AD_____

COOPERATIVE AGREEMENT NO: DAMD17-95-2-5011

TITLE: Drug Development and Conservation of Biodiversity in West and Central Africa

PRINCIPAL INVESTIGATOR(S): Maurice M. Iwu

CONTRACTING ORGANIZATION: BioResources Development and Conservation Programme
Silver Spring, Maryland 20904

REPORT DATE: August 1996

TYPE OF REPORT: Annual

PREPARED FOR: U.S. Army Medical Research and Materiel Command
Fort Detrick, Frederick, Maryland 21702-5012

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	August 1996	Annual (17 Jul 95 - 16 Jul 96)

4. TITLE AND SUBTITLE

Drug Development and Conservation of Biodiversity in West and Central Africa

5. FUNDING NUMBERS

DAMD17-95-2-5011

6. AUTHOR(S)

Maurice M. Iwu

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

BioResources Development and Conservation Programme
Silver Spring, Maryland 20904

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army Medical Research and Materiel Command
Fort Detrick
Frederick, Maryland 21702-5012

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

The report comprises of projects undertaken by the Bioresources Development and Conservation Programme (BDCP) in pursuant of the objectives of Associate Programs 2 and 5 of the ICBG project entitled Drug Development and Conservation of Biodiversity in West and Central Africa - for Year 2. The accomplishments include training of ethnobotanists, purchase and installation of equipment, and six ethnobotanic surveys which led to the identification of over 120 plants used in traditional medicine for the treatment of malaria, leishmaniasis, viral infections, etc. Plants collected from the ethnobotanical field trips were dereplicated according to a customized protocol. A multi-disciplinary team of experts in botany, chemistry, biology, clinical pharmacology and medical practitioners was used to identify and collect plant species with the greatest potential for biological activity. The collected plants were properly catalogued, voucher specimens obtained, then processed, extracted and tested for biological activity. Extracts have been prepared from some of these samples and submitted for various bioassays including brine shrimp lethality, antifungal bioautography assay, antiviral, antimalarial, antileishmanial, antitrypanosomial, antitrichomonad and cytotoxicity tests. We are also continuing our support for graduate training projects in phytochemistry, ethnobiology and bioassay screening techniques. The benefit sharing scheme for the ICBG has been fully developed.

14. SUBJECT TERMS

BDCP, training of ethnobotanists, plant collection, extracts,

15. NUMBER OF PAGES

23

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

GENERAL INSTRUCTIONS FOR COMPLETING SF 298

The Report Documentation Page (RDP) is used in announcing and cataloging reports. It is important that this information be consistent with the rest of the report, particularly the cover and title page. Instructions for filling in each block of the form follow. It is important to ***stay within the lines*** to meet *optical scanning requirements*.

Block 1. Agency Use Only *(Leave blank)*.

Block 2. Report Date. Full publication date including day, month, and year, if available (e.g. 1 Jan 88). Must cite at least the year.

Block 3. Type of Report and Dates Covered. State whether report is interim, final, etc. If applicable, enter inclusive report dates (e.g. 10 Jun 87 - 30 Jun 88).

Block 4. Title and Subtitle. A title is taken from the part of the report that provides the most meaningful and complete information. When a report is prepared in more than one volume, repeat the primary title, add volume number, and include subtitle for the specific volume. On classified documents enter the title classification in parentheses.

Block 5. Funding Numbers. To include contract and grant numbers; may include program element number(s), project number(s), task number(s), and work unit number(s). Use the following labels:

C	- Contract	**PR**	- Project
G	- Grant	**TA**	- Task
PE	- Program Element	**WU**	- Work Unit Accession No.

Block 6. Author(s). Name(s) of person(s) responsible for writing the report, performing the research, or credited with the content of the report. If editor or compiler, this should follow the name(s).

Block 7. Performing Organization Name(s) and Address(es). Self-explanatory.

Block 8. Performing Organization Report Number. Enter the unique alphanumeric report number(s) assigned by the organization performing the report.

Block 9. Sponsoring/Monitoring Agency Name(s) and Address(es). Self-explanatory.

Block 10. Sponsoring/Monitoring Agency Report Number. *(If known)*

Block 11. Supplementary Notes. Enter information not included elsewhere such as: Prepared in cooperation with...; Trans. of...; To be published in.... When a report is revised, include a statement whether the new report supersedes or supplements the older report.

Block 12a. Distribution/Availability Statement. Denotes public availability or limitations. Cite any availability to the public. Enter additional limitations or special markings in all capitals (e.g. NOFORN, REL, ITAR).

- **DOD** - See DoDD 5230.24, "Distribution Statements on Technical Documents."
- **DOE** - See authorities.
- **NASA** - See Handbook NHB 2200.2.
- **NTIS** - Leave blank.

Block 12b. Distribution Code.

- **DOD** - Leave blank.
- **DOE** - Enter DOE distribution categories from the Standard Distribution for Unclassified Scientific and Technical Reports.
- **NASA** - Leave blank.
- **NTIS** - Leave blank.

Block 13. Abstract. Include a brief *(Maximum 200 words)* factual summary of the most significant information contained in the report.

Block 14. Subject Terms. Keywords or phrases identifying major subjects in the report.

Block 15. Number of Pages. Enter the total number of pages.

Block 16. Price Code. Enter appropriate price code *(NTIS only)*.

Blocks 17. - 19. Security Classifications. Self-explanatory. Enter U.S. Security Classification in accordance with U.S. Security Regulations (i.e., UNCLASSIFIED). If form contains classified information, stamp classification on the top and bottom of the page.

