BGO NEWSLETTER

THE BOTANICAL GARDEN ORGANIZATION

PRIME MINISTER'S OFFICE

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H.M. Queen Sirikit paid her annual royal visit to the QBG on 30 Jan, 2000. Mr. Pinyo Niroj, Minister to the Prime Minister's Office is seen reporting to the Queen.

H.M. the Queen was interested in the ethnobotanical collection.

On 24 Feb, 2000, H.M. the Queen visited Ban Romklao, Pitsanulok province to follow up the progress of H.M.'s initiative projects including the establishment of the satellite garden. Mrs. Panit Nitithanprapas is seen presenting a bouquet to H.M. Queen Sirikit.

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Editorial

We are already half way through the year 2000, and so far, it has been a busy, but fruitful time for us at the Queen Sirikit Botanic Garden. Various cooperative programs involving biodiversity conservation have been initiated or put underway. The UNITAR Workshop (page 7) is a good example of a successful cooperation at international level. We are pleased to be recognized and the Garden chosen as the venue to host the event.

In this issue of the BGO Newsletter we bring to you a research note by Dr. William F. Grant, Emeritus Professor, McGill University, Canada. Prof. Grant, a Fellow of the Linnean Society of London, a Fellow of the Royal Society of Canada, and a recipient of many awards and honors for his contribution in the field of plant genetics, writes about "Plants as Detectors of Environmental Mutagen" a field in which he is a pioneer. The feature article "Production of Aromatic Plants in Asia – An Overview", was prepared by Dr. Narong Chomchalow. Dr. Narong, who is currently with the Office of the President, Assumption University, Bangkok, was formerly FAO Regional Plant Production Officer. He has enormous experience in agricultural research and development, and has been the author and/or editor of a large number of publications, including NANMAP (Newsletter of the Asian Network for Medicinal and Aromatic Plants).

It is worth noting that the Garden was visited by more than 70,000 students during the last year. This is a fine indication of how young people today take an active interest in botanical development. The Garden has benefited in various ways from this interest, for example, the volunteer work of Fay and Sarah Alikhani of Nakorn Payap International School, Chiang Mai, who assisted in the format of the newsletter and in designing the Garden website.

Please visit our website (www.geocities.com/qsbg2000). We will make every effort to produce this resource as being user-friendly and informative as possible. Your comments and feedback regarding the website and the Newsletter will be greatly appreciated.

Suyanee Vessabutr, Ph.D.

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BGO NEWS

Changing of the Minister

Mr. Pinyo Niroj has been appointed as Minister to the PM's Office to oversee the administration and policy planning of the Botanical Garden Organization since November 1999. Mr. Pinyo replaces Mr. Jurintr Laksanavisith, who took up responsibilities as Minister to the PM's Office for the Sports Authority of Thailand, and the Office of the Narcotics Control Board.

Mr. Pinyo Niroj has visited the QBG several times since he took up the responsibility.

Congratulations!

To Dr. Suree Bhumibhamon, who received the Royal Decoration of Knight Grand Cordon of the Most Noble Order of the Crown of Thailand, which was granted by His Majesty King Bhumibol Adulyadej on this year's Coronation Day (5 May 2000). Dr. Suree Bhumibhamon, a BGO board member is Vice President for International Affairs, and Director of Andaman Institute, Krabi Campus, Kasetsart University. This is the third Royal Decoration he has been granted.

Appointment

Welcome to the new executive board member - Dr. Surawit Wannakrairoj, Assistant Professor, Department of Horticulture, Kasetsart University. Dr. Surawit has replaced Dr. Pakorn Priyakorn, who recently resigned due to his demanding teaching responsibility at the National Institute of Development Administration (NIDA).

INSIDE QBG

Welcome aboard!

Mr. Chaichart Buraphacheep has been appointed as Deputy Director of Queen Sirikit Botanic Garden for Administration, effective June 1, 2000. Mr. Chaichart graduated from the Faculty of Pharmacy, Chulalongkorn University in 1979. Since his graduation, he has worked as manager in several chemical companies; and studied at the same time for his degree in business administration at the National Institute of Development Administration (NIDA). He obtained his MBA from NIDA in1984. With his extensive experience in business management, Mr. Chaichart hopes to contribute his knowledge toward the development of marketing for the QBG.

QBG ACTIVITIES

Northern Agricultural Fair

The QBG participated in the Northern Agricultural Fair at Chiang Mai University during 8-12 December 1999 by presenting an exhibition on *"Thai Medicinal Plants."*

The exhibition received much attention from the public.

National Children's Day

On 8 January 2000, the Garden celebrated National Children's Day by providing free entrance and lunch for young kids and their parents. The children had a chance to enjoy activities including games and a visit to the Glasshouse Complex.

Participation in ICV-2

The 2nd International Conference on Vetiver (ICV-2) was organized by the Office of the Royal Development Projects Board with support from the Chaipattana Foundation during 18-22 January 2000, at Phetchaburi Province. The conference was held to commemorate the 6th Cycle Birthday Anniversary of HM the King of Thailand.

Dr. Weerachai Nanakorn, QBG Director, one of the issue speakers, is seen giving a talk on "The Thai Experiences of Vetiver".

The Garden participated in the conference by presenting an exhibition on " The Use of Vetiver Grass for Land Development in the QBG area".

QBG Glasshouse Complex

The Glasshouse Complex of Queen Sirikit Botanical Garden (1) is almost ready for public viewing. It is an ongoing project expected to be completed by August 2000. The Complex comprises 5 exhibition conservatories and 8 glasshouses for plant collections.

The largest conservatory is the "Tropical Rainforest House" (**2, background**) with a floor space of 1000 sq.m., and a height of 33 m. It holds the Garden's collection of native palms, cycads, and ferns with emphasis on tropical rare species of Southeast Asia.

