

SPECIAL REPORT

CASE STUDY ON MEDICINAL PLANT RESEARCH IN GUINEA: PRIOR INFORMED CONSENT, FOCUSED BENEFIT SHARING, AND COMPLIANCE WITH THE CONVENTION ON BIOLOGICAL DIVERSITY

Medicinal plants play a very important role in the provision of primary health care in tropical countries (Farnsworth et al 1985). Contemporary research in medical ethnobotany involves collaboration with traditional healers, local communities, scientists, scientific institutions, medical clinics, non-governmental organizations, and local and national governmental offices from the host country. Only a small number of publications in the ethnobotanical literature (Blum 1993; Carlson et al. 1997b; Chinnock et al. n.d.; King and Carlson 1995) describe real life examples of how agreements for research and benefit sharing are established and implemented between northern researchers and tropical countries. This report describes mechanisms established for reciprocity and benefit sharing throughout a four-year ethnobotanical research collaboration between Shaman Pharmaceuticals and The Republic of Guinea in West Africa (Fig. 1). Discussions led to the establishment of prior informed consent and collaborative research agreements with a variety of stakeholders in Guinea (Table 1). Since the research collaboration commenced in 1994, the company has conducted field research and collected and analyzed medicinal plants used to treat Type 2 diabetes mellitus while a spectrum of stakeholders in Guinea (Tables 2–6) have received compensation and reciprocity benefits (Tables 8–14)

Shaman's ethnobotanical field research methodology includes the use of physician and ethnobotanist teams to assure appropriate interpretation of diseases being treated and accurate identification of the medicinal plants being used (Carlson and King 1998; King and Carlson 1995). These ethnobotanical research teams have focused on plants in Guinea used to treat Type 2 diabetes mellitus. Medicinal plants collected in Guinea are analyzed for antidiabetic activity in a db/db diabetic mouse model in the

Shaman laboratories in California (Luo 1998). Prior research in countries outside of Guinea by some of the authors showed that medicinal plants collected and analyzed by the above methods demonstrated antidiabetic activity in a db/db antidiabetic mouse model (Bierer et al. 1998; Luo et al. 1998a; Luo et al. 1998b; Luo et al. n.d.) Evaluation of seventy plants from around the world used to treat Type 2 diabetes mellitus showed that 57% demonstrated antidiabetic activity in a db/db diabetic mouse model (Carlson et al 1997a). Shaman has received dried plant collections of twenty-one different plant species from Guinea used to treat Type 2 diabetes mellitus. These plant species are presently being evaluated for antidiabetic activity in a db/db diabetic mouse model. When the experimental biology evaluations have been completed, the results are reported back to the collaborating scientists and traditional healers in the country of origin (Richter and Carlson 1998).

In Guinea there are numerous different cultural groups with strong and rich traditions of botanical medicine that contribute significantly to the treatment of a variety of diseases including the treatment of Type 2 diabetes mellitus. The authors collaborate with western trained scientists, traditional healers and communities representing many different ethno-linguistic groups (Tables 5 and 6) including the Dialonke, Kpelewo (Guerze, Kpele, Konoh), Malinka (Malinke, Maninke), Mano (Manoh), Pular (Peulh, Poular, Fulani, Foulani), Susu (Soussou, Sousou, Nalou, DjaKanke-Boke dialect), and Toma. These ethno-linguistic groups live in regions that comprise several different major ecosystems. Conakry (Coastal), Kindia and Coyah (dry forest), Faranah and Kankan (woodland savannah), Labe (mountains) and Nzerekore and Lola (rainforest).

Type 2 diabetes mellitus is widely recognized by the healers with whom we collaborate. Healers

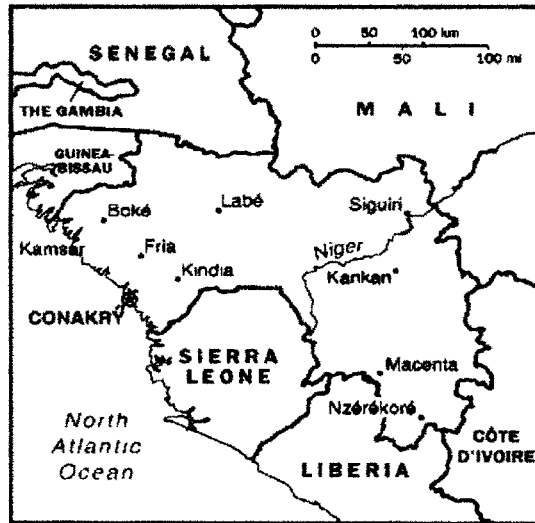


Fig. 1. Map of Guinea

TABLE 1 HOW PRIOR INFORMED CONSENT WAS ESTABLISHED.

