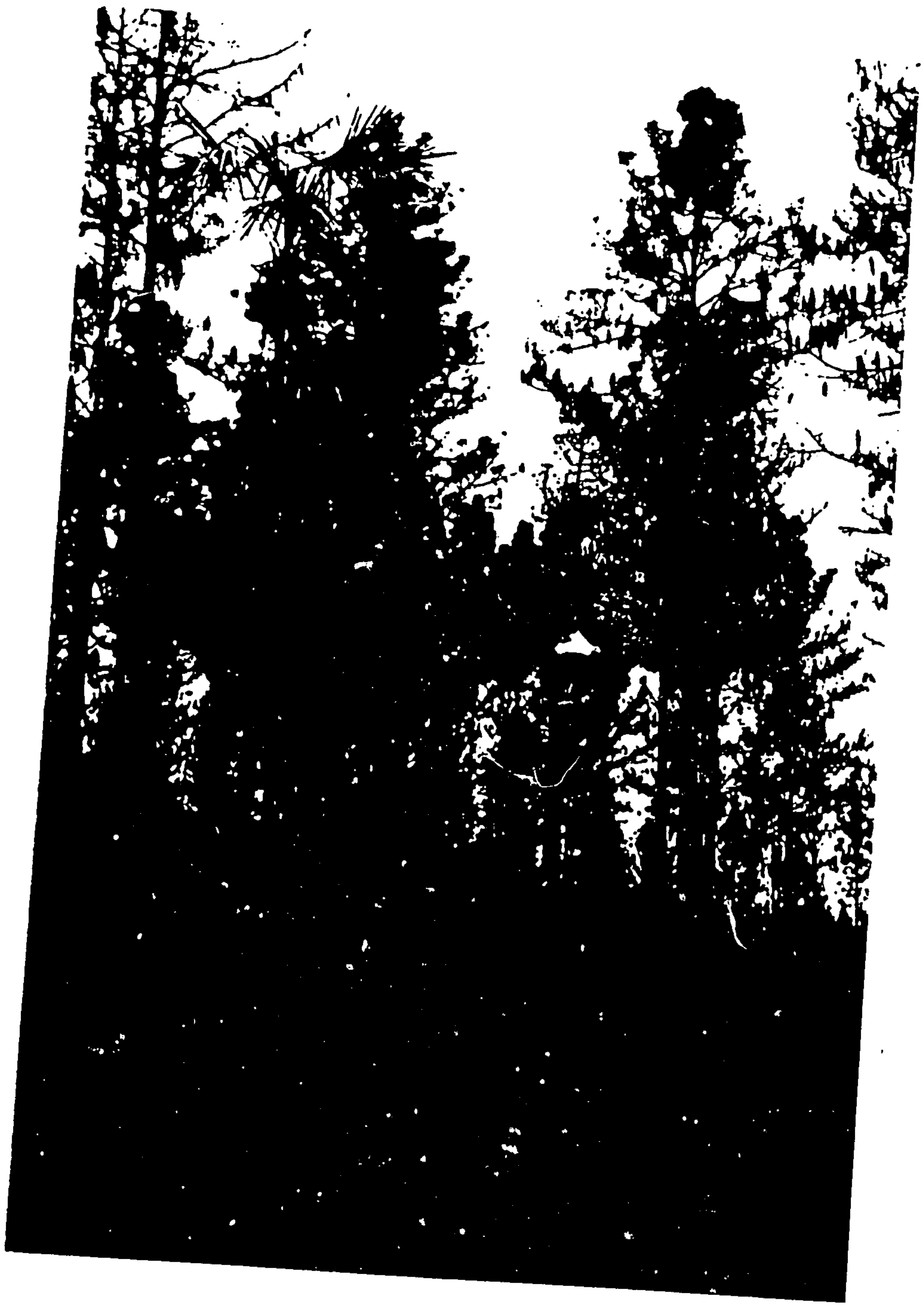

Figure 2. Schippia concolor near St. Augustine, in pine forest.

Figure 3. Thick "bark" on stem of Schippia concolor subject to frequent fires near St. Augustine.

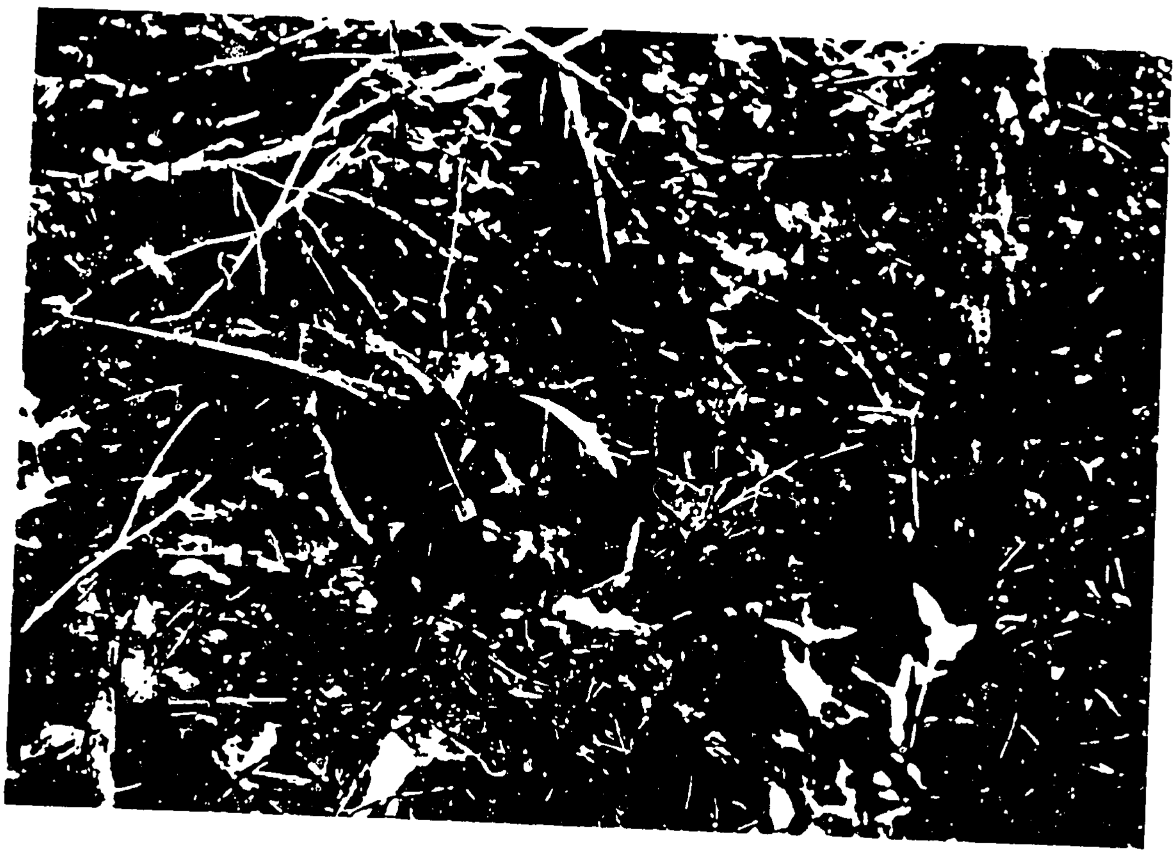

Figure 4. Seedlings under the trees of Schippia concolor; note that only very young seedlings are present.

Figure 5. Schippia concolor along the Western Highway, ca. 25 miles from Belize City.

Figure 6. Habitat of *Schippia concolor* along the Western Highway.

.70'

Figure 7. Population of Schippia concolor at the base of Mountain Pine Ridge Reserve.

Figure 8. Individual of Schippia concolor at the base of Mountain Pine Ridge reserve.

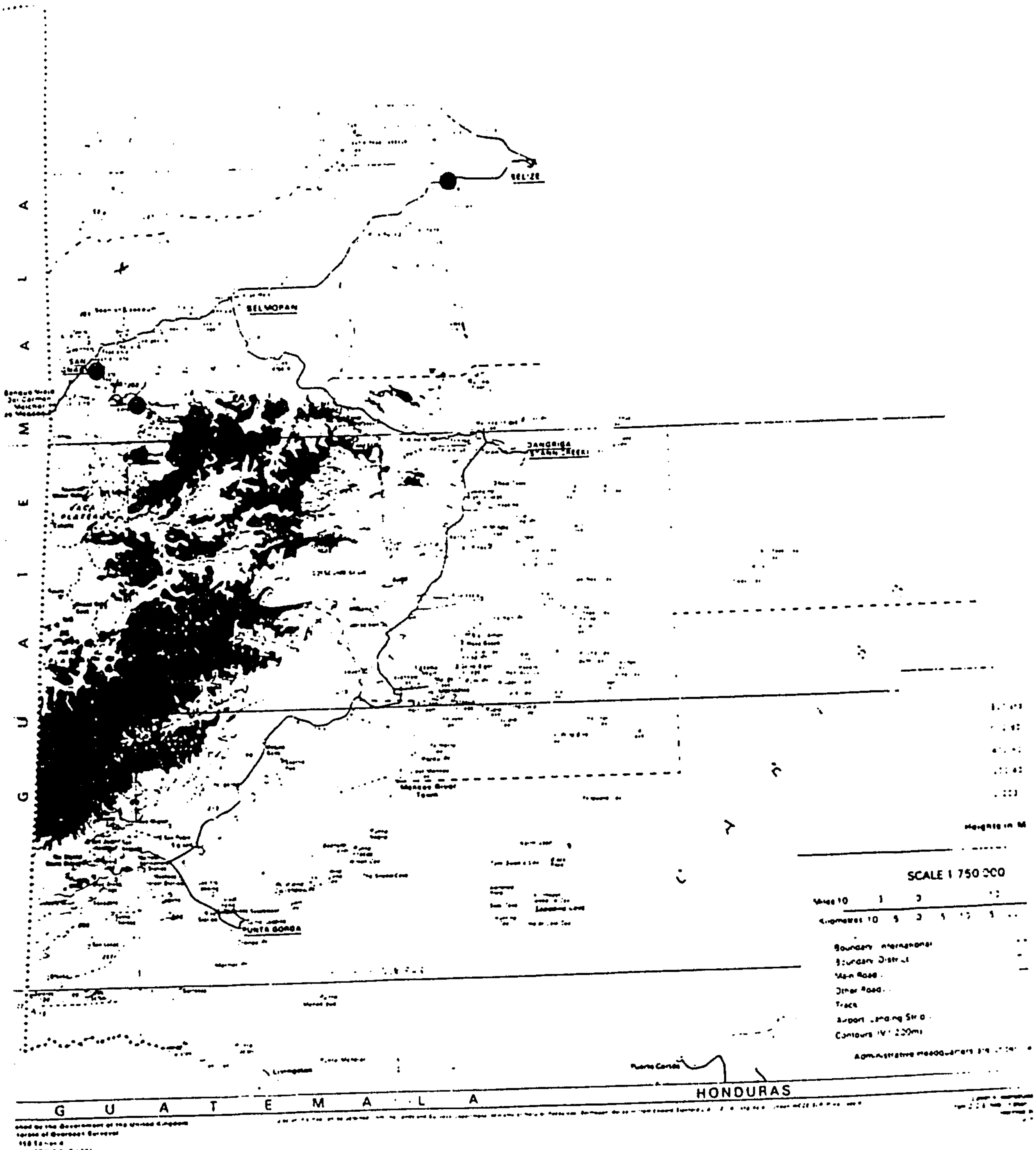

Figure 9. Localities in Belize where Schippia concolor was observed or collected.

Appendix I

Herbarium labels from collections of Schippia concolor made in Belize.

The New York Botanical Garden
INSTITUTE OF ECONOMIC BOTANY
Plants of Belize

Schippia concolor Burret

Longitude: 89°00' W   Latitude: 17°00' N
Cayo District: ca 10km SW of San Ignacio; Ix Chel Farm. Common in primary, moist forest in association with Chrysophila. Rich soil at ca 300m.

Palm to 5m with dbh of 5-8cm; "bark" slightly corky; leaves palmate; inflorescence with 3 bracts. Fruiting season said to be Sept. "Corky bark" present in the absence of regular fire.

M.J.Balick 1796   November 14, 1987
with R.Arvigo and G.Shropshire

Plants collected under the joint sponsorship of the U.S. National Cancer Institute, the US Agency for International Development, the H. John Heinz III Fund of the Pittsburgh Foundation, and the Joyce Mertz-Gilmore Fund.

