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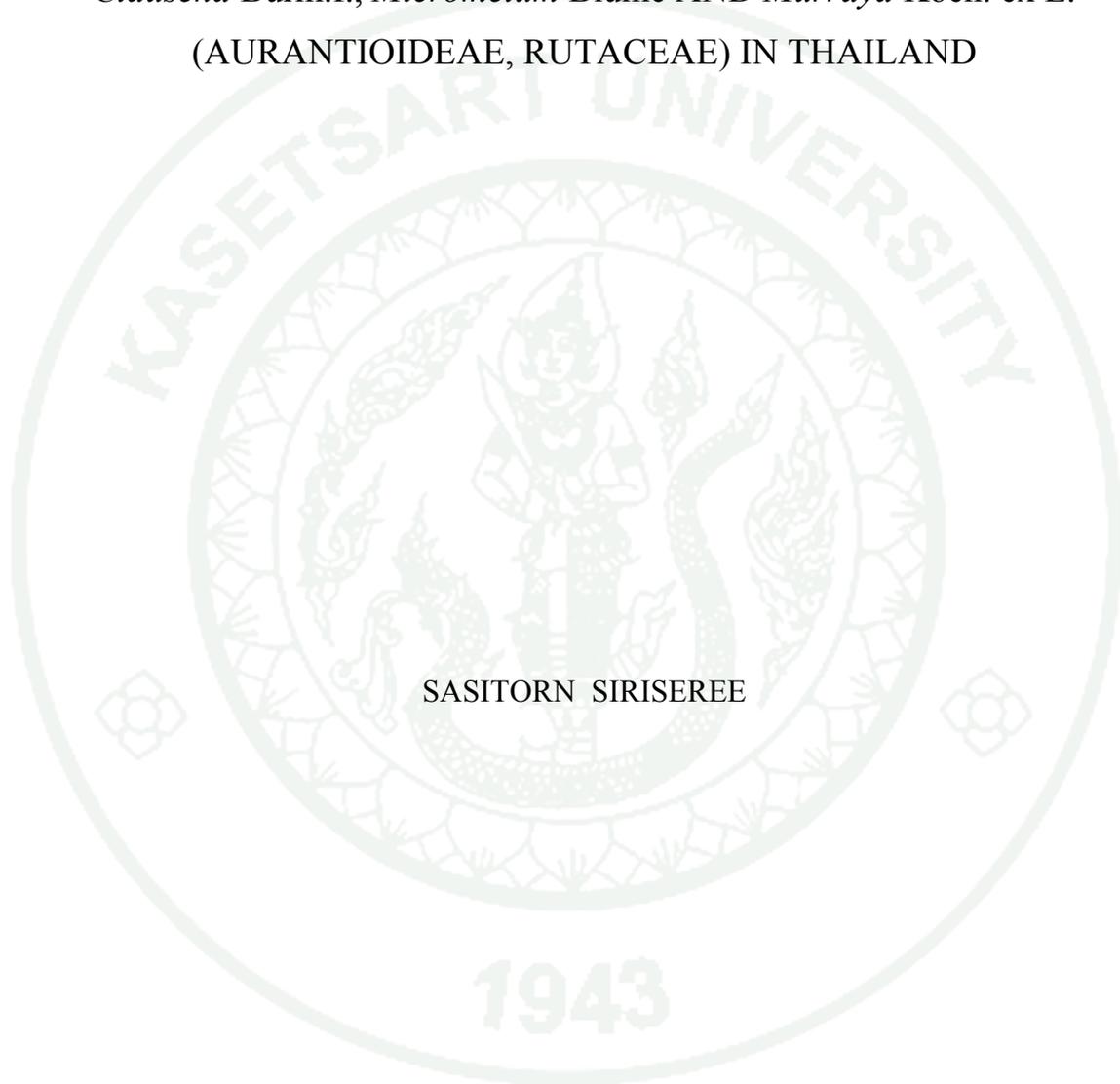
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THESIS

TAXONOMIC CLARIFICATION OF THE GENUS
Clausena Burm.f., *Micromelum* Blume AND *Murraya* Koen. ex L.
(AURANTIOIDEAE, RUTACEAE) IN THAILAND



SASITORN SIRISEREE

A Thesis Submitted in Partial Fulfillment of
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Sasitorn Siriseree 2010: Taxonomic Clarification of the Genus *Clausena* Burm.f., *Micromelum* Blume and *Murraya* Koen. ex L. (Aurantioideae, Rutaceae) in Thailand. Master of Science (Botany), Major Field: Botany, Department of Botany. Thesis Advisor: Associate Professor Srunya Vajrodaya, Dr.rer.nat. 77 pages.

Taxonomic revision of the genus *Clausena*, *Micromelum* and *Murraya* in Thailand were conducted from April 2003 to March 2010. Species diversity, morphological characters, distribution and ecological data were examined. Field collections and phenological observation of *Clausena*, *Micromelum* and *Murraya* were made throughout the country. The herbarium specimens available in Thai herbaria were thoroughly studied and identified by consulting the taxonomic literatures. Key to genera and species based on flowering, fruiting and significant vegetative characters were constructed. Full descriptions of each species were provided and supported by line drawings and photographs.

Seven species and four varieties of *Clausena*, five species of *Micromelum* and three species of *Murraya* were identified, i.e. *Clausena excavata* Burm.f. var. *excavata*, *C. excavata* Burm.f. var. *villosa* Hook.f., *C. harmandiana* Pierre ex Guillaumin, *C. heptaphylla* (Roxb. ex DC.) Wight & Arn. ex Steud., *C. lansium* Skeels, *C. longipes* Craib, *C. macrophylla* Hook.f., *C. wallichii* Oliv. var. *wallichii*, *C. wallichii* Oliv. var. *guillauminii* (Tanaka) J.F.Molino, *Micromelum pubescens* Blume, *M. falcatum* Tanaka, *M. integerrimum* Wight & Arn., *M. minutum* (G.Forst.) Wight & Arn., *M. hirsutum* Oliv., *Murraya koenigii* Spreng., *M. paniculata* (L.) Jack and *M. siamensis* Craib. *Clausena wallichii* Oliv. var. *guillauminii* (Tanaka) J.F.Molino, *Micromelum pubescens* Blume, and *M. falcatum* Tanaka are new records of distribution in Thailand. *Clausena longipes* Craib and *Murraya siamensis* Craib are likely to be rare species.