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- Step 1. 1994. Université Gamal Abdel Nasser de Conakry scientist contacts Shaman Pharmaceuticals and proposes collaboration. Shaman provides written materials about the activities and philosophy of the company, and the NGO, The Healing Forest Conservancy.
- Step 2. 1994 (October). Shaman brings Guinean scientist to its California laboratories for discussions on the proposed collaboration.
- Step 3. 1994 (November)–1995 (January). Guinean scientists meet with officials from Guinea governmental agencies, Université Gamal Abdel Nasser de Conakry, BDCP-Guinea, traditional medicine organizations, and local communities and present them with the potential for a medicinal plant research collaboration with Shaman Pharmaceuticals. Written materials translated into French were provided. Discussions were held with these different stakeholders to establish clear prior informed consent of Shaman's objectives and commitments, research collaboration, and focused benefit sharing. Questions and dialogue were communicated from these stakeholders to Shaman Pharmaceuticals throughout the duration of these discussions. In January of 1995, an "Agreement for Research and Collaboration" is established between Shaman and BDCP-Guinea. The person from Guinea who signed the agreement is the Director of BDCP-Guinea and the Vice Dean in Charge of Research at the national governmental university, Université Gamal Abdel Nasser de Conakry.
- Step 4. 1995 (December). The different Guinean stakeholders from Step #3 agreed to support an invitation to Shaman Pharmaceuticals to establish a formal medicinal plant research collaboration with Guinea which would include Shaman scientists' visits to conduct ethnobotanical field research.
- Step 5. 1996 (January–April). Shaman obtains appropriate research and plant export permits from national government, Directeur Nationale de La Recherche Scientifique Et Technique, Ministère de L'Enseignement, Supérieur de La Recherche, Scientifique Et de La Culture, Conakry, République de Guinée. Shaman scientists met with officials at this governmental office and renewed the research and plant export permits before the expeditions in April 1996, April 1997, and June 1998.
- Step 6. 1996 (April), 1997 (April), 1998 (June). Shaman ethnobotanical research scientists working with Guinean scientists met directly with Guinean national, state, and local governmental agencies, the Université Gamal Abdel Nasser de Conakry, BDCP-Guinea, traditional medicine organizations, and local communities and held discussions to further ensure prior informed consent of Shaman's goals and commitments for the research collaborations.
- Step 7. 1996 (April), 1997 (April), 1998 (June). The ethnobotanical research collaboration commences along with focused benefits for capacity building and technology transfer.
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TABLE 2. PRIOR INFORMED CONSENT FROM AND COLLABORATION WITH UNIVERSITIES, COLLEGES AND NGOS.

Universities & colleges	Non-governmental organizations
Universite Gamal Abdel Nasser De Conakry Dean of Faculty of Science, Secretary General, Maitre de Conference, Chef de la Chair	Bioresource Development & Conservation Program (BDCP)-Guinea
Institute Valery Giscard d' Estaing, Faranah Centre de Recherche Agronomique de Foulaya, Kindia Centre de Recherche Agronomique de Sereidou	Association Guineene des Diabetiques

from the different ethno-linguistic groups describe a variety of signs and symptoms in patients with Type 2 diabetes mellitus including fatigue, increased urination, urine that tastes sweet, and when they urinate on the ground the urine attracts ants. The afflicted people may also have foot sores that heal very slowly. The healers report that when they treat the patients with botanical medicines their foot sores heal, their urination returns to normal, and when they urinate on the ground, the ants do not go to the urine.

THE CONVENTION ON BIOLOGICAL DIVERSITY AND PHARMACEUTICAL RESEARCH

To slow the loss of the earth's biological diversity, the Earth Summit was held in 1992 in Rio de Janeiro, Brazil. At this summit, the Convention on Biological Diversity (CBD) of the United Nations Conference on Environment and Development opened for signature on June 5, 1992. Stated objectives of the Convention were (1) the conservation of biodiversity, (2) the sustainable use of its components, (3) the equitable sharing of the benefits resulting from the use of genetic resources, (4) appropriate access to ge-

netic resources, transfer of relevant technologies, and acknowledging rights over resources and technologies (Article 1; CBD 1992). Article 10(e) of the CBD calls for the "Encouragement of cooperation between government authorities and private sector in developing methods for sustainable use of biological resources (CBD 1992)." The private sector is involved with the CBD discussions because natural products are an important source of medicinal compounds. Twenty five percent of the modern medical drug prescriptions written between 1959 and 1980 in the United States were pharmaceuticals derived from plants (Farnsworth et al 1985).

Tropical rain forests are home to tremendous biological and cultural diversity (Durning 1992). Traditional botanical medicine systems are also widespread and diverse in these tropical regions. Medicinal plant research is commonly conducted in these regions by government, academic, or private company laboratories based in temperate countries. Numerous articles have addressed the issues of intellectual property rights (IPR) and appropriate compensation and reciprocity for local communities and scientific and conservation organizations in the host tropical countries

TABLE 3. COLLABORATING SCIENTISTS FROM GUINEA.

Four physicians from the University Medical Center in Conakry
Two nurses from the University Medical Center in Conakry
One physician from the Guinea Diabetes Association
Director of the Guinea Diabetes Association
Seven botanists from the University Gamal Abdel Nasser De Conakry
Three natural products chemists from the Universite Gamal Abdel Nasser De Conakry
Two English-French translators from the Universite Gamal Abdel Nasser De Conakry
Two botanists from the Bioresource Development & Conservation Program-Guinea
Four botanists from Institute Valery Giscard d' Estaing, Faranah
One botanist from Centre de Recherche Agronomique de Foulaya, Kindia

TABLE 4. PRIOR INFORMED CONSENT FROM AND COLLABORATION WITH TRADITIONAL HEALERS' ORGANIZATIONS, COLLECTIVES, & CLINICS

Traditional healers' organizations	Healers' clinics & collectives
Dabola Healers' Group	Kankan Clinic
Siquiri Healers' Group	Ninge bhoie, N'zerekore Clinic
St. Alexi, Kankan Healers' Group	Gbily, Nzerekore Clinic
N'zerekore Healers' Group	Almamy Market Collective
Lola Healers' Group	Daka Market Collective
Conakry Healers' Group	Kensanbouyou Market Collective

where research is conducted (Boom 1990, Carlson et al. 1997; Churcher 1996; Churcher and Nietschmann 1994; Cunningham 1991 and 1992; Elisabetsky 1991, Iwu 1996a,b; King, Carlson, and Moran 1996a; Moran 1992, 1996, Posey et al. 1995; RAFI 1996; Reid et al. 1993; Williams and Baines 1993). The CBD also addresses a wide range of ethical and political issues related to medicinal plant research and provides legal mechanisms for implementation and enforcement for the over 170 nations which have, to date, ratified it. Examples have been given that describe how to incorporate these principles and guidelines into ethnobotanical research collaborations to establish equitable collaborative agreements with tropical countries (Carlson et al. 1997; Chinnock et al. n.d.; King 1994; King and Carlson 1995; King, Carlson, and Moran 1996b). Table 14 illustrates how the company complies with the CBD in research collaboration with Guinea. This paper describes a model through which a pharmaceutical company complies with the principles set forth by the CBD and contributes a real life example to the international dialogue on what is fair and equitable benefit sharing in contemporary pharmaceutical research on tropical plants