The New York Botanical Garden

PLANTS OF BELIZE

Genus: Schippia
Species: concolor
Authority: Burret.
Family: Arecaceae.
Det. By: M.J. Balick, 1987
Field Char.: Palm to 5m with dbh of 8cm; leaves palmate; fruits round, ca 2.5cm. In 1 forest & broad leaf forest.
Locality: Belize; Cayo District; base of Mountain Pine Ridge Reserve; ca 5km from San Antonio; along road.
Alt.: 700 ft   Geogr. Coord.: 17 05' N X 88 55' W.
Coll.: M.J.Balick, R.Arvigo, G.Shropshire, A.Cuc, M.Xix.
No.: 1845.

This is a voucher specimen for anticancer and antiAIDS screening.
NCI Sample Number: Q65S0426-Y, Q65S-0423-8.

Collected under contract to: U.S. National Cancer Institute, The New York Botanical Garden.

Ethnobotany and Floristics of Belize Project

Composition of healer's garden by use: Xix Farm

Medicinal

Coll.# Latin Name	Common Name	Comment
2268-*Annona muricata* L.	Soursop (E) Annona (S)	
2269-*Byrsonima* sp.	Nanci (S) Chi (M)	vulnerary, antidiarrheal
2273-*Psidium gaujava* L.	Guava (E) Guajava (S)	anticeptic, antidiarrheal
2274-*Citrus aurantium* L.	Sour orange (E) Naranja agria (S)	antiemetic
2277-*Citrus limon* Burmann	Lemon (E) Limon (S)	antiemetic, heat exhaustion
2279-*Citrus sinensis* Osbeck	Orange (E) Naranja dulce (S)	for "bad stomach"
2282-*Gliricidia sepium* (Jacq.) Steud.	Madre cacao (S)	
2283-unid.	Maravilla (S)	for coughs, cold
2285-unid.	not reported	antidiarrheal
2286-unid.	Yierba escald-adura (S)	for baby rash
2287-*Momordica charantia* L.	Sorosi (S)	blood tonic
2288-*Sida* sp.	Chi-Chi-be (M)	analgesic, parturifacient
2289-unid.	Mosote (S)	analgesic
2290-unid.	Verbena("Male")(S)	analgesic
2291-*Commelina Diffusa* N.L. Burm	Sacatinto morado (S)	antiinflammatory
2292-*Lygodium* sp.	not reported	for "viento"
2293-*Psychotria* sp.	Canaan (M)	analgesic
2294-*Heliotropium angiospermum* Murray	Rabamico (S)	antidiarrheal
2295-*Cissampelos tropaeolifolia* DC.	Hoja preñada (S)	analgesic
2297-*Piper amalgo* L.	Cordoncillo ("male")(S)	for "viento"
2298-unid.	Hoja de salat (S)	somnifacient, tranquilizer
2299-*Psychotria* sp.	Canaan (M)	analgesic
2301-unid.	Cordiemiento (S)	analgesic
2302-unid.	not reported	anticarcinomic
2303-*Dorstenia contrajerva* L.	Lombrecina (S)	anthelmintic
2304-unid.	Claviosa	antipyretic
2305-unid.	not reported	antipyretic
2309-*Cedrela mexicana* Roem.	Cedar (E),cedro (S)	for cough
2310-*Tagetes erecta* L.	Ix-ta-púl (M)	antipyretic
2314-unid.	Trebo (S)	analgesic
2315-Verbenaceae (?)	Ruda (S)	antiflatulent
2316-unid.	Oregano (S)	antiinfective

Coll.# Latin Name	Common Name	Comment
2321-*Zingiber officinale* Roscoe	Ginger (E) Gingibre (S)	analgesic
2322-*Kalanchoe* sp.	not reported	antitussive, antiinfective
2324-unid.	Campana (S)	analgesic
2327-*Rhoeo spathacea* (SW) Stearn	not reported	antihemorrhagic
2328-*Cuphea calophylla* Chara.& Schldl.	not reported	antidiarrheal
2333-*Rosa* sp. (cultivated rose)	not reported	analgesic
2334-unid.	not reported	antifungal
2338-unid.	Apasote (M)	appetite stimu- lan
2339-*Stachytarpheta* sp.	Verbena	for "viento"
2340-*Piper marginatum* Jacq.	Cordoncillo (S) ("female")	for "viento"
2346-unid.	Chi-chi-be (M)	herbal bath
2347-unid.	not reported	herbal bath
2348-*Acacia hindsi* Benth.	Zubin (E)	hallucinogen
2349-*Psychotria* sp.	Canaan (M)	analgesic, antiulcerogenic
2351-*Vitex gaumeri* Greenm	Yash-nik (M)	unspecified
2352-*Bursera simaruba* (L.) Sarg.	not reported	antipruritic
2354-*Malvastrum corchorifolium* (desr. in Lam.) Britton ex Small	Chi-chi-be (M)	antipyretic
2355-*Annona* sp.	Anona Blanca (S)	analgesic
2356-*Adiantum* sp.	not reported	parturifacient
2357-*Malvaviscus arboreus* Cav. var. mexicanus Schldl.	Tulipan del monte(S)	antihemorrhagic
2358-*Catharanthus roseus* (L.) G.Don	not reported	antidiabetic

Food

2267-*Mangifera indica* L.	Mango (E) Manga (S)	fruit
2268-*Annona muricata* L.*	Soursop (E) Annona (S)	fruit
2269-*Byrsonima* sp.*	Nanci (S) Chi (M)	
2270-*Malpighia* sp.(?)	Plum (E) Jacóte (S)	fruit
2271-*Cocos nucifera* L.	Coconut (E) Coco (S)	fruit (oil)
2272-*Capsicum* sp.	Pepper (E) Chile (S) Mash-ik (M)	fruit
2273-*Psidium gaujava* L.*	Guava (E) Guajava (S)	fruit
2274-*Citrus aurantium* L.*	Sour orange (E) Naranja agria (S) Hos-pid (M)	rootstock
2275-unid.		fruit
2277-*Citrus limon* Burmann*	Lemon (E) Limon (S)	fruit

Coll.# Latin Name	Common Name	Comment
2279-*Citrus sinensis* Osbeck*	Orange (E) Naranja bulce (S)	
2284-*Ananas comosus* (L.) Merr.	Piña (S)	fruit
2306-*Colocasia* sp.	not reported	tuber
2311-*Origanum* sp.	Oregano (S)	leaves(spice)
2317-*Eryngium* sp.	Cimaron, Cilantro (S)	leaves, seeds
2325-*Ipomoea batatas* (L.) Lam.	Sweet potato (E) Batatas (S)	tuber
2332-*Carica papaya* L.	Papaya (S)	fruit
2341-*Eugenia ligustrina* (SW) Willd.	Cherry (E)	fruit
2342-*Bixa orellana* L.	Achote (S)	seeds(food dye)
2343-*Persea americana* Mill.	Aguacote (S)	fruit
2344-*Annona* sp.	"Anona de Hawaii"(S)	fruit
2345-unid.	Cherry (E)	fruit
2353-*Citrus paradisi* Macf.	Toronja (S)	fruit
2355-*Annona* sp.*	Anona Blanca (S)	fruit

Ornamental

2266-unid.	Guacamayo (S)	
2276-*Cordyline terminalis* Kunth	not reported	
2278-*Thunbergia erecta* (Benth.) T. Anders.	Rigoberto (S)	
2280-unid.	Jupito (S)	
2281-*Allamanda carthartica* L.	Campanitas Amarillas (S)	
2307-*Tithonia diversifolia* (Hemsl.) Gray	not reported	
2312-*Canna indica* L.		
2313-*Caladium bicolor* (Ait.) Venten	Corazon Sangriento (S)	
2318-*Asparagus plumosus* Baker	not reported	
2319-*Euphorbia pulcherrima* Willd. ex Klotz	Pas-cua (M)	
2320-*Tithonia rotundifolia* (Mill.) Blake	Daisy (E)	
2323-unid.	Campana (S)	
2326-*Impatiens wallerana* Hook.f.	not reported	
2329-*Cryptostegia grandiflora* (Roxb.) R.Br. ex Lindley	not reported	
2330-*Ruellia brittoniana* Leonard emend Fernald	not reported	
2331-*Nerium oleander* L.	Narcisso (S)	
2335-unid.	not reported	
2336-*Oxalis* sp.	not reported	
2337-*Impatiens balsamina* L.	China (S)	
2359-*Dieffenbachia maculata* (Lodd.) G. Don.f.	not reported	

Coll.# Latin Name	Common Name	Comment
Construction and crafts		
2296-unid.	not reported	stem (posts)
2300-unid.	Trompito (S)	bark (tanning agent)
2309-*Cebrela mexicana* Roem.*	Cholol (M) Cedar (E) Cedro (S)	lumber (construction)
Fuel		
2351-*Vitex Gaumeri* Greenm*	Yash-nik (M)	wood
Use unreported		
2308-unid.	not reported	

*--Also used as a medicinal
S-Spanish, E-English, M-Maya

Ethnobotany and Floristics of Belize Project

composition of healer's garden by use: Cuc Farm

Medicinal

Coll.# Latin Name	Common Name	Comment
2379-*Sechium edule* (Jacq.) Swartz.	Chayote (S) Chu-um (M)	antidysuric
2382-unid.	Oregano (S)	analgesic, cleanser, prophylactic
2383-*Piper* sp.	not reported	for "general problems"
2384-unid.	Mosote (S)	analgesic
2385-unid.	Vierba del Cancer(S)	anticarcinomic
2389-unid.	Oregano (S)	analgesic
2390-*Bixa orellana* (L.)	Cu-shúb (M)	for painful, swollen eyes
2394-*Solanum* sp.	Chal-ché (M)	for postpartum
2395-*Piper* sp.	Shu-tu-it (M)	analgesic vulnerary
2396-*Piper* sp.	Obel (S)	antirheumatic
2397-*Annona* sp.	not reported	analgesic
2400-*Annona muricata* L.	Guanabana (S)	antitussive
2402-*Byrsonima crassifolia* (L.) Kunth	Nanci, Crabu (S) Chi (M)	antiulcerogenic
2403-*Gossypium barbadense* L.	Cotton (E) Algodon (S)	antitussive
2404-*Pimenta dioica* (L.) Merrill	Allspice (E) Pimenta (S)	for "bad belly"
2409-*Psychotria* sp.	Ax-canaan (M)	antiseborrheic
2410-*Neurolaena lobata* L.R.Br.	Mano de lagarto	analgesic antiulcerogenic
2411-*Persea americana* Mill.	Aguacate	antitussive
2412-*Bursera* sp.	White Gumbo Limbo(E) Gumbolimbo Blanco(S)	antipruritic
2427-*Stachytarpheta* sp.	Verbena (S)	analgesic
2428-*tournefortia* glabra L.	Tke-nám (M)	antiinflam- -matory
2429-*Mimosa pudica* L. var unijuga (W.&D) Grsb.	Shmútz ("close your eyes)(M)	tranquilizer somnifacient
2432-unid.	Ke-kel-tún (M)	analgesic antiinfective
2434-*Punica granatum* L.	Pomegranate (E) Granada (S)	tranquilizer antipsychotic
2435-*Asclepias curassavica* L.	Cuchillo-Xiv (S-M)	"bad teeth" ex- tractor

Coll.# Latin Name	Common Name	Comment
2437-unid.	Itz-imul ("wind baths")(M)	for "viento"
2443-unid	John Crow Bead Berries (E) Yok-chom (M)	lactagogue
2444-*Psychotria* sp.	Anal ("male") (M)	herbal bath
2446-*Lygodium* sp.	Xix-el-bá ("veins of ground mole") (M)	antifungal
2447-*Thevetia ahouai* (L.) A.DC.	Dog's Tongue (E) Tze-pui (M)	helminthicide
2454-unid.	Yok-osh-om (M)	herbal bath
2458-*Persea americana* Mill		antitussive
2461-unid.	not reported	analgesic
2463-*Bauhinia herrerae* (Britton & Rose) Standley & Steyermark	not reported	antirheumetic for "viento"
2472-unid.	not reported	antiinfective antiinflammatory