Student's signature

Thesis Advisor's signature

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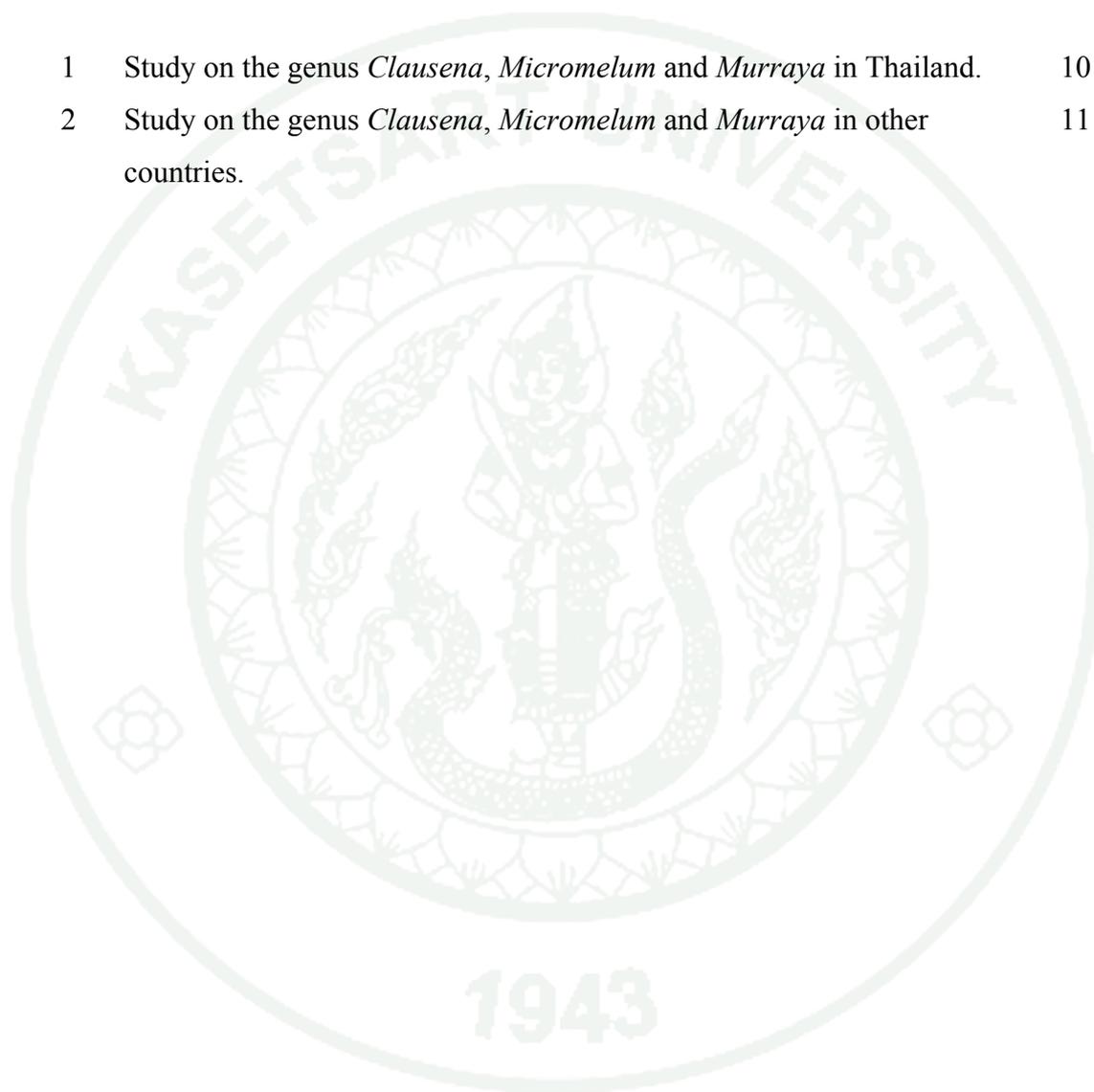
Sasitorn Siriseree
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LIST OF ABBREVIATIONS

alt.	=	altitude
BK	=	The Bangkok Herbarium, Department of Agriculture, Bangkok, Thailand
BKF	=	The Forest Herbarium, Department of National Park, Wildlife and Plant Conservation, Bangkok, Thailand
CMU	=	Chiang Mai University Herbarium
K	=	Kew Herbarium, Royal Botanic Garden, London, UK
PSU	=	Prince of Songkhla University Herbarium
QBG	=	Queen Sirikit Botanic Garden Herbarium
BSKU	=	Herbarium of Botany Department, Faculty of Science, Kasetsart University, Bangkok, Thailand
cf.	=	<i>confer</i> (compare)
ca.	=	<i>circa</i> (about)
diam.	=	<i>diametro</i> (diameter)
e.g.	=	<i>exempli gratia</i> (for example)
<i>et al.</i>	=	<i>et alii</i> (and others)
i.e.	=	<i>id est</i> (that is)
s.n.	=	<i>sine nomine</i> (without name)
sp.	=	species

TAXONOMIC CLARIFICATION OF THE GENUS
***Clausena* Burm.f., *Micromelum* Blume AND *Murraya* Koen. ex L.**
(AURANTIOIDEAE, RUTACEAE) IN THAILAND

INTRODUCTION

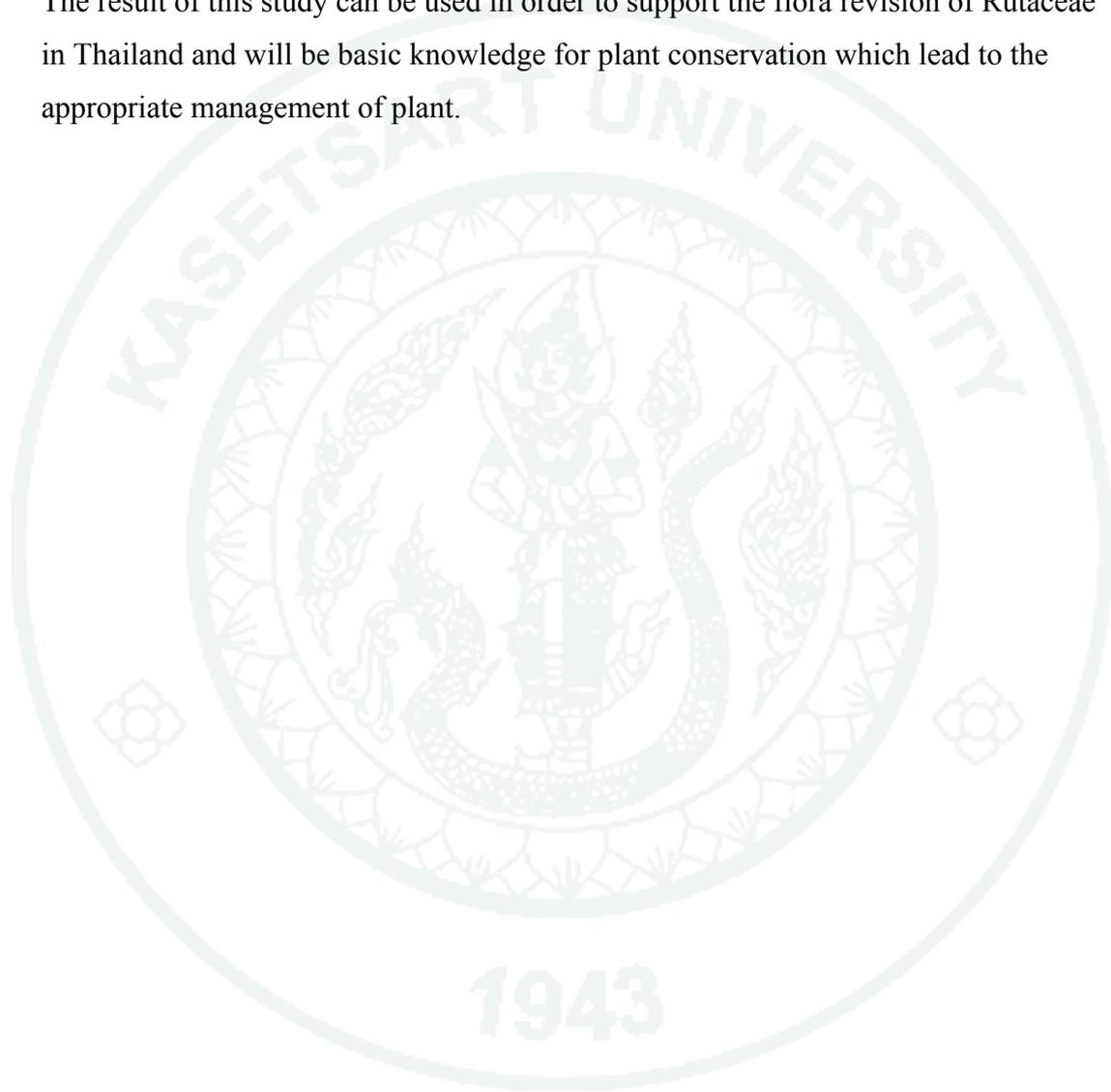
Thailand is located in a hot and humid climatic zone. The area is covered with various vegetation types ranging from the moist tropical evergreen forest in the south to the deciduous and upper montane forest towards the north. Thailand occupies the geographical center of the plants from Indo-Burmese elements, Indo-Chinese elements and Malesian elements where the species richness is high of the estimated 10,000 species of vascular plants. Then, Thailand is one of the countries richest natural resources, supporting a huge diversity of plants and wildlife, and providing forest products to support the local livelihoods.