PRIOR INFORMED CONSENT, RELATIONSHIP BUILDING, AND COLLABORATION

It is important that host country governments, scientific institutions, and local communities understand the goals, objectives, intentions, and commitments of research projects conducted by foreign groups. Before the research commences, the goals and objectives of involved parties should be discussed and established. When the different host country stakeholders are satisfied that a mutually beneficial plan has been established, consent can then be granted to the foreign researchers. The development and evolution of establishing prior informed consent and research collaboration agreements with Guinea is described in Table 1. In 1994 the Bioresource Development & Conservation Programme (BDPC), an African non-governmental organization (Iwu 1996b), sponsored a conference at the national government Universite Gamal Abdel Nasser de Conakry (UGANC) in Guinea. At this conference, discussions proceeded on the need for sustainable use and development of biological resources, pharmaceutical development from plants, and the importance of prior in-

TABLE 5. ECOSYSTEMS AND ETHNOLINGUISTICAL COLLABORATIONS.

Ecosystem	Province	Ethnolinguistic groups
Coastal	Conakry	Susu, Maninka, Pular (Peulh, Fulani)
Rainforest	N'zerekore, Lola	Kpelewo (Guerze), Maninka, Toma, Mano
Wet forest	Macenta	Maninka
Woodland savannah	Kankan	Kpelewo (Guerze), Maninka, Dialonke, Toma
Woodland savannah dry forest	Faranah	Maninka
Upland savannah, dry forest	Coyah	Maninka
Upland savannah, dry forest	Kindia	Susu
Mountain savannah, dry forest	Labe	Pular (Peulh, Fulani)

TABLE 6 COLLABORATING TRADITIONAL HEALERS, COMMUNITIES, & ETHNOLINGUISTIC GROUPS.

Traditional healers	Communities	Ethnolinguistic groups
58 traditional healers 43 males 15 females	42 communities in 7 provinces	7 ethnolinguistic groups Maninka, Susu, Kpelewo (Guerze), Pular (Peulh, Fulani), Toma, Mano, Dialonke,

formed consent and equitable benefit sharing for the tropical country scientific institutions and local communities. The Vice Dean in charge of research from UGANC attended this conference and then contacted Shaman Pharmaceuticals to propose discussions for potential research collaboration. Literature on the company's activities was provided to the Vice Dean of Research and in September 1994, and he was invited to and funded by the company to visit its laboratories in California. He toured the laboratory facilities and held discussions with numerous people from different departments about research approach, philosophy, and the company's "Agreement of Principles" (Shaman 1997). Discussions included how Guinean scientific institutions and local communities could benefit from medicinal plant research collaboration.

The Vice Dean returned to Guinea and initiated meetings with Guinea governmental agencies, UGANC, BDCP-Guinea, traditional medicine organizations, and local communities. Literature translated into French that describes Shaman's activities and philosophy was provided to these stakeholders. Discussions were conducted that included detailed descriptions of how the medicinal plants would be analyzed, potential for commercialization, and issues of equitable compensation and benefit sharing. Questions, concerns, or requests expressed by any of these entities were communicated to the company to facilitate dialogue and communication with different Guinean stakeholders. The Directeur Na-

tionale de la Recherche Scientifique Et Technique, the National Government of the Republique de Guinea in Conakry was also involved with these discussions. University scientists, government officials, and numerous communities representing a variety of different ethnolinguistic groups expressed interest in collaborating with the company. By January 1995, an "Agreement for Research and Collaboration" between BDCP-Guinea and the company was established. The agreement was signed by the Vice Dean in charge of research at the national government university in Conakry (UGANC), who is also the director of the non-governmental organization, BDCP-Guinea. Later that year, the company was formally invited in writing to collaborate with the country of Guinea in medicinal plant research. In the early months of 1996, appropriate research and plant export permits were obtained from the Directeur Nationale de la Recherche Scientifique Et Technique of the National Government of the Republique de Guinea in Conakry. Before each of the ethnobotanical research expeditions in 1996, 1997, and 1998 Shaman scientists visited this governmental department and renewed our research and plant export permits.

EDUCATIONAL WORKSHOPS

In April 1996 Shaman scientists (physician and ethnobotanist) participated in an all-day educational and informational meeting at UGANC. This day consisted of presentation and discus-

TABLE 7. BOTANICAL SPECIMENS COLLECTED IN GUINEA.

Botanical voucher specimens and ethnomedical data	Dried plant material for analysis
During ethnobotanical field research expeditions in 1996, 1997, and 1998, voucher specimens and ethnomedical information were collected on 145 different plant species in 118 genera used to treat symptoms related to Type 2 diabetes mellitus. Copies of the ethnomedical and botanical information and voucher specimens were deposited in herbaria in Guinea and at Shaman Pharmaceuticals	Forty kilograms of dried plant material was collected for 21 of the 145 different plant species by Guinea scientists and traditional healers. This plant material was sent to Shaman's California laboratory for analysis of antidiabetic activity

TABLE 8. FOCUSED BENEFITS 1994–1998. THE OPERATING COSTS TO MAINTAIN THE COLLABORATION WITH GUINEA DURING AND IN BETWEEN EXPEDITIONS SUCH AS LODGING, FOOD, TRANSPORTATION, AND COMMUNICATION COSTS BOTH FOR THE GUINEA CONSULTANTS AND SHAMAN SCIENTISTS ARE NOT CONSIDERED AS PART OF THE COMPENSATION AND RECIPROCITY FOCUSED BENEFITS FOR GUINEA