Block 20. Limitation of Abstract. This block must be completed to assign a limitation to the abstract. Enter either UL (unlimited) or SAR (same as report). An entry in this block is necessary if the abstract is to be limited. If blank, the abstract is assumed to be unlimited.

*U.S.GPO:1993-0-358-779

FOREWORD

Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the US Army.

X Where copyrighted material is quoted, permission has been obtained to use such material.

____ Where material from documents designated for limited distribution is quoted, permission has been obtained to use the material.

X Citations of commercial organizations and trade names in this report do not constitute an official Department of Army endorsement or approval of the products or services of these organizations.

____ In conducting research using animals, the investigator(s) adhered to the "Guide for the Care and Use of Laboratory Animals," prepared by the Committee on Care and Use of Laboratory Animals of the Institute of Laboratory Resources, National Research Council (NIH Publication No. 86-23, Revised 1985).

____ For the protection of human subjects, the investigator(s) adhered to policies of applicable Federal Law 45 CFR 46.

____ In conducting research utilizing recombinant DNA technology, the investigator(s) adhered to current guidelines promulgated by the National Institutes of Health.

____ In the conduct of research utilizing recombinant DNA, the investigator(s) adhered to the NIH Guidelines for Research Involving Recombinant DNA Molecules.

____ In the conduct of research involving hazardous organisms, the investigator(s) adhered to the CDC-NIH Guide for Biosafety in Microbiological and Biomedical Laboratories.

M. Mauney LW 8-30-96

PI - Signature Date

TABLE OF CONTENTS

INTRODUCTION

The project report covers work performed by the Bioresources Development and Conservation Programme (BDCP) as part of Associate Programs 2 and 5 of the International Cooperative Biodiversity Group (ICBG). The ICBG is a program funded jointly by National Institute of Health, U.S. A.I.D and National Science Foundation and administered by the Fogarty International Center. This Cooperative Research and Development Agreement provides a mechanism for the disbursement of fund to BDCP for the execution of some aspects of the Scope of work outlined in the ICBG project on "Drug Development and Conservation of Biological Diversity in West and Central Africa"

The ICBG has as its primary aim the development and implementation of an effective and constructive resource management and conservation plan based on an intimate understanding of the key factors driving medicinal plant use and loss of biodiversity. The overriding concept is to increase the net worth of tropical forest as living resource base and to demonstrate the feasibility of an ecological management strategy which uses dug development as a catalyst for the conservation of biological diversity. The ICBG is a highly integrated team which involves scientists from the participating developing countries in all aspects of the program so that lessons learned from this project can be internalized in Africa and continued even after the end of the proposed project.

The ICBG goals are being achieved through a combination of the following approaches:
1. assisting with the development of drugs while addressing the priority health needs of the United States and the participating countries;
2. developing inventories of native species and indigenous knowledge;
3. training targeted towards achieving the research goals of the program and meeting the needs of the participating countries and;
4. improving the scientific infrastructure within the host country.

The main target therapeutic categories are tropical diseases such as malaria, leishmaniasis and trypanosomiasis. In the drug development component of the program, the emphasis is on identification of new therapeutic leads over as wide variety of plant sources as can be possible with the available resources. Thus, there was a great need for a highly selective plant selection strategy. Bioresources Development and Conservation Programme uses a carefully designed approach which combines selection based on ethnomedical uses, chemical and biological profile of plant candidates and information from literature and chemotaxonomical evaluation.

A compensation and benefit sharing plan has been developed by this ICBG to ensure equitable compensation to the source of plant materials used in this study. Although the compensation plan remain loyal to the aims and objectives of the funding agencies, a strategy was developed which will ensure benefits to the host countries both immediately and in a sustainable manner over a long time. BDCP compensation plan in this program was based on deriving maximum benefits from the process of

drug discovery rather than the promise of huge royalties that may never materialize. In doing this, we have equitably distributed benefits to individual healers involved, Associations of Traditional Healers as well as various local communities in both Nigeria and Cameroon. The royalty derived from licensing of the drugs developed will be distributed through a legal Trust Fund which has been established. Each community is asked to establish a consultative committee drawn from the executive of the village unions or town associations, village heads and professional guild of healers. It is the village committee that make decisions and select priorities regarding compensations and projects and BDCP has used this approach successfully. It is our position that when determining compensation for access to genetic resources that emphasis should be placed on capacity building and training rather than short term cash payments. The project provides for various training programs both in-country and in the United States for ecologists, biologists, chemists, pharmacologists, ethnobiologists and field taxonomists. This non-monetary benefit will strengthen the ability of the scientists of the two countries to conduct similar project in the future.

The objectives of Associate Program 2 for Phytochemistry and preliminary bioassay is to conduct the extraction of selected medicinal plants, perform initial bioassay screens of extracts, bulk extraction of plant material for drug development, maintain an inventory of the extracts, their distribution and status in the test systems. AP-2 will also perform tests using the brine shrimp lethality bioassay and potato disc assay to determine extracts with high probability of containing biologically active compounds. The active extracts will undergo bioassay-guided fractionation, isolation by a combination of chromatographic techniques and structure determination by a combination of spectra studies and chemical analyses.