Currently, less than 60 percents of the plants of the whole country have been studied. For this reason, taxonomic revision is necessary to complete the Flora of Thailand which will be enable to identify plants by using key and plant descriptions. The data which consists of botanical characteristics, distribution, ecology and utilization would aid successful study on conservation and plant resources management in Thailand.

The family Rutaceae comprises of 160 genera, 1,650 species (Takahtajan, 1997). In Thai culture Rutaceous plants are used as food, medicinal plants and perfume. Anyway, the studies of this family was not completed for the Flora of Thailand Project.

The genus *Clausena* Burm.f., *Micromelum* Blume and *Murraya* Koen. ex L. were classified in family Rutaceae, subfamily Aurantioideae, and they widely distribute in many parts of Thailand. Many of ethnobotanical uses have not been documented yet. The classification of plants in this family is rather problematic

because of many synonyms and also variation of morphological characters. So, taxonomic studies of these 3 genera in Thailand should be done as these following: botanical character, distribution, ecology, uses and key to species. At present, there is still no tools for identify the genus *Clausena*, *Micromelum* and *Murraya* in Thailand. The result of this study can be used in order to support the flora revision of Rutaceae in Thailand and will be basic knowledge for plant conservation which lead to the appropriate management of plant.



OBJECTIVES

1. To study the morphological characters and construct keys to species of the genus *Clausena*, *Micromelum* and *Murraya* in Thailand for plant identification.
2. To record the numbers of species distribution and ecology of the genus *Clausena*, *Micromelum* and *Murraya* in Thailand.
3. To support the taxonomic revision of the genus *Clausena*, *Micromelum* and *Murraya* for family Rutaceae of the flora of Thailand project.

LITERATURE REVIEW

Classification

The general key of the Rutaceae given by Engler (1931) is about 7 subfamillies 12 tribes (containing 29 subtribes), about 150 genera and 1,600 species. The subfamillies of the Rutaceae were

Subfamily I. RUTOIDEAE. Carpels usually 4-5, seldom 1-3 or more, often united only by the common pistil and free below, at maturity more or less separated, opening inward by splitting the follicle (loculicidal), usually with a dehiscent endocarp, very seldom with 4-1 fleshy drupes (Pitaviinae). Leaves and bark of twigs with schizolysigenous oil glands. (5 tribes, 17 subtribes, 86 genera)

Subfamily II. DICTYOLOMATOIDEAE. Leaves with many-celled but not lysigenous oil glands. Flowers actinomorphic. Stamens isomerous and alternate with the petals, with bractlets at the base. Carpels united only at the base, with several ovules. Fruits with dehiscent endocarp, 3-4 seeded. Small trees with doubly pinnate leaves. (1 tribe, 1 genus)

Subfamily III. FLINDERSIOIDEAE. Trees or shrubs. Carpels 5-3, united, each with 2-8 ovules in 2 rows. Fruit a loculicidal or septicidal capsule, with persistent endocarp. Seed winged, without endosperm. Leaves with lysigenous oil glands. (1 tribe, 2 genera)

Subfamily IV. SPATHELIOIDEAE. Carpels 3, completely fused, each with 2 pendent ovules. Fruit a winged drupe with a 3-loculed hard pit. With oil-bearing secretory cells in the leaves, bark, and pith; lysigenous oil glands in the leaf margins. (1 tribe, 1 genus)

Subfamily V. TODDALIOIDEAE. Carpels 5-2, incompletely or completely united, or else only 1, each with 1 or 2 ovules. Fruit formed out of 4-2 drupelets

united only at the base, or which some occasionally abort, or else a drupe with a thick or thin mesocarp and a thick or thin endocarp, or a dry, winged, indehiscent fruit. Seeds with or without endosperm. (1 tribe, 6 subtribes, 25 genera)

Subfamily VI. AURANTIOIDEAE. Fruit a berry [or hesperidium] with a leathery rind or hard shell, in tribe Citreae often with pulp formed by juicy emergenzen that arise on the carpellary walls. Seeds without endosperm, sometimes with 2 or more nucellar [false] embryos. Leaves and bark [of twigs and young branches] with schizolysigenous oil glands [small or sometimes large trees, rarely shrubs.]. (2 tribes, 33 genera)

Subfamily VII. RHABDODENDROIDEAE. Flowers with a bowl-shaped concave receptacle, with obliterated calyx, 5 petals, and very numerous stamens. Ovary free, ovoid, 1-locular, with 1 basal ovule. Pistil attached to the side of the ovary, with a long lateral stigma. Fruits with thin exocarp and thin endocarp. Leaves simple. (1 tribe, 1 genus)

Swingle and Reece (1967) had classified *Clausena*, *Micromelum* and *Murraya* into family Rutaceae, subfamily Aurantioideae, tribe Clauseneae (Genus *Micromelum*, *Clausena*, *Murraya*, *Glycosmis* and *Merrillia*).

The native habitat of the subfamily Aurantioideae is limited to the Old World. Most of the genera are found in the Monsoon region from West Pakistan to north-central China, the East Indian Archipelago to New Guinea and Bismarck Archipelago, northeastern Australia, New Caledonia, Melanesia, and the western Polynesian islands. Of the thirty-three genera that constitute the Aurantioideae, no fewer than twenty-nine are native to the Monsoon region and twenty-seven of them are found only there. Five genera, belonging to two tribes and to three subtribes, are native to tropical Africa and four genera are found only there. Only one genus, *Clausena*, is native both to the Monsoon region and to tropical Africa.

The tribe Clauseneae (3 subtribes, 5 genera.): Subtribe Micromelinae (*Micromelum*), Subtribe Clauseninae (*Clausena*, *Murraya* and *Glycosmis*), Subtribe Merrillinae (*Merrillia*) more primitive genera of the orange subfamily. None of the species develop spines in the axils of the leaves and the odd-pinnate leaves; leaflets attached alternately to the rachis, which does not break up into segments when the leaves fall; rachis wingless (except in *Merrillia caloxylon*, *Murraya alata*, *M. alternans*, *Clausena guillauminii*, *C. wallichii* and *C. luxurians*). The ovary has two to five locules with only one or two ovules in each locule. The fruits are usually small berries. The mature ovaries and young fruits of *Micromelum* have the locule walls convolute. This genus has the petals valvate in aestivation, differing thereby from all the other genera of the subfamily.

Key to genus *Clausena*, *Micromelum* and *Murraya* (Stone, 1985)

- I. Petal valvate; cotyledons crumpled; style as long as ovary; flower in mostly flat-topped corymbose cymes.....**3. Micromelum**
- I. Petal imbricate; cotyledons flat; style as long as or shorter than ovary; flower in cymose or racemose panicles
- II. Inflorescence cymose; flower about 10 mm long; style as long as or longer than ovary.....**2. Murraya**
- II. Inflorescence racemose-paniculata; flower 3-6 mm long; style shorter than ovary.....**1. Clausena**

1. *Clausena* Burm.f.

