

Review

## Inventory of medicinal plants of the Lao People's Democratic Republic: A mini review

Kongmany Sydara<sup>1</sup>, Mouachanh Xayvue<sup>1</sup>, Onevilay Souliya<sup>1</sup>, Bethany G. Elkington<sup>2,3</sup>  
and Djaja D. Soejarto<sup>2,3\*</sup>

<sup>1</sup>Institute of Traditional Medicine, Ministry of Health, Vientiane Capital, Lao People's Democratic Republic (PDR).

<sup>2</sup>Department of Medicinal Chemistry and Pharmacognosy, University of Illinois at Chicago, 833 S. Wood St., Chicago, Illinois 60612, USA.

<sup>3</sup>Science and Education, Field Museum, 1400 S. Lake Shore Drive, Chicago, Illinois 60605, USA.

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The Lao People's Democratic Republic (Lao PDR) or Laos has a long history in the use of medicinal plants, as well as in the use of traditional medicines. The Government of Laos also supports the use of medicinal plants and traditional medicines in the prevention and treatment of diseases. As a government institution, the Institute of Traditional Medicine (ITM) has carried out surveys and inventories of medicinal plants as part of its mission since the beginning of its establishment in 1976, both by the staff of this institution, as well as in collaboration with national and international partners. The number of plant collections that have been made to date as a result of these activities, and those that have been deposited at the herbarium of ITM, reaches more than 14,000. Of these, 7,201 (51%) collections represent medicinal plant species, corresponding to an estimated number of between 2,000 and 3,000 species of Lao medicinal plants. A sizeable portion of this medicinal plant collection has been computerized in a database system called Natural Products Information System (NAPIS). Based on a number of criteria, some medicinal plant species are considered rare and endangered. Therefore, the Lao government issued the Prime Minister Decree No. 155 in 2003 and set guidelines for the cultivation of medicinal plants for domestic consumption and for exportation. The government also supports the initiative in the establishment of Medicinal Plant Preserves (MPPs) and Medicinal Biodiversity Preserves (MBPs), which today form a network of 10 such preserves throughout Laos.

**Key words:** Laos, medicinal plants, inventory, species at risk, conservation.

### INTRODUCTION

The Lao People's Democratic Republic (Lao PDR) or Laos has a long history in the use of medicinal plants as part of the traditional medical practices of the country's health care system. These practices have contributed to the health of the people through treatment

and prevention of diseases. The Lao government acknowledges the importance of medicinal plants and traditional medicine. One reason for the heavy use of medicinal plants in Laos is the limited access to Western health care systems by the majority of the

\*Corresponding author. E-mail: [doelsoejarto@gmail.com](mailto:doelsoejarto@gmail.com). Tel: +1 (312) 665-7865.

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population who live in rural areas. In a 2005 survey of six hundred households from lowland and mountainous districts, it was found that seventy-seven percent of families reported that they used traditional medicine in their day-to-day health maintenance practices (<http://www.sciencedirect.com/science/article/pii/S0965229905000518>). The heavy use of medicinal plants as part of traditional medicine practices in Laos is in line with the findings of the World Health Organization (WHO), which reported that in Africa up to 80% of the population turns to medicinal plants for primary health care (<http://www.who.int/mediacentre/factsheets/2003/fs134/en/>). Indeed, medicinal plants play an important role in the day-to-day prevention and treatment of diseases in Laos. They have been used for centuries to treat disease and this traditional knowledge has been passed down from one generation to the next and is held by many healers today. Therefore, in 2012 the government endorsed the National Strategy for Traditional Medicine for a period of 4 years (2012 to 2015) (Ministry of Health, 2013).

Aside from disease treatment, the Lao people also have extensive experiences on the use of medicinal plants for various other purposes, such as the use of the extract of the plant *Kok Nong*, *Antiaris toxicaria* (Pers.) Lesch. (Moraceae) which contains a toxic substance for hunting or killing enemies. In the case of *A. toxicaria*, the long history of Lao nation has recorded that an extract of this plant is placed at the tip of an arrowhead to be shot at an animal or a human subject.

Today, the exact number of medicinal plants used in Laos is unknown. Based on the estimates that Laos, belonging to the Indo-Burma biodiversity hotspot, harbors between 8,000 and 11,000 species of flowering plants (Schmidt, 1989; Ministry of Agriculture and Forestry -- Science, Technology and Environment Agency, 2003; Flore du Lao, 2011), a substantial percentage of these numbers must represent species of medicinal value. According to Pottier (1971) the Lao people know about 4,000 medicinal plants, and Lao books on medicinal plants contain about 3,000 medicinal plant species, while the best traditional practitioners know more than 1,000 medicinal plant species, though the majority normally uses less than 500 of these in their day-to-day practices. Studies of medicinal plants of Laos were initiated by the French botanist Alfred Petelot, Chief of the Botany Division of the Scientific and Technical Centre of the Mixed Faculty of Medicine and Pharmacy in Saigon (Vietnam), who, in collaboration with Charles Crevost (1928 to 1933), published a catalogue of products of Indochina in 1933 (in the French language - Petelot, 1952).

Petelot's research on Indochinese medicinal plants expanded and eventually culminated with the publication of his four volumes of books about the medicinal plants of Cambodia, Laos and Vietnam (in the French language: Petelot, 1952, 1953, 1954a, 1954b). This book lists 1,392 species of medicinal plants belonging to 169 families. However, the actual number of plants attributed

to Laos alone is not known. In 1959, Vidal published a list of vernacular names of plants in use in Laos (in the French language), in which more than 1,000 species with their local names and uses are listed (Vidal, 1959), but the number of those with medicinal uses is not defined. More recently, a book on medicinal plants of similar coverage was published (Nguyen, 1993), listing 674 species of medicinal plants, however, no breakdown is given on the number of species found in Laos. Between 2004 and 2005, Sengphet Phongphachanh carried out a survey on medicinal plants of Laos that were exported and those with potential for exportation (Phongphachanh, 2004).