The objectives of Associate Program 5 on Ethnobiology, Economic botany and Plant inventory is to conduct an interdisciplinary ethnobotanical survey and produce an ethnobiological inventory on the plant and insects in the rainforest of West and Central Africa. AP-5 will also generate a prioritized list of plants recommended for collection and further studies and prepare voucher specimens of samples collected from the biodiversity plots and wild flora which will be deposited at the host country herbaria and at Smithsonian Institution. It will also expand the Afrimed database to include plants collected during the project , conduct an economic value assessment of the biological resources in the study area and provide training in parataxonomy and economic value assessment.

BODY

PLANT COLLECTION:

Four basic methods are presently being used in the selection of plants investigated for biological activity, viz:
- selection based on ethnomedical uses
- leads from literature searches and review of databases
- chemotaxonomic approaches
- random selection of plants followed by mass screening.

This ICBG team has developed a customized approach which involves a carefully

designed ethnomedical survey, followed by chemical and biological profile of plant candidates, and finally integrating the result with information from literature and chemotaxonomical evaluation to generate a highly selective prioritized list. This method has been tested in the search for new antimalarial, antileishmanials and antiviral drugs. In each case the correlating factor was more than 85%.

Malaria: BDCP collected and submitted about 200 plant extracts. 14 active substances were identified.
Leishmaniasis: 110 plant extracts have been screened and 42 active substances identified.
Trypanosomiasis: 17 plant extracts were screened and 3 active substances identified.
Trichomonas: 17 plant extracts were screened and 7 very active substances identified.
HIV: 25 extracts were screened for Hlv and 2 active substances identified.

Ebola Virus: One of the plant isolates showed *in vitro* activity against *ebola* virus.

Cytotoxicity: 20 plants extracts were tested against human colon tumor cell line. 16 were active at 50ug/ml level and 5 active below 5ug/ml.

Plant De-replication Protocol:

Plants collected from the ethnobotanical field trips were dereplicated according to a customized protocol. BDCP utilized a multidisciplinary team of experts in botany, chemistry, biology, clinical pharmacology and medical practitioners in a collaborative effort to identify and collect plant species with the greatest potential for biological activity. The collected plants were properly catalogued, voucher specimens obtained, then processed, extracted and tested for biological activity.

Project Staff:

Associate Program 2

AP Leader : Prof Johnson Foyere Ayafor
Department of Organic Chemistry
Faculty of Sciences
University of Dschang, Cameroon.

Cameroon: Dr. Pierre Tane Miss
Marguerite Tchuendem (Student)
Mr Appolonaire Tsopmo (Student)
Dr. Ngnokam (Post-Doc)
Dr. Nkeng Efouet (Post-Doc)

Nigeria: Prof P. Iwe Akubue
Dr Lewis Duru
Mr Christopher Ezeugwu
Dr P. I. Awachie

Ms Franca Ugwu (Study leave)
Ms Chibuzo Obayi
Mrs Nkemdirim Ezueh
Mr Cyprain Obijiofor
Dr Chris Okunji (U.S.A)

Associate Program 5:

AP-Leader: Prof Maurice M. Iwu
Bioresources Development & Conservation Programme
14228 Castle Boulevard, Silver Spring, MD 20904.

Cameroon: Dr. Focho Derek
Ms Augustina Fongod
Terry Sunderland
Vincent Gwanyama (U.S.A)

Field team: Twelve ethnobotanists engaged as needed for ethnobotanical survey and plant collection.

Nigeria: Prof Elijah Sokomba
Mr Cosmas Obialor
Mr Fred Ozioko
Dr Chike Onyechere
Mr Justin Onuorah
Ms Joy Anyiam
Mrs Gloria Okosi
Ms Oluchi Sunday
Dr Anene Anumba
Ms Ngozi Asogwa.

Field Team: Nineteen ethnobotanists engaged in surveys and sample collection.

ETHNOBIOLOGICAL SURVEY:

Six ethnobotanical field trips have been conducted in Nigeria and Cameroon. BDCP has collected over 200 plants for the treatment of various diseases and the herbarium specimen have been prepared for these plants. An inventory of plants used in the region for healing is also maintained.

Four zones have been identified within the project area in Nigeria for indepth ethnobotanical survey: Enugu-Nsukka-Abakaliki, Benue-Jos-Taraba, Owerri-Port Harcourt, and Calabar-Ogoja zones. In Cameroon, two similar zones have been selected for the same exercise. These are the North West and the South West zones.
The primary source of plants for drug development has been from a selected list of prioritized based on the analysis of the ethnobotanical information, chemotaxonomy

and correlation with previous information from AFRICMED Database and/or commercially available databases. The biodiversity plots established by AP-1 will provide us with permanent "Nature Laboratories", in which random sampling will be made of only species that are considered unique from a taxonomic viewpoint or previously unknown.

PLANT EXTRACTION PROCESS:

The installation of the project at the University of Dschang has been completed. Modalities for the acquisition of extra laboratory space has been initiated. The first major equipment, two Buchii Rotavapors, were purchased and installed in February 1996. These were followed by the acquisition of three percolators of different sizes (2L, 3L and 4L) which are essential for the cold extraction of plant material. Adsorbents, silica gel of varying grades, and sephadex LH20 have also been bought. Finally, there was an initial delay in the purchase of organic solvents due to some international restrictions on their random sale. We however succeeded in acquiring all the solvents we needed. Several sample vials of different sizes for supply of plant extracts to testing laboratories were also bought.

