

## ETHNOBOTANY OF NATURAL PRODUCTS

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### Summary

The present chapter summarizes the history and evolution of ethnobotany and the contribution of this branch of science in the discovery and development of natural product drugs in clinical use derived from plants traditionally employed for disease treatments. Ethnobotany has also made significant contributions in the maintenance of human health and welfare, especially, in the less developed regions of the world, where plant-based traditional medicines represent the mainstay of disease therapies. Also covered in this chapter is a discussion on the contemporary methods of ethnobotanical field research, and of the challenges facing the continuing effort in the search for new bioactive natural products through ethnobotanically-guided drug discovery and development endeavor.

## 1. Introduction

Ethnobotany is broadly defined as the study of *relationships* between people and plants. Some prefer to define it as the scientific study of the *interactions* between human cultures and plants. Although the scope of ethnobotany includes the study of plants used for a variety of economic and non-economic societal purposes (e.g., as tools and construction materials, as food, in ritual, for divination, as cosmetics, for ornamentation, as textiles or clothing, as currency, and in social life), this chapter primarily focuses on the contributions that ethnobotany has made to modern medicine through its studies of the uses of plants in traditional societies. This subset of ethnobotany is referred to as Medical Ethnobotany.

In the past, ethnobotany has emphasized on the relationships and interactions between plants and people in traditional tribal or non-Western cultures. Today, ethnobotanical studies also include all culture areas, including Western peoples, who utilize plants in folk medicine or traditional remedies in contradistinction to the use of conventional medicine (i.e., biomedicine or modern medicine) to treat illnesses and injuries. Ethnobotany encompasses both plant knowledge that is commonly known by all individuals belonging to a specific cultural group, as well as plant knowledge that is only known by specialists within that group, such as shamans, healers, or bone-setters.

Since ethnobotany covers a wide range of topics proper to an even wider range of disciplines, and is, in short, a composite science, anyone with cross-disciplinary training in botany and another academic field may find that their work is essentially research in ethnobotany. Because of the unique contributions each of these researchers makes (with their unique educational backgrounds), he or she can claim to be an ethnobotanist without asserting an advantage over those with training in other fields.

Ethnobotanists document, describe and explain complex relationships between people and how they use and manage plants as economic and medicinal resources. Ethnobotanists also record the ritual and ceremonial uses of plants in society, discussing the role that a specific plant or set of plants has within a cultural group. In addition, ethnobotanists note when similar uses, ideas, or cultural perceptions surrounding a specific plant are shared among several distinct cultural groups across a larger region, such as a continent. Even in areas where traditional peoples hold dissimilar beliefs about illness causation, treatment and curing within a single region (e.g., the diverse tribal groups of the Amazon Basin), ethnobotanists have often noted that each tribal

group uses any of the same plants medicinally to treat the same illnesses, notwithstanding cultural differences in beliefs about illness and healing.

## 2. History of Ethnobotany

### 2.1. Western Sources (Written Tradition)

The history of ethnobotany began long before its formal recognition as a distinct field of study within botany. People have been interested in plants for their medicinal properties for hundreds, if not thousands of centuries. The first records of plants used for medicinal purposes in the Western tradition appear in ancient Egypt (*Ebers Papyrus*, copies of which date to 1550 B.C., as well as in numerous texts from funerary monuments, sarcophagi, and wall paintings), and ancient Sumer (a tablet listing physician's prescriptions, dated to about 3,000 B.C.). While these early artifacts represent the knowledge held by medical specialists of ancient Old World civilizations, it is thought that these written records regarding medicinal plant use reflect a medical tradition at least five to twenty-five centuries prior to the compilation of this medicinal knowledge in written form.