The Lao government promotes the integration of traditional medicine with conventional medicine. As evidence of this effort and policy, the Ministry of Health of Laos established the Research Institute of Medicinal Plants (RIMP) on the 27th of April, 1976, later (2000) re-named the Traditional Medicine Research Centre (TMRC), and today known as the Institute of Traditional Medicine (ITM) (since April, 2010). The staff of the ITM has been active in the study of medicinal plants of Laos. Among books that have been published as a result of the ITM's studies are Bouamanivong and Southavong (1990) and Southavong and Bouamanivong (1995). The latest effort of the ITM is the publication of the book "Medicinal Plants and Herbs in the Lao People's Democratic Republic" (Southavong et al., 2013, 2014), listing a total of 181 medicinal plant species.

It is to be noted that many medicinal plant species of Laos are considered rare and at risk, either threatened or endangered. Ninety-six species of medicinal plants at risk are listed in the Prime Ministry Decree No. 155 of 2003 (Prime Minister of Lao PDR, 2003) as medicinal species worthy of protection. The fact that so many species of medicinal plants of Laos are at risk is a serious matter. In our fieldwork to study medicinal plants, we have had first-hand opportunity to observe the occurrence of these and other rare plants and to record their distribution. Our observations have confirmed the risk, the rarity and the possible endangered status of species listed in the Prime Minister's Decree No. 155, as well as of other species.

In this paper, we present a brief review on the results of the effort and the current status in the inventory of medicinal plants of Laos by the Institute of Traditional Medicine since its establishment in 1976. We have examined the activities carried out by the staff of the ITM and its collaboration with other national and international partners, including non-governmental organizations. Issues on the commercialization, export and protection of rare medicinal plant species of Laos are also discussed.

## METHODOLOGY

A review of activities of the scientific staff of the ITM during the past 38 years (1976 to 2014) was performed. All documents and

field study reports in deposit at the ITM were searched and consulted to determine the exact dates, activities, results, the involvement of national and international collaborators, field work locations, and the funding that supported each study. Indeed, as part of its mission and responsibilities since 1976, the ITM scientists have carried out surveys and inventories of medicinal plants in many provinces of Lao PDR and have compiled data on medicinal plants of Laos. Starting in 1997, the ITM staff's activities received the support and collaboration of a foreign partner, the University of Illinois at Chicago (UIC), as part of a contract to collect plants in South East Asia between the UIC and the US National Cancer Institute (NCI), Bethesda, Maryland, USA. Under an umbrella memorandum of agreement between the US NCI and the ITM, joint plant collections were conducted between the ITM scientists and a UIC scientist in several provinces of Laos. Plant samples collected were dispatched to the laboratories of the NCI for anticancer screening at this US government institution.

In 1998, this cooperation evolved into a more solid collaborative relationship that lasted for 14 years (1998 to 2012). On that date, ITM joined a consortium made up of academic and research institutions, a national park, and a pharmaceutical company to study medicinal plants of Laos and Vietnam, in a program called the International Cooperative Biodiversity Groups (ICBG) (<https://www.uic.edu/pharmacy/research/icbg/UIC-ICBG-Pbio-1999-soejarto.pdf>; <http://www.fic.nih.gov/programs/pages/biodiversity.aspx>) funded by the Fogarty International Center, an agency within the United States National Institutes of Health (NIH). Under this program, the ITM and the UIC staff carried out field interviews with healers throughout Laos and collected medicinal plants for studies (Soejarto et al., 2012). Plants were collected based on interviews with healers of Laos. All plant samples collected for anticancer screening at the laboratories of the NCI, and those collected based on interviews as part of the ICBG project are documented by voucher herbarium specimens. These vouchers have been deposited at the ITM Herbarium.

Besides the UIC cooperation, the ITM has also collaborated with other entities, national and foreign, in the explorations and collections of medicinal plants of Laos. All plants collected have also been deposited in the ITM Herbarium. Data on medicinal plants collected are stored in a database system called Natural Products Information System (NAPIS) (<http://www.wps2.com/products.htm>). Up to 2014, the number of the species that have been entered into this database stands at 1,698. It should be noted that efforts to study and to inventory medicinal plants of Laos have also been undertaken independently by some organizations without the involvement of the ITM. Herbarium collections gathered by these entities are not deposited in the ITM Herbarium. In addition to the inventory of medicinal plants, a second important activity of ITM during the past 10 years has been to oversee and coordinate the establishment of Medicinal Plant Preserves (MPPs) and Medicinal Biodiversity Preserves (MBPs).

## RESULTS

### Inventory of medicinal plants

The results of activities carried out in an effort to inventory the medicinal plants of Laos since the establishment of the Institute of Traditional Medicine (ITM) in 1976 are listed in chronological order.

#### ***Inventory performed by the staff of the Institute of Traditional Medicine***

**Under the Lao government support:** Work to carry out

the inventory of medicinal plants of Laos has been undertaken by the ITM staff since the establishment of this institute in 1976, and continues to the present. This activity is part of the institutional operation under the support of the institutional annual budget allocated by the Lao government. Routine fieldworks to perform interviews with healers in different provinces were undertaken. Although the exact number of plants collected (number of collections) is not known, the records at the ITM indicate that at least 2,500 collections documented by a set of 2,500 voucher herbarium specimens, comprising between 500 and 1,000 species of medicinal plants, were gathered during this period.