Food

Coll.# Latin Name	Common Name	Comment
2377-*Abutilon permolle* (Willd.)Sweet	Arepa (S)	(sweetner) (garnish)
2379-*Sechium edule* (Jacq.) Swartz.*	Chayote (S) Chu-um (M)	fruit
2380-*Amaranthus* sp.	Calaloo (S)	leaves,seeds
2386-*Renealmia* sp. (?)	Shma-bui (M)	fruit
2387-*Solanum* sp.	Cha-yúk (M)	leaf
2390-*Bixa orellana* (L.)*	Cu-shúb (M)	seeds
2391-*Capsicum* sp.	Smash-ik (M)	fruit (spice)
2392-*Saccharum officinarum* L.	Tó (M)	stem, sap (sweetner)
2393-*Canna indica* L.	X'chi-qui-laba (M)	leaves (tamale wrap)
2398-*Musa sapientum* L.	Banana de marono (S)	fruit
2399-*Cnidoscolus chayamansa* McVaugh	Chaya (S)	leaves
2400-*Annona muricata* L.*	Guanabana (S)	fruit
2402-*Byrsonima crassifolia* (L.)Kunth*	Nanci, Crabu (S) Chi (M)	fruit
2404-*Pimenta dioica* (L.) Merrill*	Allspice (E) Pimenta (S)	fruit, leaves (spice)
2405-*Coffea arabica* (L.)	Café (S)	fruit(beverage)
2406-unid.	Ter-ech-mach (M)	fruit
2407-*Orbignya cohune* (Mart.) Dahlg.	Cohune (S)	fruit (oil)
2408-*Musa paradisiaca* (L.)	Platano (S)	fruit
2411-*Persea americana* Mill.*	Aguacate	fruit
2430-*Vigna unguiculata* (L.) Walp.	Pelon (S) Sh-pelú (M)	seed
2431-unid.	Lo-ló (M)	whole plant
2433-unid.	Orga de polo (S)	fungus
2438-unid.	not reported	fruit, sap

Coll.# Latin Name	Common Name	Comment
2439-unid.	Wild plum (E)	fruit
2441-unid.	(?)	for sugar making
2450-*Brosimum alicastrum* Sw.	Ramon (S)	fruit
2451-unid.	Sik-ey-yáh (M)	fruit (chewing gum)
2452-unid.	not reported	fruit
2453-unid.	Ter-ech-másh	fruit
2458-*Persea americana* Mill*	not reported	fruit
2467-*Spondias purpurea* L.	Plum (E), Ab-úl (M)	fruit

Ornamental

2378-*Portulaca grandiflora* Hook	not reported	
2388-unid.	Tza-kel-bák (M)	
2401-unid.	unreported	
2436-*Corchorus siliquosus* L.	Chi-chi-bé (M) (white variety)	
2440-*Lasianthaea fruticosa* (L.) K.Becka	Ish-tá (M)	
2442-unid.	not reported	
2449-unid.	not reported	
2456-*Ludwigia octovalvis* (Jacq.) Raven	not reported	
2459-unid.	not reported	
2468-*Dahlia pinnata* Cav.	Margarita (S)	
2470-*Kalanchoe* sp.	not reported	
2471-*Malvaviscus* sp.	Tulipan del Monte (S)	
2472-unid.*	not reported	
2473-unid.	not reported	

Fuel

2460-*Acacia hindsii* Benth.	Zubin (S)	wood
2462-unid.	not reported	wood
2464-*Cupania belizensis* Standl. vel aff.	Palo Carbon, Grande Betty (S)	wood

Construction and crafts

2457-*Licaria peckii* (Johnst.) Rosterm.	Tzo-otz-né (M)	trunk (house poles)
2469-*Sida* sp.	Escoba (S)	stem (broom handles)

Use unreported

2381-*Sida* sp.	Chi-chi-be	
2445-unid.	Sa-ku-ché (M)	
2455-*Pouteria* cf. *mammaso* (L.) Cronq.	Mamee sapote (S)	
2465-unid.	Xshik-en-ché (?)	

*--Also used as a medicinal
S-Spanish, E-English, M-Maya

APPENDIX V

COMMERCIAL NON-TIMBER FOREST PRODUCTS IN BELIZE

By: Robert M. Heinzman and Conrad C.S. Reining
January 31, 1990

For: Dr. Michael Balick
Institute of Economic Botany
New York Botanical Garden
Bronx, New York 10458-9980

INTRODUCTION

This chapter describes current and potential non-timber forest products (NTFPs) in Belize. NTFPs, in our usage, are defined as all products and services of forested ecosystems with the exception of timber destined for dimensioned lumber. Also excluded in this usage are the products and services of forestry plantations and simple or species-poor agroforestry systems. Thus, this investigation is restricted to "natural" forests. A natural forest, even one quite heavily modified or managed, retains a level of plant and animal diversity that far exceeds, often by an order of magnitude or more, plantations and simple agroforestry systems. Examples of NTFPs in Belize are latexes, spices, ornamental plants, resins, fruits, seeds, fibers, medicinal plants, charcoal fuelwood, wood for artisanal purposes, and forest-based tourism. Ecosystem services such as watershed, soil, wildlife, and germplasm protection, while also NTFPs, are excluded from this investigation.

More specifically, this chapter examines markets, as well as methods and history of production for many of the NTFPs of Belize. In addition to a discussion of individual products, we discuss the economic role forest products play in Belize.

Before discussing the NTFPs themselves, a review of the importance of NTFPs in natural forest management is warranted. The high diversity of flora and fauna in tropical forests is well documented, especially as compared with temperate forests. Often, however, this diversity is perceived to be a hindrance to increasing the productivity of forest land. The result is often a vast reduction in diversity as highly simplified agricultural, silvicultural, and livestock production systems replace the original forest. Yet abundant research attests not only to the negative ecological impacts of forest conversion, but to the often short-term economic production derived from cleared lands. Such knowledge challenges land-use planners to find ways of increasing the productivity of species-rich forest without sharply compromising the diversity of these forests (Myers 1988, Fearnside 1989).

By developing markets, or placing greater emphasis on existing markets, for larger numbers of forest species, while carefully controlling exploitation, four results are achieved. The first result is an increase in the value of the intact, natural forest (Peters et al. 1989). Though individual products and services may not have substantial value, in combination the value may be significant indeed. Second, by using larger numbers of products, the rural producers, and the country as a whole, are more insulated from the vicissitudes of external markets, inadequate infrastructure, and natural disasters that make dependence on a limited number of products and services a risky venture. Third, conservation of species-rich forests and associated ecosystem services does not conflict with the welfare of rural people and may help maintain, if not improve, the level of local and regional socio-economic well-being (May 1987). Finally, forest that is left relatively intact can, and in the case of Belize does, provide substantial foreign earnings from tourism.

That natural forest management, or management of species-rich forests is increasing is illustrated by the efforts throughout Central America to establish biosphere reserves. A biosphere reserve is a model for land-use that balances conservation with development. For example, within biosphere reserves there are zones of varying protection status. Some central areas are completely protected, while outer areas are open to increasing levels of exploitation as one moves from center to periphery. The outer areas serve as buffers for the inner areas. The idea with such reserves is that, while they will be protected from wholesale conversion or exploitation, they will be open to controlled forms of exploitation.

Belize retains a large percentage of its original forests, and despite the fact that all but the most inaccessible have been exploited for timber and other products, the opportunity now exists to promote diverse forest production and forest-based tourism.

METHODS

Because NTFP's must be seen within the context of the social and economic needs of the individuals, communities, and businesses which collect, process, and market these products and services, our investigation is necessarily holistic. That is, we have endeavored to provide ecological, economic, social, and political perspectives in our discussions of NTFPs. This approach consisted of conducting interviews with resource collectors, farmers, scientists, government representatives, and business people in the Cayo, Corozal, Orange Walk, Toledo, and Belize City districts.

We encountered some difficulty due to the rains and, consequently, impassable roads. This was especially true in the Vaca Plateau and western Orange Walk regions. In addition, the 4 September nation-wide elections and two national holidays within 10 days of each other during September combined to slow our investigation somewhat. The government was affected by the elections and the resulting change in ruling party.

BACKGROUND

The draft Tropical Forestry Action Plan (TFAP 1989) for Belize and the Country Environmental Profile (Hartshorn et al. 1984) provide excellent background information for the forests of Belize. According to the TFAP,

> Belize is an unusually heavily forested country. Although there was extensive Mayan agriculture up to a millennium ago, widespread selective logging for the past 300 years, and more recently a spread of shifting and settled agriculture, the greater part of the land area is still under forest [and other natural vegetation]. Moreover, most of the forest remains ecologically intact.

Belize is 22,963 km2 (8855 mi2) in area and lies between 15 and 19 north latitude. The northern half of the country and the eastern fringe of the southern half form an area of low relief. In the north and northwest, the substrate is limestone while in the southeast coastal plain sediments predominate. The Maya Mountains are comprised of arkosic sandstone and limestone sediments that commonly overlie exposed metamorphic rocks. Rising 300-1000 m (985-3,280 ft) in altitude, these mountains dominate the south-center of the country. The other major physiographic features are the karst landscape on the north and west of the Maya Mountains and the prominent and discontinuous karst foothill ranges in the southern interior (TFAP 1989).

Climatically, Belize lies in the subtropics. Mean monthly minimum temperatures range seasonally from 16-17 C to 33 C, the coolest season being November to January. The dry season normally extends from January or February to May. The rainy season peaks in July with a second peak in September or October. Rainfall varies greatly within the country and generally increases from north to south. Mean annual rainfall in Orange Walk is about 1,500 mm, while that in Punta Gorda is 4,230 mm. Hurricanes are a constant threat, with significant events in 1931, 1955, 1961, 1974, and 1978.

Because of large variations in soils, topography, altitude, temperature, and rainfall, there are six Holdridge ecological life zones in Belize. These range from Subtropical Moist in the north and west, to Tropical Wet -- transition to Subtropical in the extreme south. Within these ecological lifezones there are a variety of natural vegetation types, including broadleaf forests of high, medium, and low stature, shrublands with pines, pine forests with orchard savanna, marsh and swamp communities, mangrove and other coastal vegetation formations, and cohune palm (Orbignya cohune) forest. Within these vegetation types there are estimated to be 4000 flowering plant species. These species exhibit strong affinities with the flora of the Yucatán (Wright et al. 1959, in TFAP 1989).

Mahogany (Swictenia macrophyla) and logwood (Haematoxylon campechianum), supplemented by chicle (Manilkara achras, M. chicle) and secondary timber exports initiated at the turn of the 20th century, provided the majority of the country's wealth for nearly 300 years. Agriculture was actively discouraged and most food imported (Bolland 1988). Timber production peaked in 1952 and then declined rapidly until recently. Export-oriented agriculture involving large-scale clearing of land, in contrast to the shifting agriculture of the Mayas and Creoles, developed only after World War II. By the late 1950s, agricultural crops exceeded forest products in value of output (TFAP 1989).

Present-day Belize was originally established as a protectorate of England in the mid-1600s for both purposes of frustrating Spanish colonial efforts and as a source of timber. Extraction of both mahogany and tropical ceder (Cedrela odorata) gradually opened the interior, provided timber for the English navy, and established slavery in the region. A treaty signed with Spain restricted the development of agriculture (Bolland 1989).

Up to the middle of this century, timber extraction dominated the economy of the English colony. A steady decline in timber exports, related to both Belizean independence and British withdrawal from forest production management, and increasingly inaccessible or depleted forests have shaped forest production in recent decades. Timber exports in 1989 valued $6 million, approximately 3% of the Belizean economy (Forestry Department, unpublished data)[1]. Exports are dominated by mahogany and tropical ceder, though secondary hardwoods such as rosewood (Dalbergia stevensonii) and Santa Maria (Calophyllum brasiliense var. rekoi) are also important timber forest products.

The entire forestry sector of Belize suffers from the critical abscense of an industrial kiln and a veneer plant, both important components to the establishment of value-added production of hardwood products such as furniture.

[1] All monetary values are given in Belizean dollars. The current exchange rate is $2.00 Bze = 00 U.S. See the note on currency values for historical data presented in Table 1.

Currently, there are 6,368 km2 (2,488 mi2) of reserved forest, 6,219 km2 (2,431 mi2) of national lands, 282 km2 (110 mi2) of reserved land in Toledo District, 56 km2 (22 mi2) of conservation areas, and 8,397 km2 (3,283 mi2) of private land. This total of 21,322 km2 (8337 mi2) is virtually all of the 21,555 km2 (8,428 mi2) mainland area of Belize. How much of each land category remains forested is unclear, but estimates are that at least 60% of the country is covered by intact forest, with additional areas of disturbed forest (Steven Szadek pers. comm. 1989).