Systematic investigation of plants for their medicinal uses has a long history in the West, built upon Greek, Roman and Islamic foundations and intensified by colonial expansion and geographic exploration of the known world. In this tradition, the first hallmark work was Dioscorides' *De Materia Medica*, whose date of compilation has variously been estimated at 64 through 77 AD. Dioscorides relied on the texts of Crateuas, physician to King Mithrades VI from 120 to 63 B.C., whose texts have not survived to the present day. Dioscorides' work became the authoritative on medicinal plants and the infant science of folk pharmacology in the West for the next 1,500 years that followed. While he wrote the original text in Greek, *De Materia Medica* was translated by scholars into Syriac, and later, Persian and Arabic, and was incorporated into the medicinal knowledge held by the educated priests and physicians in the Muslim world, when the Arab civilization was in full flower (600-900 A.D.). Copies of *De Materia Medica* were also translated into Latin and were faithfully reproduced and preserved in monasteries across Europe for the first millennium A.D.

Dioscorides was the first to attempt to systematize all plant knowledge known at the time to the Greek world. While his mode of organization was to group medicinal remedies by form and origin of the illness and/or the remedy itself rather than by a botanical, zoological or mineralogical nomenclature, nevertheless his work was all-encompassing and, therefore, quite valuable to the scholars of his day and thereafter. The works of other classicists, such as Pliny the Elder's *Naturalis Historia*, also survived and were passed down in the physician and scholarly community (as a learned person was often scholar, physician, and priest and/or nun all in one) and influenced the practice of medicine and medicinal knowledge in the West and the Arab world for the centuries from classical Greece to medieval times.

Dioscorides' work was cited in the works of most other herbalists for the centuries to follow, including *Hortus sanitatis* (attributed to Jacob Meydenbach and first published in 1491) and *Herbarius latinus*, which represented the culmination of herbal knowledge

in medieval Europe. During the medieval period and later, “herbals,” or compendia of knowledge of herbal medicine, were produced and appeared throughout Western Europe, but most notably in Naples, southern Italy, Germany, and England. The works of the classicists influenced all work on plant knowledge until after the Renaissance, including the herbals of John Gerard and Nicholas Culpepper in England, Pietro Matthiolus in Italy.

## 2.2. Non-Western Sources (Written Tradition)

However, the systematic study of plants is not solely a Western phenomenon. For example, in ancient China the first text of medicinal plants was compiled purportedly by Emperor Shen Nung around 2,700 B.C, the *Pen T'sao Ching*. Similarly, the Rig Vedas and Ayurvedic medicine, compiled in ancient India, include information on many plants used medicinally for healing. Ayurvedic medicine is thought to date back at least 5,000 – 10,000 years, and the Rig Veda around 2500 B.C. or earlier. Other medicinal traditions that employ medicinal plants, rooted in Buddhism, are recorded in palm-leaf manuscripts found in Burma, Laos, Cambodia, Thailand, Vietnam and elsewhere in Indonesia (Java, Bali). Tibetan medicine, also rooted in Ayurvedic medicine, evolved from the works— Caraka Samhita (around 1,500 B.C.), the Susruta Samhita (300 – 400 A.D.) and the Ashtang Hrdayam (around 500 A.D.). Records containing medicinal uses of plants are found in extant Mayan codices, such as the *Book of Chilam Balam of Kaua*. The Incas of South America and the Aztecs of Mesoamerica maintained botanical gardens containing economically and medicinally useful plants.

## 2.3. Oral Tradition

The discovery and utilization of plants for medicinal purposes does not necessarily coincide with the evolution of complex societies and sociopolitical structures. Given that medicinal knowledge and the quest for healing illnesses is common to all cultures, from foraging societies to the more complex city-state polities, the written texts on medicinal plant knowledge and healing only demonstrate how specialized such knowledge had become. A prerequisite to practicing medicine in complex societies was and continues to be literacy, specialized training and education. In contrast, the medicinal knowledge of non-literate groups was and continues to be transmitted through oral tradition, in the context of apprenticeship to a ritual practitioner or healer, a village shaman, or a “household herbalist” who collects and prepares remedies for ill children or other household members.