Waterfall in the Tropical Rainforest House

Sheltering over 100 species of aquatic plants which grow at the edge of rivers, lakes, ponds, streams, and marshes, the Aquatic House (3) displays waterlilies, aquatic ferns, reeds, water hyacinth, and some insect-eating species (carnivorous plants).

The Arid House (4) features the cacti collection and other succulents including native euphorbes, American agaves, and African aloes.

The Orchid and Fern House (5) has emphasis on the native orchids and ferns, however, it features other epiphytes such as bromeliads.

The 8 glasshouses for displaying plants in collections (6) are grouped according to plant usage and their economic importance. The collections include ornamental plants, wild species, ethnobotanical collection, and medicinal plants.

UNITAR Workshop

During 20-24 March 2000, the QBG hosted a regional workshop on "The Application of Multilateral Agreements Related to Biological Diversity". The workshop was a collaborative program of the United Nations Institute for Training and Research (UNITAR), the UNEP, the UNESCO; and the Office of Environmental Policy and Planning (OEPP), Ministry of Science, Technology, and Environment,Thailand. The financial support of the Carl Duisberg Gesellschaff, and the Hanns Seidel Foundation is greatly appreciated. There were about 50 participants from various national and overseas institutes. Judging from the response of the participants and sponsors, the workshop was a great success.

Reception Party with northern traditional food and dances at the Imperial Mae Ping Hotel on 19 March, 2000.

Opening Ceremony
From left: Dr. Weerachai Nanakorn, QBG Director
Dr. Daniel Navid, UNITAR
Dr. Yoshihiro Natori, UNEP
Dr. Hans Thulstrup, UNESCO

Discussion in small groups was an important component of the training program.

Brief introduction about Doi Inthanon National Park before the field trip.

Field study at Doi Inthanon National Park.

Parataxonomist Training

The 5th Parataxonomist Training Workshop was organized during 24-27 April 2000, at Queen Sirikit Botanic Garden with field studies at Doi Suthep-Pui and Doi Inthanon National Parks. The workshop was co-sponsored by the National Center

for Genetic Engineering and Biotechnology, Ministry of Science, Technology and Environment. The workshop, with the theme of indigenous plants and local wisdom, was a successful one.

The Parataxonomist Training Workshop is organized annually with the aim to support plant conservation by raising awareness in relevant issues of various aspects. For the effectiveness of field studies, the workshop will accommodate not more than 50 participants. Those who are interested in the program, please contact the Education Section, Technical and Research Department, tel 298-171 ext. 1639 or 1208.

HUMAN RESOURCE DEVELOPMENT

Staff Relation Workshop

A staff workshop related to organization development was held during 8-10 March 2000. The workshop was aimed to improve the overall working environment at the Queen Sirikit Botanic Garden (pictured below).

Botanical Training at RBG Edinburgh

Mr. Santi Wattana and Mr. Piyakaset Suksathan, two QBG botanists, visited the Royal Botanic Garden Edinburgh during 9 May – 8 June 2000. Many thanks to Dr. George Argent, Head of South Asian Botany, who kindly provided them with supervision and accommodation.

QBG-DANCED Capacity Building Project

Following the visit to Denmark (28 April – 8 May 2000) by the project management group led by Dr. Weerachai, Project Director, and Dr. Peter Kurt Hansen, Chief Technical Adviser; twelve QBG staff have gone for specific training programs at various Danish partner insitutions during the months of May to July 2000. The training topics include plant taxonomy, and herbarium and database management at the Botanical Institute, University of Aarhus; and environmental education at Esrum Moellegaard Environmental School. The training programs include visits to the Botanic Garden and Zoological Museum in Copenhagen; the Natural History Museum, and other gardens in Denmark and Sweden.

Marketing and Tourism Training

Through the Netherlands Management Corporation Program (NMCP), Mr. Robert Nahon was assigned as a senior adviser to assist the QBG Marketing Department between 30 October - 14 November 1999. After his assignment, Mr. Nahon kindly arranged for Ms. Patavee Sangchai from the Marketing Department to attend two training programs concerning marketing and tourism in the Netherlands during 9 April – 8 May 2000. The two programs included topics in "Marketing for Hotel and Tourism Management", and "Commercial Management of a Recreational Botanical Garden". Ms. Patavee had the opportunity to visit Kasteeltuinen Areen, Keukenhof Lisse, and the Rizste Herbarium, Leiden. Our sincere appreciation goes to Mr. Robert Nahon, and the NMCP.

Special Lectures

Dr. Sermlap Wasuwat, a Thai expert on water lilies, gave a talk on "Water Lilies and the Cultivation Techniques" on 25 January 2000.

On 27 June 2000, Dr. Anders Barfod (pictured left), a palm expert from the Department of Systematic Botany, Aarhus University, Denmark, was invited to give a special lecture on "Palm Classification" to the QBG staff, students, and academic members from local universities.

VISITORS

Professor Rapee Sakrik, a world leading orchid specialist, visited the Garden on 19 November, 1999.

Prof. Sakrik visited the native orchid collection.

Mr. Tadao Chino (seated third left), President of the Asian Development Bank (ADB), visited the Queen Sirikit Botanic Garden with a select group of ADB delegates on 1 March 2000. During 6 – 8 May, while all delegates attended the 33rd Annual Meeting of the Board of Governors which was held in Chiang Mai, over 300 of their accompanying persons toured the Garden.

H.E. Chuan Leekpai, Prime Minister, visited the QBG on 20 November 1999.

The Prime Minister and the QBG Director at the Rock Garden.