(Clausen, a botanist known to Burmann. Jones, 1995)

Shrubs or small trees, spineless. **Leaves** imparipinnate, alternate, rachis sometime winged; leaflets usually 5-9 (-31), oblique (Jones, 1995). **Inflorescences** terminal or axillary, paniculate or laxly racemose. **Flowers** bisexual 4 -5 merous, flower buds small, subglobose or ovoid, never long-cylindric; calyx 4-5 lobed; sepals fused into a cup below; petals 4 or 5 free, imbricate in the bud, oval-oblong (Backer, 1965); stamens 8 or 10, free, in 2 whorls, the outer opposite the sepals and longer, filaments inflated or flattened at base, often narrowed at apex, glabrous (Jones, 1995); anthers ovate or elliptical, rarely short and subglobose, dorsifixed; disc annular, glabrous, hourglass-shaped; gynophore supporting (sometimes clasping) the base of the ovary above; ovary with 2-5 locules, often pubescent or glandular, ovules 2 in each locule (rarely 1); style deciduous, often shorter than the ovary or equaling it in length (rarely longer), thick, sometimes merging gradually into the ovary, often sharply delimited and narrowed where it joins the ovary, stigma inconspicuous, sometimes subcapitate after the style shrivels. **Fruits** berry, subglobose or ovate or oblong (Ridley, 1967), with 2-5 segments; seeds usually 1 (-5) per fruit, testa of seed membranous (Kurz, 1877), cotyledon green.

Type species.— *Clausena excavata* Burm. f.

Distribution.— Twenty nine species (Jones, 1995); from Southwestern Asia, East Indian Archipelago, Philippines, New Guinea, Australia, northeastern tropical Africa from Abyssinia south to Natal and Pondoland, in Cape Province of the Republic of South Africa, central tropical Africa and western Africa from Angola to Sierra Leone (Swingle and Reece, 1967).

2. **Micromelum** Blume

(Greek, *mikros* = small, *melon* = apple; the shape of the fruits. Jones, 1995)

Shrubs or small trees, spineless. **Leaves** imparipinnate (rarely 3-foliolate or 1-foliolate in *M. diversifolium*); leaflets 7 -15 (-23), oblique, alternate on wingless rachis. **Inflorescences** usually large, terminal corymbose panicles often flat-topped. **Flowers** small, bisexual, 5-merous (except the stamens, which are twice as many as the petals); calyx cupular, 3-5 toothed or lobed (Hooker, 1875); petals oblong-linear, free, thick, valvate in the bud; stamen 10 inserted round a disc, alternately long and short (Ridley, 1967); filaments linear-subulate, glabrous; anther ovate, sub-basifixed; ovary with 2-6 (usually 3-5) locules with 2 superimposed ovules in each locule; style rather slender, narrowed at the base and articulated with the ovary, deciduous; radial walls of the locules usually curved as if twisted during development by a rotation of the outer wall of the ovary with reference to the axis. **Fruits** subglobose oblong or ovoid, dry berries, pericarp thin with a gland-dotted peel; seeds 1 or 2 per fruit, oblong, thin, foliaceous and crumpled cotyledons (Stone, 1972).

Type species.— *Micromelum pubescens* Blume

Distribution.— Ten species (Stone, 1972); from through the East Indian Archipelago to the Philippines, Northeastern India, southern China, Burma, Indo-China to Australia and New Caledonia, Fiji, Samoan islands in western Polynesia, Tonga islands to New Guinea, Ceylon, northeastern India, and West Pakistan. (Oliver, 1861)

3. *Murraya* Koen. ex L.

(J. A. Murray, 1740-1791, student of Linnaeus. Jones, 1995)

Shrubs or small trees, unarmed. **Leaves** imparipinnate, alternate leaflets, rachis wingless; leaflets usually 3-9 (-25). **Inflorescences** axillary or terminal panicles cymes or corymbs. **Flowers** bisexual, over 1 cm long, buds cylindrical or long-ovoid, 5-merous; calyx 5, ovate or lanceolate sepals united at the base or only in the lower third; petals 5, rather large, lanceolate or linear, imbricate; stamens 10, free, elongate, filaments flattened in some species, anthers small, broadly elliptic or oval, nearly basifixed; disk annular, cushion-shaped or cylindrical, short; ovary ovoid, with 2-5 locules, each with 2 (or 1) superimposed or almost collateral ovules, glabrous or sometime finely hairy; style rather long and slender, finally falling off, stigma capitate. **Fruits** a small berry, ovoid or subglobose, with mucilaginous pulp; seed 1 to several per fruit, smooth or hairy with a thin testa, cotyledons green, plano-convex (Jones, 1995).

Type species.— *Murraya paniculata* (L.) Jack

Distribution.— Fifteen species from India, southern China: Hainan, Indo-China, Thailand, Malay Peninsula, Andaman Islands, Sumatra, Java, Borneo, Philippines, Taiwan, Celebes, New Guinea, New Caledonia, northeastern Australia (Jones, 1995).

The report of the genus *Clausena*, *Micromelum* and *Murraya*.

The study on the genus *Clausena*, *Micromelum* and *Murraya* in Thailand and other countries has shown in Table 1-2

Table 1 Study on the genus *Clausena Micromelum* and *Murraya* in Thailand.

Genus	Authors / Year			
	Craib (1931)	Hansen (1966)	Suvatti (1978)	Smitinand (2001)
<i>Clausena excavata</i> Burm.f. var. <i>excavata</i>	+		+	+
<i>C. excavata</i> Burm.f. var. <i>villosa</i> Hook.f.	+	+	+	
<i>C. excavata</i> Burm.f. var. <i>lunulata</i> (Hayata) Tanaka		+		
<i>C. harmandiana</i> (Pierre) Pierre ex Guillaumin	+	+	+	+
<i>C. heptaphylla</i> (Roxb. ex DC.) Wight & Arn. ex Steud.	+			
<i>C. kerrii</i> Craib	+			
<i>C. lansium</i> (Lour.) Skeels	+		+	+
<i>C. lenis</i> Drake				+
<i>C. longipes</i> Craib	+	+		
<i>C. macrophylla</i> Hook.f.	+		+	
<i>C. wallichii</i> Oliv. var. <i>wallichii</i>	+	+	+	+
<i>C. wallichii</i> Oliv. var. <i>guillauminii</i> (Tanaka) J.P.Molino.		+		+
<i>Micromelum glanduliferum</i> B.Hansen		+		+
<i>M. falcatum</i> Tanaka		+		
<i>M. hirsutum</i> Oliv.	+	+	+	
<i>M. integerrimum</i> Roxb.				+
<i>M. minutum</i> (G. Forst.) Wight & Arn.	+	+	+	+
<i>Murraya koenigii</i> (L.) Spreng.	+		+	+
<i>M. glabra</i> (Guillaumin) Swingle		+		
<i>M. paniculata</i> (L.) Jack	+	+	+	+
<i>M. siamensis</i> Craib	+		+	+

Note + Report

Table 2 Study on the genus *Clausena*, *Micromelum* and *Murraya* in other countries.

Authors / Year	Study site	Number of species/variety		
		<i>Clausena</i>	<i>Micromelum</i>	<i>Murraya</i>
Hooker (1875)	India	9	2	3
Kurz (1877)	Burma	6	2	3
Collett (1921)	Simla	-	-	1
Merrill (1922)	Phillippines	6	2	2
Maheshwari (1963)	Delhi	1	-	2
Backer (1965)	Java	3	1	2
Ridley (1967)	Malay Peninsula	1	2	1
Stone (1972)	Malaysia	2	2	2
Brandis (1978)	India	5	1	3
Stone (1985)	Ceylon	3	1	4
Molino (1991)	World	15/6	-	-
Chaudhuri (1993)	Eastern India	3	1	2
Jones (1995)	Sabah and Sarawak	2	1	3
Zhang & Hartley (2008)	China	10	2/2	9/2

The differences of *Clausena*, *Micromelum* and *Murraya*.

Micromelum, with ten species, many of them very much alike and rather difficult hard to distinguish. The leaves of *Micromelum* are very similar to those of *Clausena* and *Murraya*, to which genera specimens of *Micromelum* are sometimes assigned, even by experienced collectors and also by experienced botanists. The flowers, ovaries, and seeds are, however, very different. The petals of *Micromelum* are valvate, not imbricate, and the cotyledons are flat and folded, not thick and plano-convex as in all other genera of the subfamily Aurantioideae.