Studies in the ethnobotany of cultural groups that rely on the oral tradition to pass on traditional medicinal plant knowledge from generation to generation show that, in addition to a great wealth of knowledge about medicinally useful plants, these cultural groups also have an extensive knowledge of economically useful plants and the traditional techniques used to manage, harvest, and conserve these species. These studies have revealed that many traditional peoples possess an intimate knowledge of their environment and are keen observers of subtle changes across the landscape, including changes in weather, where and when medicinal plant resources may be found at different times of year. This extensive oral tradition also includes knowledge of illnesses, remedies, treatments and healing techniques, learned through an

apprenticeship with an experienced healer, in addition to experience in evaluating symptoms and diagnosing the illness, collecting, preparing and treating illness using medicinal plant remedies, as well as providing follow-up patient care and evaluating the patient's progress. Furthermore, recent studies in medical ethnobotany have shown that the traditional medicinal knowledge systems of non-literate cultural groups are also extensive, and can be as extensive as that of literate societies.

### 3. Age of Discovery

As early as the reports from Marco Polo about the faraway “spice islands”, Europeans' interest in exotic and commercially valuable plants from elsewhere was piqued. However, the European discovery of the New World at the end of the 15th century, and the subsequent political and economic expansion, exponentially increased knowledge of the known world and the natural phenomena occupying that world. Explorations in the New World brought back to Europe many economically and medicinally useful plants, including new foods, medicines, construction materials (hardwoods), and items of commerce (dyes, tobacco, etc.). The establishment of botanical gardens and publication of herbals and botanical treatises in Renaissance Europe began in the sixteenth century and spread rapidly. This movement of economically useful plants worldwide is often referred to as the Columbian Exchange.

Economically useful food plants brought back from the New World to the Old World include: tomatoes (*Solanum lycopersicum* L., Solanaceae), maize (*Zea mays* L., Poaceae), potatoes (*Solanum tuberosum* L., Solanaceae), cacao beans, from which chocolate is made (*Theobroma cacao* L., Sterculiaceae), tobacco (*Nicotiana rustica* L., Solanaceae), cassava (*Manihot esculenta* Crantz, Euphorbiaceae), pineapple (*Ananas comosus* (L.) Merr., Bromeliaceae), peanuts (*Arachis hypogaea* L., Fabaceae-Papilionoideae), avocados (*Persea americana* Mill., Lauraceae), and the common bean (*Phaseolus vulgaris* L., Fabaceae-Papilionoideae). New World spices include chili peppers (*Capsicum* spp., Solanaceae), vanilla bean (*Vanilla planifolia* Andrews, Orchidaceae), and Jamaica pepper (*Pimenta dioica* (L.) Merr., Myrtaceae), while quinine bark (*Cinchona* spp., Rubiaceae) provides an example of one of the most important medicinal plants, and rubber tree (*Hevea brasiliensis* (Willd. ex A. Juss.) Muell.-Arg., Euphorbiaceae), the most important species of industrial application. Although it appears that fewer spices used in the New World were brought back to the Old World, one cannot underestimate the economic and culinary importance of vanilla and chocolate in the “traditional” cuisines of the Old World!

Food plants that were brought from the Old World to the New World include coffee (*Coffea* spp., Rubiaceae), sugarcane (*Saccharum officinarum* L., Poaceae), wheat (*Triticum* spp., Poaceae), rice (*Oryza sativa* L., Poaceae), eggplant (*Solanum melongena* L., Solanaceae), mangoes (*Mangifera indica* L., Anacardiaceae), watermelon (*Citrullus lanatus* (Thunb.) Matsum. & Nakai, Cucurbitaceae), apples (*Malus pumila* P. Mill., Rosaceae), onions (*Allium cepa* L., Alliaceae), bananas (*Musa* spp., Musaceae), plantains (*Musa x paradisiaca* L., Musaceae), oranges (*Citrus x sinensis* (L.) Osbeck, Rutaceae), grapefruit (*Citrus paradisi* Macf.), lemons (*Citrus limon* (L.) Burm.f.), and limes (*Citrus aurantiifolia* (Christm.) Swingle). Old World spices include cinnamon (*Cinnamomum zeylanicum* J. Presl., Lauraceae), nutmeg (*Myristica fragrans* Houtt.,

Myristicaceae), black pepper (*Piper nigrum* L., Piperaceae), ginger (*Zingiber officinale* Roscoe, Zingiberaceae), and cloves (*Syzygium aromaticum* (L.) Merr. & L.M. Perry, Myrtaceae). Not only were spices successfully grown in the New World as a cash crop, but the medicinal uses of spices were brought to the New World as well.