Immediate-term reciprocity	Immediate-term compensation	Medium-term compensation	Total benefits 1994–1998
\$28 150	\$34 770	\$82 000	\$144 920

sion of Shaman's activities and philosophy to 150 attendees including the following, national government ministers; national religious leaders; representatives from the Guinea Diabetes Association; traditional healers, an NGO, the Bioresource Development & Conservation Programme-Guinea (BDCP-Guinea); students and faculty from the Universite Gamal Abdel Nasser De Conakry departments of botany, chemistry, forestry, pharmacology, and medicine; and newspaper journalists and a television crew. Parts of the event were televised on the evening news in Conakry. Discussions included the importance of Guinean scientists and traditional healers receiving appropriate intellectual credit and benefits from the collaboration with Shaman or any other collaborating northern research group. There were also presentations on the technical aspects of Type 2 diabetes mellitus, ethnobotany, botany, and conservation. The Guinean participants were enthusiastic about the

topic because Type 2 diabetes mellitus is a growing problem in Guinea. The participants were eager to establish a research program to better understand how botanical medicines from Guinea are used to treat this disease. Literature in both English and French about Type 2 diabetes mellitus, ethnobotany, botany, conservation, and intellectual property rights was provided to the people that attended. There were opportunities for questions and discussion on a variety of issues throughout the day. All presentations and discussions were translated into French. In April 1996 and April 1997 Shaman scientists conducted four day intensive ethnobotany field research training sessions in Conakry with twenty seven Guinea scientists (Table 3) and six Conakry traditional healers. Plant presses, books, written materials, and ethnomedical and botanical field research methodology were provided by Shaman to all the participants of both these training sessions.

TABLE 9. IMMEDIATE TERM FOCUSED BENEFITS FOR CAPACITY BUILDING & SUPPORT FOR EDUCATION, WORKSHOPS AND CONFERENCES

1996 and 1997 four day workshops conducted in Conakry, Guinea and attended by 30 Guinea scientists on research methods in ethnobotany, conservation, public health, and mechanisms for benefit sharing. Written materials in French were provided.
1996, 1997, 1998 eight weeks of ethnobotanical research expeditions throughout Guinea involved and trained twelve different Guinea scientists in detailed field research methods. Over 50 different traditional healers also learned about our field research methods.
1994, October, one Guinea scientist to a International Bioresources Development & Conservation Program meeting, Washington, D C USA
1995, October, two Guinea scientists, Second Congress on the "Utilization of Tropical Plants and Conservation of Biodiversity," Cameroon, Douala
1997, September, one Guinea scientist, Conference title: "Commercial Production of Indigenous Plants as Phytomedicines and Cosmetics," Nigeria, Enugu
1998, February, one Guinea scientist, Drug Information Association Conference. "Phytomedicines Development Botanicals for the 21st Century," South Africa, Cape Town
1997, April, desks and supplies for schools in the communities of Pella-Malal Labe, Bhawo Taghe Labe, and N'zerekore.
1997, April, Contribution to construction of schools in the communities of Damakhanya Kindia, Faranah, Macenta, Gah Lola, Bounouma N'zerekore, and N'zerekore
1998, June, Contributed books to school in Abattoin Secteur 1 community near Faranah

TABLE 10. IMMEDIATE TERM FOCUSED BENEFITS FOR CAPACITY BUILDING AND SUPPORT FOR SCIENTIFIC RESEARCH.

Resources were provided for infrastructure development for a Guinea NGO, BDCP-Guinea that has members that are scientists and traditional healers This organization works to facilitate ethnobotanical research collaborations between scientists and traditional healers

Members of the BDCP-Guinea and the Department of Botany at UGANDC received literature in botany, plant presses, and a GPS (geographical positioning system) to facilitate their botanical research

Resources for herbarium maintenance at the Institute Valery Giscard d' Estaing in Faranah.

Resources for herbarium maintenance at the Centre de Recherche Agronomique de Foulaya in Kindia

Voucher specimens of all plants collected for ethnobotanical research are deposited both in the herbarium at BDCP-Guinea and at the Department of Botany at UGANDC All voucher specimens collected in Guinea are determined at the Missouri Botanical Gardens. These determinations are communicated to the botanists at BDCP-Guinea, Department of Botany at UGANDC, Institute Valery Giscard d' Estaing in Faranah, and Centre de Recherche Agronomique de Foulaya in Kindia

Resources for herbalist and botanist from Centre de Recherche Agronomique de Foulaya in Kindia to conduct research on efficacy of plants used to treat Type 2 diabetes mellitus

Five physicians from the University Medical Center in Conakry were trained in ethnomedical research methods to learn about medicinal plants used to treat Type 2 diabetes mellitus

Physicians from the University Medical Center in Conakry were trained in methods and study design to conduct small human studies on the therapeutic efficacy of medicinal plants used to treat Type 2 diabetes mellitus.

Support for a new program through the University Medical Center in Conakry called, "Phytomedicines for Diabetic Patients "

Antidiabetic activity evaluation of Guinea plants are conducted by Shaman Pharmaceuticals and the results are returned to the physicians, botanists, and traditional healers in Guinea

Publications on Guinea medicinal plants will include authors from Guinea

In April 1996, April 1997, and June 1998 Shaman scientists visited and discussed the research collaboration with several top officials at the Universite Gamal Abdel Nasser de Conakry (including the Dean of Faculty of Science and the Secretary General of the University), the Directeur of National de la Recherche for Republique de Guinee, Director of the Guinea Diabetes Association, local governmental officials, traditional medicine healers, and local community members. All these stakeholders were provided written materials in French describing the com-

pany's research activities. In these meetings, the philosophy, and objectives of the company were discussed and prior informed consent was established with a spectrum of people and institutions in Guinea (Tables 2-6).