Belize has a very low population, with many of its 160,000-170,000 inhabitants concentrated in the seven largest population centers. Nonetheless, with increases in population, spurred in part by Guatemalan and Salvadoran immigrants, combined with the expansion of export-oriented agriculture and pasture development, significant reduction in the country's forests has occurred. There have been several transfers of forested national lands and reserved forests to agricultural production. Many of these transfers have occurred in a very ad-hoc manner and in areas of dubious suitability for permanent agriculture, orchards, or pasture development (TFAP 1989).

Belize is part of a larger bioregion that includes Chiapas, Mexico and Petén, Guatemala to the west and the Yucatán Peninsula to the north. Vegetation types are quite similar throughout this region, as are many of the forest-based economic activities. Chicle is collected throughout the region, and ramón (Brosimum alicastrum), mahogany, spanish cedar, and cohune palms are important forest components (Snook 1988, Wagner 1964). As this international area formed the center of Classic Maya civilization, and is currently undergoing both similar economic transitions and conservation efforts, we call it the Maya Bioregion.

NON-TIMBER FOREST PRODUCTS

The following section presents non-timber forest products used in Belize. In this list we present data that are both historical and contemporary, placing the current use of NTFPs within an historical context. Following the list of NTFPs is a discussion of the net economic contribution NTFPs make in Belize.

Much of the information presented below comes from diverse field interviews, observations, and experiences. Where possible we have identified either people or locations. A list of people interviewed is included as an appendix. As well, The Flora of Guatemala (various authors and dates) and numerous other references provide information.

One very important source of information, particularly for historical data, are several years of Forestry Reports, initially produced by the Forest Trust of British Honduras, later the Forestry Department of British Honduras, and still later by the Forestry Department of Belize[1]. British involvement in the forests of Belize began to decline in the late 1950s. In turn, there were extensive budget reductions and, subsequently, a decline in the quality, quantity, and reliability of data. Severe cutbacks in Forestry Department funding took place after the 1959 Downie report, which argued that such cutbacks were motivated by the reduction in mahogany and pine production. That diminishing British involvement in Belize resulted from a growing nationalism movement is also likely (Hartshorn et al. 1984). The last yearly Forestry Report is from 1971 but appears a mirror copy of the Forestry Report of 1970. Though there are subsequent reports, prepared mainly for regional forestry conferences, they are of a cursory nature.

Non-timber forest products fall into two categories. The first category is those products that are harvested for international or large national markets. These forest resources are

[1] Belize used to be called British Honduras. In this report, for purposes of simplification, we only the name Belize.

includes forest resources used in both national and local markets. Quantitative data for this category of products are often difficult to find because both prices and volumes fluctuate from community to community depending on several factors: seasonality, relative abundance, and customs regarding collection times and processes; the fact that many forest products are valued in barter and reciprocity rather than on a monetary basis; and, as they are not a source of ever-in-demand foreign currency, that they merit little regulatory or accounting effort. Detailing this second category of forest products requires in-depth ethnobotanical research, which is the objective of the USAID-sponsored project currently underway.

In the list below, [illegible] listed alphabetically by common name. Certain NTFPs are grouped within use categories (i.e. construction materials, palm products). These are listed alphabetically. Production data are presented in Table 1.

Allspice (Pimenta dioica)

The fruits of this mid-canopy species are harvested when ripe, usually from mid-July through September, and are sold in local markets throughout Belize. The dried seeds are used in a variety of dishes and the green leaves make a refreshing and medicinal tea. Exports are first mentioned in the Forestry Report of 1962, as summarized in Table 1. It is likely that exports continued beyond 1970 but, as with all of the products in this list, we could find no data for the period 1970 to 1987.

In Petén, Guatemala, harvesting has traditionally been done by scaling the trees, in the manner of chicle harvesters, and cutting off fruit laden branches. The tree grows a new canopy and can be harvested again after an undetermined number of years. In Guatemala there also exists an established marketing structure that harvests, transports, processes, and exports the spice to other countries. This export trade competes against the world's leading producer, Jamaica (Heinzman and Reining 1988). It appears that little allspice is exported from Belize. In addition, the Belizean populations of P. dioica have suffered from the practice of felling trees to get access to the fruiting canopy, as have populations in other part of the bioregion. Felling allspice trees for their fruit is not new: the Forestry Reports of 1962 and 1966 mention that several people were prosecuted for felling trees. Though some enforcement occurred in the 1960s, at present we know of no organized efforts to curb illegal felling.

Animals

Skins and Live Animals

A prolific trade in both live animals and skins is revealed in the Forestry Reports. Skins of unidentified species and live birds were exclusively exported to the U.S. By the mid-1930s "alligator" skins dominated this trade sector, and importing countries included Honduras and Guatemala. After 1959, reporting on this trade stops, a reflection either of cessation of trade or of budgetary cuts within Forestry. Belize is now a CITES member and all trade in forest animals is either restricted or closely monitored. As is the case throughout the Maya Bioregion, however, an illegal trade in skins and live birds flourishes, the latter commonly kept as pets throughout Belize.

The Belize Zoo remains inseparable from the traffic in live animals. The Zoo often acquires pets from owners overwhelmed by the responsibility or burden of caring for a wild animal. As well, the Zoo, which is currently building new facilities, entertains a large number of visitors each year, and remains one of the most prominent advocates of environmental education in the country. Several species of mammals, birds, and reptiles are the basis for this endeavor. Hence, the Zoo, and its role in nature tourism and education, is a product of the forests of Belize. While classifying a zoo as a NTFP may seem unrelated to actual forest productivity, such classification underscores the diverse products -- both economic and cultural -- that forests provide.

Butterflies

Also not commonly thought of as an NTFP, production of butterflies can, if intensively managed, impart significant value to forests. Harvesting and production of butterflies appears to be restricted to two locations, the "Dem Dats Doin'" farm in southern Toledo District and the Shipstern Wildlife Reserve in northern Corozol District. In the former, harvesting is more a hobby than a commercial endeavour, so this discussion focuses on the larger commercial production at Shipstern.

The Preserve is 110 sq km (43 sq mi) in size and is owned by a British real estate developer who also owns three butterfly houses in Europe. A butterfly house, of which there are nearly 40 in Europe and a few in the United States, is an enclosed botanical garden that hosts live tropical insects, reptiles, and plants for commercial display to the public, particularly educational groups. The intent of the Preserve's managers, who are butterfly specialists, is to not disturb the land, while covering expenses of the Preserve through the intensive production and exportation of live butterfly and moth pupae.

Both butterflies and, to a lessor extent, moths and nurse plants (mostly herbaceous plants and shrubs) are harvested from the Preserve and bred within mesh enclosures. The forest mainly provides fresh genetic stocks of plants and animals. Nearly all production occurs within the farm. Caterpillers are allowed to pupate and, as soon as an export permit is awarded, they will be sent in bulk to international destinations. Production goals are set at 10,000 pupae/year, divided among 30 species, each pupa selling for an average of $3.20 f.o.b.[3]

Future plans include using the Preserve within the context of the biosphere reserve model, with limited extraction of NTFP's along the Reserves borders by the people of nearby Sarteneja village. Other biosphere uses include beekeeping, nature education and

[3] Fee on board: The gross value of an export item exclusive of cost of international transport.

development of the existing trail system, and the expansion of the existing scientific research facilities (J.C. Mermann and T. Boomsa, pers. comm. 1989).

Chicle (Manilkara achras, Manilkara chicle)

Historically, the latex of this common forest emergent has been the most important NTFP extracted from the Maya Bioregion. Harvesting probably started in Petén, Guatemala (Soza 1970) and in the forests of southern Mexico (Snook 1988) in the 1880s. In Belize, which has dense populations of Manilkara achras in the northern plains and Manilkara chicle in the southern Maya Mountains, it is less certain when tapping began. The Forestry Report of 1924, the earliest we could obtain, indicates substantial latex production in 1923. Thus, the industry was well developed by this time.

Production. Production for the entire Maya Bioregion was 5.45 million kg (12 million lbs) annually from 1927-1929. In 1930 output of chicle rose to 6.4 million kg (14 million lbs) with a retail market value of US$70 million (Standley and Williams 1967, 8:222-228). Principle importing countries included the U.S., the U.K., Canada, Italy, and France. Output fell with a drop in demand during the economic depression of the early 1930s. Consumption in the U.S. alone dropped by 50% and, as most companies retained a reserve stock to last 3-4 years, demand remained curtailed (Forestry Report 1933).

Prior to the closing of the Guatemalan border with Belize in 1934, most of the production of Guatemala was exported through Belize City. For example, 1928 production from the forests of Belize was 209,171 kg (460,176 lbs) but exports were 1,167,743 kg (2,569,035 lbs). The production of Belize and the amount exported were equal in 1934, though by 1937 it appears the border once again became leaky and the colony was re-exporting latex extracted from Petén.

In the 1940s production peaked again. In 1942 Mexico produced a peak of 3.27 million kg (7.2 million lbs) (Snook 1988). In 1947 Guatemalan production peaked at 2.23 million kg (4.9 million lbs) (Soza 1970). From Table 1, it appears that the production of Belize also peaked during this period, with an average annual export from 1938 to 1947 of 0.5 million kg (1.1 million lbs).

First mention of different grades of chicle appears in the Forestry Report of 1950, though the difference between grades is not consistently indicated until the Forestry Report of 1953. A distinction is made between the exportation of "crown gum" and "chicle". Crown gum is the lower quality latex of M. chicle, harvested in the wetter, higher altitude south. Chicle is the higher quality latex of M. achras, which originates in the lower, drier forests of the north and west. The lower value crown gum was mixed with higher grade chicle latex, or sold as a secondary grade latex throughout the history of Manilkara exploitation.

By the mid-1950s, international demand for both classes began to decline. Petrochemical substitutes developed during World War II provided a less costly gum base of higher consistency and began to replace the more costly and variable natural forest product. For example, Mexican production dropped in 1952 to 0.68 million kg (1.5 million lbs), a decrease of 80% from a decade before.

Despite such trends, demand for Belizean production remained relatively constant in the 1950s, perhaps because of strong commercial ties with the U.K. and, more importantly, with the U.S. through the presence of international investment. However, the market was weakening in Belize, as reflected in the Forestry Report of 1956, which indicates that demand was shifting towards purer, higher quality latex of M. achras. Moreover, demand for first grade chicle had suffered because of adulteration, and therefore inconsistent quality, with second class Manilkara latex and the latexes of other species such as mammee apple (Pouteria mammosum) and black poisonwood (Metopium brownii). Such complaints of reduced quality through adulteration are echoed today by both importers of chicle from the Maya Bioregion and contractors responsible for fulfilling contracts with exporters.

The drop in international demand was soon felt by the Colony: production fell to 62,273 kg (137,000 lbs) in 1970 and, by the mid-1980s, production was nearly zero (TFAP 1989). As can be seen in Table 1, however, a resurgence in demand is occurring. Mexico exported 64,545 kg (142,000 lbs) in 1987 (Snook 1988), and Guatemalan production, though fluctuating in the 1980s between 61,818 and 124,090 kg (136,000 and 273,000 lbs) per year (Gremial 1988), reached a level of 431,633 kg (950,000 lbs) in 1989 (Chicle warehouse, Santa Elena, Peten). Demand is only for latex of the highest purity and quality, hence only the latex of M. achras of the northern forests, which are privately held lands in Belize, is being extracted. This demand originates almost entirely from Japan and, to a lessor extent, Italy, where markets for higher quality, natural chewing gum exist.

The value of production, as a percentage of total forestry exports from Belize during the late 1920s was approximately 10% (mahogany and tropical ceder represented over 80% of all exports). This percentage increased to over 30% during the Great Depression as the higher value hardwood trade was more severely curtailed. Latex production in 1988 was again 10% of forestry exports, yet the entire forestry sector, approximately $6,000,000, represented only 3% of total exports.

Current production totals 90,909 kg (200,000 lbs) of first grade chicle to be collected entirely in northern Belize by about 90 chicleros. Trees are bled through a series of crossing cuts that descend the bole of the tree. In camp, the collected latex is boiled until the desired moisture content is achieved (25 - 30%) and formed into 9 kg (20 lb) bricks. Each brick requires the latex of five or six trees. If the moisture content is too high, the latex is too elastic, and if too dry, the latex becomes brittle. Each chiclero stamps or carves his mark into his bricks so that he may be paid for his production.