Today, many of the foods and spices that are considered to be at the heart of the cuisines of the “Old World” – as well as the “New World” – are a direct result of the Columbian exchange. For example, tomatoes are a major part of the Mediterranean regional cuisine. Similarly, peanuts are a mainstay in the diets of many peoples living in sub-Saharan Africa. In Central and South America, the use of bananas, plantains, mangoes, garlic, ginger and citrus fruits is as common as other tropical fruits native to the New World. And the New World common bean, of which there are dozens of well-known varieties (black bean, kidney bean, cranberry bean, pinto bean, white bean, etc.), is now found in virtually every traditional cuisine worldwide.

Subsequent explorations by Europeans resulted in travelogues and catalogues of traditional peoples and their ways of life, including notes on medicinally and economically useful plants. Carl Linnaeus, the builder of the Latin binomial system for naming plant and animal species, conducted ethnographic fieldwork among the Saami (Laplanders) in 1733. Ethnobotanists today are reviewing the notes, which Linnaeus recorded on the traditional medicinal plant use among the Saami, to determine to what extent medicinal and economic plant uses among these people have survived subsequent centuries of cultural change and acculturation. In addition, European powers fought for economic supremacy, which often took the form of attempts to monopolize the market in exotic and commercially valuable herbs and spices.

The eighteenth and nineteenth centuries produced additional explorations, including the collection of medicinally and economically useful plants to be brought back to museums and herbaria in Europe and North America. Increasingly, these collections recorded information on how traditional peoples used plants, regarded plants, and the relationship between traditional peoples and their surrounding natural environments.

#### **4. Modern Ethnobotany**

Modern studies in ethnobotany are distinguishable from earlier studies of useful plants, in that modern ethnobotanical studies tend to include more information about the cultural groups that use the plants medicinally or for other purposes. Modern medical ethnobotanical studies include information about: (1) cultural beliefs surrounding illness, treatment, and healing, including the process by which a person seeks treatment for illness; (2) cultural beliefs about plant and human ecological relationships, and the role medicinal plants play in larger society; (3) ritual, ceremonial, and other uses of medicinal plants; and (4) the role of the traditional healer, shaman, or other ritual specialist who uses medicinal plants to treat patients, whether the illness at issue is believed to have a natural or organic cause, or it is believed to have been caused by spiritual forces, malevolence or another non-organic cause. In addition, modern medical ethnobotanical studies often seek to show evidence of their efficacy in treating illness and the plants' medicinal effects on the human body.

Although there have been numerous reports of medicinally and economically useful plants used by traditional peoples since the beginning of exploration of the New World, studies of plants for their potential contribution to modern medicine only became more systematized as modern medicine advanced to a stage where the effects of medicine on the human body generally were better understood. Examples of early ethnobotanical studies focusing on the medicinal effects of specific plants include studies by William Withering (*Digitalis purpurea* or foxglove, 1785), and John Harshberger, who first coined the term “ethnobotany” (*The Purposes of Ethnobotany*, 1896).

The evolution of the relatively new social science, cultural anthropology, at the end of the nineteenth century also contributed to a modern emphasis on the peoples and cultures that used medicinal plants. This evolution was fueled, in one part, by a desire to better understand the medical science behind traditional medicinal plant use, and in other part, by convictions that traditional cultures, including medicinal plant knowledge, were fast disappearing in the face of culture change. As a result, many early modern ethnographers and ethnobotanists documented long lists of plants used by traditional peoples for medicinal purposes, but also included cultural beliefs about the causes and cures of specific illnesses. Early examples of modern ethnography and ethnobotany in the American Southwest include works of Matilda Cox Stevens (*Ethnobotany of the Zuni Indians*, 1915) and Ralph Roys (*Ethno-Botany of the Maya*, 1931).