ETHNOBOTANICAL FIELD RESEARCH EXPEDITIONS

In April 1996, April 1997, and June 1998 Shaman scientists conducted ethnobotanical field research with Guinea scientists (botanists, physicians, and a natural products chemist) who

TABLE 11. IMMEDIATE TERM FOCUSED BENEFITS FOR CAPACITY BUILDING AND SUPPORT FOR PUBLIC HEALTH AND MEDICAL ORGANIZATIONS.

1996, 1997, 1998 = \$3400 given Guinea Diabetes Association, a non-governmental organization, for medicines and medical supplies to provide health care for low income diabetic patients A physician and Medical Director of the Guinea Diabetes Association were trained in ethnomedical research methods to study plants used to treat type 2 diabetes mellitus

Five glucometers, supplies of blood glucose test strips, and diabetes literature were provided to the Diabetes Division at the University Medical Center in Conakry for provision of patient care.

Physicians, ethnobotanists, and traditional healers in Guinea have received workshop training in field research methods in medical ethnobotany These skills will help them better understand how the traditional botanical medicine systems can contribute to provision of primary care in Guinea

TABLE 12. IMMEDIATE TERM FOCUSED BENEFITS FOR CAPACITY BUILDING TRADITIONAL HEALERS ORGANIZATIONS AND CLINICS.

Money for infrastructure development of traditional healers organizations on a national level based in Conakry
Support for Traditional Medicine Hospitals, in Gbily, N'zerekore, Loule Nord, N'zerekore, St Alexi, Kankan, and in Kankan, Kankan.
Support for Traditional Healer's Association, Siguiri, Kankan, Lola Healers' Association in Lola, and the N'zerekore Traditional Healers' Association
Support for traditional medicine clinic & garden, in Ninge bhoie, Nzerekore, and Lola Healers' Association traditional medicine garden in Lola
Maintenance of urban medicinal plant dispensaries in Almamy, Labe, Kensanbouyou, Labe, Daka, Labe, and Dabola, Kankan
Plant grinder to prepare their medicinal plants provided to traditional herbalists organization in the Abatton Secteur 1 community near Faranah

were associated with the Universite Gamal Abdel Nasser de Conakry and members of BDCP-Guinea. The focus of the research was on plants used to treat Type 2 diabetes mellitus and symptoms caused by this disease (Fig 2-4). Prior to research expeditions in 1996, 1997, and 1998 Guinean scientists traveled to different regions of Guinea and discussed the research collaboration with the communities and healers. The binational team was invited by these communities to collaborate on ethnobotanical research. On each expedition, before the research commenced, the team had direct discussions with the communities and healers about the goals and objectives of the collaboration including benefit sharing. The decision-making bodies in these villages were typically groups of male and female elders, some of who were traditional healers. These communities did not want to sign written agreements. They preferred verbal commitments for collaboration and benefit sharing and gave their verbal consent for research to commence. Ethnobotanical field research expeditions were conducted in Guinea at the following times and places: April 1996 in the regions of Conakry, Kindia, Faranah, and Nzerekore; April 1997 in the regions of Labe, Kankan, Con-

akry, and Lola; June 1998 in the regions of Faranah, Kindia, and Coyah. Copies of all ethnomedical and botanical data collection forms and plant vouchers were left in Guinea at the end of each expedition.

BOTANICAL SPECIMENS COLLECTED IN GUINEA

Table 7 describes the number of botanical specimens collected from research in Guinea. During ethnobotanical field research expeditions in 1996, 1997, and 1998, voucher specimens and ethnomedical information was collected on 145 different plant species in 118 different genera used to treat symptoms related to Type 2 diabetes mellitus. Copies of the ethnomedical and botanical information and voucher specimens were deposited in herbaria in Guinea and at Shaman Pharmaceuticals. Forty kilograms of dried plant material was collected by Guinea scientists and traditional healers for 21 of the 145 different plant species. This plant material was sent to Shaman's California laboratory facility for analysis of antidiabetic activity.

TABLE 13. IMMEDIATE TERM FOCUSED BENEFITS FOR CAPACITY BUILDING COMMUNITY PUBLIC HEALTH PROJECTS.

Contribution to construction of a clean water well in Dubreka Kindia, and Sasrakoleah Kindia
Contribution to construction of Health Center in Gheim N'zerekore, and Kouroussa, Kankan
Support for maintenance of Health Center in Coyah Dialloya Kindia, and Maferinya Kindia
Money to pay for hospitalization and medicines for seriously ill patients in Bheion Boo-Huona N'zerekore, Loule Nord N'zerekore, and Lola

TABLE 14. MEDIUM TERM FOCUSED BENEFITS FROM PLANT COLLECTIONS.

Dried bulk plant collections of the most compelling Guinean medicinal plants used to treat Type 2 diabetes mellitus are ordered by the company. The Conakry based botanists work with the traditional healers and local community members to collect bulk materials of specific medicinal plant species. Collections are done only on plant species that are not rare or endangered. The local communities, traditional healers, and BDCP-Guinea all benefit financially from these bulk plant collections. The total amount money that has been paid to these Guinea stakeholders for these collections is \$82 000 for the bulk collection of 21 species.

IMMEDIATE-TERM, MEDIUM-TERM, AND LONG-TERM FOCUSED BENEFITS

The focused benefits described in this section represent the compensation and reciprocity that has been provided to Guinea. The operating costs of conducting the research expeditions such as lodging, food, transportation, and communication costs for the Guinea consultants are not considered as part of the compensation or reciprocity focused benefits in Table 8–13. Also the operating costs of the company to maintain the collaboration with Guinea during and in between expeditions is not included as part of the focused benefits received by Guinea.