**Under external funding support:** The ITM received an external funding support to undertake study and inventory of medicinal plants of Laos from the International Plant Genetic Resources Institute (IPGRI; <http://www.fao.org/forestry/4994/en/>) in 2004. Under this funding, 201 medicinal plant collections were gathered through healers' interviews. All collections have been deposited at the ITM Herbarium. In 2005, the ITM received funding from the ASEAN Regional Center for Biodiversity Conservation (ARCBC; <http://www.arcbc.org.ph/>). Through this support, 432 medicinal plant collections were made through healers' interviews, each of which is documented by a set of voucher herbarium specimens. These specimens have also been deposited at the ITM Herbarium.

#### ***Inventory performed by the joint effort of ITM and University of Illinois at Chicago (UIC)***

**Funding from the US National Cancer Institute (NCI):** Under this funding (1997 to 1998), explorations were conducted in the provinces of Oudomxay, Vientiane, Bolikhamxai, Khammouan and Champasak. Although plants were collected without regard of their traditional medicinal uses, data on medicinal uses were frequently provided by healers and collaborators in the areas where a collection was performed. For each plant collected, plant samples (such as root sample, bark sample, leaf + twig sample, etc.) were also collected for biological (anticancer) evaluation at the NCI laboratories. In this collaboration, 320 collections were gathered, comprising about 300 plant species. Each collection is documented by a set of voucher herbarium specimens, all of which have been deposited in the ITM Herbarium.

**The International Cooperative Biodiversity Groups (ICBG) program:** Under this collaboration (1998 to 2008), the ITM staff worked jointly with the staff of the University of Illinois at Chicago (UIC) to carry out an inventory of medicinal plants in all provinces of Laos, except one (Bokeo) (Soejarto et al., 2012). More than 1,000 new collections of medicinal plants, each of which

is documented by a set of voucher herbarium specimens, were added to the herbarium collection holding of the ITM. For each collection, plant samples were also gathered for biological evaluation at the UIC laboratories against cancer, HIV, tuberculosis and malaria disease systems. Some examples of valuable discoveries through this project include the discovery of new anticancer compounds spirostanol saponin (asparacoside), a polyphenol (3'-hydroxy-4'-methoxy-4'-dehydroxyxyasol), and a phenolic 3'-methoxyxyasolC-27 spirosteroid from *Asparagus cochinchinensis* (Lour.) Merr. (Asparagaceae) (<http://pubs.acs.org/doi/abs/10.1021/np030370b>); a new antimalarial pregnane glycoside from *Gongronema napalense* (Wall.) Decne. (Asclepiadaceae) (<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3644423/>); and an antimycobacterial compound from *Marsypopetalum modestum* (Pierre) B. Xue and R.M.K. Saunders (Annonaceae) (<http://www.ncbi.nlm.nih.gov/pubmed/24333958>).

**The Palm Leaf Manuscript (PLM) project with the national library of Laos:** Through a Fulbright Fellowship and the ICBG funding, this project involved a search through old medical palm leaf manuscripts for disease entries. A list of more than 7,000 diseases was created, giving valuable information about the medical history and traditional medicine heritage of the people of Laos, as well as providing an index for faster research into specific diseases and their traditional treatments. Study of the PLM was followed by fieldwork involving healer interviews. A total of 341 collections, comprising as many species of plants was collected through healers' interviews, each of which is documented by a set of voucher herbarium specimens (<http://www.ncbi.nlm.nih.gov/pubmed/23847746>). All these specimens have been deposited at the ITM Herbarium.

**The California Community Foundation Project:** For the period of July, 2013, through the end of October, 2014, the ITM staff collaborated with the staff of the UIC under the funding support of the California Community Foundation (USA) to carry out surveys and inventories of medicinal plants found growing in four locations referred to as Medicinal Plant Preserves and Medicinal Biodiversity Preserves (Table 2). A total of 207 medicinal plant collections together with 84 taxonomic inventory collections, each supported by a set of voucher herbarium specimens, was made in the Oudomxai, Xiengkhuang, Bolikhamxai and Savannakhet preserves, all of which have been deposited at the ITM Herbarium.

#### **Joint activities between the ITM and the National University of Laos (NUoL)**

Under this cooperation, the ITM technical staff carried

out joint field surveys with the staff of the NUoL for the period of 2011-2012 to inventory medicinal plants used by the Hmong ethnic group in Nonghed District, Xiengkhuang Province. This survey (presented as a M.Sc. thesis at the NUoL) resulted in the collection and recording of 110 medicinal plant species, each documented by a set of voucher herbarium specimens. These specimens have been deposited at the ITM Herbarium.

#### **Joint activities between the ITM and other foreign institutions**

The ITM has also collaborated with other foreign institutions in the survey and collection of medicinal plants.

**Kunming Institute of Botany (KIB) (People's Republic of China):** For the periods of 2007 to 2010 and 2010 to 2013, the ITM staff collaborated with Chinese scientists from the Kunming Institute of Botany to survey the diversity of the flowering plants and ferns of Laos. A total of 6,274 herbarium collections (mostly pteridophytes/ferns) was gathered, many of them with a record of their medicinal uses. Voucher herbarium specimens collected have been deposited at the herbaria of the ITM and the KIB.

**Korean Research Institute on Bioscience and Biotechnology (KRIBB):** From 2009 to 2013, the ITM collaborated with scientists from KRIBB to carry out a plant diversity survey, while also collecting plant samples (documented by herbarium voucher specimens) for biological testing. A total of 1,206 medicinal plant collections were made. The voucher herbarium specimens of these collections have been deposited at the herbaria of the ITM and the KRIBB.