Extracts have been prepared from some of these samples and have already been logged in for anti-malarial screening. Extraction work is continuing for other plants and Literatures searches have also been conducted on the plants so far extracted. As soon as a feed back from screening laboratories has been received activity guided fractionation will be conducted. Brine Shrimp Lethality Bioassay, a rapid low-cost test for extracts with high probability of containing biologically active compounds, has also been revitalized. Two members of the group have updated their knowledge of the Antifungal Bioautography Assay through an international workshop held by IOCD in Harare, Zimbabwe. 3 Ph.D students in phytochemistry and 1 graduate student in *in vitro* anticancer screening techniques are currently being supported. An extract bank has been established in Nsukka, Nigeria and will be established in Cameroon this year.

Due to incessant closures of universities in Nigeria, there was a dire need to establish a laboratory that will function independently. This ICBG was instrumental in establishing the Center for Research in Medicinal and Aromatic Plants at Nsukka. This center has attracted grants from other institutions like Shaman Pharmaceuticals etc. It is our hope that the Center will perform preliminary bioassays and bulk extraction for other research scientists and institutions in West Africa and generate funds for its upkeep after the ICBG grant has ended. We also have many graduate students and interns training in our laboratories in Dschang and Nsukka.

SOCIO - ECONOMIC VALUE ASSESSMENT STUDIES:

This segment of the project has just been initiated. The project has been designed to achieve the following objectives as indicated in the original project proposal:

1) to quantify the economic value of forest resources for comparison with other land

use options.
2) to prioritized the production and marketing of biological resources in local markets which could provide a source of income for local residents.
3) to provide baseline data for the formulation of a sustainable management plan for the forest resources.
4) to train local natural resource managers and users at both national and community level to conduct economic and market research which takes into account the connection between conservation and development.

Study Plan

The socio-economic studies of forest resources in the project area will be undertaken to establish the value of the forest to various stake holders. The individual forest dweller, his community and the local administrative units have different uses for forest resources. And their collective need differ from those of the nation states and the international conservation agencies. In determining the economic value of forest resources from the region, emphasis will be placed on identifying actual values of the genetic resources and not the imagined or expected values. Most of the arguments advanced in support of the protection of biodiversity as a renewable resource have been based on the value of medicinal plants as potential sources of new drugs. While it is true that several plants have yielded valuable medicinal agents, drug development alone holds little attraction to local communities and the expected revenues from royalty payments in the future can hardly compensate for the attraction of other use options such as timber extraction and agriculture. Some economic botany studies have included local uses of medicinal plants but such studies often consisted largely of the evaluation of the estimated value of plants in forest inventories and multiplying the quantity of medicinal plants found per hectare by the suggested price of an equivalent herbal remedy. In this study, four sets of evaluations will be conducted:

1. Value of the forest resources to the local economy as articles of trade.

2. Market survey of herbal remedies used in the study area and the determination of their potential in the formulation of modern phytomedicine and cosmetics. This will include a review of medicinal and aromatic plants found in the study area which have been studied for their pharmacological and chemical properties by other investigators and are good candidates for formulation into phytomedicines.

3. Establishment of the presence and density of occurrence of selected medicinal plants used either locally as medicines or of pharmaceutical importance found in the small biodiversity plots.

4. Evaluation of other values as indicated above.

The Project Team

Consultants: a team of three consultants will be retained for this project to assist in the experimental design and analysis of the data generated from the project.

Contacts have been made with the Yale University School of Forestry, New York Botanical Gardens and Harvard University's Institute for Development Studies .

Research Team: The first year of the economic value assessment will be devoted to the collection of base-line data. The team will consist of the following people:

Ms Sarah Laird	- Project Coordinator
Dr. N. J. Nwaeze	- Agric. Economics (Nigeria)
Cosmas N. Obialor	- Agro-forestry
Thomas Tata	- Agric. Economics (Cameroon)
Terry Sunderland	- Forestry, biodiversity plots

Project Field Team: The field team will comprise of the people listed above and the ethnobotanical team of 10 persons in Nigeria and 6 in Cameroon.

INVENTORY:

The AP is maintaining two databases on behalf of the ICBG. The first is an extension of the Africmed database and the second is project database to track the location of plant collections, deposits and distribution of plant materials, quantity and distribution of extracts and isolates, and drug development status of each plant sample.

AFRICMED

The fields of the database have modified to include the following:

Genus
Species
Authority
Family
Common Names
(Several local names - see below)
Parts Used
Uses - Leaves
Uses - Stem
Uses - Root
Other Uses
These fields will be in addition to the other entries on chemical constituents, pharmacological activities and references.

Nigerian Plant Names

It is the plan to provide ethnobotanical information on all the 240 distinct ethnic or linguistic groups that inhabit Nigeria, but for the purposes of this project plant names for only twenty-two major languages (mainly those spoken by more than 500,000 people) will be included in the study. The languages include:

1. Anaang (400,000 - 600,000)

2. Ebira (500,000)
3. Edo (1,000,000)
4. Efik (360,000 - 1,000,000)
5. Fulfulde (7,611,000)
6. Gbari (300,000 - 500,000)
7. Goemai (568,107)
8. Gun-Gbe (500,000)
9. Hausa (18,525,000 - 22,000,000 as second language)
10. Ibibio (3,186,000)
11. Idoma (600,000)
12. Igala (800,000)
13. Igbo (14,691,000 - 16,000,000)
14. Ijo (500, 000)
15. Isekiri (510,000)
16. Izi-Ezaa-Ikwo-Mgbo (593,000)
17. Kanuri (3,628,000)
18. Mumuye (400,000 - 600,000)
19. Nupe (1,000,000)
20. Tiv (2,212,000)
21. Urhobo (340,000 - 500,000)
22. Yoruba (17, 965,000 - 20,000,000).