On 13th January 2000, participants of the 4th International Training Program on Sustainable Highland Agricultural Development visited the Garden, and attended a lecture on "Management and Conservation of Biological Resources" given by Dr. Suyanee Vessabutr, Head of the QBG Technical and Research Department. The program was organised by the Faculty of Agriculture, Chiang Mai University, with support from the Japanese International Cooperation Agency (JICA).

H.E. Niels Dyrlund, Ambassador of Denmark to Thailand, paid a visit to observe the QBG's activities on 15 June 2000.

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QBG Publications

Flora of QBG Vol.6

Flora of QBG Vol.6 featuring native orchids of Thailand is now available for 600 baht (not included shipping and handling).

It has more than 600 coloured photographs of 144 species of Thai wild orchids with their scientific and local names, description, and distribution.

Special Offers !!!

Flora of QBG Vol.1-5, is 500 baht each. A set of five costs only 2,000 baht (not included shipping and handling).

Contact:
Marketing Department
Queen Sirikit Botanic Garden
P.O.Box 7 Mae Rim
Chiang Mai 50180, Thailand
Tel: (66 53) 273-379, Fax: (66 53) 299-753

SSRF NEWS

The Sanga Sabhasri Research Foundation (SSRF) granted 20,000 baht as scholarships to 14 students from several local schools on 29 December, 1999.

New Release!!

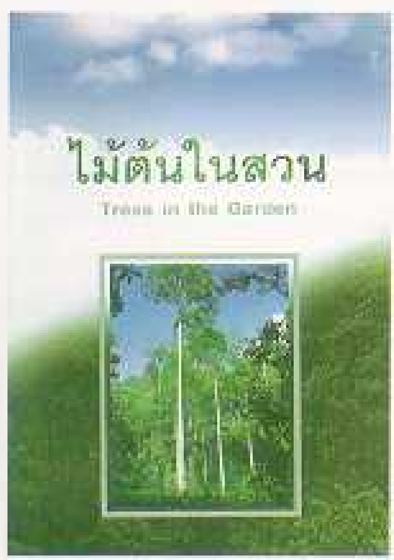
Greeting cards and postcards in a series of "Thai Wild Orchids" are now available.

A set of four greeting cards can be ordered for 40 baht, and a set of twelve postcards costs only 60 baht (not included shipping and handling).

GREETING CARDS

POSTCARDS

Please place your orders to:
Sanga Sabhasri Foundation
c/o Miss Sineenat Honhuta
QBG, Box 7, Mae Rim
Chiang Mai 50180, Thailand



"Trees in the Garden"
Handbook (in Thai language) to study indigenous trees in the Queen Sirikit Botanic Garden
212 pages with colored illustrations
Available for ฿ 200

Plants as Detectors of Environmental Mutagens

William F. Grant, Emeritus Professor,
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Fasciation of garden cockscombs

There are several plants that possess unique characteristics for screening and monitoring environmental mutagens. A mutagen, like radiation, or a chemical like nitrogen mustard, by affecting a gene or a chromosome, causes an alteration from the normal condition to an altered one, e.g., a white sector in a normally red flower or an albino condition in humans. As a result, mutations may lead to adverse genetic effects on future generations. This may come about by affecting germ cells (gametes) resulting in the accumulation of heritable abnormal genes in the population. Also, by affecting body (somatic) cells mutations may result in the formation of malignant cells in individuals. In plants, a fasciated condition, the abnormal flattening or widening out of the spike or stem, as in the garden cockscomb (*Celosia cristata*) is common. It has been estimated that 10.5% of infants have some hereditary deviation from normal development. The question arises as to the extent this genetic load is determined by the processes of natural mutagenesis and the extent to which it is induced by the influence of mutagenic environmental pollutants artificially introduced into the biosphere. It is clear that the number of defective infants will rise as the pollution of man's environment increases due to the introduction of chemical compounds into the biosphere.

Synthetic chemicals have steadily increased and become an integral part of modern society. Chemicals may enter the atmosphere, soil or water through a variety of direct or indirect routes and be inhaled directly or ingested indirectly through the food chain. Via either route, they pose a risk to human health. People can cry out if they are pinched, but not so when they are unknowingly affected by chemicals from the atmosphere, water or soil that creep silently up the food chain. Direct chemical pollutants arise from emissions from motorized vehicles, industrial effluents, nuclear reactors, refuse burning, and personal habits, such as smoking. Some gaseous and particulate forms are dissipated into the open air over large geographic areas of the globe, whereas others, such as cigarette smoke and household chemicals, are released into more confined areas. Human beings may be exposed to a single chemical at relatively high concentrations or a combination of chemicals as in the case of individuals who come in contact with chemicals in their manufacturing and application. Of concern for humans has been the relatively long lag period (15 or more years) between exposure and overt effect.

The genetic effects of environmental chemicals on the flora and fauna (including the build-up of species resistance) and on the ecosystem are also of considerable concern. While long-term whole animal bioassays are viewed as the most satisfactory procedures for assessing mutations, such tests are very expensive, as well as time- and space consuming. As a result, plant genetic test systems have been developed. Plants which provide such systems for detecting and analyzing the effects of environmental mutagens include *Allium* (onion), *Arabidopsis thaliana*, *Crepis capillaris*, *Glycine max* (soybean), *Hordeum vulgare* (barley), *Lilium*, *Lycopersicon esculentum* (tomato), *Nicotiana tabacum* (tobacco), *Oryza sativa* (rice), *Pisum sativum* (pea), *Tradescantia*, *Triticum*, *Vicia faba*, and *Zea mays* (Grant, 1994). Plant assays are inexpensive to use, easy to regenerate and the cost of training individuals is relatively small. The detection of airborne or aquatic pollutants may be carried out on-site or in the laboratory. Plant genetic assays are the only systems currently in use as on-site monitors of polluted air. The use of plants to test for mutagens is not new. The Gene-Tox program of the U.S. Environmental Protection Agency reviewed nine assays in seven plant species for testing plant genotoxicity - *Allium*, *Arabidopsis*, *Glycine*, *Hordeum*, *Tradescantia*, *Vicia*, and *Zea mays* (Grant, 1999). These nine assays have been shown to have a high sensitivity and to be most appropriate for the prediction of carcinogenicity (Grant, 1994).