#### **Joint activities between the ITM and non-governmental organizations**

**International Union for the Conservation of Nature of Lao PDR (IUCN-LAO):** Through the initiatives of and in cooperation with the IUCN-Lao, a survey on medicinal plants at Khat Ngong wetlands and surrounding forested areas in Champasak province was undertaken in 2009. A team of researchers consisting of a representative from the IUCN-Lao, the ITM, a representative from the Champasak Provincial Agriculture and Forestry Office, local healers/guides, an ethnobotany researcher, and a photographer took part in this survey. A survey route of a distance of more than 35 km was covered. A total of 418 plants, mostly angiosperms, representing approximately 250 species, belonging to at least 200 genera in 93 families of vascular plants was identified as being used by traditional healers to treat 95 symptoms

of diseases (<http://www.pubzpro.com/Pubz#/search/a/8421791>). Voucher herbarium specimens of the plants collected have been deposited at the ITM Herbarium.

**The Agro-Biodiversity Initiative (TABI):** In 2011, the technical personnel of the ITM was invited by TABI to carry out a survey of medicinal plants in the medicinal plant preserve of Ban Houay Khing in the Phon Xay District, Luang Prabang Province. During this short fieldtrip, 197 medicinal plant species were collected. In July, 2013, ITM was again invited by this organization to carry out an inventory of medicinal plants of Phoukout District, Xiengkhuang Province. During this fieldtrip, 247 medicinal plants were collected. Lastly, in March, 2014, the ITM was again invited by TABI to perform an inventory of medicinal plants of Chomphet district, Luang Prabang province. From this fieldtrip 121 medicinal plants were collected. The voucher herbarium specimens of all plants collected (565) have been deposited in the ITM Herbarium.

**International Cooperation Unit for Biodiversity and Environmental Conservation (ICUBEC):** In 2013, the ICUBEC provided partial support to the ITM to carry out surveys to collect medicinal plants in Luang Prabang Province, Xayabouly Province and Vientiane Capital. A total of 568 collections of medicinal plant species was inventoried during these surveys. All voucher specimens have been deposited at the ITM Herbarium.

#### ***Independent inventory activities of medicinal plants of Lao PDR***

**Department of Geography and Resource Management, The Chinese University of Hong Kong, Shatin, Hong Kong (an independent survey):** A survey on the role of medicinal plants in the provision of health care in Laos was conducted by Claudio Delang in 2006, focusing on medicinal plant materials sold by vendors in the Morning Market in Vientiane and along the streets surrounding the market, along with two other smaller markets in Vientiane. A total of 61 medicinal plants were recorded, of which 53 were identified (Delang, 2007). None of the voucher herbarium specimens from this study has been deposited at the ITM Herbarium.

**Centre for Human Ecology Study of the Highlands (CHESH):** CHESH-Lao (<http://www.slideshare.net/ecologicalenterprise/overview-of-chesh-laos-program-over-the-past-10-years-approach>) is an organization under the umbrella of the Social Policy Ecology Research Institute (SPERI) (<http://www.speri.org/>) with headquarters in Vietnam. In the Lao PDR, CHESH-Lao operates in Long Lan vill-

age of Luang Prabang District, Luang Prabang Province. One of the activities of CHESH-Lao is to promote the preservation of economically useful plants. For the period of 2013 to 2014, CHESH-Lao inventoried 485 plants in Long Lan village that can be used for food, medicines and technological instruments. None of the voucher herbarium specimens from this effort has been deposited at the ITM Herbarium.

**Pha Tad Ke Botanical Garden:** The Pha Tad Ke Botanical Garden (<http://www.pha-tad-ke.com/>) is a private organization located in Luang Prabang. It started its broad-based operation on plant conservation in 2008 by planting endemic and introduced species in its private property. This organization also contributes to the publication of books on the use of medicinal plants intended for use by schools and surrounding communities. However, none of the voucher herbarium specimens from this effort has been deposited at the ITM Herbarium.

The results of the medicinal plants inventory activities as listed above are summarized in Table 1. As seen in this table, a total of 14,079 numbers of plant collections has been made and deposited at the ITM Herbarium since the establishment of the ITM. It should be noted, however, that in many instances, two or more voucher herbarium specimens have been mounted for each collection and deposited in this herbarium. If we account for such additional duplicate collections, the actual number of herbarium specimens in repository at the ITM Herbarium is much higher than the total number of collections. Although the specific number will not be known until a full inventory of the specimen holding is made, it is safe to say that more than 15,000 herbarium specimens are in repository at the Herbarium of the ITM. Of the 14,079 collections, 7,201 or 51% represent medicinal plant collections, corresponding to an estimated number of between 2000 and 3000 species.

#### ***Conservation of medicinal plants of Laos***

As part of the ITM-UIC collaboration under the ICBG grant, the first Medicinal Plant Preserve (MPP), located in Somsavath Village of Bolikhan District, Bolikhamxai Province, was established in 2004. This preserve was inaugurated in 2006 by the Deputy of the Cabinet of the Minister of Health, and has been managed since then by the Village Council of Somsavath, under the auspices of the Bolikhamxai Provincial Health Department. The staff of the ITM has been serving as technical advisers. At a later date, through funding from the Lao Biodiversity Fund (LBF), a semi-private unit of the Lao Ministry of Health founded through funds made available by the UIC, additional medicinal plant preserves were established in other provinces. Each of the Traditional Medicine Stations (TMS), a government Unit of