Clausena and *Murraya* having very simple, more or less primitive flower and fruit structures. The flowers of *Clausena* and *Murraya* are usually borned in dense, often large, paniced clusters at the tips of the branches. The leaflets are alternate on the rachis, which is not articulated and does not break into segments when the leaves fall. The flowers are 3 to 5 merous except that the stamens (always free) are twice as many as the petals. The ovaries have two to five locules and each locule contains one to two ovules. The fruits are small berries, either soft and juicy with few seeds immersed in mucilaginous pulp, or semidry with a clearly distinguished gland-dotted peel. The seeds are glabrous. (Swingle and Reece, 1967)

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MATERIALS AND METHODS

Materials

1. Plant press, pruning knife, plastic bags, newspapers, corrugated cardboards, rope, tags, field book, pencil, altimeter, camera, color films of both printing and slides.
2. Materials for preserving and mounting specimens comprised of alcohol 70%, various sizes of bottles, deep freezer for preserving specimens from insects and fungi, mounting papers (papers of 300 gram of 42 x 26.5 cm, covers of 42 x 27 cm, brown covers of 42 x 27.5 cm), needle and thread, labels of 13.5 x 10 cm and glue.
3. Instruments for identifying specimens comprised of stereo microscope together with scale, ruler, calipers, petri dish, dissecting needles and razor blade.

Methods

1. Data of *Clausena*, *Micromelum* and *Murraya* from literatures, such as floras, journals and reports on the survey of this genus in various sites were collected and compiled. The herbarium specimens deposited in the Forest Herbarium (BKF), National Park Wildlife and Plants Conservation Department, Bangkok Herbarium (BK), Department of Agriculture, Chiang Mai University Herbarium (CMU), Queen Sirikit Botanic Garden (QBG) and Prince of Songkhla University Herbarium (PSU) were also studied.
2. Collections of *Clausena*, *Micromelum* and *Murraya* were made in sets of five to ten, from the natural habitats in various regions of Thailand. Photograph and notes were also taken. The specimens were mounted as in herbarium sheet and some of flowers and fruits were preserved in alcohol 70 % for further study.

3. Morphological character of the genus *Clausena*, *Micromelum* and *Murraya* were observed from the fresh materials and several herbarium specimens deposited in the Forest Herbarium (BKF), National Park Wildlife and Plants Conservation Department and Bangkok Herbarium (BK), Department of Agriculture as well as other herbaria, i.e. Chiang Mai University Herbarium (CMU), Queen Sirikit Botanic Garden Herbarium (QBG) and Prince of Songkhla University Herbarium (PSU). Flowers were dissected and examined under stereo microscope and also photographs as well as measurement of various parts of plants were taken.

Places and Duration

Places

This study covered several areas as follows:

1. Natural forests in 35 provinces of Thailand (Appendix Figure 2) i.e.

NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Nan, Lampang, Phitsanulok and Nakhon Sawan.

NORTHEASTERN: Phetchabun, Loei, Sakon Nakhon and Mukdahan.

EASTERN: Nakhon Ratchasima and Ubon Ratchathani.

SOUTHWESTERN: Uthai Thani, Kanchanaburi and Phetchaburi.

CENTRAL: Saraburi and Nakhon Nayok.

SOUTHEASTERN: Sa Kaeo, Phachin Buri, Chachoengsao, Chon Buri, Chanthaburi and Trat.

PENINSULAR: Chumphon, Ranong, Surat Thani, Phangnga, Phuket, Nakhon Si Thammarat, Phatthalung, Trang, Satun, Songkhla and Narathiwat.

2. Botany Department, Faculty of Science, Kasetsart University.
3. Forest Herbarium, Department of National Park Wildlife and Plants Conservation (BKF).
4. Bangkok Herbarium, Department of Agriculture (BK).
5. Chiang Mai University Herbarium (CMU)
6. Queen Sirikit Botanic Garden Herbarium (QBG)
7. Prince of Songkhla University Herbarium (PSU)

Duration

This study has been conducted during April 2003 to March 2010.

RESULTS AND DISCUSSION

Key to genera

1. Flower \geq 10 mm long **Murraya**
1. Flower < 10 mm long
 2. Petal valvate; cotyledons crumpled **Micromelum**
 2. Petal imbricate; cotyledons flat **Clausena**

Morphological character of the genus **Clausena** Burm.f.

Clausena Burm. f. Fl. Ind. 243. 1768; Kuze, Fl. Brit. Burma 1: 187. 1877; Hooker. f., Fl. Brit. India 1: 501. 1886; Backer, Fl. Java 2: 104. 1965; Hansen, Studies Fl. Thailand 36: 289. 1966; Ridley, Fl. Malay. Penins. 1: 352. 1967; Jones, Tree Fl. Sabah & Sarawak 1:369. 1995.

Shrub or small trees, spineless. **Leaves** imparipinnate, alternate; leaflets usually 3-7 sometimes 19-32; rachis usually not winged, oblique at base.

Inflorescences terminal branching, panicles. **Flowers** bisexual, ellipsoid or subglobose, never cylindrical in bud, 4 or 5 merous; cupular, calyx 4-5 lobed; sepals fused into a cup below; petals free, 4 or 5 imbricate in the bud, usually elliptical; stamens 10, in 2 whorls, the outer row opposite, the sepals usually longer, filaments dilated or flattened below; anthers ovate or elliptical, rarely short and subglobose; disk columnar, or hourglass-shaped sometime, usually glabrous; ovary with 2-5 locules, often pubescent or glandular, ovules 2 in each locule (rarely 1); style deciduous, often shorter than the ovary or equaling it in length (rarely longer), thick, often sharply delimited and narrowed where it joins the ovary, stigma inconspicuous, sometimes subcapitate after the style shrivels. **Fruits** berry, subglobose or ovate, with 2-5 segments; seeds 1-5, with membranous seed coat; endosperm lacking; embryo straight; cotyledons elliptic, plano-convex.

Seven species four varieties were found in Thailand. Key to species of *Clausena* Burm.f. in Thailand was provided.

Key to species of **Clausena** in Thailand

1. Leaves \geq 30 cm long, leaflets 12.5-17.5 cm long **7 C. macrophylla**
1. Leaves < 30 cm long
 2. Rachis narrow winged **6 C. wallichii**
 3. Leaflet 1-7 with dimorphic oil glands var. **guillauminii**
 3. Leaflet 9-17 with monomorphic oil gland var. **wallichii**
 2. Rachis wingless
 4. Flower bud star-shaped, ovary densely pilose, fruits \geq 15 mm long
..... **4 C. lansium**
 4. Flower bud not star-shaped, fruits < 15 mm long
 5. Leaflet \geq 21, **1 C. excavata**
 6. Twigs, leaflets and petals glabrous var. **excavata**
 6. Twigs and leaflets pubescent, petals hirsute var. **villosa**
 5. Leaflet < 21
 7. Pedicels < 10 mm long
 8. Style shorter than ovary, ovary without large gland at tip of each
locule **3 C. heptaphylla**
 8. Style as long as ovary, ovary with a large gland at tip of each
locule **2 C. harmandiana**
 7. Pedicels \geq 10 mm **5 C. longipes**

Key to varieties of **Clausena excavata** Burm.f.

Twigs, leaflets and petals glabrous var. **excavata**

Twigs and leaflets pubescent, petals hirsute..... var. **villosa**

1 Clausena excavata Burm.f. var. **excavata**, Fl. Ind. 87. 1768; Kuze, Fl. Brit.

Burma 1: 188. 1877; Hooker. f., Fl. Brit. India 1: 504. 1875; Backer, Fl. Java 2: 104. 1965; Hansen, Studies Fl. Thailand 36: 289. 1966; Ridley, Fl. Malay. Penins. 1: 352. 1967; Stone, Tree Fl. Malaya 1: 370. 1972; Chaudhuri, For. Pl. East. In. 156. 1993; Jones, Tree Fl. Sabah & Sarawak 1:369. 1995.