Two assays, which are considered ideal for *in situ* monitoring and testing of mutagens, are the *Tradescantia* stamen hair assay and the *Trandescantia* micronucleus assay. Both assays have been used to investigated polluted aquatic sites, air pollution around commercial and industrial sites and polluted soil (Ma *et al*., 1996; Kong and Ma, 1999).

Perhaps the greatest contribution of plant genotoxicity assays will be their continued use for ambient air and aquatic *in situ* monitoring and testing that can be carried out on a global scale. Higher plant genetic assays possess many advantages that make them ideal for use by scientists in developing countries (Plewa, 1985).

A new international initiative, **"The International Program on Plant Bioassays"** was started in 1992 under the leadership of T.H. Ma, W.F. Grant, and F.J. de Serres. Three test systems were used in an international study, the *Tradescantia* micronucleus test, the *Tradescantia* stamen hair test; and the *Vicia faba* root chromosome aberration test. In 1995, a workshop, sponsored by the United Nation Environment Program, was conducted at Quingdao Ocean University, Quingdao, People's Republic of China to familiarize participants with a follow-up study. This involved the practical application of two of the three plant bioassays to monitor or test for polluted air, water or soil in their home region. The participants from 14 countries completed their analyses and 26 manuscripts have now been published in Mutation Research (Grant *et al*., 1999). It is planned to continue this global environmental monitoring. This kind of monitoring work can be carried out as an accessory project in any research laboratory. Individuals interested in participating in this global environmental monitoring may contact the Principal Coordinator; Dr. Te-Hsiu Ma, Department of Biological Sciences, Waggoner Hall, Western Illinois University, Macomb, Illinois 61455, U.S.A.
E-mail: mftm@uxa.ecn.bgu.edu

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Production of Aromatic Plants in Asia - An Overview

Narong Chomchalow
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Introduction

What are Aromatic Plants ?

Aromatic plants (AP) are plants that possess aromatic compounds, mostly essential oils which are volatile at room temperature. These compounds are synthesized and stored in a special structure called 'gland' which is located in different parts of plants such as leaves, flowers, fruits, seeds, barks and roots. In ancient times, these plants were used as raw materials for their fragrance, flavor, or therapeutic properties. In modern days further to the traditional methods of usage, essential oils are extracted from aromatic plants by various means and utilized in the production of cosmetics, pharmaceuticals, botanical pesticides, and other applications.

Importance of Aromatic Plants

Aromatic plants can be divided into four groups based on how they are utilized:

* *As raw materials for essential oil extraction:* This is the major use of AP and is the one dealt with in this paper.

* *As spices:* These are plants in which their non-leafy parts are used as a flavoring or seasoning.

* *As herbs:* These are plants in which their leafy or soft flowering parts are used as a flavoring or seasoning.

* *Miscellaneous group:* These are AP used in some ways other than those mentioned above, for example, as medicines, cosmetics, dyes, air fresheners, disinfectants, botanical pesticides, insect repellents, herbal drinks/teas, and potpourris.

People have made extensive uses of aromatic plants from time immemorial. The Egyptians, the Persians, and the Babylonians were known to grow and use AP in making perfumes and other scented waters from a distillation of rose petals and orange blossoms. In the Orient, AP were grown in the palace compounds and used as raw materials to make incense, perfumes, and scented water.

With advances in technology, large scale production of essential oils has increased and modern facilities for processing and utilization of AP are employed. Essential oils can be extracted by various physical and chemical processes such as steam distillation, maceration, expression, enfleurage and solvent extraction. The extracted aromatic essences are used in flavor and fragrance industries, cosmetics and other aromatic products.

Recent Popularity of Natural Flavor and Fragrance Derived from Aromatic Plants

Several factors have contributed to the recent popularity of natural flavors and fragrances derived from AP:

Back-to-nature campaign: The growing dissatisfaction with synthetic chemical products in perfumery, food, cosmetic, and pharmaceutical industries has motivated many people to turn to natural flavors and fragrances obtained from AP.
Health conscious: Certain synthetic flavor and fragrant compounds used in various industries have been known to cause health hazards. Thus, there industries were forced to use natural materials even at a much higher price.

AROMATIC PLANTS IN ASIA

Tropical and sub-tropical Asia are rich in the number of species of AP due to their favorable climatic conditions. The earliest known records related to APwere from Asia where the local people made use of indigenous plants in various traditional ways. In India, for example, old literature mentions numerous uses of essences obtained from plants in performing religious rites since prehistoric times. India is regarded as the traditional home of oriental perfumes (Sharma 1996). In China, Emperor Shen Nung, who lived around 2800 BC, held regular spice commodity market and practicing what he preached, consumed large quantities of spices everyday to strengthen his health and prolong his life. Throughout the long history of almost 5000 years, the Chinese have continued to put faith in spices for medicinal purposes and for preserving and flavoring foods. At present, Chinese people make use of more than 400 species of AP, not only for their flavor and fragrant properties, but also as medicines. China now produces more than 120 natural essential oils for domestic consumption as well as for export markets (Xiao 1996).

List of Aromatic Plants in Asia

For convenience in describing AP, the following system of grouping is devised:

I. Naturally-occurring species: These are AP which occur naturally in the wild. Native people normally collect them for their own domestic uses. Some, however, are collected in large quantities for industrial processing. They can be sub-divided into three categories on the basis of the quantity available and their potential.