**Table 1.** Tabulated results of recent plant collection surveys on medicinal plants of Lao PDR.

Year of survey	Purpose of collection & Number of collections made			Projects/Collaborative efforts	Funding source
	Biological screening	Medicinal plant studies	Activities	(ITM &) collaborating institution	
1976-2013	-	2,500	Healers' interviews	ITM staff	Lao government funding
1997-1998	320	-	Taxonomic diversity collection	ITM and University of Illinois at Chicago (UIC)	NCI plant Screening Program <sup>1</sup>
1998-2008	200	-	Biological screening collections	ITM and University of Illinois at Chicago (UIC)	ICBG program (Fogarty International Center) <sup>1</sup>
1998-2008	-	990	Healers' interview	ITM and UIC	ICBG program (Fogarty International Center) <sup>1</sup>
2004	-	201	Healers' interviews	ITM staff	IPGRI (Philippines)
2005	-	432	Healers' interviews	ITM staff	ARCBC (Philippines)
2006 (independent)	-	?	Healers' interviews	Chinese University of Hong Kong	Chinese University of Hong Kong
2007-2010	2,674	-	Strictly taxonomic inventory; no interviews	ITM staff & KIB (Kunming Institute of Botany) scientists	KIB (People's Republic of China)
2008-2014 (independent)	-	?	Cultivation of introduced and native species	Pha Tad Ke Botanical Garden	Pha Tad Ke Botanical Garden
2009	-	418	Healers' interviews	IUCN-Lao and UIC	IUCN-Lao; ICBG program
2009-2014	-	1,206	Healers' interviews and biological screening	Korean Research Institute of Bioscience and biotechnology (KRIBB)	KRIBB (South Korea)
2011-2012	-	114	Healers' interviews	M. Sc. Degree, National University of Laos (NUoL)	NUoL, Lao PDR
2011-2012	3,600	-	Strictly taxonomic inventory; no interviews	ITM staff & KIB scientists	KIB (PRC)
2011-2014	-	565	ITM staff	ITM staff & The Agro- Biodiversity Initiative (TABI)	TABI (Lao PDR)
2013	-	568	Healers' interviews	ITM staff	ICUBEC
2012-2013 (independent)	-	?	Healers' interviews	CHESH-Lao staff	CHESH-Lao
2013-2014	84	207	Healers' interviews	ITM & UIC staff	California Community Foundation (USA)
Subtotal	6,878	7,201	-	-	-
Total	(6,878) + (7,201) = 14,079 (accounted number of collections)				

<sup>1</sup>NIH, USA. \*Collections are not in deposit at the ITM Herbarium

**Table 2.** Data on the Medicinal Plant Preserves and Medicinal Biodiversity Preserves

Location	Area (ha)	Year established	Remarks	Geographic coordinates; altitude	District location
Medicinal Plant Preserve, Bolikhamxai province	13.13	2004	<i>In situ</i>	18° 27' N; 103° 48" E; alt. 163 m	Bolikhan
Medicinal Plant Preserve, Vientiane Capital	6.00	2006	<i>Ex situ</i>	18° 10' N; 105° 46" E; alt. 130 m	Xaythany
Medicinal Plant Preserve, Champasak province	4.00	2008	<i>In situ</i>	15° 09' N; 102° 34" E; alt. 180 m	Pakse
Medicinal Biodiversity Preserve, Savannakhet province	15.00	2008	<i>In situ</i>	16° 39' N; 104° 51" E; alt. 159 m	Kaisone Phomvihane
Medicinal Biodiversity Preserve, Oudomxay province	15.00	2009	<i>In situ</i>	20° 40' N; 101° 57" E; alt. 680 m	Xay
Medicinal Plant Preserve, Luangnamtha province	10.00	2010	<i>In situ</i>	20° 86' N; 101° 31" E; alt. 798 m	Namtha
Medicinal Biodiversity Preserve, Xiengkhuang province	500.00	2010	<i>In situ</i>	19° 42' N; 103° 35" E; alt. 1129 m	Kham
Medicinal Plant Preserve, Xekong province	30.00	2010	<i>In situ</i>	15° 28' N; 106° 20" E; alt. 790 m	Thateng
Medicinal Biodiversity Preserve, Luang Prabang province	2,300.00	2012	<i>In situ</i>	19° 56' N; 102° 45" E; alt. 1300 m	Phon Xay
Medicinal Biodiversity Preserve, Bokeo province	100.00	2013	<i>In situ</i>	20° 13' N; 100° 34" E; alt. 372 m	Houang Xay

These preserves were established through the funding support provided by the Lao Biodiversity Fund, except the Medicinal Plant Preserve in Bolikhamxai Province (through the ICBG support) and the Medicinal Biodiversity Preserve in Luang Prabang (through TABI support).

the Provincial Health Department, has been responsible in the planning and in the implementation of the establishment of each of the new preserves. Only one new preserve, located in Luang Prabang Province, was established by a private citizen through funding from TABI. In order to broaden the scope of forest protection, some of the new preserves were inaugurated under the name of "Medicinal Biodiversity Preserves" (MBPs). Today, there is a network of 10 MPPs/MBPs throughout Laos (Table 2 and Figures 1 to 4). Each preserve is administered by the Provincial Health Department, under its Foods and Drugs Division. The staff of the Institute of Traditional Medicine in Vientiane serves as the technical coordinator of these preserves.

## DISCUSSION

As stated in the introduction, the actual number of medicinal plant species in Laos is presently

unknown. Petelot listed 1,392 species of medicinal plants found in Cambodia, Vietnam and Laos, but the specific number of medicinal plants of Laos is not given. The most extensive inventory of medicinal plants in recent years is that performed by the ITM- UIC team under the ICBG project, in which 990 collections, comprising more than 573 medicinal plant species were collected and databased. Although a large number of collections of medicinal plants based on interviews were gathered by the ITM-KRIBB team (Table 1), no comprehensive identification of these collections have been performed, hence, the number of species comprising these collections cannot be estimated. A conservative estimate on the number of medicinal plant species represented by the 7,201 medicinal plant collections held by the ITM Herbarium places the number of species between 2,000 and 3,000. Since many species are represented by duplicate collections, the exact number of species, however, awaits a full physical count. Do

we still need to continue ethnobotanical and ethnomedical explorations in Laos? It is our belief that continuing explorations are needed, since the data on hand are still well below what we believe to represent the totality of medicinal plants of Laos.