#### **4.1. Early Ethnobotanical Studies – Intersection with Cultural Anthropology**

Although the appearance of cultural anthropology as a distinct social science in the late-nineteenth century strove to remove long-held biases against traditional peoples as “primitive savages”, early ethnographers and ethnobotanists were stymied in their study and understanding of traditional medicinal plants on a variety of logistical grounds. Not all ethnobotanists had the luxury of spending several months (or several years) to exclusively devote to the study of medicinal plants. Fieldwork devoted to ethnobotany could range from a few weeks to months, and typically the ethnobotanist (as well as the ethnographer) was limited by the knowledge of their informants (today referred to as *research participants*) and/or translators in gathering information about medicinal plants. In addition, not all cultural anthropologists were trained in botany or had the inclination to work with botanists to identify plants used as traditional medicine. Cultural anthropologists also were restrained by time limits on conducting anthropological fieldwork, and often had to choose their topic of study on the basis of what could be realistically investigated within the time limits imposed.

In some cases, both cultural anthropologists and ethnobotanists have struggled to gain the trust of the traditional peoples with which they worked. This is due in part to the fact that, in the colonial context, the practice of traditional medicine was suppressed either through legal or non-legal means by Western authorities. Christian missionaries also discouraged the use of traditional medicine because of its close association with indigenous (non-Christian) religion, religious beliefs, and shamanistic practices. Christian missionaries eager to suppress indigenous religious and ceremonial life would further warn that traditional medicine was evil, inspired by Satan or other demonic forces. For ethnographers and ethnobotanists, who nearly always were white Europeans and/or North Americans, the twin histories of colonialism and Christian proselytization

became additional obstacles in trying to encourage traditional peoples, who often had been marginalized and disenfranchised on the basis of their beliefs in traditional medicine to now: (1) openly talk about it; and, even more threatening, (2) allow the researcher to write it down, and even publish it.

Because of the intimate linkage that often exists in non-Western cultures between medicine, healing and (non-Christian) religion, this has generally meant that the ethnobotanist has also had to gain the trust of the individuals with whom he or she works and has had to show that it is acceptable to talk about non-Christian religious beliefs openly without risk of contempt, ridicule, or other public sanction. Often, ethnobotanists live at the margins of village life and extraordinary efforts must be made in order for the stranger-ethnobotanist who has mysteriously appeared in the village to be accepted and trusted before any collaborative relationship may begin in studying medicinal plant use. To the extent an ethnobotanist is not allowed access to specific traditional medicinal plant knowledge, understandable gaps in what is known about medicinal plant use among traditional peoples exist.

#### **4.2. Expanded Fieldwork**

Expansion in the length of time for ethnobotanical fieldwork led to increased data collection, both in terms of culture and ethnobotany. In addition, advances in modern medicine and pharmacology have allowed for more advanced and systematic exploration, isolation, and testing of bioactive chemical compounds found in medicinal plants to verify their medicinal properties and pharmaceutical potential.

However, as the twentieth century progressed, the methodology in both ethnography and ethnobotany changed. For example, one of the pioneers in modern ethnographic methods, Bronislaw Malinowski, spent several years in the Trobriand Islands and produced nuanced ethnographies showing his intimate knowledge and understanding of the Trobriand Islander culture and lifeways (*Argonauts of the Western Pacific*, 1917). Likewise, the research of pioneering ethnobotanist Richard Evans Schultes resulted in his spending 14 years among the indigenous peoples of the Northwest Amazon Basin (starting in 1941).

Schultes, like other ethnographers, lived, ate, worked with, and carried out his studies in ethnobotanical research side by side with the tribal peoples who used the medicinal plants. Unlike most ethnographers of his time, Schultes also went beyond mere observation. He participated in the ceremonial life of the Amazonian peoples he lived with, also ingesting plants used for medicinal, religious or ceremonial purposes. Schultes returned to North America and established a long, productive and illustrious career in ethnobotany at Harvard University. Under Schultes, several generations of ethnobotanists were trained using his fieldwork methods for collecting medicinal plants and ethnobotanical information: (1) long field stays in order to establish rapport and trust among the people whose medicinal plant system is the object of study; (2) respect and advocacy for traditional culture and lifeways; (3) validation and promotion of traditional medicine, namely it is not based on superstition and magic, but on empirical knowledge and practical application of observable plant properties.