(1) Available in small quantity: These are AP that are found scattered in the wild in small quantity. However, they are still collected for domestic uses. The list is given in Table 1.

(2) Available in large quantity: A few countries in Asia still maintain natural forests where AP are growing in pure stands (e.g. *Pinus* spp.), or scattered in large number such that native people can earn a good income by collecting them from the wild and selling them to local essential-oil factories. Examples can be sited of a few factories in Nepal which process pine resin from *Pinus roxburghii* for the production of turpentine and resin. About 4000 to 5000 t of pine resin are produced annually (Rawal 1996). Comparable situation can be found in Northern Thailand where similar product is obtained from *Pinus kesiya* and *P. merkusii*. The list of naturally-occurring AP collected for processing is shown in Table 2.

Commercial utilization of naturally-occurring AP is facing a number of constraints particularly the lack of raw materials for the factories, and where the material exists there is the lack of manufacturers. In Nepal, with the establishment of a state enterprise in 1991, known as the Herb Productions and Processing Company Limited (HPPCL), such commercial utilization of naturally-occurring AP has taken a strong foothold in essential-oil industry in the country (Rawal 1996).

(3) Potential naturally-occurring species: Taking advantage of the abundant naturally-growing AP in certain countries with suitable ecological conditions, e.g. in Bhutan, Lao PDR, and Nepal, attempts have been made to explore the possibility of industrial utilization of certain species in the future. The species that have been selected, through processing and marketing studies, are shown in Table 3.

Table 1. List of naturally-occurring AP in Asia available in small quantity for domestic uses

Scientific name	Common name	Family	Parts used	Country
Acorus gramineus	Sweetflag	Araceae	Aerial parts	LAO
Aquilaria crassna	Eaglewood	Thymelaeaceae		
Cinnamomum iners	Thai cinnamon	Lauraceae	Bark	THA
C. loureirii	Vietnamese cassia	Lauraceae	Bark	VIE
C. tamala	Indian cinnamon	Lauraceae	Leaf	BGD
Elsholtzia blanda	-	Lamiaceae		
Hingtsha repens	-	Asteraceae		
Homalomena aromatica	-	Araceae	Rhizome	
Litsea cubeba	Cubeb	Lauraceae		
Vetiveria zizanioides	Vetiver	Poaceae	Root	

Adapted from Country Reports in ASIUMAP, FAO/RAP, 4-9 Nov.96 (see details in References)

Table 2. List of naturally-occurring AP in Asia available in large quantity for industry

Scientific name	Common name	Family	Parts used	Country
Artemisia vulgaris	Mugwort	Asteraceae	Aerial parts	NEP
Cinnamomum glaucescens	-	Lauraceae	Berry	NEP
Cymbopogon distans	-	Poaceae	Aerial parts	NEP
Gaulteria fragrantissima	Wintergreen	Ericaceae	Leaf	NEP
Juniperus indicus	Juniper	Cupressaceae	Berry	NEP
Nardostachys grandiflora	Spikenard	Valerianaceae	Rhizome	NEP
Pinus kesiya	Pine	Pinaceae	Resin	THA
P. merkusii	Pine	Pinaceae	Resin	THA
P. roxburghii	Pine	Pinaceae	Resin	NEP
Parmelia nepalensis,	Lichens/Tree moss	Parmeliaceae	Whole plant	NEP
Usnea spp.,*Ramalina* spp.	Lichens/Tree moss	Usneaceae	Whole plant	NEP
Rhododendron anthopogon	Rhododendron	Ericaceae	Twig	NEP
Zanthoxylum armatum	Zanthozylum	Rutaceae	Fruit	NEP

Except for Pinus kesiya *and* P. merkusii *in which their resin collected from the wild in Thailand, all others are from wild sources in Nepal (Rawal 1996)*

Note: BGD = Bangladesh, BHU = Bhuthan,CPR = Cambodia People's Republic, IND = India, INS = Indonesia, LAO = Lao PDR, NEP = Nepal, PAK= Pakistan, PHI = Phillipines, SRL = Sri Lanka, THA = Thailand, VIE = Vietnam

Table 3. List of potential naturally-grown AP in Asia

Scientific name	Common name	Family	Part used	Country
Abies densa	Silver fir	Pinaceae	Wood	BHU
Acorus calamus	Sweet flag	Araceae	Rhizome	BHU
Acorus gramineus	-	Araceae	Rhizome	LAO
Adenosma indicum	-	Scrophulariaceae	Aerial parts	LAO
Amomum sp.	Cardamom	Zingiberaceae	Fruit	LAO
Cinnamomum camphora	Camphor	Lauraceae	Wood	LAO
Artemisia vulgaris	Mugwort	Asteraceae	Aerial parts	BHU
Blumea balsamifera	-	Asteraceae	Leaf	LAO
Chenopodium ambrosioides	-	Chenopodiaceae	Aerial parts	LAO
C. cassia	Cassia	Lauraceae	Bark, leaf	LAO
C. obtusifolium	-	Lauraceae	Bark, leaf	LAO
Cunninghamia sinensis	-	Taxodiaceae	Saw dust	LAO
Elscholtzia cristata	-	Lamiaceae	Aerial parts	LAO
Eucalyptus globulus	Eucalypt	Myrtaceae	Leaf	LAO
Homalomena occulta	-	Araceae	Rhizome	LAO
Hyptis suaveolens	-	Lamiaceae	Herb	LAO
Litsea cubeba	Cubeb	Lauraceae	Fruit	LAO
Zanthoxylum armatum	-	Rutaceae	Fruit	LAO

From Lama (1996), Southavong (1996)

II. Cultivated species: AP grown in cultivation, normally are selected from promising varieties or clones from the wild, or have been improved through breeding, or introduced from other countries. This group can also be sub-divided into 3 sub-groups on the basis of their scale of cultivation and their potential for cultivation.