On average, a chiclero can harvest between 23 and 32 kg (50 to 70 lbs) a week, though some are capable of producing 45 kg (100 lbs). Chicleros are paid $4.40 per kg ($2.00/lb). The exporter receives $6.16 per kg ($2.80/lb) for chicle with 30% moisture content, $6.60 per kg ($3.00/lb) for 25% moisture content, f.o.b. Great care is taken to inspect the bricks for adulteration with the latex of other species and for the presence of rocks or other foreign objects. Chicleros tap trees only during the rainy season because dry season stresses reduce sap flow.

Chicle harvesting illustrates the dependency of NTFP economies on diverse forest species. The gravity-drained latex is gathered at the base of each tree in burlap bags, often bags sealed with ulé, or castillo, the rubber latex of Castilla elastica. Mules that provide supplies to harvesting camps and carry the finished bricks out of the forest are fed the bark, leaves, and fruit of the nutrient-rich ramón tree (Brosimum alicastrum).

Research. Because of the commercial importance of Manilkara, extensive research was initiated during the late 1920s. The focus of the research was to increase levels of sustained latex production as well as decrease the level of plant mortality resulting from inappropriate or over-tapping. This research led to regulatory efforts in the early 1930s. Though such research is discussed in the forestry reports, greater emphasis is placed upon reporting the type of research conducted rather than the results. Even so, some interesting conclusions can be drawn. As well, the individuals, research institutions, and publications mentioned in the reports are discussed here.

Research was conducted by both the Forestry Trust and academic researchers from the U.S. in conjunction with the Chicle Development Corporation (CDC) and the Belize Estates Company[4]. The CDC enlisted the assistance of Dr. J.S. Karling of Columbia University and

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[4] These two entities controlled the vast majority of forested land in northern British Honduras. Such tenure has resulted in the present day ownership of northern Belize by only a few private interests, including the Belize Estates and Produce Company and the Programme for Belize.

his student, C.L. Lundell, as well as P.C. Standley of the Smithsonian Institute, and W.D. Durland, a Yale School of Forestry graduate. It also appears that the Tropical Woods Research Foundation of Washington, D.C. played a role in research efforts, as did the Tropical Woods organization of the Yale School of Forestry. In the late 1920s, the CDC, in conjunction with Forestry personnel (of whom the CDC made extensive use), established an experimental station at Honey Camp Jib Forest Reserve, now the only remaining forest reserve in northern Belize. Karling conducted tapping experiments on this land.

Research conducted include the following: determination of plant population and size class distribution; effects of improvement, such as clearing away competitive growth, on latex production and mean annual increment (MAI, a measure of tree growth); impact of different types of tapping tools and techniques on latex production and tree mortality; determination of optimal recuperation time between tapping cycles; impact of changes in edaphic conditions (principally meteorological), season of year, and time of day on latex production; and the success of seedlings in enriched plantings.

Results of this extensive research, as documented by earlier forestry reports, were significant. The density of chicle trees in one 670 ha (1700 acre) parcel of CDC land in northern Belize was 58 trees/ha (23 trees/acre). This compares to data quoted in Snook (1988) of 27 trees/ha (11 trees/acre), or 31% of the standing volume, in the ejido Noh Bec forest in Quintana Roo, Mexico, just to the north of the CDC land. Schwartz (pers. comm. 1988), who has worked with chicleros to the west in Petén, Guatemala, reports average densities of 15 tapped trees/ha (6 trees/acre), and areas with as many as 50 trees/ha (20 trees/acre). Additional results include MAI for improved and unimproved trees, as well as the number and cost of trees improved. Unfortunately, only brief reference is made to the actual levels of latex production under different management regimes, variations in latex quality, and average worker production. In short, through experimentation and experience, it appears that a management prescription for sustained-yield of latex, regeneration of plant populations, and distribution of benefits including labor and wage was established.

Regulatory efforts by Forestry included the use of appropriate tapping technique and tools, restrictions on the time between tapping each tree, provision of permits for harvesting and for the collection of "Crown Taxes" for subsequent harvest, investment in stand improvement, and regulations to prevent felling of chicle trees. The Chicle Control Act of 1935 regulated ownership of chicle resources and made it possible to punish individuals caught stealing chicle. The principal concern of Forestry appears to have been mortality resulting from inappropriate harvesting, a result of cutting too deeply or harvesting too often. This concern appears in the earliest report to which we have access (1924) and is echoed in 1935 and again in 1956.

Locating previous research. Much of the research already conducted is likely to provide valuable information for both the sustained extraction and regulation of future chicle harvesting. It is difficult draw many conclusions from the forestry reports themselves, though they indicate where results of research may be found. The TFAP mission to Belize mentions that they had no success in locating information, though they argue that chicle is only of historical significance, a point which we disagree with given the resurgence in demand for natural latex.

At present, we recommend the following references, in addition to those already mentioned: Empire Forestry Journal (1930), Lundell (1933), and Karling (1934)[5]. The field notes of both Karling (Columbia University) and Lundell (Chicago Field Museum) may hold a great deal of information for the management sustained latex production. Currently, research is being initiated by Peter Alcorn, a graduate student from the University of Florida, Gainesville, on

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[5] The Lundell reference is from Field and Laboratory, a publication of the Chicago Field Museum (the organization that also funded several botanical expeditions to Northern Central America, resulting in the publication of the first Flora of Guatemala and Flora of British Honduras). The publication is not in the Yale or the NYBG libraries.

the Programme for Belize lands.

Construction Materials

This category includes a variety of forest species used in the construction of houses and other enclosures. Excluded from the discussion here is roofing material, or thatch, which is discussed below in the section on palm products. Volumes and values for these products are not easy to determine as production originates at the community level and remains undocumented. In theory, a forestry tax – still called a "crown tax" – is collected for every forest product collected (Samuel Edwards, pers. comm. 1989). This tax is successfully collected for lumber and a variety of other forest products, but data availability for NTFPs from each forestry district is highly variable. Hence, apart from a discussion of the species and the uses, we present little numerical data here.

Posts and Polewood (Various species)

The species most favored for the construction of house posts include the following secondary hardwoods, all characterized by their density and resistance to decay (Notes on Forty-Two Secondary Hardwood Timbers of British Honduras 1946).

Bucida buceras: Bullet tree, reputed to be the densest wood in Central America.

Calophyllum brasiliense var. rekoi: Santa Maria, also the most important secondary hardwood used in the timber trade.

Lonchocarpus castilloi: Black cabbage bark.

Lignum vitae

Manilkara achras: Chicle. This dense and decay-resistant wood is highly valued. While illegal to fell live trees, dead trees, often killed by inappropriate tapping, may be used. Used in ancient Maya construction, beams over one thousand years in age are relatively intact.

Metopium brownei: Black poisonwood. Harvesting of this tree first requires girdling in order to bleed the tree of its highly irritable sap.

Rafters and framing

Aspidosperma megalocarpum: Mylady. Favored for long, straight and flexible lengths (Tom Harding, pers. comm 1989).

Various other undetermined species.

Siding (Various species)

Siding is a general term that refers to several species of small diameter trees harvested to make siding for structures. The most prominent of these is Tasiste palm (spelling and species uncertain. Probably a palmetto, such as Paurotis wrightii (Griseb. & Wendl.) Britt.). In northern Belize the trunk of this palm is commonly used for siding. Near Sarteneja, 100 poles sell for $40 (J.C. Meerman, pers. comm. 1989).

Vines

Four unknown species of vines are use to lash together posts, beams, rafters, and thatch in the wetter, forested regions of Southern Belize. Such use is intensive: as many as 250 vines may be required for one 10 m x 8 m house. In many regions, locating such vines near permanent populations requires several hours of walking into primary forest as past over-harvesting has depleted plant populations. Vines are used instead of wire because it is far easier to disassemble a house held together with vines. Houses or parts of houses may last for decades, but people move, recycle, or reconstruct houses more frequently; hence, the ability to disassemble a house easily is highly prized. Common names of the vines, often called "wiss" as a group, are iguana, peccary vein, white vine, and green vine. It is unclear how these species overlap, if at all (Cauffman, pers. comm. 1989).

Copal (Castilla copal)

The sap of this tree has long been used as an incense throughout the Maya Bioregion. Commonly seen in Catholic religious processions and churches (Standley and Steyermark n.d., 5:435), in southern Belize the smoke of the resin is used as an offering to ensure plentiful crops. In addition, varnish has been made in commercial quantities in England from the sap. It is unclear if this industry still exists.

Dyewood

Logwood (Haematoxylon campechianum)

Demand for a dye made from this swamp forest legume by the European textile industry resulted in a lucrative trade initiated in the mid-sixteenth century that continued until the eighteenth century. English raiders stole the small diameter logs from Spanish galleons until a treaty was signed in 1670 that acknowledged certain British rights to the resources of the New World (Bolland 1988). The subsequent establishment of logwood cutter camps resulted in the eventual creation of British Honduras.

Logwood grows in inundated areas common to the limestone plains of northern Belize. Dense stands are common. Harvesting consists of removing complete stems, though the potential for sustained production is favored by the fact that the species stump sprouts and propagates rapidly. Dye is extracted by boiling the chipped heartwood in water. The resulting color depends upon the fixative used. Red-orange, yellow, and black are the end products, with black being the most common (Standley and Steyermark n.d., 5:139-140).

Demand for natural dye dropped in the late 1930s with the advent of synthetic substitutes. As with chicle, there has been a resurgence in demand from Japan.

Rosewood (Dalbergia stevensonii)

Like logwood, this tree species is mainly of historical importance. Unlike logwood, when the natural dye market dissolved in the mid- to late-1930s, export volumes did not drop (Table 1). Instead, rosewood became an important forest resource not as a natural dye, but as a decorative hardwood. The Forestry Report of 1934 mentions that demand for dyewood was diminishing in the face of competition from Madagascar wood (species uncertain), presumably a dyewood from that African republic. The report also states that trial commercial shipments of rosewood "undoubtably drew the attention of the [hardwood] market to this wood." That such attention resulted in increased exports of rosewood can be seen in the years after 1935. Some dyewood is likely included in these exports, though the level of demand is uncertain.

Honey

A particularly lucrative NTFP, honey can bring a producer significant cash income. One hive costs approximately $100 in initial investment in materials and can produce 90-114 kg (200-250 lbs) of honey each year. In the predominantly Maya populations in southern Toledo district, a cooperative buys all production for $1.10 per kg ($.50/lb). Efforts are underway to remove africanized bees from the hives by replacing the queens. Currently 60 farmers in the Toledo district area are producers. A Peace Corps worker is providing excellent technical assistance by all accounts. Honey production in other areas, such as the CAyo District, have failed.

Medicinal Plants

Many plants are used by local people to address a variety of ailments. In this report we do not attempt to present a detailed discussion; a thorough accounting of the wide variety of medicinal species requires extensive ethnobotanical work, clearly beyond the scope of the present study. Moreover, analysis of medicinal plant resources in Belize is currently being conducted by the New York Botanical Garden's Institute for Economic Botany in conjunction with USAID, the National Cancer Institute, and Rosita Arvigo and Gregory Shropshire of the Ix Chel Tropical Research Center, Belize. We do mention, however, a few points here in reference to the economic significance of medicinal plants.

Western health care in the rural, forested tropics is scarce. People are cash-poor. However, where there exist abundant medicinal plant resources and the cultural traditions that guide their use, the forest provides great benefit. Yet valuation of this benefit remains difficult because of the constraints of standard econometric analysis. The first, and most simple reason for this difficulty, is that the practice (or science) of healing with forest resources is

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often done on a reciprocity basis. Second, traditional healing is often beyond the acceptance of Western medicinal practice.
Valuation requires comparing Western medicine with traditional healing practices. As these healing practices are based on different assumptions and cultural norms, this comparison, or valuation, can be difficult indeed.

Yet the benefits of traditional healing using forest resources are easily seen. A long list of remedies have been proven to work, from negrito (Simaruba glauca), which stemmed a dysentery epidemic in France from 1718-1725, to red gombolimbo (Bursera simaruba), which readily stops the rash acquired from black poisonwood (Metopium brownei) (Rosita Arvigo, pers. comm. 1989). Established commercial markets exist in Belize City in the city market. There are two stalls that sell a variety of dried plant roots, leaves, barks, and woods.