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### Biographical Sketches

**Dr. Djaja Doel Soejarto**, born in Indonesia, obtained his B.Sc. degree from the College of Biology-Tjiawi, Indonesia in 1962, and his M.A. (1965) and Ph.D. (1968) degrees (Biology) from Harvard University under the mentorship of the late Professor Richard Evans Schultes. Immediately after his doctoral graduation, he served as a Latin American Teaching Fellow of the Tufts University School of Law and Diplomacy's Latin American Teaching Fellowship (LATF) Program and took an assignment at the Department of Biology, University of Antioquia, Medellin, Colombia. Following the completion of his term with the LATF, he joined the Department of Biology of this university (1971-1976) as a member of the faculty. In 1977-1979, he was a Consultant to the Human Reproduction Unit of the World Health

Organization on a project on traditional medicine plants as fertility regulators, then, 1979-1983, an Adjunct faculty member at the Department of Medicinal Chemistry and Pharmacognosy. In 1983 he was promoted to Associate Professor, and in 1989 to Professor of Pharmacognosy. He has held an honorary Research Associate position at the Botany Department of the Field Museum, Chicago, since 1977. A plant taxonomist-ethnobotanist by training, Dr. Soejarto has an extensive fieldwork experience, having undertaken bioprospecting plant collection expeditions in more than 20 countries. He has the credit for the establishment of three Herbarium institutions [Colombia, Philippines, Vietnam], and was presented an honor plaque as Founder of the Herbarium of the University of Antioquia (Medellin, Colombia) during a 2004 national conference on medicinal and toxic plants to celebrate the founding of this herbarium, and for the deposit of its 100,000<sup>th</sup> specimen. In 2007, he was presented with another plaque of honor by the Colombian Association of Botany for his contribution to the development of botany in Colombia. As part of his exploration program in Southeast Asia under the United States National Cancer Institute's funding (1986-2004) the anti-HIV calanolides were discovered from species of *Calophyllum* trees of Malaysia; he is a co-author together with the NCI scientists on the calanolides patent, and was presented with the University of Illinois Senior University Scholar award, 1996-1999. He has been working closely with chemist, biologist, and legal colleagues, as well as with the Office of Intellectual Property/Technology Management at the University of Illinois at Chicago for the past 15 years in shaping and implementing a project [International Cooperative Biodiversity Groups or ICBG Program – the *Vietnam-Laos ICBG*, Fogarty International Center, NIH, 1998-2003; 2003-2009; 2009-2011] involving ethnobotanically-guided discovery of bioactive compounds from plants of Vietnam and Laos, for potential therapies against cancer, AIDS, malaria and tuberculosis. He has been Editor of the *Journal of Ethnopharmacology* (1988-2004), and is currently a member of the editorial board of five scientific journals, including *Journal of Ethnopharmacology* and *Pharmaceutical Biology*. He is author and co-author of more than 10 books and 192 scientific papers, including 149 in peer-reviewed scientific journals, others as book chapters and conference proceedings. One genus of plants (*Ectopopterys*, Malpighiaceae) and more than 30 plant taxa new to science have been discovered to his credit. Dr. Soejarto is presently a member of the Society of Ethnobotanists, International Society of Ethnopharmacology, the Society for Economic Botany, and the American Society of Pharmacognosy.

**Dr. Charlotte Gyllenhaal** was born in Bryn Athyn, Pennsylvania, U.S.A. and earned undergraduate degrees in natural resources and education at the Ohio State University in Columbus, Ohio in 1972, and an M.S. in biology in 1974 at the same institution. After dissertation fieldwork in the ecology of slash-and-burn agriculture at the Smithsonian Tropical Research Institute in Panama, she earned her Ph.D. at the University of Alabama in 1984. Shortly after graduating, she received the Fulling Award from the Society for Economic Botany. She is an ethnobotanist by training and is a Research Assistant Professor at the University of Illinois at Chicago as well as Research Program Manager at the Block Center for Integrative Cancer Treatment in Evanston, Illinois. She worked in the areas of ethnobotany and pharmacology with the Natural Products Alert (NAPRALET) database at the University. She has been active in a broad range of research that includes herbal supplements, with a special emphasis on cancer therapy; traditional medicines; biological activities of natural products; and issues concerning intellectual property on indigenous traditional medicinal plant knowledge. In addition, she acts as a clinical study coordinator in pharmaceutical trials of cancer-related drugs. Her teaching involvement with the University includes herbal medicine instruction for pharmacy and medical students, coordination of an integrative medicine program for medical students, and clinical supervision of pharmacy interns. Her involvement with Dr. Soejarto's NIH/FIC ICBG grant has given her substantial experience in administering and subcontracting for international collaborative projects. She has over 40 journal publications, and 9 book contributions. She has been the editor of the International Traditional Medicine Newsletter of the World Health Organization Traditional Medicine Program; Associate Editor of Economic Botany; Taxonomy Editor of *Journal of Natural Products*, and since 2001 has been the Associate Editor and later Managing Editor of *Integrative Cancer Therapies*.