Shrub or small tree, 1-6 m high, evergreen, strongly aromatic, young shoots tomentose. **Leaves** imparipinnate, 15-30 cm long; leaflets 21-32; ovate or lanceolate, acuminate, crenate, both surfaces glabrous or only pubescent along veins, oblique at the base, 2-9 cm long 1-3 cm wide, petiolules 2-5 mm long, petiole slender, cylindric. **Inflorescences** panicle 10-30 cm high. **Flowers**, flower bud subglobose, 4 merous; petals 4, white or pale greenish white, oblong or ovate, glabrous, 4-5 mm long and 3-4 mm wide; stamens 8, filaments basally dilated, apically linear; ovary ovoid or elliptic, hairy or hirsute, style as long as ovary, 1- 1.5 mm long. **Fruits** berry, white or pink when ripe, ellipsoid, glabrous, 1.2-1.8 cm long and 0.8-1.5 cm wide; seeds 1-2 per fruit. Figure 1, 2, 4.

Thailand.— NORTHERN: Mae Hong Son, Chiang Mai, Chiang Rai, Lampang, Tak, Sukhothai, Phitsanulok, Nakhon Sawan; NORTHEASTERN: Loei, Nong Khai; EASTERN: Nakhon Ratchasima, Ubon Ratchathani, SOUTHWESTERN: Kanchanaburi, Ratchaburi; CENTRAL: Saraburi, Nakhon Nayok; SOUTHEASTERN: Sa Kaeo, Chon Buri, Rayong, Chanthaburi, Trat; PENINSULAR: Chumphon, Phatthalung, Krabi, Satun, Songkhla, Trang and Narathiwat.

Ecology.— Common in Opened area, dry evergreen forest to lower montane rain forest; altitude: 5-1,200 m. Flowering: January-May, fruiting: March-July.

Vernacular.— Samat yai (ส้มดีใหญ่), Mui (หมุย)

Uses.— Young shoots edible. (Southern)

Note.— This species differs from the other in leaflets more than 21 with strongly aromatic.

Specimens examined.— *S. Siriseree* 106, 114, 116-118, 120, 151-153, 162, 167, 169; *Chirayupin* 190 (BK); *Collins* 1017 (BK); *Eryl Smith* 2011 (BK); *JF. Maxwell* 87-436, 87-350 (PSU), 93-125, 95-303, 97-328, 98-591, 98-652 (BKF); *Kerr* 8408, 8547 (BK); *Pradit* 861 (BK); *Put* 3899 (BK); *T. Smitinand* 5439, 10685 (BKF); TDBS 11345, 11969, 4373 (BKF); *Vacharee* 389 (BK).

***Clausena excavata* Burm.f. var. *villosa* Hook.f., Fl. Brit. Ind. 1:505. 1875.**

This variety is similar to *C. excavata* Burm.f. var. *excavata* but differs in whole plant clothed with soft spreading hair and hirsute petals. Figure 1, 3, 4.

Thailand.— NORTHERN: Nan, Chiang Rai; EASTERN: Nakhon Ratchasima, Surin, Ubon Ratchathani.

Ecology.— Dry evergreen forest. Flowering: December-February, fruiting: February-March.

Specimens examined.— *S. Siriseree* 137-138, 147, 164-165; *JF. Maxwell* 97-321 (BKF); *Mc. Lakshanakara* 870 (BK); *Sakol* 271 (BK).

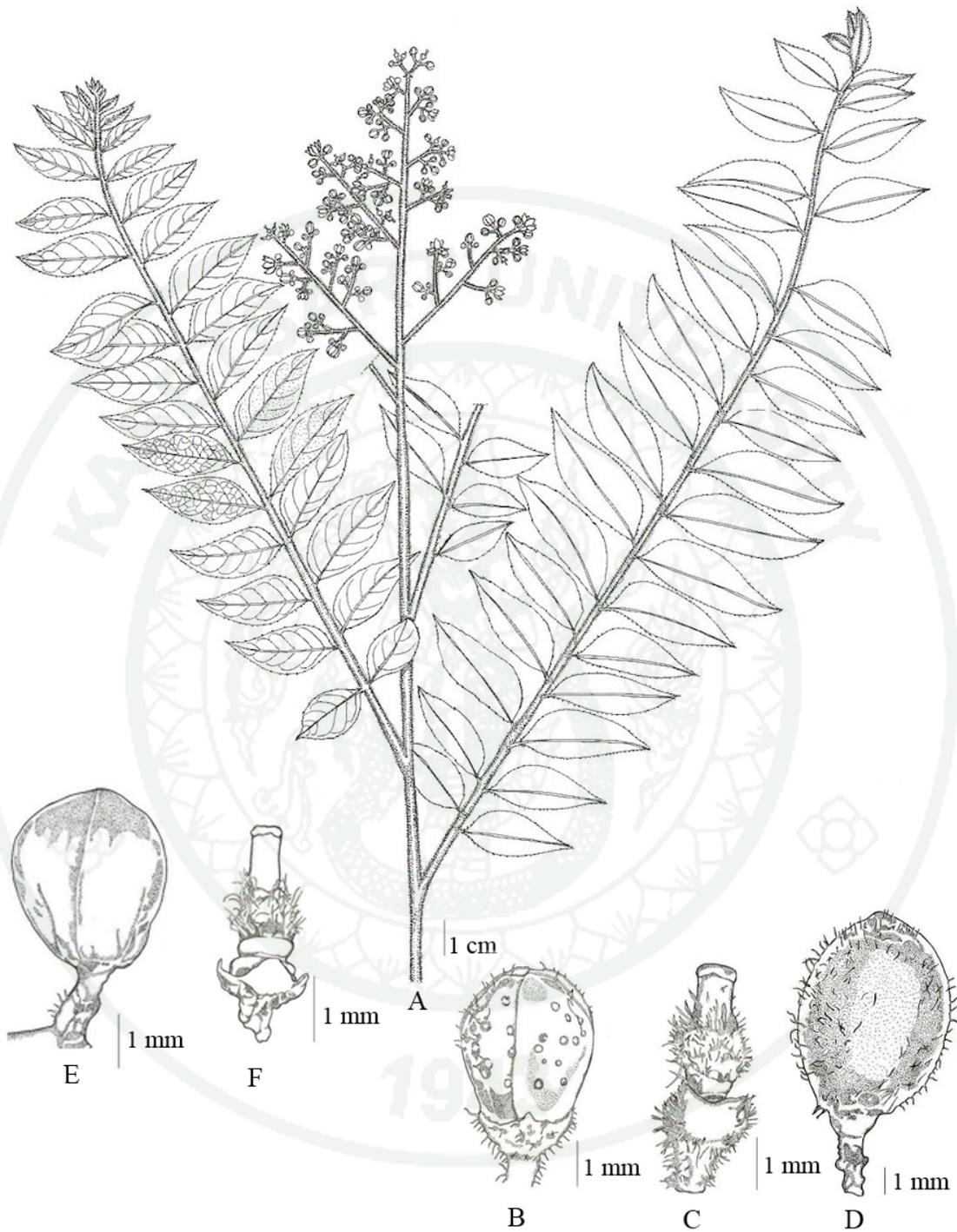


Figure 1 *Clausena excavata* Burm.f. var. *excavata* and *C. excavata* Burm.f. var. *villosa* Hook.f.