Also of note is a reference in the Forestry Report of 1959 of investigations into the propagation of several species of the Dioscorea genus, an historically important forest NTFP in Mexico. This forest floor tuber contains the alkaloid diosgenin, used in making the birth control pill and other medicines. The Report indicates that 25 species were distinguished, three or four of them with promising quantities of diosgenin. Further reported in 1960 is a note that efforts to propagate these economically valuable species were unsuccessful. As the plant seems to be slow growing (Mexican populations were greatly reduced by past over-exploitation; Guatemala prohibits export (Heinzman and Reining 1988)), propagation must be an important part of any attempt to develop a market for this NTFP.

Koch (1966) conducted a survey of Dioscorea in Guatemala to determine which species produce diosgenin. Of the 14 tested, only three had more than 4% diosgenin (dry weight) in the tubers. These three, D. spiculiflora var. chiapasense (4.30 %), D. escuintlensis (6.19%), and D. floribunda (4.74 %) occur in Huehuetenango, Escuintla and Santa Rosa, and Costa del Sür and Alta Verapaz, respectively. There are several other species that produce less than 4% and have wider distributions. It is uncertain which species occur in Belize.

Ornamental Plants

Izote (species uncertain)

The species collected are uncertain. We believe that there are two major possibilities, namely Yucca elephantipes or Beaucarnea spp. Both are discussed below, as well as a more general discussion of the collection and transportation of izote, regardless of correct identification.

Yucca elephantipes

This plant, a mid-canopy tree that may attain a height of 30 feet, is found throughout Mexico and Central America (Standley and Steyermark 1952, 3:89). It grows in areas of thin, rocky soil and is likely favored by droughty conditions. The stem is swollen at the base and is topped by a spiny growth of close set leaves. Favored as a hedge plant that produces an edible panicle, it is commonly seen in Central American gardens and in Florida, where it has been propagated as an ornamental plant since 1956 (Morton 1974).

Beaucarnea spp.

This genus is often grouped with Nolina because of superficial similarities. The various species of Beaucarnea are generally low trees with tall trunks usually much swollen at the base. Leaves are long, linear, and stiff. The various species described from Guatemala grow on dry or wet, rocky hillsides at altitudes of 600 to 1700 meters (1,968-5,577 ft). The lower elevations in this range can be found throughout the Vaca Plateau and the Maya Mountains of central Belize. B. Ameliae is reported from central Belize. Beaucarnea spp. may be called izote, izote real, or izote de montaña (Standley and Steyermark 1952, 3:71-72; Morton 1974).

Izote has been exported from Guatemala for many years. Growing principally in the Copan region, native populations are reputed to be greatly reduced from over-exploitation. Currently in Belize one permit has been issued by the forestry department to harvest plants with base diameters of 7 - 25 cm (4-12 in) from the Vaca Plateau region of the northern Maya Mountains. Harvesting under this permit has been occurring since April 1989, though illegal harvesting by Guatemalans, who cross the border at Arenal (13 km (5 mi) south of Benque Carmen de Viejo) has been occurring for an unknown period of time. Such illegal extraction is thought to be extensive.

A visit to an izotero camp revealed stacks of cleaned and cut izote stems, each stem 60-90 cm (23-35 in) in length, with the base cleaned of roots. There were approximately 10,000 stems at the camp. Currently 40 - 50 men are extracting up to 80,000 stems per month. All are being exported to West Germany, though, given the high volume of trade, it seems reasonable to assume the shade tolerant, drought resistant species is sold throughout Europe as a house and office plant.

The government of Belize receives a crown tax of $0.50 per plant. Izoteros are paid $0.035 per cm ($0.09 per in), at the widest point of swelling, per plant harvested. At present, the international price of the species is unknown, and Mr. Bols, the exporter of izote from Belize, could not be contacted.

Orchids and Bromeliads (several species)

Local markets for epiphytes have always been strong. Homes, hotels, and businesses often have gardens that include a variety of orchids. Exportation of orchids is first reported in the Forestry Report of 1966, with 4,134 plants exported. Current trade, both domestically and internationally, appears to be dominated by Godoy and Sons, Ltd. of Orange Walk. They supply several hundred to 1000 plants per year, by their own estimate, to the local market and have exported 800 plants internationally. Trees are climbed in the tradition of chicleros, and plants are collected, "cleaned" of insects with malathion, and sold internationally at a price of $5.00 each f.o.b. On the national market, plants are sold for the same price, or for $10 for the plant plus a basket. At Christmas time, bromeliads are traditionally sold, usually for $15 in a basket. In addition to Godoy and Sons there are several other very small scale collectors and sellers operating throughout Belize.

The small volume of current exports is overshadowed by a contract with Japanese interests for 10,000 plants in late 1989. Due to opposition by the Belize Audubon Society, the most visible Belizean conservation organization, Forestry may not issue the permit necessary to collect and export these orchids. Members of the Godoy family, in our view conservation-minded businesspeople, are quick to point out that far more orchids are lost each year to the accelerated timbering and clearing of forest for crops and marijuana production. Equally, they expressed a great deal of knowledge of the different species of orchids, their densities, and the impact of harvesting. Even so, as international demand grows, increased management and monitoring efforts are justified.

Palms

Basket Tie-Tie (Desmoncus martius and possibly other species)
Common to the forests throughout Belize, this climbing palm is harvested and stripped of its spiny exterior. The stems sometimes reach several hundred feet (Standley and Steyermark 1958, 1:196). The core is quartered and the strands are woven into baskets, hats, floor mats, and wall coverings. The potential for this palm as a raw material used in the production of rattans has been investigated by Ralaypayon (1989). In comparison with the commercial rattan genera (Daemonorops, Calamus, Korthalsia), D. martius was found to be quite porous and of low tensile strength with a tendency to disintegrate into granules upon drying and use.

Bay Leaf (Sabal morrisiana)

Bay leaf palm provides the most desired thatch material in Belize. A roof lasts up to 15 years. Leaves cost as little as $0.10 to $0.12 each in northern Belize, where leaves are readily available, or as much as $0.50 each on the Cayes, where they must be shipped by boat. A 46 sq m (500 sq ft) structure requires approximately 1500 leaves. In certain populated regions, such as the Maya areas in Toledo district, the population of this species has been substantially reduced and people have switched to lower quality cohune leaves for thatch.

Cohune (Orbignya cohune)

A dominant forest species over wide regions of Belize, this palm is commonly the only tree left standing in cleared areas. It is a highly valued species with many products, including oil, charcoal, thatch, and soap. Population densities of cohune in mature forest can be virtual single-species forests in low-lying, seasonally inundated areas (bajos) (Stevenson 1932), and/or in well-drained areas (Standley and Steyermark 1958, 1:274). Stevenson reports that one inventory in northern Belize indicated 280 trees/ha (112 trees/acre) in all size classes.

Fruiting panicles often weigh 45 kg (100 lbs) and may contain kernals with up to 40% oil. This prodigious production once supported a substantial palm oil industry in Belize. Investment in commercial level production was initiated in November of 1928 by the Tropical Oil Product Co. in southern Toledo District. To increase production, cohune-rich forest was "improved" by leaving only cohunes standing (Stevenson 1932). A crushing machine was developed that could crack the very hard 8 x 4 cm (3 x 1.6 in) oblong nut. Exports of cohune oil are first recorded in 1950, though cohune product was exported much earlier. Nuts were first exported in 1936 and charcoal in 1937. Exports stopped in 1963 (Table 1).

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The cohune palm has historically been and continues to be more important in the domestic economy. Production of oil, a cottage industry comprised principally of women and children, is in decline today due the hardness of the nut (or the ease of producing coconut oil). Nuts are cracked with rocks, sticks, or machete, the meat ground in a large wooden mortar, and, with the husks as fuel, boiled in water. The oil is drained off the top of the solution, bottled, and sold in the market for $5.00/lt (1 lt = 1 qt). The husks, in addition to making a good fuel, were valued in World War II as a charcoal filter in gas masks.

The apical meristem of the cohune is locally harvested in the making of hearts of palm. One eight year old tree can provide up to three liters of palm heart, each liter selling for $9.00, retail. Production of heart of palm has temporarily stopped because one of the principal producers is ill. International interest is high. An order for 10,000 cases (8 liters/case) has been received from West German interests. It is not likely that the order will be filled because the scale of production is too small. When active, production is about 500 cases per year. Attempts to establish a small factory met with little success because quality control was hard to maintain (Roberson, pers. comm. 1989).

Cohune is left standing in cattle pasture as a shade tree and for the large volume of organic material it supplies to the soil. The leaves, up to 18 meters (59 ft) in length, provide one of two thatch materials used throughout Belize. A roof built from cohune leaves lasts from seven to ten years.

Panama Hat Palm (Cyclanthus spp.)

This understory palm is common to southern Belize. The broad, fibrous leaves produce a high-quality fiber used in the fabrication of baskets, mostly by Maya women in the southern rural areas. Based on interviews and personaly observation, the palm is limited to the high rainfall environments of the south.

Xate (Chamaedorea spp.)

While various parts of Belize, especially the Cayo and Orange Walk districts, should provide the correct forest habitat for these understory palms, there is no evidence of active collection. See Heinzman and Reining (1988) for more information about this valuable floral green and for an overview of the xate industry in Guatemala.

Perfume

This NTFP is not known to be sold commercially, though the fact that it is being produced merits mention. One of the co-owners of the Dem Dats Doin' Farm in San Pedro Columbia, Toledo District, uses the flowers of several species in making his fragrance for personal use.

Pine Seeds (Pinus caribaea var. hondurensis, Pinus patula ssp. tecunumanii)

The seeds of these two species have given rise to plantations throughout the tropics. First reported in 1953, exploitation of pine seeds resulted in exports to several

Amount (Kg (lbs))	Value (1955 $)	Destination
9.5 (21)	210	Australia
5.7 (12.5)	125	Br. W. Indies
5.9 (13)	130	Kenya
9.1 (20)	200	Rhodesia
4.5 (10)	100	Fiji
2.3 (5)	50	Ceylon
2.3 (5)	50	Nyasaland
1.8 (4)	40	Br. Guiana
0.9 (2)	20	Fr. W. Indies
0.5 (1)	10	Gold Coast
0.5 (1)	10	U.S.A.
0.2 (0.5)	5	Fr. Guiana
0.2 (0.5)	5	Belgian Congo
Total 43.4 (95.5)	955	

Table 2
Volume, value, and countries of destination for Pinus spp. seed exports in 1955 (Forestry Report 1955).

countries (Table 2). Seeds originated from the Mountain Pine Ridge Forest Reserve. Exports during the 1970's declined to zero. Nonetheless, the level of deforestation throughout Central America makes the Belizean forests ever more valuable as a source of seed. While there are probably enough plantations of P. caribaea scattered throughout Central America to accommodate demand, the difficulty of protecting those provenances from encroaching agriculture indicates a small but significant demand for wild Belizean seed. A similar, though more persuasive, argument can be made for the tecunumanii seed, which has performed well in provenances in other parts of Central America, but is in greater demand because fewer plantations exist. As with P. caribaea, the difficulty in protecting provenances outside of Belize means that demand will remain significant (TFAP 1989).

Rubber Tree (Castilla elastica)

No more than 200 tons of the latex of this common forest species has ever been exported from the Maya Bioregion. Even at the height of the natural rubber industry, the superior latex of Hevea spp. dominated the market (Standley and Steyermark 1946, 4:17). Current use appears to be restricted to waterproofing the collection bags of chicleros.

Secondary Hardwood Artistry (several species)

Several species of hardwoods are used in the fabrication of carvings, bowls, and other basic utensils. High quality carvings are seen throughout the country in hotels, gift shops, and other tourist destinations. Species commonly used include ziricote (Cordia dodecandro) and nargusta (Terminalia amazonia).

Tourism

Tourism in Belize grew from 28,000 visits in 1983 to 74,000 in 1988. Approximately 28-30% of the tourists in this latter year came for forest related reasons: natural history (or ecotoursim) and archeological tourism. We assert that archeological tourism can not be separated from ecotourism: without forests it is highly unlikely Maya ruins would attract as many people. The average tourist spends approximately $689.50 (Siegfried Loeper pers.

comm. 1989). Hence, forest-based tourism in 1988, assuming 29% of the tourists came to Belize for forest-based activity, produced $29,593,340 in foreign revenue, approximately 15% of all foreign receipts. By comparison, the entire forestry sector, timber and non-timber products alike, produced approximately $6,000,000, or 3% of all export value. The significance of forest-based tourism is evident to the government of Belize: the Ministry of Tourism has recently been expanded to become the Ministry of Tourism and the Environment. Moreover, tourism infrastructure is growing: the recent opening of the Chan Chich Lodge in western Orange Walk District is one prominent example.