IMMEDIATE-TERM FOCUSED BENEFITS

Immediate-term focused benefits in the form of both compensation and reciprocity (Table 8) have been provided since the beginning of the relationship with Guinea and will continue throughout the duration of the collaboration. **Compensation** is the daily wage paid to consultants such as the scientists, traditional healers, and local community members that collaborate on the ethnobotanical research. The daily compensation of the traditional healers is equivalent to what the scientists receive. In addition to compensation to consultants, resources are also provided as reciprocity. **Reciprocity** is provided to benefit communities, organizations, and institutions rather than individuals. This form of benefit sharing involves the provision of resources that contribute to capacity building and technology transfer for scientific institutions, public health programs, traditional healers organizations, and local communities (Tables 8–13).

MEDIUM-TERM FOCUSED BENEFITS

Medium-term focused benefits come in the form of financial compensation for dried plant collections for chemical and pharmacological

analysis (Table 14). The local communities, traditional healers, and BDCP-Guinea all participate in the collections and benefit financially from providing dried plant materials. The ecology and abundance of each plant species is evaluated and no rare or endangered plants are collected.

LONG-TERM FOCUSED BENEFITS

In addition to short and medium-term focused benefits, long-term focused benefits may also be provided. If a marketable product is developed from research on plants collected from Guinea or any other collaborating country, a mechanism has been established to distribute long-term focused benefits to all the collaborating countries. Half of these benefits will go to the government for support of conservation programs and half will be distributed amongst the different ethnolinguistic groups with whom we have collaborated in each country. The Healing Forest Conservancy (Moran 1996), an NGO established by Shaman Pharmaceuticals, will work with the BDCP-Guinea to maintain communication and distribute long-term benefits to these ethnolinguistic groups to contribute to the conservation of cultural and biological diversity.

DISCUSSION/CONCLUSION

The Shaman ethnobotanical field research methodology in Guinea is a focused strategy to learn about antidiabetic plants. The research involves collaborating with traditional healers who are familiar with Type 2 diabetes mellitus and only collecting those medicinal plants used to treat this disease. We did not collect ethnobotanical information or plants used to treat other diseases. Shaman also has an approach of focused immediate and medium-term benefit sharing. The distribution of these benefits is focused on our research collaborators in Guinea including local communities, traditional healers, medical clinics, medical organizations, scientific institu-

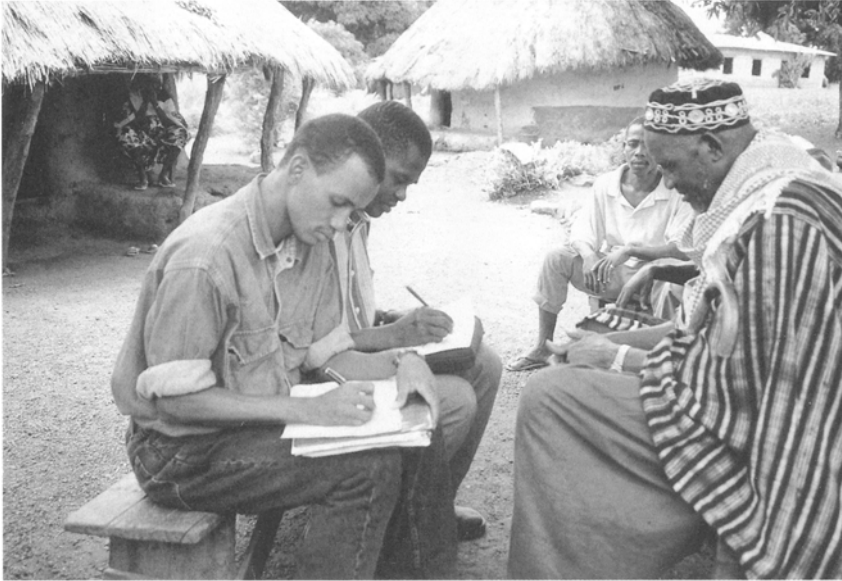


Fig. 2. Physician Amadou Bah and botanist Gandeka Abdourahmane conduct ethnomedical and botanical interviews with Elhadj Nausira Fode, a Maninke traditional healer from Faranah (June 1998; photo by T. Carlson).



Fig. 3. Traditional healer Mohamed 54 Camara and botanist Bah Mamadou Sannoussy collect *Ravenala madagascariensis* Sonn. to treat Type 2 diabetes mellitus (June 1998; photo by T. Carlson).

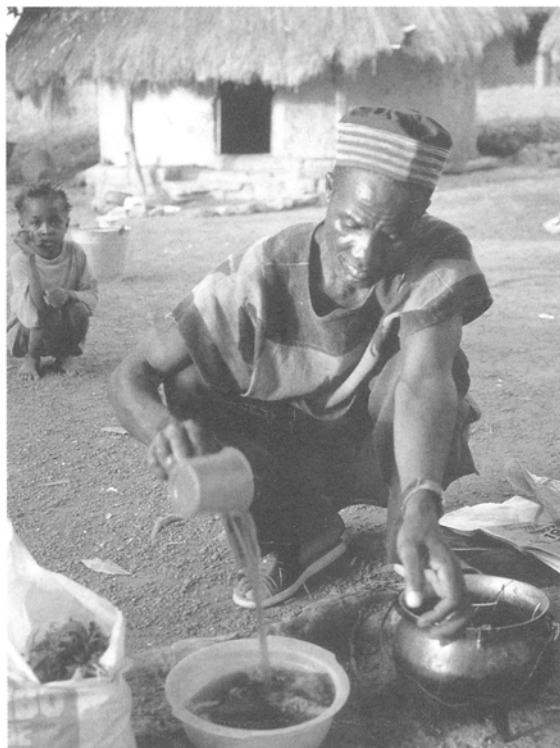


Fig. 4. Sekou Ahmed Cisse, a Maninke traditional healer from Faranah is preparing botanical medicine to treat Type 2 diabetes mellitus (June 1998; photo by T. Carlson).