(1) Small-scale cultivation: Normally cultivated in backyard gardens or in mixed, subsistence cropping practice for domestic uses or processing in cottage industry (Table 4).

(2) Large-scale cultivation: Aromatic plants with sufficient market and use in different industries are cultivated in large scale. Table 5 provides a list of major plants known to be cultivated for industrial processing.

(3) Potential cultivated species: AP that have been subjected to extensive yield trials at research stations. They are normally introduced crops that have been grown commercially. Some, however, are native species that have been found to be promising after investigation with respect to adaptation to cultivation, having yield of essential oils, with simple processing techniques, and with assured markets (Table 6).

Table 4. List of AP cultivated on a small-scale in Asia

Scientific name	Common name	Family	Parts used	Country
Citrus hystrix	Leech lime	Rutaceae	Fruit peel	THA
Jasminum sambac	Arabian jasmine	Oleaceae	Flower	IND, PHI
Lavandula angustifolia	Lavender	Lamiaceae	Flower	IND
L. officinalis	Lavender	Lamiaceae	Flower	IND
Lonicera japonica	Honeysuckle	Caprifoliaceae	Flower	
Michelia alba	'Champi'	Magnoliaceae	Flower	CPR, THA
Ocimum gratissimum	Lemon basil	Lamiaceae	Aerial parts	VIE
O. tenuiflorum	Holy basil	Lamiaceae	Aerial parts	THA
Pelargonium capitatum	Alta of roses geranium	Geraniaceae	Leaf	IND
P. crispum	Curly-leaved geranium	Geraniaceae	Leaf	IND
P. fragrans	Nutmeg-scented geranium	Geraniaceae	Leaf	IND
P. graveolens	Pot geranium	Geraniaceae	Leaf	IND
P. macrorrhizum	Scented geranium	Geraniaceae	Twig	IND
P. pratense	Scented geranium	Geraniaceae	Twig	IND
Piper betel	Betel pepper	Piperaceae	Leaf	INS
Rosa centifolia	Provence rose	Rosaceae	Flower	CPR
R. damascena	Damask rose	Rosaceae	Flowers	CPR
R. glanteria	Sweet briar	Rosaceae	Flowers	CPR
R. gallica	French rose	Rosaceae	Flowers	CPR
Zingiber purpureum	'Phlai'	Zingiberaceae	Rhizomes	THA

Adapted from Country Reports in ASIUMAP, FAO/RAP, 4-9 Nov. 96 (see details in References)

Table 5. List of AP cultivated on a large-scale for industrial processing in Asia

Scientific name	Common name	Family	Parts used	Country
Acorus calamus Sweet flag		Araceae	Rhizome	
Amomum villosum		Zingiberaceae	Fruit	CPR
Artemisia vulgaris	Wormwood, Mugwort	Asteraceae	Aerial parts	
Cananga odorata	Cananga, Ylang Ylang	Annonaceae	Flower	INS, PHI
Chrysanthemum morifolium	Chrysanthemum	Asteraceae	Flower	CPR, THA
Cinnamomum burmanii	Indonesian cassia	Lauraceae	Bark	INS,
C. cassia	Chinese cassia	Lauraceae	Bark	CPR
C. camphora	Camphor	Lauraceae	Bark	CPR
C. loureirii	Vietnamese cassia	Lauraceae	Bark	VIE

Table 5 (cont'd). List of AP cultivated on a large-scale for industrial processing in Asia

Scientific name	Common name	Family	Parts used	Country
C. tamala	Indian cassia	Lauraceae	Bark	IND, NEP
C. verum	Cinnamon	Lauraceae	Bark	IND, INS, SRL
C. zeylanicum	Cinnamon	Lauraceae	Bark	SRL
Citronella nardus	Citronella	Poaceae	Leaf	INS, SRL
Curcuma domestica	Turmeric	Zingiberaceae	Rhizome	INS
Cymbopogon citratus	Lemongrass (W.Indian)	Poaceae	Leaf	THA, IND, SRL
Cymbopogon flexuosus	Lemongrass (E. Indian)	Poaceae	Leaf	THA, IND, SRL
Cymbopogon martinii var. motia	Palmarosa	Poaceae	Leaf	IND, NEP
Cymbopogon nardus	Citronella (Ceylon)	Poaceae	Leaf	IND, SRL
Cymbopogon winterianus	Citronella (Java)	Poaceae	Leaf	IND, INS
Elettaria cardamomum	Cardamom	Zingiberaceae	Fruit	IND, SRL
Eucalyptus globulus	Eucalypt	Myrtaceae	Leaf	IND, INS
Glycyrrhiza glabra	Licorice	Fabaceae	Stem	CPR
Glycyrrhiza urens	Licorice	Fabaceae	Stem	CPR
Illicium verum	Star anise	Illiciaceae	Fruit	CPR
Jasminum officinale	Jasmine	Oleaceae	Flower	IND
Matricaria chamomilla	German chamomile	Asteraceae	Flower	NEP
Mentha arvensis .	Japanese mint	Lamiaceae	Aerial parts	IND, PAK THA
Mentha citrata	Bergamot mint	Lamiaceae	Aerial parts	IND
Mentha piperita	Peppermint	Lamiaceae	Aerial parts	IND
Mentha spicata	Spearmint	Lamiaceae	Aerial parts	IND
Myristica fragrans	Nutmeg/Mace	Myristicaceae	Seed/aril	INS, SRL
Ocimum basilicum	Basil	Lamiaceae	Aerial parts	IND, THA
Pimpinella anisum	Anise	Apiaceae	Seed	IND
Pinus caribaea	Turpentine	Pinaceae	Resin	NEP
Piper nigrum	Black pepper	Piperaceae	Berry	IND, INS, SRL
Pogostemon cablin	Patchouli	Lamiaceae	Aerial parts	INS
Syzygium aromaticum	Cloves	Myrtaceae	Flower bud	INS
Tagetes minuta	Marigold	Asteraceae	Flower	NEP
Trigonella foenumgraecum	Fenugreek	Fabaceae	Seed	IND, PAK
Vanilla planifolia	Vanilla	Orchidaceae	Pod	INS, SRL
Vetiveria zizanioides	Vetiver	Poaceae	Root	IND, INS
Zingiber officinale	Ginger	Zingiberaceae	Rhizome	THA