Tourism revenues also include "development tourism" (i.e. USAID contractors, the authors of this report) and scientific researchers. In the case of the latter, scientific research support stations have been built and are in the process of being expanded at the Shipstern Wildlife Reserve (see Butterflies) in Corozol District, the Ix Chel Tropical Research Center in Cayo District, and the Belize Agroforestry Research Center in Toledo District. The Rio Bravo Research Station on the Programme for Belize lands is currently under construction.

DISCUSSION

Throughout the forested tropics, traditional paths to development have, for the most part, resulted in the conversion of forested land to other uses. In addition to a drastic reduction in species diversity and the elimination of ecosystem services, abundant research attests to severe social and economic problems that often erupt in the wake of large-scale deforestation (See, for example, Leonard 1987).

In Belize there exists the opportunity not to repeat mistakes made elsewhere. Significant socio-economic benefits can be found through the conservation of forest resources and preservation of biologically diverse habitat. The low population density, the high level of education, and the high percentage of land still covered by forest all combine to provide an opportunity to implement a biosphere reserve model on both public lands and private lands, alike.

In theory, the biosphere reserve model prescribes a pathway for development with the explicit goal of conserving forest resources and preserving biodiversity and ecosystem services. As such, development, defined as the generation of employment and cash income, leaves the integrity of the larger forested ecosystem intact, even after long-term economic activity. With an ecological boundary on development – namely the protection of large forested areas from conversion – extraction of NTFP's, in addition to certain forms of select logging, may combine to successfully implement a biosphere reserve model.

Yet is the economic contribution of NTFPs large enough to justify the protection of large forested areas? In 1989, NTFPs represent, in gross sum and excluding tourism, $2,000,000 in foreign revenues[6], about 1% of the value of exports from Belize[7]. Given the large land base from which these products originate, the value seems relatively small. Yet forest-based tourism revenues in 1989 will be approximately $36 million[8]. In sum, the total gross value of non-timber forest revenues for 1989 will be $38 million, or 17% of total foreign revenue sources.

This bottom-line figure is conservative. First, under-assessment of forest resources appears to be more the rule than the exception: often, quantification of NTFPs requires extensive ethnobotanical research. Even with such research, valuation of forest productivity for agriculture in the form of fodder, mulch, fuel, and construction materials is difficult because

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[6] This calculation values the current export of chicle and izote only. We assume a very conservative international price for izote of $2.00 f.o.b. per plant, with 80,000 plants being extracted every month from April, 1989 (when the official permit was issued), to the end of 1989.

[7] Total exports valued $198 million in 1987. We inflate this value by adding real inflation at 3% annually and growth in foreign receipts that result from increases in tourism, the only sector for which we have growth data. This values total foreign receipts at approximately $221 million for 1989.

[8] We assume that the growth in tourism from 1988 to 1989 will continue at the average annual rate experienced by the entire tourism industry over the past five years of 21%.

commercial exchange does not occur. Second, we focus on exports or sources of foreign revenue and ignore any contributions forests make in domestic markets. Third, we have only considered chicle and izote here, in addition to tourism. Fourth, these calculations in no way include the value of biodiversity and protection of ecosystem services. Fifth, the actual value of NTFPs is likely to be larger than $38 million because we inflated forest-based tourism at 21%, the average growth of the entire tourism industry, yet forest-based tourism is the fastest growing sector of tourism. Hence, the actual receipts of forest-based tourism are likely to be larger in 1989.

Moreover, the market for several of the most important NTFPs is growing. Japanese demand for orchids, chicle, and logwood, as well as European demand for izote, are good examples. Forest-based tourism is also likely to continue its rapid growth, particularly in light of the recent Ruta Maya article in the October 1989 issue of National Geographic[9]. Finally, when one considers that much of the area under forest in Belize is at best marginal for permanent agriculture, orchards, or pasture, forests appear to be the best land-use.

Returning to our initial question the answer appears to be: Yes, the value of forests based upon NTFPs does warrant the conservation of large areas of forest. Stated differently, implementation of a biosphere reserve model for both developing and at conserving forests in Belize is not only possible, but prudent. That the biosphere model meshes well with tourism is clear: forest-based tourism results in relatively low levels of forest disturbance while generating significant revenues. Nonetheless, given that large areas of forest can be protected from conversion as a tourism resource, it seems reasonable to seek added value from standing forests. If so, then the portfolio of botanical NTFPs discussed in this report could, if properly managed for sustained production, create such added value. Yet it is important to ask: To what extent are the extraction of non-timber forest products compatible

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[9] As one of the owners of Chan Chich Lodge, an eco-tourism lodge premiered in the National Geographic article, commented: "You can't buy that kind of advertising."

with tourism, as well as compatible with each other? Additionally, to what extent is timber extraction compatible with tourism and other NTFPs? These questions raise one central challenge, specifically the challenge of managing natural forests for sustained production of diverse forest resources.

We suggest that a general strategy for maximizing forest value while respecting tropical nature in Belize is found in a biosphere reserve model. This model attempts to unite the interests of development and conservation and applies to both forest products and species, as well as tourism and other activities that do not directly involve harvesting and production. Such a strategy requires knowledge both of the ecological character of each species and the impact of harvesting on each species. Conducting research that describes population densities, reproductive biology, rates of growth, as well as the impact of harvesting on each, provides critically important baseline data for maximizing the level of sustained production. Additionally, the degree to which the harvesting of different species is compatible must be considered (i.e. harvesting orchids from the canopies of felled timber species), and the total ecological disturbance that results if all the extractive activities occur in the same area of forest. Finally, ecological studies must be balanced by socio-economic studies such as the distribution of benefits and the role NTFPs play in rural communities and urban markets.

These suggestions all reflect one major theme: provision of information. Implementation of the biosphere reserve model requires such data so that forest products and services in Belize may be managed as a coordinated whole. Maximizing both potential economic benefits and protection of forest habitat requires integrated planning over large regions of Belize. This reveals a second major theme: successful implementation of a biosphere model will require not only information but a level of commitment from and communication between local communities, government, and business that is substantial and currently not evident, but attainable. Without commitment, forest use and likely continued forest conversion will continue in a haphazard, ecologically destructive, and economically imprudent manner. A key to the realization of this commitment will be seen in increases both the number of people working in natural resource management and their expertise. Only if Belizean institutions motivate to wisely safeguard and use their resources, will wise use occur.

We make no assertion that the implementation of a biosphere model of development with conservation is easy. We also make no assertion that the diverse botanical resources of Belize's forests will provide the greatest short-term profit relative to other land uses in all areas, though in certain areas, especially tourist destinations, this is certainly the case. Yet we do assert that if forested habitats are to be wisely exploited or are to be protected outright, use of diverse forest species and products is essential. This is a significant departure from past forest management efforts that have borrowed too much from management models based on species-poor temperate forests. But this departure is necessary if we humans are to safeguard remaining Central American forests and still see to people's needs. Moreover, if we ignore the opportunity to implement an ecologically-based path to development, future generations will find the destruction of forests, and the life therein, incomprehensible.

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TABLE 1 (cont.)

	DYEWOOD Logwood *Haematoxylon campechianum* Amt. (tons)	Value	Rosewood *Dalbergia stevensonii* Amt. (tons)	Value	ORNAMENTAL PLANTS (d) *Irote* (f) Amt. (#)	Orchids Amt. (#)	Value	PINE SEEDS *Pinus caribaea* *Pinus patula* Amt. (lb)	Value	TOURISM (e) # Tourists	Value
1923			23								
1924	820	13,125	20								
1925	609	15,225	24	5,362							
1926	667	16,531	76	2,315							
1927	332	8,405	137	2,925							
1928	1,046	25,564	435	9,601							
1929	200	5,966	249	6,118							
1930	225	5,130	62	1,870							
1931	268	5,803	6	135							
1932	103	1,545									
1933	136	1,702	36	730							
1934	105	1,180	37	637							
1935	183	1,997	263	6,864							
1936	156	1,745	297	8,518							
1937	114	3,362	251	7,672							
1947			320	13,042							
1937-47	10	435	142	8,951							
1950											
1951											
1952											
1953								226	2,260		
1954								209	2,086		
1955								96	955		
1956								194	1,940		
1959								1,640	16,400		
1960								1,036	15,540		
1962								200	2,500		
1963								461	6,915		
1964											
1965											
1966						4,134	150	247	1,960		
1967								516	---		
1968						4,571	528	1,278	23,438		
1969								1,287	23,909		
1970								6,947	43,351		
1971											
1983										8,120	11,187,480
1984										9,280	12,797,120
1985										12,905	17,785,994
1986										15,080	20,795,320
1987	78	42,000				800	4,000			17,690	24,384,510
1988						800	4,000			21,460	29,593,340
1989					720000						

(c) All figures here for the years 1850-1853 are for exports of nuts and oil, listed in that order. Volumes are pounds and gallons, resp. For the year 1937, the figures given are for pounds of nuts and pounds of charcoal, resp.

(d) Number and value of plants exported in recent years are estimates.

(e) Calculations assume 29% of total tourists are forest-based tourists and that each spends an average of $1,379.00.

(f) Estimated from interviews and field inspections.

TABLE 1: Export data for several non-timber forest products. See text for sources.*

	ALLSPICE *Pimenta dioica*	ANIMALS		CHICLE (b) *Manilkara achras* *Manilkara chicle*		COHUNE *Orbignya cohune*	
YEAR	Amt. (lb)	Amt. (a)	Value	Amt. (lb)	Value	Amt. (c) (lb) (a=1)	Value
1923				244,584	107,217		
1924			508	306,167	139,301		
1925		272	192	334,592	154,875		
1926		1,941	1,559	259,848	111,943		
1927		2,297	3,915	460,176	204,618		
1928		2,103	6,651	441,886	193,963		
1929		2,563	5,760	598,286	275,383		
1930		6,040	7,668	373,408	171,797		
1931		3,513	3,274	300,651	181,508		
1932		7,868	9,413	264,262	125,870		
1933		12,309	18,641	726,784	210,031		
1934		84,200	35,068	787,526	199,572		
1935		23,800	9,250	787,416	174,874		
1936		10,100	5,836	767,152	191,068	585,568	16,734
1937		7,000	5,363	659,916	189,186	224,070	11,107
						877,385	
1947		7,200	15,225	1,420,160	1,311,080		
1937-47 **		7,000	11,228	1,[illegible]84,000	833,962	288,000	
1950		6,200	12,646	806,100	1,002,451	298,300	31,933
				28,100		2,697	4,276
1951		7,700	29,536	835,551	950,347	175,800	20,666
						15,471	28,424
1952		5,475	22,323	612,721	624,838	320,000	41,718
						8,178	15,990
1953		5,010	11,062	872,600	833,968	980,490	129,192
						7,938	16,444
1954		5,302	15,498	931,900	883,475	308,701	38,198
				172,000	125,884		
1955		13,681	37,562	580,900	528,581	537,800	48,353
				54,800	54,150		
1956		6,907	21,536	481,400	470,333	218,373	48,663
				127,000	102,543		
1959							
1960				546,634	493,439	308,561	26,233
				169,006	121,221		
1962	82,000			350,000	381,546	1,000	73
				40,000	33,071		
1963				214,000	235,406	2,200	166
				28,000	24,971		
1964							
1965	145						
1966				196,900	187,808		
1967							
1968	94			107,800	104,374		
1969	8,285			61,000	58,753		
1970	3,824			137,000	130,688		
1971	28,400			137,000	130,688		
1983							
1984							
1985							
1986							
1987							
1988				110,588	378,000		
1989				200,000	600,000		

* All values are in Belize dollars for the year given. No adjustments for changes in currency value have been made. Values are assumed to be f.o.b.

** This is the annual average export over the period 1937-1947.

(a) In the year 1934, unit volume accounting changed from number of skins to pounds of skins.

(b) Reporting distinguishes between the latex of *M. achras* and *M. chicle* between the years 1950 and 1963 only.