tions, and scientists (Tables 8–14). During field expeditions in 1996, 1997, and 1998, the ethnobotanical research teams collaborated with 58 traditional healers from seven provinces, 42 communities, and seven ethnolinguistic groups including the Maninka, Susu, Kpelewo (Guerze), Pular (Peulh, Fulani), Toma, Mano, and Dialonke. This research generated 145 different plant species representing 118 genera that are used to treat Type 2 diabetes mellitus. The study of traditional botanical medical systems involves the collaboration of traditional healers, people from rural communities, scientists, scientific institutions, medical clinics, and appropriate governmental and non-governmental organizations from the host country. Establishment of collegial relationships between the western scientists and the local healers is essential for developing trust and fluent communication. In compliance with the Convention on Biological Diversity (CBD), prior informed consent with appropriate discussions, agreements, and permission took place with these parties before initiating a research project. This included discussions on the follow-

ing issues: How medicinal plants would be analyzed and their potential for commercialization; How host country collaborating scientists and traditional healers would be compensated for the time they contribute to the research; and, How equitable focused benefit sharing would be distributed as reciprocity through support of locally initiated projects that benefit institutions, organizations, and communities rather than individuals. It is the right of host country government, scientists, traditional healers, and community members to decide whether or not they will collaborate and provide information on medicinal plants. Discussions with the different stakeholders in Guinea led to the establishment of mutually beneficial agreements for collaborative research. As mandated by the CBD, the host country should receive appropriate technology transfer and benefit sharing from the research collaboration (Tables 8–14). Provision of benefits started when the collaboration commenced and will continue throughout the duration of the collaboration. Since ethnobotanical field research began in 1995, the Company has started

preliminary evaluations on a variety of medicinal plants from Guinea. There is, however, no guarantee that a marketable product will ever be developed from the collaboration with Guinea. The provision of immediate and medium-term focused benefits has guaranteed that technology transfer and resources for capacity building, have been received by scientific institutions, medical clinics, and communities, even though a commercialized product has not yet been developed. If research on plants collected from Guinea or any other collaborating country results in a marketable product, long-term benefits will be distributed equally among all the countries that collaborate with Shaman. Half of the benefits that Guinea receives go to the seven different collaborating ethnolinguistic groups and half to the Guinean government to support programs in conservation. The Healing Forest Conservancy (Moran 1996), an NGO established by the company, will facilitate the distribution of these long-term benefits.

From 1994 to 1998 benefits totaling over \$144 000 US dollars (Table 8) have been provided by the company to scientists, scientific institutions, health care clinics, local communities, traditional healers, and traditional healers organizations. This does not include the overhead costs of communications, transportation, food, research supplies, and lodging for the ethnobotanical field research team and the Guinean collaborators. The provision of these benefits along with educational workshops conducted by company scientists has had some of the following effects. Improve ability of departments at the Universite Gamal Abdel Nasser de Conakry and the Bioresources Development and Conservation Programme-Guinea (an NGO) to collaborate with traditional healers and conduct medicinal plant research; Enhance the understanding and appreciation within the scientific, medical, and governmental communities in Guinea of the importance of medicinal plants and the interconnections between conservation of biological and cultural diversity and human health, Improve infrastructure development for traditional healers' organizations and clinics; and, Support protection of community medicinal plant forests and gardens. The resources that helped support these projects represent immediate and medium-term focused benefits provided long before any drug has been developed from this research. This approach has ensured that whether or not a mar-

ketable product results from collaboration, the Guinean scientific institutions, medical organizations, traditional healers organizations, and rural communities are guaranteed focused benefits for capacity building.

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LITERATURE CITED

- Bierer, D. E., D. M. Fort, L. G. Dubenko, C. Mendez, J. Luo, M. Reed, P. Peterli-Roth, R. E. Gerber, J. Litvak, N. Waldeck, T. J. Carlson, S. R. King, R. C. Bruening, R. F. Hector, and G. R. Reaven.** 1998. Ethnobotanical-directed discovery of *Cryptolepis sanguinolenta*: its isolation, synthesis and antihyperglycemic activity. *Journal of Medicinal Chemistry* 41: 894-901.
- Blum, E.** 1993. Making biodiversity conservation profitable: A case study of the Merck/Inbio agreement. *Environment* 35(4): 16-20, 38-45.
- Boom, B.** 1990. Ethics in ethnopharmacology. In Vol 2 of *Proceeding of the First Congress of Ethnobiology*, edited by E. Elisabetsky, Museu Paraense Emilo Goeldi, Belem, Brazil.
- Carlson, T. J. S.** 1998. Ethnomedical field research, medicinal plants, and tropical public health. *Rainforest Medical Bulletin*, Netherlands 5(1): 7-8.
- Carlson, T. J. and S. R. King.** 1997. Ethnomedical field research methods to assess medicinal plants. In Iwu, M. M., E. N. Sokomba, C. O. Okunji, C. Obijiofor, and I. P. Akubue, eds., *Commercial production of indigenous plants as phytomedicines and cosmetics*. BDCP Press, p. 152-165.
- , **R. Cooper, S. R. King, and E. J. Rozhon.** 1997a. Modern science and traditional healing. Special Publication, Royal Society of Chemistry, 200 (Phytochemical Diversity) 84-95.
- Carlson, T. J., M. M. Iwu, S. R. King, C. Obialor, and A. Ozioko.** 1997b. Medicinal plant research in Nigeria: an approach for compliance with the convention on biological diversity. *Diversity* 13(1): 29-33.
- Chinnock, J. A., M. J. Balick, and S. S. Camberos.** n.d. Traditional healers and modern science—