Information obtained from Country Reports of ASIUMAP, FAO/RAP, 4-9 Nov. 96 (see details in References Section)

Table 6. List of potential cultivated species of AP in Asia

Scientific name	Common name	Family	Parts used	Country
Abelmoschus moschatus	Musk heart	Malvaceae		BHU
Acorus calamus	Calamus	Araceae	Rhizome	IND, INS
Artemisia annua	Worm wood	Asteraceae	Aerial parts	BHU
Bursera delpechiana	Linaloe	Berseraceae	Seed	BHU
Cymbopogon flexuosus	Lemongrass	Poaceae	Aerial parts	BHU
Cymbopogon martinii var. motia	Palmarosa	Poaceae	Aerial parts	BHU, INS
Cymbopogon winterianus	Java citronella	Poaceae	Aerial parts	BHU
Melissa officinalis	Lemon balm	Lamiaceae	Aerial parts	BHU
Mentha piperita	Pepper mint	Lamiaceae	Aerial parts	BHU
Ocimum basilicum	Basil	Lamiaceae	Aerial parts	BHU, IND, LAO, THA
Ocimum gratissimum	Lemon basil	Lamiaceae	Aerial parts	LAO
Vetiveria zizanioides	Vetiver	Poaceae	Root	BHU

From Country Reports at ASIUMAP, FAO/RAP, 4-9 Nov. 96 (see details in References)

Cultivation of AP in Asia

Although AP have been cultivated for a long time, they are mainly for direct uses as herbs and spices, or as medicinal plants. Those that are grown for the purpose of essential-oil extraction are of small-scale operation since the demand for essential-oils is not great. The lack of technology is another factor responsible for the lack of large-scale cultivation of AP. Only in a few countries in Asia, large-scale cultivation of AP for essential-oil extraction has been made. These are China, India, Indonesia, Nepal, Sri Lanka, and Thailand. The major AP grown for essential-oil extraction in these countries are shown in Table 7.

Characteristics of Aromatic Plant Cultivation

At present, cultivation of AP is characterized by the following attributes:

Subsistence cropping system: Production of AP in many countries in Asia is done by small farmers who grow different kinds of crops, including AP, in small areas. Normally, they are grown as mixed crops with various other cash crops, or as inter-crops under other perennial crops. Primitive varieties are commonly used.

As plantation crops: In certain countries, particularly large producers of AP, and with certain species, AP are grown as plantation crops, occupying large area. The use of farm machinery and tools is necessary for this type of plantation.

Concentrated areas of production: Since AP are grown mainly for extraction of essential oils, there is a need for them to be planted near the factory. Thus, unlike medicinal plants, or spices, or herbs, AP are produced in specific locations having facilities for processing as well as suitable conditions for their cultivation, e.g. good soil, adequate source of water, availability of labor, fuel (for the factory), good transportation, etc.

Table 7. Producing countries in Asia of major AP

Species	Country						
	CHN	IND	INS	NEP	SRL	THA	Others
Canango odorata		•			o		PHI
Cinnamomum burmannii		•					
Cinnamomum camphora	•						
Cinnamomum cassia	•						
Cinnamomum tamala		o		o			
Cinnamomum verum		o		•			
Curcuma domestica	o	•	o	o	o	o	PAK
Cymbopogon citratus		•					
Cymbopogon flexuosus		•			o		BHU
Cymbopogon martinii		•		o			
Cymbopogon winterianus			•				
Elettaria cardamomum		•			•		
Mentha arvensis	•	•		o		o	PAK, VIE
Myristica fragrans		o	•			o	
Ocimum basilicum		•					
Pimpinella anisum		•					
Piper nigrum		•		•		o	
Pogostemon cablin			•	o			
Syzygium aromaticum		o	•	o			
Vanilla planifolia	o	o	•	o			
Vetiveria zizanioides		o	•				
Zingiber officinale	o	•	o	o			

Legend: • = major producer o = minor producer

Advantages of Commercial Cultivation of AP

Produce uniform material: Commercial cultivation of selected clones or improved varieties results in the production of uniform material. Such material yields consistent standard products of high quality, a pre-requisite for successful flavor and fragrance industries.

Provide good income to the farmers: AP are high-valued crops; thus they bring higher income to the growers, particularly if high-yielding clones or varieties are used.

Provide opportunity for value-addition through processing: Technology of processing AP is quite simple and available in most developing countries in Asia. Commercial cultivation would provide raw material for further processing, many steps of which can be done in the locality where cultivation takes place, while the other benefit is value-addition through industrial processing.

Important Issues in Cultivation of AP

Improved cultivars

Conventional methods: Unlike food or other crops whose major objective in their breeding program is high yield of the biomass, the main objective of aromatic plant breeding is high quality of essential oils. Nevertheless, yields of each component of the biomass are also of considerable importance. The case in extraction of active compounds, uniformity of the compounds and their products, early maturity, resistance to pests, diseases and environmental stress are among other characters deemed important.

Due to the lack of breeders and facilities, not much breeding work on AP has been conducted in most Asian countries, except for India. As an example, development of a new variety of *Jasminum grandiflorum* at the Indian Institute of Horticultural Research in Bangalore, India can be cited. A profusely-flowering strain, of "Pink Pin" was developed with 0.35% concrete, and is capable of yielding 35 kg concrete per ha. A triploid genotype of this species has been found to yield flowers containing 0.4% concrete (IIHR 1993).