LIST OF CONTACTS AND PERSONS INTERVIEWED

Peter Alcorn
820 NE 5th
Gainesvile, FL 32601

Rosita Arvigo and Gregory Shropshire
Ix Chel Tropical Research Center, Ltd.
San Ignacio, Cayo District

Dr. Michael Balick
Institute of Economic Botany
The New York Botanical Garden
Bronx, New York 10458-5126

Belize Audubon Society
P.O. Box 1001
49 Southern Foreshore
Belize City

Belize Estates and Produce Company, holder of current Forestry permit for chicle
Belize City

F. William Burley
Programme for Belize
1 King Street
Belize City

James Cauffman
Belizean Agroforestry Research Station
Punta Gorda, Toledo District

Alfredo and Yvonne Villoria
Dem Dats Doin' Farm
P.O. Box 73
Punta Gorda, Toledo District

Samuel Edwards
District Forester
Machaga Creek Forest Station, Toledo District

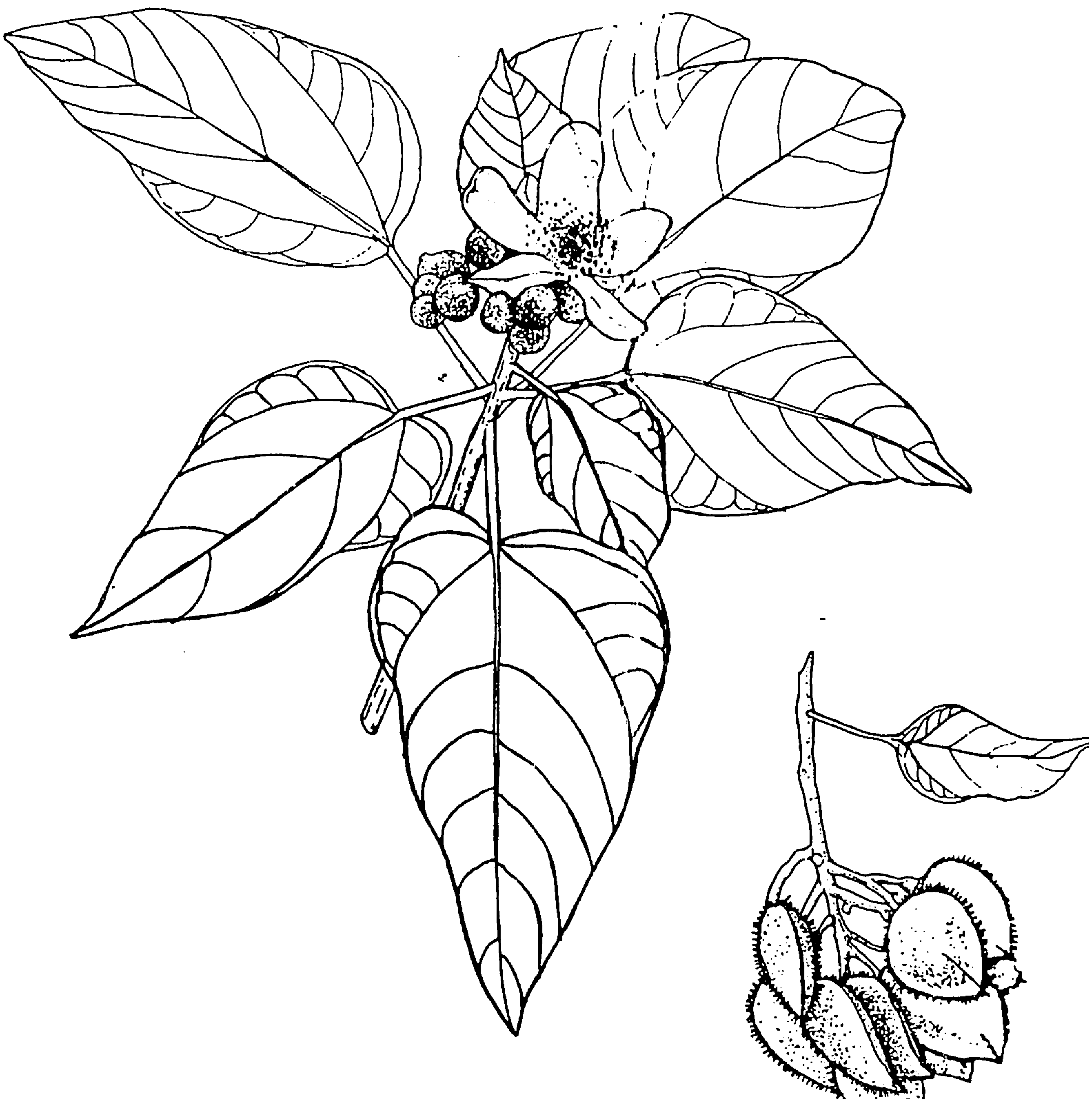
Tom and Josie Harding
Chan Chich Lodge
P.O. Box 37
Belize City

Mr. Green
District Forester
Augustine Forest Station, Cayo District

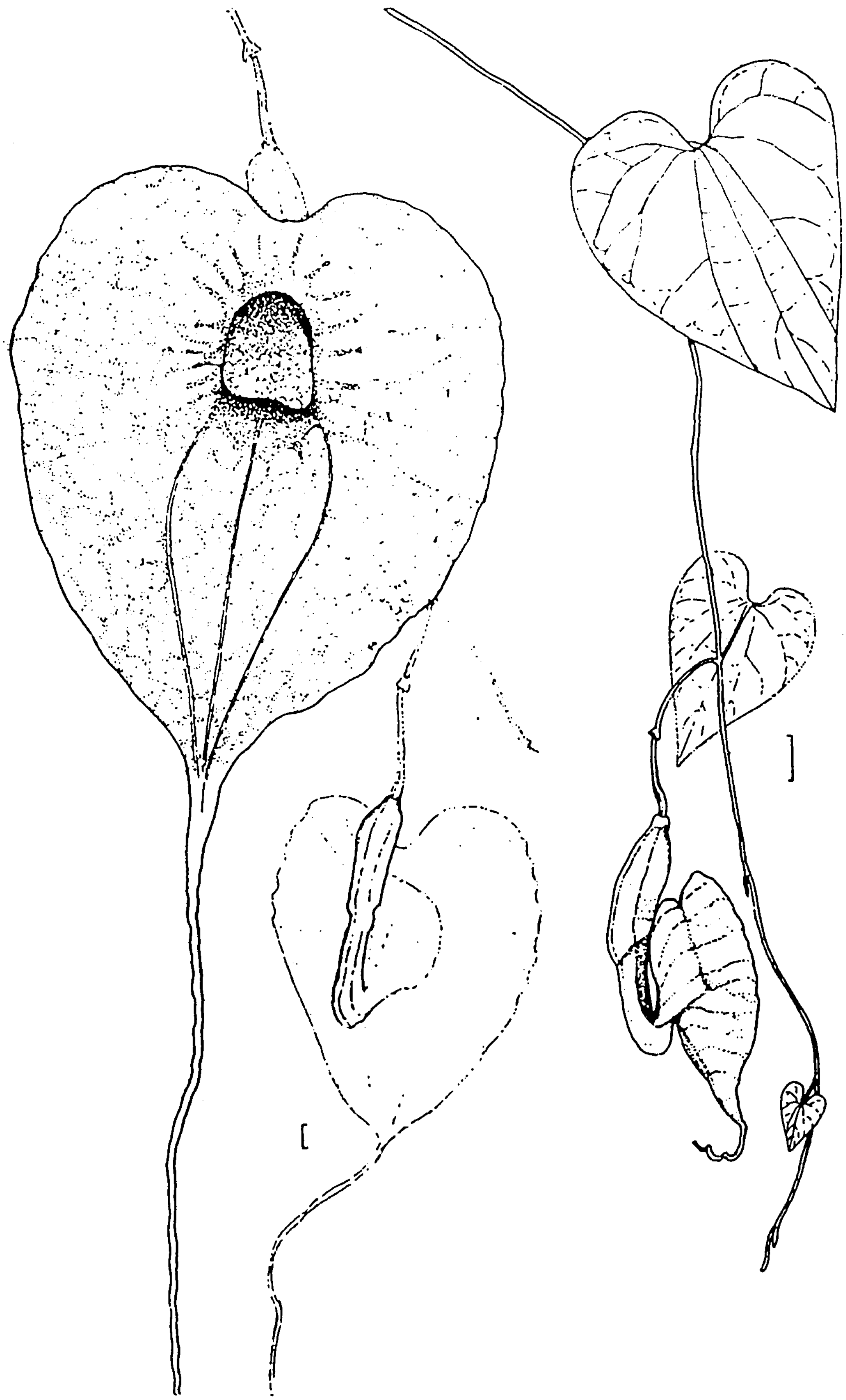
Godoy and Sons, Ltd.
4 Trial Farm Rd.
Orange Walk Town, Orange Walk District

APPENDIX VI

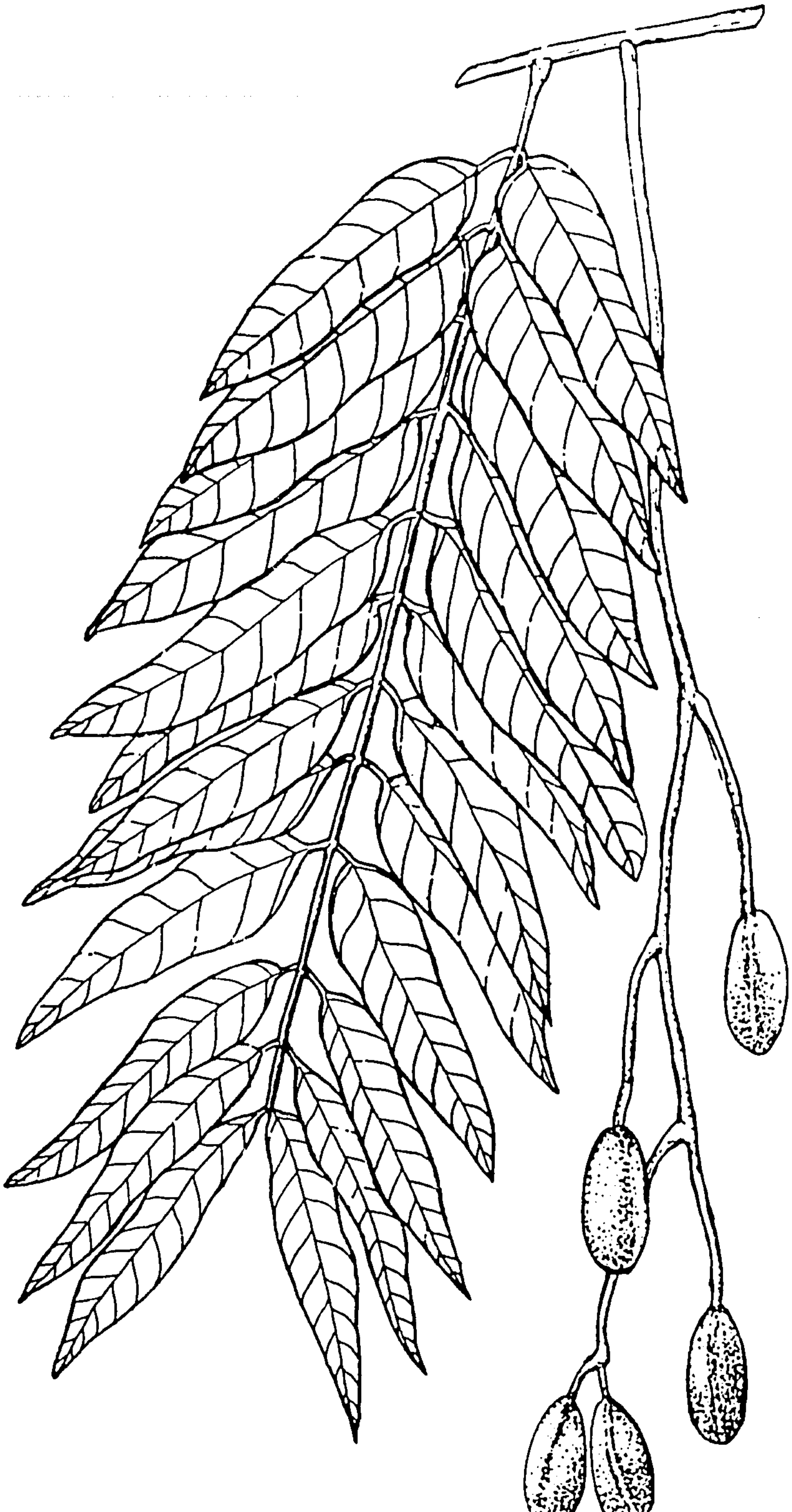
SAMPLE PLATES BY LAURA EVANS



<u>BIXA</u> <u>ORELLANA</u>



ARISTOLOCHIA GRANDIFLORA



CEDRELA ODORATA