The population figures are based on old census some dating as far back as 1973, with a national population of 88,514,501 derived from the 1991 census.

Cameroonian Plant Names:

Plant names in eight Cameroonian languages will be provided in database. The limit number was population of 200,000. The population figures for Cameroon are based on 1982 and 1987 estimates some and the national population of 11,900,000 is derived from the 1990 census.

The eight languages are (population of speakers in bracket):

1. Bamun (215,000)
2. Basaa (230,000)
3. Beti (200,000)
4. Ewondo (577,000)
5. Fulfulde (668,700)
6 Ghomala (260,000)
7. Medumba (210,000)
8. Yemba (300,000)

Names in other languages from the over 150 linguistic groups will be collected from the field team and entered as "other names".

TRAINING:

The project provides for various training programs both in-country and in the United States for ecologists, biologists, chemists, pharmacologists, ethnobiologists and field

taxonomists. This non-monetary benefit will strengthen the ability of scientists of the two countries to conduct similar projects in future.

The Bioresources Development & Conservation Programme has successfully conducted two training workshops for Ethnobiology and Field Taxonomy in Cameroon and Nigeria. A Congress on "Utilization of Tropical Plants and Conservation of Biodiversity" which incorporated a training course, symposium and a workshop on " Commercialization of Renewable Biological Resources" have also been held in both countries. These courses have provided the much needed trained personnel for the planned ethnobiological field work and for accurate identification of plants.
These training courses and workshop on practical aspects of biodiversity prospecting for local scientists including those involved in the ICBG project is the first of its kind in Africa.

The following persons participated in the training course held in Nigeria:

NAMES	AFFILIATION AND ADDRESSES
Don I. Eze	National Horticultural Research Institute Mbato Station, P.M.B. 1076, Okigwe, Imo State.
J.L.C. Ibuzo	Anambra State Forestry Dept. Awka Proposed Herbarium at College of Agric., Igbariam, 9/2 Housing Estate, Trans Ekulu, Enugu.
G. Ojiaka	National Horticultural Research Institute, Mbato Station, P.M.B. 1076, Okigwe, Imo State.
E.J. Usoro	Ministry of Agriculture & Natural Resources, Agric. Dept. Hqtrs. Block I Secretariat Complex Uyo, Akwa-Ibom State.
E.O. Okechalu	Min. of Agric. & Natural Resources, Forestry Dept. P.O. Box 451, Otukpo, Benue State.
S. Onwuchi (Mrs)	Min. of Agric. & Natural Resources, Forestry Dept. Hqtrs. P.M.B. 1188, Owerri, Imo State.
M.C. Anukwo	Dept of Forestry, P.M.B. 1028, Enugu.
Okon Isoni	Divisional Forest Officer, Akpet Central, Biusa LGA, Cross River State.
A.O. Iwu	School of Education, Alvan Ikoku College of Education, P.M.B. 1033, Owerri, Imo State.
B.N. Nwokocha	Forestry Department, Forestry Hqtrs, P.M.B. 1028, Enugu. Enugu State.

P.E. Mbukpa	Federal Environmental Protection Agency, Conservation Monitoring Center, P.M.B. 1171, Uyo, Akwa-Ibom State.
A. Aliyu-Bindawa	Federal Environmental Protection Agency (FEPA), P.M.B. 0176, Garki, Abuja.
S. Ndaman	Fed. Environmental Protection Agency (FEPA) Conservation Monitoring Ctr, P.M.B. 57, Bauchi
Ishaku A. Ali	Min. of Agric. & Natural Resources, Jalingo.
J.I. Ahamefula	Federal Forestry Research Institute, P.O. Box 12, Akamkpa, Cross River State.
A.T. Sorkwagh	Min. of Agric. & Rural Devpt., P.M.B. 102638, Makurdi, Benue State.
Uche I. Uzoechi	Fed. Agric Coordination Unit, P.O. Box 1766, Enugu.
Sebastine Musa	Min of Agric. & Natural Resources, Jalingo, Taraba State.
O.A. Odumegwu	Forestry Dept., Min of Agric. & Nat. Resources P.M.B. 1188, Owerri, Imo State.

The following persons participated in the training course held in Cameroon

Gregory Nyeti Ayuk	c/o Makime Tanyi Ayuk P.O.Box 25, Buea. Cameroon
Atanga Ekobo	WWF-Cameroon B.P. G776, Younde.
Mary Molombe Enanga	Mt Cameroon Project Limbe Botanic Garden, Limbe.
Derek Focho	Dept Life Sciences, Faculty of Sciences University of Dschang, Cameroon.
Barry M. Mamadou	Faculte' de Sciences, Universite' de Conakry B.P. 1147, Republique de Guinee'.
Danny Naidoo	Dept . of Botany, University of Durban-Westville, Durban 4001, South Africa.
Augustina G. Fongod	B.P. 291, Douala.

Bernard-Alos Nkongmeneck	Dept of Plant Biology Faculty of Sciences, University of Younde.
Abdourahmane Gandeka	Diplome' chercheur ethnobotaniste sur les plantes Medicinale, Universite' de Conakry.
Diarra Diawara	Chef de Chaire d'EcoBotanique, Dept Biologie Faculte' des Sciences, Universite' Conakry.
Donald Ndjindje Ngatoum	Delegation of Envt. and Forestry, Fako Box 832, Limbe. Cameroon.
Joseph Mimb Ngembus	c/o Cerut, Box 170, Limbe, Cameroon
Benjamin Serkfem (Shey)	Living Earth, B.P. 373, Beau SW Province. Cameroon.
Thomas E. Njock	Dept of Life Sciences, Faculty of Sciences, University of Beau.
Nole Tsabang	IMPM CRPMT Laboratory Botanique et Medecine Traditionnelle, B.P. 193, Younde.
Claudia Buma-Kor	Lycee Bilque Essos, Younde, Cameroon.