### Significance of the inventory effort in the context of risk status of medicinal plants of Lao PDR

As indicated in the introduction, many species of medicinal plants of Laos are considered rare and at risk, either threatened or endangered. Ninety-six (96) species of medicinal plants at risk are listed in the Prime Minister Decree No. 155 of 2003 as medicinal species worthy of protection. In a later (2007) document (Minister of Health of Lao PDR, 2007), the list is trimmed to 30 medicinal plant species. Still, this is a significant number and is a serious matter. In our fieldwork



**Figure 1.** Bolikhamxai Medicinal Plant Preserve (MPP) at Somsavath Village in Paksan District, showing the preserve's entrance gate sign and the visitor shelter and meeting hall, and the forest preserve, in the background. Note the deep-water pump on the lower right-hand corner being operated.



**Figure 2.** Xiengkoung Medicinal Biodiversity Preserve at Kham Village of Kham District, Xiengkoung province. The forest in the foreground and the forested slope that leads to the distant mountain are part of the preserve. An MBP preserve sign and warning notice are on the right-hand corner.



Figure 3. Sign posted at the entrance to the Medicinal Biodiversity Preserve at Phon Xay district, Luang Prabang province.



Figure 4. A team of Oudomxay young researchers carrying out a field survey at the Oudomxay MBP, as part of the effort to inventory the medicinal plant species in this MBP.

**Table 3.** Rare and threatened medicinal plant species of Laos

No.	Local names	Scientific names	Traditional use (disease/affection treated)	Part used
1	<i>Koud Tin Houng</i>	<i>Helminthostachys zeylanica</i> Hook.f. (Ophioglossaceae) <sup>2</sup>	Fever; tonic	Root
2	<i>Khing Pha</i>	<i>Polygonatum kingianum</i> Coll. & Hemsl. (Asparagaceae).	Tonic; diabetes	Root/rhizome
3	<i>Kha Yom Phou</i>	<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz (Apocynaceae) <sup>1</sup>	Hypertension	Root
4	<i>Hoa Tom Ngeune</i>	<i>Stephania rotunda</i> Lour. (Menispermaceae) <sup>1</sup>	Insomnia	Tuber
5	<i>Man Onh Ling</i>	<i>Fallopia multiflora</i> (Thunb.) Czerep. (Polygonaceae) <sup>1</sup>	Tonic, back pain, longevity	Tuber
6	<i>Man Kha Kai</i>	<i>Codonopsis pilosa</i> (Franch.) Nannf. (Campanulaceae)	Tonic	Rhizome
7	<i>Kheua Haem</i>	<i>Coscinium fenestratum</i> (Gaertn.) Colebrooke (Menispermaceae)	Dysentery, diarrhea, diabetes	Liana
8	<i>Vane Hoa Tor</i>	<i>Disporopsis longifolia</i> Crab. (Asparagaceae)	Tonic	Rhizome
9	<i>Tin Houng</i>	<i>Paris marmorata</i> Stearn (Melanthiaceae).	Tonic, stomach pain	Rhizome
10	<i>Pom Bi Ka Thing</i>	<i>Panax vietnamensis</i> Ha et Grushv. (Araliaceae)	Tonic	Rhizome
11	<i>Mak Chong Ban</i>	<i>Sterculia lychnophora</i> Hance (Sterculiaceae) <sup>1,2</sup>	Cold medicine, heat inside the body	Fruit
12	<i>Leu Lang Lai</i>	<i>Aeschynanthus longicaulis</i> Wall. ex R. Br. (Gesneriaceae)	Nervous system disorders, tonic	Whole plant
13	<i>li Tu Ton</i>	<i>Cinnamomum camphora</i> (L.) Priesl. (Lauraceae) <sup>2</sup>	Vertigo/dizziness	Essential oil
14	<i>Mai Tha Lo</i>	<i>Cinnamomum parthenoxylon</i> (Jack) Nees (Lauraceae)	Vertigo/dizziness	Essential oil
15	<i>Hat Mee</i>	<i>Artocarpus lakoocha</i> Roxb. (Moraceae) <sup>1, 2</sup>	Tape worm	Stem wood (without sap)
16	<i>Lep Meu Nang</i>	<i>Schefflera elliptica</i> Harms. (Araliaceae) <sup>1</sup>	Rheumatism, tonic	Stem bark
17	<i>Ien Don</i>	<i>Eurycoma harmandiana</i> Pierre (Simaroubaceae)	Tonic, fever	Root
18	<i>Khao Kai</i>	<i>Curculigo orchidoides</i> Gaertn. (Hydroxylaceae)	Tonic	Root/rhizome
19	<i>Chan Dai Deng</i>	<i>Dracaena cambodiana</i> Pierre ex Gagnep. (Dracaenaceae) <sup>1,2</sup>	Blood tonic; blood purifier	Stem wood from dried tree
20	<i>Seng Beua</i>	<i>Strychnos nux-vomica</i> L. (Loganiaceae) <sup>1,2</sup>	Rheumatism, joint pain, paralysis, antispasmodic	Seed
21	<i>Yang Bong</i>	<i>Litsea monopetala</i> (Roxb.) Pers. (Lauraceae)	Flatulence, shooting pain	Stem

<sup>1</sup>Also cited in the Prime Minister's Decree on Natural Resources for Medicines (Prime Minister of Lao PDR, 2003). <sup>2</sup>Also cited by Sydara (2007).

to study medicinal plants, we have had a first-hand opportunity to observe the occurrence of, and to collect some of these rare or threatened species, and to record their distribution. The collections we have accumulated to date are important in contributing new data for understanding the rarity and the risk status of many Lao medicinal plant species. Thus, our observations have confirmed, in certain cases, the risk, the rarity and the possible threatened status of species listed in the Prime Minister's Decree No. 155, as well as of other species. However, such observations still need to be further confirmed by more rigorous scientific

studies, preferably following guidelines set up by the IUCN (2001).