A-D. *C. excavata* Burm.f. var. *villosa* Hook.f.. A. Leaves and Inflorescence; B. Flower bud; C. Ovary; D. Fruit

E-F. *C. excavata* Burm. f. var. *excavata*. E. Flower bud; F. Ovary



Figure 2 *Clausena excavata* Burm.f. var. *excavata*

A. Inflorescence; B. Young tree; C. Infructescence; D. Flower;
E. Flower bud; F. Ovary



Figure 3 *Clausena excavata* Burm.f. var. *villosa* Hook.f.

A. Inflorescence and young shoot; B. Infructescence; C. Flower bud;
D. Ovary



Figure 4 *Clausena excavata* Burm.f. var. *excavata* and *C. excavata* Burm.f. var. *villosa* Hook.f.

C. excavata Burm. f. var. *excavata*. A. Inflorescence; C. Flower bud

C. excavata Burm. f. var. *villosa* Hook.f.. B. Inflorescence; D. Flower bud

2 *Clausena harmandiana* Pierre ex Guillaumin, Notul. Syst. (Paris) 1: 219. 1910; Backer, Fl. Java 2: 104. 1965. —*Glycosmis harmandiana* Pierre, Flore Forest. Cochinch. 4(18):text to pl. 285. 1893.

Shrub 1-2 m high, branches rounded. **Leaves** imparipinnate, 25-30 cm long, leaflets 4-9, ovate-acuminate, glabrous, 5-14 cm long and 5-8 cm wide, 7-8 pairs of small lateral veins. **Inflorescences** terminal, pubescent, 10-20 cm long, much branched with rather large, 5-6 mm diam. **Flowers** sessile, 5 merous, sepals 5, 1 mm long, pubescent on the outside and ciliate; petals 5, yellowish white, very concave, obovate, 3.5-4 mm long; stamens 7-10, 2.5 mm long, with the filaments flattened below and subulate above, 2-2.5 mm; ovary subglobose or broadly oval, 1-1.2 mm long and 1-1.3 mm wide, with a large glands at tip of each locule; the style is cylindrical, 1-1.5 mm long; ovules 2 in each locule. **Fruits** globose, pink, glabrous, pellucid diam. ca. 1 mm; seeds 1-2 per fruit. Figure 5, 6.

Thailand.— NORTHEASTERN: Loei; EASTERN: Nakhon Ratchasima; SOUTHWESTERN: Kanchanaburi; SOUTHEASTERN: Chanthaburi.

Ecology.— Dry evergreen forest. Flowering: January-March, fruiting: April-July.

Vernacular.— Song fah Dong (ส่องฟ้าดง)

Note.— This species stands apart from all the other species of the genus in branches rounded, big shrub and fruit globose with largest pellucid dot ≥ 1 mm diam.

Specimens examined.— *S. Siriseree* 163, 166; *Kerr* 838, 8782, 5486 (BK); *R. Geesink & C. Phengkhai* 6060 (BKF); *TDBS* 9244, 10321, 11324, 11365 (BKF); *Vacharee* 513 (BK).



Figure 5 *Clausena harmandiana* Pierre ex Guillaumin
 A. Leaves and Inflorescence; B. Flower; C. Ovary



Figure 6 *Clausena harmandiana* Pierre ex Guillaumin

A. Shrub; B. Inflorescence; C. Infructescence; D. Flower bud; E. Flower;
F. Ovary

3 *Clausena heptaphylla* (Roxb. ex DC.) Wight & Arn. ex Steud., Nomencl. Bot. [Steudel], ed. 2. 1: 377. 1840; Hooker. f., Fl. Brit. India 1: 504. 1875; Kuze, Fl. Brit. Burma 1: 188. 1877. — *Amyris heptaphylla* Roxb. ex DC., Prodr. (DC.) 2: 82. 1825.

Small tree 3-8 m high, smelling strongly of anise seed. **Leaves** imparipinnate 15-25 cm long, sweet taste; leaflets 7-11, ovate or lanceolate, acuminate, entire, glabrous except the midrib on the under surface, with 6-8 pairs of lateral veins, membranaceous, unequal, 4.5-16 cm long and 2.5-7 cm wide, petioles cylindrical, with pubescent hair. **Inflorescences** terminal, paniculate. **Flowers** buds glabrous, 6 mm diam., subsessile or shortly pedicellate; sepals 5, triangular, 1 mm long with ciliate margins; petals 5, yellow-white, obovate, glabrous but papillose, twice as long as the sepals; stamens 10, slightly shorter than the petals; filaments filiform at base then abruptly dilated below the anther; anthers almost rhombohedral; ovary cylindrical, glabrous, 1-1.5 mm long and 1-1.2 mm wide, 4-locular, each with 2 ovules; style cylindrical, 0.5-0.7 mm long. **Fruits** ovoid, 2 cm long and 1 cm wide, white-reddish or pale yellow; seeds 1-2 per fruit. Figure 7, 8.

Thailand.— SOUTHWESTERN: Uthai Thani

Ecology.— Dry evergreen forest and cultivated. Flowering: February, fruiting: March

Vernacular.— Mui wan (หมุยหวาน), Hack (แฮ็ค)

Uses.— Leaves edible (sweet).

Note.— This species have smelling strongly of anise seed and sweet taste.

Specimens examined.— *S. Siriseree* 171; *Kerr* 9918 (BK); *JF. Maxwell* 75-499 (BK).



Figure 7 *Clausena heptaphylla* (Roxb. ex DC.) Wight & Arn. ex Steud.