The training curriculum included core courses as:

1. Fundamental Concepts in Ethnobiology

Core subjects include: Definitions of relationship with allied disciplines; Differential approaches to ethnobiological studies; Community participation in ethnobiological studies; Ethnobiology and economic development; Ethnobiological collections; Sustainable collection of wood and bark samples; Preparation of ethnobiological and plant collection data sheets.

2. The African World - View and Indigenous Belief Systems

Core subjects consists of Rituals, religion and symbols in ethnobiology;
The sacrality of the earth and sustainable development; The forest as a "sacred canopy".

3. Indigenous Ecological Knowledge

This included Traditional landscape mapping methods; Rituals and conservation; Traditional agriculture and sustainable utilization of forest resource; Indigenous forest management systems and Natural pest control methods.

4. Physical and Human Geography of West Africa

Core subjects: Land: area, location, geology, elevation ranges, soil types, climatic zones, vegetation and major geographical features.
People: land tenure and use, major social groups, ethnicity, language, settlement history, population size and relative densities, history, agro-economic activities, sustenance and commercial crops.
Forestry: Use ratios, size and status of protected areas, effects of logging on the environment, forest reserves, and other conservation options.

5. Plant Taxonomy and Systematics

Core subjects: Classification as a logical system of categories:
1. Sexual (or artificial) systems
2. Phylogenetic classification
3. Indigenous methods of classification
Identification or determination (the naming of an organism by reference to an already existent classification)
Nomenclature: the study of system and method of naming organisms, the binomial system; Field identification and Identification keys.

6. Insect Taxonomy and Systematics

Core subjects: Insects and human welfare, Pollination, Soil building, Soil management, Biological control of parasites; Destructive role of insects; Insect classification, Identification and Feeding habits; Methods of field collection.

7. Plant collection and Herbarium Sample Preparation

Core subjects: Methods of collection; Sampling technique; Sterile collections and problems of identification; Collection bags/field presses;
Handling of fresh plant materials; Drying techniques; Field notes; Herbaria and the curation of plant specimens; Botanical databases (BRAHMS).

8. Ethnographic methods

Core subjects: Anthropological issues in bioresources research; Traditional oral documentation; Role of linguistics in folk classification;
Focal group approach - systematic or structured interactions;
Participatory discussion groups; Structured interviews and semi-structured interviews; Research methods in social science
Ethnographic data collection; Data analysis, differential ranking systems.

9. Inventory and Monitoring of Biodiversity

Core subjects taught were Importance, Procedures, Problems; Rapid and detailed vegetation mapping; Data management.

10. Propagation and cultivation of medicinal plants

Core subjects: Field collection; Selection of propagated materials (sampling techniques); Sexual and vegetative propagation - a comparison;
Assessment of cultivation requirements.

11. Basic Pharmacognosy and Ethnomedical Methods

12. Field Training

Participants were accompanied into the field in order to practice some theoretical aspects of the course and extend the coverage of the topics discussed in the formal teaching sessions. This practical experience is completed in six weeks after which those who wish to participate in the ICBG program continue the field work in their various stations. This has enabled us to cover many faucets of the large and varied vegetation of both countries.
Participants from neighboring countries have also attended these training programs and a manual of the training course has been produced to enable future organization of similar courses.

EQUIPMENT AND SUPPLIES:

The following equipment was purchased for the ICBG project this financial year:

Vacuum pump
1 Fax machine/HPMulti-fun/Printer
1 Colored printer Brother
1 Smith Corona Personal Word Processor
PWP 4200 14" Monitor 115K Memory
2 Smith Corona Dictionary Typewriter SC 900
1 Smith Corona Sc Spellmate Typewriter
2 computer Desks
1 Storage Cart
3 Plastic Organizers
1 Handtruck
Packard bell 486 complete Unit (CPU + monitor + Printer)
Printer HP BJ 855C
IBM Format Disc 2pk
1 Nec 610 plus Laser Printer
1 Canon LBP-460 Laser printer
1 Aptiva IBM computer.120 mHz
1 HP Fax/printer/copier
Canon Printer and accessories
Pagemaker Egghead Discount software
Chromatography materials;
Sephadex -Sigma & Silica gel Aldrich
Chromatotron
Round bottom flasks
Beakers Griffin

Measuring Cylinders
2 Metal maxi rack
Electrical Accessories; Surge suppressors
Honda 8.0 HP /Japan Generator 220 Volt/50Hz
2 1000Watts Transformers
Westinghouse Deep freezer Model FC16V
1 GE Refrigerator Model TFG20JR 220V
2 GE Dryer # DDES102
1 Air can
6 sets of Perculators different sizes
1 Plain Paper Fax
Sample bottles etc
4 Perculators different sizes
Plain Paper Fax
2 Buchi Rotary Evaporators R-114A
Refrigerator/Freezer

CAPACITY BUILDING:

1. Universities:

Universities in Africa function as part of the educational, cultural, economic and social systems. This ICBG has taken the approach of treating the African participants as equal partners creating a platform for the scientists and field staff to work as a team and having most of the investigation carried out in source countries. AP-5 and AP-2 supplements the funding for laboratory equipment, computers and basic infrastructure to both the Center for Medicinal and Aromatic Plants at Nsukka and the University of Dschang. As part of the ICBG, funds have also been provided to the University of Ibadan for post-doctoral training in malaria molecular biology.