The following factors appear to be some of the causes that have led to the risk status (Table 3) of these species:

1. Lack of awareness of the rural population on the sustainability of natural resources.
2. The weakness of the implementation of rules, regulations, and laws for the protection of biodiversity.
3. The lax cooperation among regulatory authorities.
4. The inappropriate techniques in the collection of plant raw materials, such as bark, fruit, and

root.

5. The increased demand for the raw materials in the international markets.

Although the collection of medicinal plants and other non-timber forest products are known to contribute to the reduction of poverty among members of the local communities, the inefficiency of the collection methods and the lack of properly coordinated management have caused serious negative impact on biodiversity richness (Phongphachanh, 2004). Medicinal plants are just one component of the biodiversity that is lost. Other living organisms are affected as well. Many

**Table 4.** Commercially cultivated and exported medicinal plant species of Laos.

Local name(s)	Scientific Name <sup>1</sup>	Traditional Use	Part Used	Remarks <sup>2</sup>
<i>Tin Ped</i>	<i>Alstonia scholaris</i> (L.) R. Br. (Apocynaceae) <sup>3,4</sup>	Malaria; dysentery	Stem bark	Harvested from wild; exported
<i>Mak Naeng</i>	<i>Amomum</i> spp. (Zingiberaceae)	Tonic	Seed	Harvested from wild; cultivated; exported
<i>Hua Dukdeua</i>	<i>Amorphophalus</i> spp. (Araceae)	Reduce weight	Tuber	Harvested from wild; exported
<i>Ra Sa Bi, Samphan Bi</i>	<i>Andrographis paniculata</i> (Burm. f.) Wall. ex Nees (Acanthaceae) <sup>3,4</sup>	Tonic	Herb	Commercially cultivated; commonly grown
<i>Vane Bai Lai</i>	<i>Anoectochilus formosus</i> Hayata (Orchidaceae)	Tonic	Whole plant	Harvested from wild; exported
<i>Fang Daeng</i>	<i>Caesalpinia sappan</i> L. (Fabaceae) <sup>4</sup>	Blood tonic; diarrhea	Stem wood	Commercially cultivated; collected from the wild
<i>Kao Bok</i>	<i>Catharanthus roseus</i> (L.) G. Don (Apocynaceae) <sup>3,4</sup>	Diabetes	Leaf	Commercially cultivated; commonly grown
<i>Phak Nok</i>	<i>Centella asiatica</i> Urban (Apiaceae) <sup>3,4</sup>	High fever, cough	Whole plant	Commercially cultivated; commonly grown
<i>Khae</i>	<i>Cinnamomum cassia</i> Bl. (Lauraceae) <sup>3,4</sup>	Tonic, heart tonic, flatulence	Stem bark	Commercially cultivated <sup>5</sup> ; harvested from wild; exported
<i>Mak Kieng</i>	<i>Citrus aurantium</i> L. var. <i>daidai</i> Makino (Rutaceae)	Decreases the fragilities of blood capillaries	Fruit peel	Commercially cultivated <sup>5</sup>
<i>Man Kha Kai</i>	<i>Codonopsis pilosa</i> (Franch.) Nannf. (Campanulaceae)	Tonic	Rhizome	Harvested from wild; exported
<i>Kheua Haem</i>	<i>Coscinium fenestratum</i> (Gaertn.) Colebrooke (Menspermeaceae)	Dysentery, diarrhea, diabetes	Liana	Harvested from wild; exported
<i>Khi Min Kheun</i>	<i>Curcuma longa</i> L. (Zingiberaceae) <sup>3,4</sup>	Stomach ache	Rhizome	Commercially cultivated; commonly grown
<i>Van Hua Deo</i>	<i>Curcuma xanthorrhiza</i> Roxb. (Zingiberaceae) <sup>4</sup>	Leucorrhea, uterine pain	Rhizome	Commercially cultivated; produced in some provinces
<i>Dok Pheung</i>	<i>Dendrobium</i> spp. (Orchidaceae)	Tonic, cough, stimulate or strengthen breathing	Whole plant	Harvested from wild; cultivated; exported; commercially cultivated <sup>5</sup>
<i>Chan Dai Deng</i>	<i>Dracaena cambodiana</i> Pierre ex Gagnepain (Dracaenaceae) <sup>3,4</sup>	Blood tonic, blood purifier	Stem wood from dried tree	Harvested from wild; exported
<i>Phak Bua Leuat</i>	<i>Eleutherine subaphylla</i> Gagnep. (Iridaceae) <sup>3,4</sup>	Stomach ache; bleeding	Bulb	Commercially cultivated; commonly grown
<i>Ien Done</i>	<i>Eurycoma harmandiana</i> Pierre (Simaroubaceae)	Tonic, hot fever	Root	Harvested from wild; exported
<i>Hed Lin Cheu</i>	<i>Ganoderma lucidum</i> (Leys. Ex Fr.) Karst. (Ganodermataceae)	Tonic; hyperglycemia; cancer	Whole mushroom	Harvested from wild; exported
<i>Vane Hang Xang</i>	<i>Grammatophyllum speciosum</i> Bl. (Ochidaceae)	Throat inflammation	Whole plant	Harvested from wild; exported
<i>Hoa Sam Phanh Hou</i>	<i>Hydnophytum formicarum</i> Jack (Rubiaceae)	Diabetes	Tuber	Harvested from wild; exported
<i>Nhor Ban</i>	<i>Morinda citrifolia</i> L. (Rubiaceae) <sup>4</sup>	Emmenagogue; anti-vomiting	Young fruit	Commercially cultivated; a wild plant
<i>Phak li Houm</i>	<i>Moringa oleifera</i> Lam. (Moringaceae)	Galactagogue; diuresis	Young leaf	Commercially cultivated; commonly grown
<i>Mone</i>	<i>Morus alba</i> L. (Moraceae) <sup>4</sup>	Fever, chronic cough	Leaf	Commercially cultivated; commonly grown
<i>Nha Nuat Meo</i>	<i>Orthosiphon stamineus</i> Benth. (Lamiaceae) <sup>3,4</sup>	kidney stone, diuresis; diabetes	Leaf	Commercially cultivated; commonly grown; exported
<i>Hed Pek</i>	<i>Poria cocos</i> F.A. Wolf	Tonic	Rhizome	Commercially cultivated <sup>5</sup>
<i>Hoa Sam Sib</i>	<i>Stemona tuberosa</i> Lour. (Stemonaceae) <sup>4</sup>	Lung inflammation; tuberculosis	Rhizome	Harvested from wild; exported
<i>Hua Tom Ngeuene</i>	<i>Stephania rotunda</i> Lour. (Menispermaceae) <sup>3</sup>	Insomnia	Tuber	Harvested from wild; exported
<i>Mak Chong Ban</i>	<i>Sterculia lychnophora</i> Hance (Sterculiaceae) <sup>3,4</sup>	Cold medicine, heat inside the body	Fruit	Harvested from wild; exported
<i>Nhane</i>	<i>Styrax tonkinensis</i> (Pierre.) Craib ex Hartwich (Styracaceae) <sup>3,4</sup>	Cough	Resin	Commercially cultivated <sup>5</sup> ; exported
<i>Nam Khor</i>	<i>Uncaria rhynchophylla</i> (Miq.) Mq. ex Havil. (Rubiaceae)	Rheumatism, hypertension	Stem hook	Commercially cultivated <sup>5</sup>
<i>Van Phai</i>	<i>Zingiber cassumunar</i> Roxb. (Zingiberaceae) <sup>4</sup>	Flatulence	Rhizome	Commercially cultivated; commonly grown
<i>Khing</i>	<i>Zingiber officinale</i> Roscoe (Zingiberaceae) <sup>4</sup>	Cough, sore throat	Rhizome	Commercially cultivated <sup>5</sup> ; exported