- bridging the gap Belize, a case study in building bridges with traditional knowledge A Paul, D Wigston, and C Peters, eds New York Botanical Garden Press
- Churcher, T.** 1996 Directory partial of guidance documents relating to biodiversity and cultural knowledge research and prospecting. Compiled for the Biodiversity & Ethics Working Group of Pew Conservation Fellows Berkeley. Department of Geography, University of California, Berkeley. Unpublished manuscript
- Churcher, T., and B. Nietschmann.** 1994 Biodiversity rights: paper presented at Pew Conservation Fellows Annual Conference 1994 Tucson, Arizona Berkeley compiled for the Biodiversity & Ethics Working Group of Pew Conservation Fellows Department of Geography, University of California, Berkeley Unpublished manuscript
- Convention on Biological Diversity.** (UNCBD), 5 June 1992 UNEP, Nairobi
- Cunningham, A. B.** 1991 Indigenous knowledge and biodiversity global commons or regional heritage? *Cultural Survival Quarterly* 15(3) 1-4
- . 1992 Botanists, brokers and biodiversity Paper presented at the Third Meeting of the International Society for Ethnobiology, Mexico City
- Durning, A. T.** 1992 Guardians of the land: indigenous peoples and the health of the earth Ed Ayres, ed., Worldwatch Paper 112 Washington DC.
- Elisabetsky, E.** 1991 Socioeconomic, political and ethical issues in medicinal plant research *Journal of Ethnopharmacology*
- Farnsworth, N. R., O. Akerele, A. S. Bingel, D. D. Soejarto, and Z. Guo.** 1985 Medicinal plants in therapy *Bulletin of the World Health Organization* 63(6) 965-981.
- Iwu, M. M.** 1995 Linking biodiversity and socio-economic development *Bioresources Development and Conservation Programme* Washington, DC
- . 1996a Implementing the biodiversity treaty how to make international co-operative agreements work *Tibtech* 14 78-83
- . 1996b Biodiversity prospecting in Nigeria seeking equity and reciprocity in intellectual property rights through partnership arrangements and capacity building. *Journal of Ethnopharmacology* 51 209-219
- King, S. K.** 1994. Establishing reciprocity biodiversity, conservation and new models for cooperation between forest dwelling people and the pharmaceutical industry *In* Greaves, T, ed., *Intellectual property rights for indigenous peoples: a source book* The Society for Applied Anthropology, Oklahoma City
- , and **T. J. Carlson.** 1995 Biomedicine, biotechnology, and biodiversity *The Western Hemisphere Experience Interscencia*, May-June 1995, (20)3 134-39
- , ———, and **K. Moran.** 1996a Biological diversity, indigenous knowledge, drug discovery, and intellectual property rights *In* Brush S and D. Stabinsky, eds., *Valuing local knowledge indigenous people and intellectual property rights* Island Press, p 167-185
- , ———, and ———. 1996b. Biological diversity, indigenous knowledge, drug discovery, and intellectual property rights Creating reciprocity and maintaining relationships *Journal of Ethnopharmacology* 51:45-57
- Luo, J.** 1998 In vivo antidiabetic drug discovery *Exp Opin. Invest. Drugs* 7(6):987-996.
- , **T. Chuang, J. Cheung, J. Quan, J. Tsai, C. Sullivan, R. Hector, M. J. Reed, K. Meszaros, S. R. King, T. J. Carlson, and G. M. Reaven.** 1998a Masoprocol. a new antihyperglycemic agent isolated from the creosote bush (*Larrea tridentata*) *European Journal of Pharmacology* (Netherlands) 346:77-79
- , **D. Fort, T. J. Carlson, B. K. Noamesi, D. nii-Amon-Kotei, S. R. King, J. Tsai, J. Quan, C. Hobensack, P. Lapresca, N. Waldeck, C. D. Mendez, S. D. Jolad, D. E. Bierer, and G. M. Reaven.** 1998b Cryptolepine, a potentially useful new antihyperglycemic agent isolated from *Cryptolepis sanguinolenta* an example of the ethnobotanical approach to drug discovery *Diabetic Medicine* 15 367-374
- , **J. Cheung, E. M. Yevich, J. P. Clark, J. Tsai, P. Lapresca, R. P. Ubillas, D. M. Fort, T. J. Carlson, R. F. Hector, S. R. King, N. Waldek, C. D. Mendez, S. D. Jolad, and G. M. Reaven.** 1998c Novel terpenoid-type quinones isolated from *Pycnanthus angolensis* of potential utility in the treatment of type 2 diabetes *Journal of Pharmacology and Experimental Therapeutics*
- Moran, K.** 1992. Ethnobiology and US policy *In* Plotkin, M and L Farnolak, eds., *Sustainable harvest and marketing of rainforest products* Island Press, Washington, DC
- . 1996. Returning benefits from ethnobotanical drug discovery to native communities *In* Proceedings of biodiversity and human health NIH, NSF, and Smithsonian Institute joint conference Island Press, Washington DC
- Posey, D., G. Dufield, and K. Plenderleith.** 1995 "Collaborative research and IPR's" *Biodiversity and Conservation* 4 892-902.
- RAFI.** 1996. The geopolitics of biodiversity a biodiversity balance sheet. *Rural Advancement Foundation International* January/February, p 1-6
- Reid, W. V., S. Laird, C. Meyer, R. Gámez, A. Sittenfeld, D. Janzen, M. Gollin, and C. Juma.** 1993 Biodiversity prospecting using resources for sustainable development *World Resources Institute*, Washington, DC
- Richter, R. K., and T. J. S. Carlson,** 1998. Report

of biological assay results on tropical medicinal plants to host country collaborators *Journal of Ethnopharmacology* 62 85–88

Robineau, L., and D. D. Soejarto. 1996 TRAMIL A research project on the medicinal plant resources of the Caribbean *In* Balick M J, E Elisabetsky, and S Laird, eds, *Medicinal resources of the tropical forest*, Columbia University Press, New York, p 317–325

Shaman Pharmaceuticals. 1997 Draft of “Agreement of Principles” Shaman Pharmaceuticals Inc, South San Francisco

Williams, N. M., and G. Baines, eds. 1993 *Traditional ecological knowledge: wisdom for sustainable development* Centre for Resource and Environmental Studies, Australian National University, Canberra

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