2. Local Non-Governmental Organizations:

One of the objectives of the ICBG is strengthening the capacity of BDCP, a local network created by university researchers to address the problem of conservation. The ICBG provides some basic infrastructure support to BDCP for unique sustainable economic development programs such as: cultivation trials for the valuable medicinal species, *Physostigma venenosum* (once used as an ordeal poison) - in the Calabar region (Nigeria); assistance provided to local forest communities in acquiring legal rights to communal lands; and farm inventories conducted in Northeastern and Southeastern Nigeria. Pilot cultivation has also been initiated to raise 2,000 stands of *Prunus africana* in North-western region of Cameroon. The plant is valued for the treatment of male prostract gland disease. AP-5 also provided basic funds to purchase herbarium equipment, which will be used jointly by the University of Nigeria, Nsukka, four-wheel drive vehicle (for field work) and computers.
AP-5 and AP-2 jointly facilitated the establishment of the Center for Medicinal and Aromatic Plants at Nsukka, Nigeria, incorporating a medicinal plant herbarium, plant processing unit and data processing unit.

3. Traditional Healer's Association:

The African ICBG provided assistance to Nigerian Union of Herbal Medical Practitioners to establish two traditional herbal complexes in Enugu and Bida (Nigeria) for health care services, formal training of herbalists and medicinal plant gardens. Plans have been made to identify suitable partners in Cameroon for similar collaboration. ICBG has also provided immediate reciprocity funds and access fees to the association which the Union used in the following on-going project by the Union: a) plant nursery facilities for the ex-situ conservation of plants used by the healers in their practice; b) cultivation of selected medicinal plants as hedges for the demarcation of the herbal garden; and c) preparation and storage of samples in the community based herbal pharmacy.
We also provided support to the National Institute for Pharmaceutical Research and Development Abuja (Nigeria). At the State Government level ICBG funds provided support to the Enugu State Forestry Department for the rehabilitation of Enugu Reference Herbarium. The herbarium serves as a reference herbarium for the flora of south-eastern parts of Nigeria and western Cameroon.

4. Local Communities:

Local communities are important collaborators for this ICBG. We work with existing local authorities (for example, chiefs, traditional healers, village councils, development associations) in communities where ownership and authority are generally clearly defined. These communities usually share cultural and tribal ties. It is not our place to decide on their behalf the "truly representative" bodies. The working arrangement adopted by this ICBG are the outcome of several months of village meetings, discussion with influential members of the community and negotiation with the appropriate government agencies.

AP-5 provided assistance to communities to establish Community Forest Areas in Ehime Mbano and Owai (Nigeria). BDCP has been collaborating with the Eze (the chief) of the town and the council of elders and titled men to preserve two of the community lands as an extractive reserve. The program provided funds which was used for demarcation of the lands and for application for a legal instrument of ownership. ICBG is collaborating with individual herbalists in the town to identify useful plants that will be investigated.

ICBG/BDCP staff facilitated the establishment of a Community Development Fund which was fed initially by payments made as a form of "access fee" in exchange for the inventory of local ethnobiological knowledge. Local community members were also paid for both information supplied and assistance in the field as guides, plant collectors and porters. ICBG has worked to obtain a legal certificate of occupancy for forest extraction in neighboring communal forest areas as a medicinal plant sanctuary.

ESTABLISHMENT OF BENEFIT-SHARING PLAN:

ICBG has established a compensation and benefit sharing plan for the participating individuals, communities and institutions. Details of the plan are as provided below.

A Short Term and Immediate Compensation - Collection fees to individuals and communities.
Payment and compensation have been made for plants collected from local communities in three ways viz:
1. "Small" cash payment to the informant/ collector
2. Assisting the community in their development projects
3. Medical members of our ethnobotanical team consult with the local healers and help them in treating life threatening conditions.

Long term Benefits - Royalty Payments

The royalty derived from licensing drugs developed from any of the leads provided under this ICBG will be distributed between the informant/herbalist, the community and the scientific inventors. The individual informant will also benefit from bulk recollections. If a drug results from a lead provided by an individual herbalist, 25% of the royalty from the drug discovery will be given to the individual and the rest treated as a communal resource to be distributed and used as determined by the Committee.

Trust Fund Management Committee

The Board of Management for the Trust Fund has been constituted and consists of representatives from U.S.A, Cameroon and Nigeria. The royalty generated from licensing of the drugs developed during this project will be distributed through this legal Trust fund. The Trust is completely independent and will administer the funds only for the purpose outlined in its Charter. The communities we are working with have established a consultative committee drawn from the executive of the village unions or town association, village heads and professional guild of healers. This village committee make decisions and select priorities regarding compensations and projects.

We firmly believe that emphasis should be placed on capacity building rather than short term cash payments when determining compensation for access to genetic resources. It is our position that source countries should add value to their resources before trading the samples.

PUBLICATIONS:

The following papers and publications were presented by AP-5 Leader this financial year:

CONFERENCE PRESENTATIONS - 1995

1."Search for Bioactive Plants and Plant Products", International Symposium on Medicinal & Aromatic Plants, University of Massachussetts, August 28-31, 1995.

2.IBC Conference on Drug Discovery and Commercial Opportunities in Medicinal Plants & Natural Products, September 11, 1995.