<sup>1</sup>Plants listed in alphabetical order by scientific name (genera). <sup>2</sup>Some plants are both cultivated and collected from the wild. For plants that are cultivated, some are cultivated exclusively by foreign companies, as is designated. Many of the plants are exported. <sup>3</sup>Plant species was also cited by Phongphachanh (2004). <sup>4</sup>Plant species was also cited by Sydara (2007).

medicinal plant species have become rare due to over-collection to generate income, in particular for satisfying exportation demands.

### **Significance of the results of the inventory in the context of cultivation and commercialization of medicinal plants of the Lao PDR**

The Decree No. 155 of 2003 by the Lao Prime Minister defines measures for the promotion, cultivation, production and general exploitation, management, and preservation intended to protect the country's medicinal natural resources and its rich biodiversity, and to ensure the sustainable use of these medicinal natural resources. The decree classifies medicinal natural resources into three categories:

Category I: Species that are considered rare and endangered.

Category II: Species that have a high commercial value, both for use in the domestic consumption and for exportation.

Category III: Species that are easily available and are in abundance throughout the country.

In harvesting and collecting medicinal plants and other components of the biodiversity listed in Category I, the approval of the Ministry of Health and other competent authorities is required. In this category, 56 species of plants and animals are listed.

For category II, harvest and exploitation of these species must also be certified by the Ministry of Health and concerned authorities, and a plan for the management in the harvest and replanting must be provided. In this category, 60 species of plants and animals are listed.

For category III, the exploitation of these species is not restricted. In this category, 63 species of plants and animals are listed.

It must be noted, however, that this classification is not rigid. For example, the plant species listed in categories II and III may also be placed in category I in the future if their risk status becomes apparent and their management is inadequate.

Products of most species of medicinal plants that are exported to other countries are in the form of raw materials or extracts. A well-known purified extract that is exported to neighboring countries is berberine, derived from a Lao indigenous species, *Cosciniium fenestratum* Colebr. (Menispermaceae), and the total extracts of *Dracaena cambodiana* Pierre ex Gagn. (Asparagaceae)

([http://www.iisd.org/pdf/2008/rtea\\_lao\\_plants\\_spices.pdf](http://www.iisd.org/pdf/2008/rtea_lao_plants_spices.pdf)). The collections of medicinal plants which we have gathered and deposited at the ITM Herbarium serve as reference material in the identification of these commercially cultivated and exported medicinal plant species. Having reference material is crucial in the event that a suspected species at risk is being gathered in massive amounts and is exploited for commercialization.

A list of species that are commercially cultivated for both domestic use and for exportation is presented in Table 4. In case of exportation, the plants should be cultivated instead of collected from the wild in order to help ensure the sustainable supply and consistent quality of the exported raw materials.

## **CONCLUSION**

Medicinal plants and traditional medicines continue to play an important role in the prevention and treatment of diseases in the national health care system of the Lao People's Democratic Republic. Our efforts in the inventory of medicinal plants of the Lao PDR have demonstrated the enormity to which the Lao population depends for their health maintenance. Although attempts to inventory medicinal plants in many provinces have been made by the ITM in collaboration with both domestic and foreign institutions in recent years and a large volume of collections has been made and deposited at the ITM Herbarium, many species of medicinal plants in the country are still unknown. Hence, we feel that many more medicinal plants of the Lao PDR need to be found, collected, documented and identified.

In parallel with the promotion in the use of medicinal plants, appropriate measures should be implemented in order to ensure the sustainability of the supply. The enforcement of the laws and regulations is a basic contributing factor in the preservation of medicinal natural resources and their availability for future generations. In this effort, the participation of local communities in safeguarding these resources is paramount, which would ensure the sustainable utilization of these resources.

## **Conflict of interest**

The authors declare that this paper has been prepared independently and that they have no conflict of interest, either commercially or otherwise, in the publication of this paper.

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