Selection of the desired genotypes can be made from existing variants in the germplasm collection. In Thailand, a selection, SoWo 1, of the Japanese mint has been made from introduced materials. It has very high fresh herbal yield, high oil content, and very high menthol content (90%) in the oil (Chomchalow 1978). A common approach for selection of genotypes is introduction from other countries, since it is the easiest and least time- and effort-consuming. Moreover, introduced varieties normally yield standard marketable products.

Biotechnological approach: Recent advances in biotechnology have been applied to genetically improve AP for commercial exploitation. These are used as a means of: (i) increasing genetic variability, (ii) culturing and selecting desirable genotypes, (iii) rescuing embryo of selected genotypes, (iv) rapid multiplication of clones of selected genotypes, (v) transferring genes from distantly related species, and (vi) specific gene transfer. The subject of biotechnology and AP has received considerable attention from scientists and researchers. In the series of books on Biotechnology in Agriculture and Forestry, seven volumes are allocated to the publication of research articles on Medicinal and Aromatic Plants and more volumes are expected to come (Bajaj, 1994).

Cultural Practices

Cultural improvement contributes significantly to the success of commercial cultivation of AP. Several methods have been known to improve the cultivation of AP, including the following.

Good Agrotechnological Practices (GAP): It has been demonstrated in a number of species of AP that improved cultivars alone cannot produce high yield and desirable quality of the products. It has to be accompanied by GAP such as proper soil preparation and fertilizer application, plant spacing, control of weeds, insects and diseases, proper time and technique of harvesting, all the way to proper post-harvest treatment. In addition, knowledge of biosynthetic pathways that lead to the production of physiologically important constituents that make these crops economically valuable is of great importance. Likewise, knowledge of physiological response of genotype to the environment will help in the understanding of the crop's behavior, especially with respects to enhanced fertilizer responsiveness, water and light requirement, etc. These will also help in the reduction of crop duration in the field, increase the amount of desirable secondary metabolites and even reduction of any undesirable constituents.

Cropping systems: In order to obtain maximum benefits of existing space, season, soil moisture and nutrients, several cropping systems involving AP have been employed. Many cash crops, e.g. vegetables, legumes, cereals, and root crops, can be grown together with AP as inter-crop resulting in several advantages, such as reduction of weed, extra income from the same area. This practice is particularly recommended for AP with slow growth like vetiver and palmarosa. Inter-cropping trials on vetiver for achieving higher productivity, for exmaple, were conducted by the Indian National Bureau for Plant Genetic Resources which indicated that vetiver-guar/cowpea, intercropping gave higher overall monetary returns over the sole vetiver crop and did not affect oil quality of vetiver. Similarily, in palmarosa, inter-cropping with short duration pigeonpea was highly profitable (NBPGR 1993). Another approach is crop rotation. This practice reduces incidence not only of weed growth but also of seed-born diseases. Normally, leguminous crops which possess the ability to fix atmospheric nitrogen are often used in crop rotation program with AP.

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A New Genus Record forThailand:

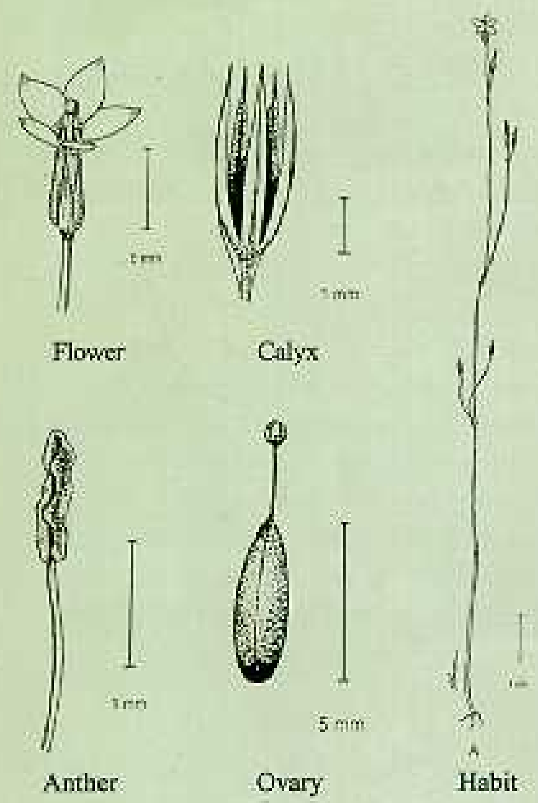
Sebaea microphylla (Edgeworth) Knoblauch

GENTIANACEAE

Seven genera of GENTIANACEAE were recorded in ***Flora of Thailand 1987***. They are *Canscora, Cotylanthera, Crawfurdia, Exacum, Gentiana, Microphium,* and *Swertia*. In September 1998, *Sebaea*, a new genus record, was found during a survey trip to Doi Suthep-Pui National Park by two QBG botanists: Piyakaset Suksathan and Sawitree Sasirat. The specimens were sent to the Royal Botanic Gardens, Edinburgh, UK.; and confirmed as *Sebaea microphylla* by Drs. George Argent and Eona Aitkin.

There are members of about 100 species in the genus Sebaea, mostly found in temperate regions of Africa, Madagascar, Sri Lanka, India, Bhutan, Nepal, and China.

Sebaea microphylla is easy to recognize by the slender stem with small scale-like leaves and the bright yellow flowers. Manuscript on ***Sebaea microphylla*: A New Genus Record for Thailand** has been submitted for publication in Thai Forest Bulletin.



Illustrations: P. Suksathan