3.Keynote Address BDCP Congress on "Utilization of Tropical Plants and Conservation of Biodiversity", October 1995.

4. Series of Lectures at Center for Scientific and Industrial Research, Pretoria, South Africa , November 1995.

CONFERENCE PRESENTATIONS - 1996

1. Keynote Speech at SAAB Indigenous Plant Use Forum, South Africa, Jan 18, 1996.

2." Development of Indigenous Genetic Resources: The BDCP Experience" American Association for Advancement of Science Symposium, February 1996.

3."Bioprospecting Using African Genetic Resources", USDA Beltville Symposium on Global Genetic Resources - Access, Ownership and Intellectual Property Rights, May 19-21, 1996.

4. DIA Conference, San Diego, June 9-12, 1996.

5. National Council for International Health HIV/AIDS Program Conference on Global Health - Future risks, Present Needs June 1996.
6.Keynote Address, BDCP International Workshop on Commercial Production of Indigenous Plants as Phytomedicine and Cosmetics, 24-25 June 1996.

7.IOCD Workshop at Center for Scientific and Industrial Research, Pretoria South Africa, July 1, 1996.

8. "ICBG on Drug Development and Conservation Program in West and Central Africa" ,Shaman Science & Technology meeting, Aug. 2, '96.

CONTRIBUTED CHAPTERS:

Iwu , Maurice & Sarah Laird "Health, Conservation, and Economic Development: The International Cooperative Biodiversity Group Drug Development and Biodiversity Conservation in Africa - A Benefit Sharing Plan", a paper prepared for the Rainforest Alliance's *Natural Resources and Rights Program.*

Iwu, Maurice "Resource Utilization and Conservation of Biodiversity in Africa", *Medicinal Resources of the Tropical Forest : Biodiversity and its Importance to Human Health* edited by Micheal Ballick, Elaine Elisabetsky and Sarah Laird.

Iwu, Maurice "Biodiversity prospecting in Nigeria: seeking equity and reciprocity in intellectual property rights through partnership arrangements and capacity building", *Journal of Ethnopharmacology* 51(1996) 209-219.

"ICBG -Drug Development and Conservation of Biodiversity in West and Central Africa - A new Standard of Collaboration for Indigenous People" -ICBG Program Document. AP-2 Leader presented the following papers this financial year:

1. J.F. Ayafor (1996). Ethnodietary Preparations as a source for phytomedicines: The Case of Nah-Poh of the Bamileke Tribe in Cameroon. Paper presented at the BDCP International Workshop on the Commercial Production of Indigenous Plants as Phytomedicines and Cosmetics, June 24-25, 1996, Lagos, Nigeria.

2. J.F. Ayafor (1995). The Chemical Diversity of selected Cameroonian Medicinal Plants. Paper presented at the BDCP International Congress on the "Utilization of Tropical Plants and the Conservation of Biodiversity". October 23-27, 1995, Douala, Cameroon.

WORK PLAN AND TIME-LINE FOR 1996-97

1. Field trips in the two remaining zones in Nigeria will be conducted during the next plan period.

2. One ethnobotanical training will be conducted in the Calabar region of the project area.

3. The work of the AP in Cameroon has not fully taking place because of logistics problems caused by the late start of AP-1. With the establishment of the biodiversity plots and the acquisition of vehicles by AP-1, it is expected that more ethnobotanical surveys and field trips will be organizaed in Cameroon. A sub-team leader will be appointed for AP-5 in Cameroon to take-care of the inventory.

4. The inventory of plants collected from the biodiversity plots will be included in the database.

5. A major activity to be undertaken during the next year is the implementation of the socio-economic value assessment studies. Data will be collected on useful plant species and their products that have been recognized through indigenous knowledge. The second set of database will include information on all species found in the biodiversity plots of any utility based on the team's knowledge of African flora and botanicals. Economic analysis of the value of the forest as commodity items in the local economy and possible value in international commerce will be conducted.

CONCLUSION

The project achieved all the objectives outlined under AP 2 and 5 of the ICBG:

- Established a multidisciplinary team of experts to identify and select plant species with greatest potential for biological activity.
- Conducted six ethnobotanical field trips in Nigeria and Cameroon.
- Collected over 200 plants for the treatment of various target diseases.
- Prepared herbarium specimens for all the plants collected.
- Updated the database on African Medicinal plants.
- Maintains an inventory of plants used in the region for healing.
- Established a fully equipped laboratory for plant processing and extract bank in Nsukka, Nigeria.
- Provided scientific equipment to the project laboratory at the University of Dschang, Cameroon.
- Processed and extracted over 120 medicinal plants. Screened samples for activity against bacteria and fungi. System established for screening of random collected plants.
- Supporting three Ph.D students in phytochemistry, one graduate student in *in vitro* anticancer screening techniques and two students in pharmacognosy.
-Conducted two training courses in ethnobotany and field taxonomy in Cameroon and Nigeria.
- Held two workshops on sustainable utilization of biological resources in Cameroon and Nigeria.
- Conducted a workshop on production of phytomedicines and cosmetics.
- Assisting Nigerian Union of Herbal Medical Practitioners to establish traditional medical complexes in Enugu and Bida (Nigeria) for health care services, formal training of herbalists and medicinal plants garden.
- Provided assistance to communities to establish Community Forest Areas in Ehime Mbano and Owai (Nigeria).
- Provided support to the National Institute for Pharmaceutical Research and Development Abuja (Nigeria)
- Refurbishing of Enugu Reference Herbarium.