**Dr. Mary Riley** was born in Milwaukee, Wisconsin, U.S.A., and earned her undergraduate degree in anthropology and museum studies at Beloit College in Beloit, Wisconsin in 1990. With her dissertation fieldwork in ethnomedicine supported by a Fulbright IIE award, she earned the doctorate in cultural anthropology at Tulane University, New Orleans, Louisiana, U.S.A. (2000). After having taught anthropology, sociology, urban studies, and social science research methods at Columbia College (Chicago, Illinois) and Calumet College of St. Joseph (Whiting, Indiana), she continued her studies at the College of Law, Northern Illinois University in DeKalb, Illinois, U.S.A., to earn the degree of juris doctor

in law (2006). Admitted to the South Carolina bar in December 2006, she is a practicing attorney and cultural anthropologist. In addition to working as a law associate with the law firm Merritt, Flebotte, Wilson, Webb & Caruso (P.L.L.C.) in Columbia, South Carolina, U.S.A., she is currently affiliated as a Visiting Research Specialist in the Program for Collaborative Research in the Pharmaceutical Sciences (PCRPS) at the University of Illinois at Chicago. Her research interests include indigenous intellectual property rights, ethnobotany and ethnomedicine. She edited the volume *Indigenous Intellectual Property Rights: Legal Obstacles and Innovative Solutions* (2004) and guest edited (with Katy Moran) the Winter 2001 Issue of *Cultural Survival Quarterly*, which was devoted to the topic of indigenous intellectual property rights. In addition to her research and publications in cultural anthropology, she has also worked with Drs. Soejarto and Gyllenhaal as a co-investigator with the UIC-based International Cooperative Biodiversity Groups (ICBG) Program and has co-presented the research results from the ICBG at several international conferences. Dr. Riley is a member of the South Carolina Bar Association, the American Anthropological Association and the Society for Applied Anthropology.

**Dr. Hongjie Zhang** obtained his BS in chemistry in the Department of Chemistry, Yunnan University, Kunming, Yunnan, China, 1985, and his MS (1988) and Ph.D. (1994) in phytochemistry, Kunming Institute of Botany (KIB), the Chinese Academy of Sciences, Kunming, Yunnan, China. He is currently a faculty at the University of Illinois at Chicago (UIC), holding the title of Research Associate Professor in Medicinal Chemistry and Pharmacognosy, College of Pharmacy, University of Illinois at Chicago, 833 South Wood Street, Chicago, IL 60612 (UIC). Previous to his appointment as a Research Associate Professor, Dr. Zhang held a position of Research Associate, then, Research Assistant Professor at UIC, and, before that, Research Fellow, Assistant Professor, Associate Professor, and, lastly, Professor, at Kunming Institute of Botany. He has also held a position as a visiting scientist at the Laboratory of Applied Material Sciences, Faculty of Integrated Arts and Sciences, Tokushima University, Tokushima, Japan, and a visiting scientist at Xechem, Inc., New Jersey. Dr. Zhang has been the chemistry pillar of the Vietnam-Laos ICBG since its inception in 1998 through the present. He has published more than 100 scientific research papers and two patents. He has devoted 17 years in the area of natural product chemistry since 1985. He has many years of research experience in the isolation, identification, structure elucidation, analysis, synthesis and biological evaluation of natural products and other small molecules, leading to more than 200 new compounds being discovered. Dr. Zhang is currently a member of American Chemical Society and the American Society of Pharmacognosy.