A. Leaves and inflorescence; B. Flower bud; C. Flower; D. Ovary

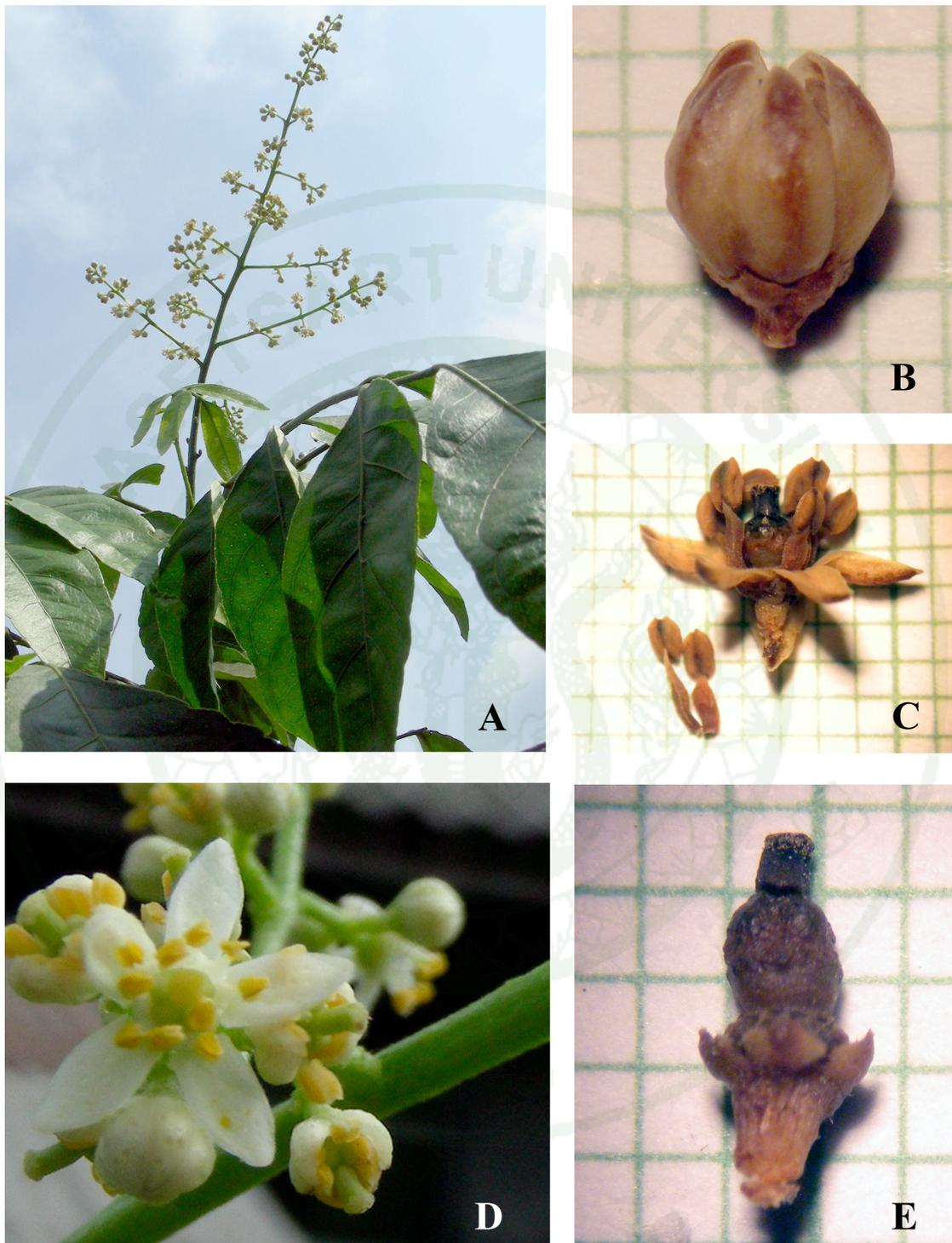


Figure 8 *Clausena heptaphylla* (Roxb. ex DC.) Wight & Arn. ex Steud.

A. Inflorescence; B. Flower bud; C-D. Flower; E. Ovary

4 Clausena lansium (Lour.) Skeels, U.S.D.A. Bur. Pl. Industr. Bull. 168, 31 1909; Corner, Wayside Trees of Malaya 1: 571. 1940; Backer, Fl. Java 2: 104. 1965; Stone, Handb. Fl. Ceylon 5:438. 1985. —*Quinaria lansium* Lour. Fl. Cochinch. 272. 1790. —*Cookia wampi* Blanco, Fl. Filip. ed. 1. 358. 1837. —*Clausena wampi* Oliv. Jour. Linn. Soc. Bot. 5(2):34. 1861; Hooker. f., Fl. Brit. India 1: 505. 1875; Kuze, Fl. Brit. Burma 1: 189. 1877.

Small tree 8 m high, evergreen young branches pubescent. **Leaves** imparipinnate 20-25 cm long; leaflets 5-11, ovate to ovate-elliptic, apex obtuse to slightly acuminate, margin repand to crenulate, glabrous or glabrescent, the midrib and veins pubescent, oblique at the base, petiolules 4-8 mm long, 6-14 cm long 3-6 cm wide. **Inflorescences** terminal, paniculate, 30 cm long. **Flowers** star shape in bud, subsessile or shortly pedicellate; calyx 5 lobes, triangular or ovate, ca. 1 mm long; petals yellowish- white, oblong, 5-6 mm long; stamens 10, filaments linear, basal portion slightly expanded, 5-5.5 mm long, anthers oblong or elliptic, ca. 2 mm long; ovary hirsute, glandular, very often 5-locular, ovules 2 in each locule; style ca. 1 mm long, distinct, stigma 5-lobed, slightly wider than style. **Fruits** globose, ellipsoid, or broadly ovoid, usually with 5 locules, 2-3 cm diam., pale yellow, edible, sour; seeds 1-5 per fruit, or sterile, ovoid-globose, 1.5-3 cm long 1-1.5 cm wide, green and brown. Figure 9-10.

Thailand.— NORTHERN: Nan

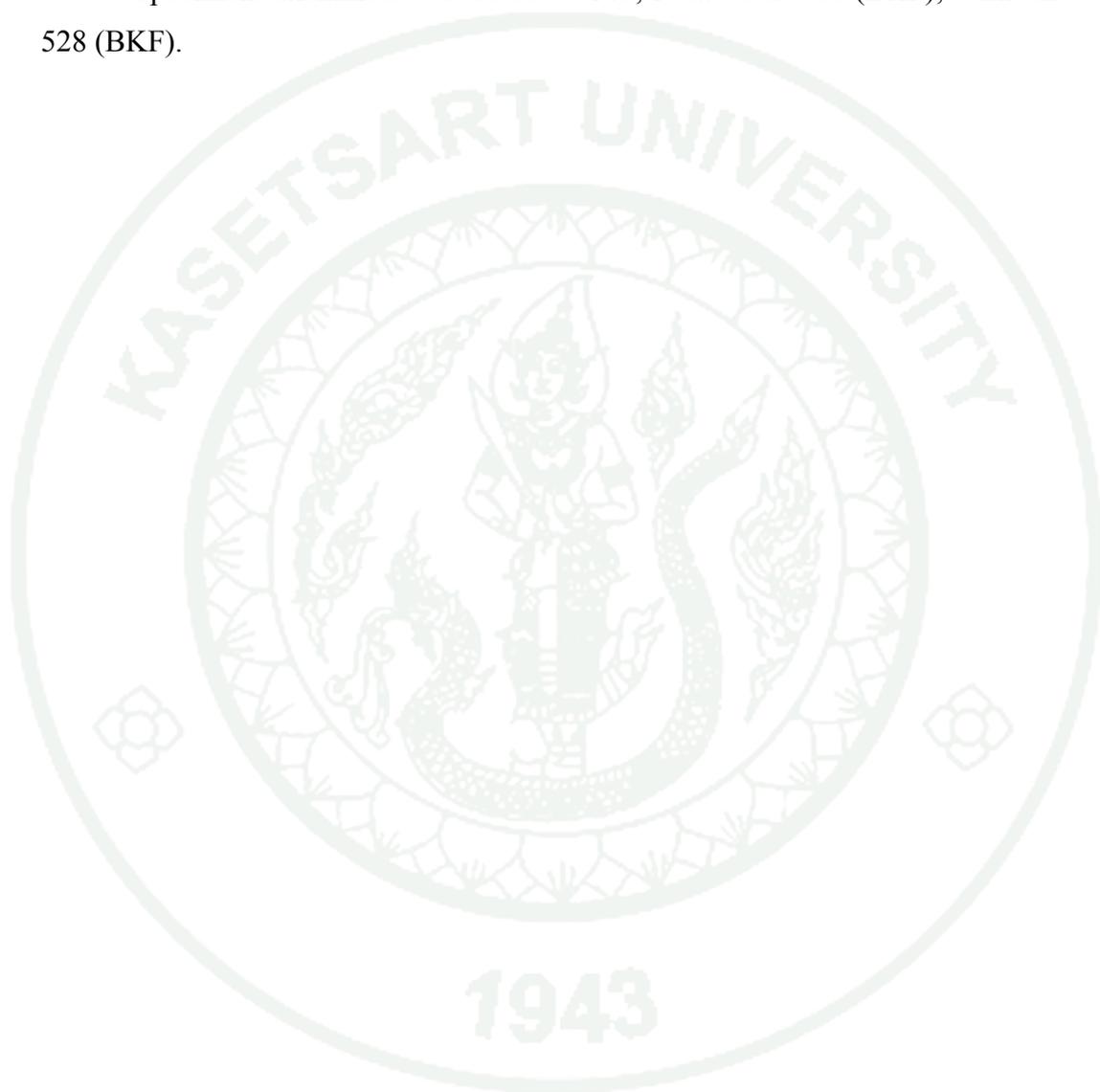
Ecology.— Cultivated. Flowering: February-March, fruiting: March-April

Vernacular.— Mafai chin (มะไฟจีน)

Uses.— Fruit edible, cultivated for commercial purpose.

Note.— This species stands apart from all the other species of the genus in having a star-shaped flower bud and 5-angled ovary, very strongly hirsute and the largest fruits and seeds.

Specimens examined.— *S. Siriseree* 148; *T. Smitinand* 63 (BKF); Winit sn. 528 (BKF).



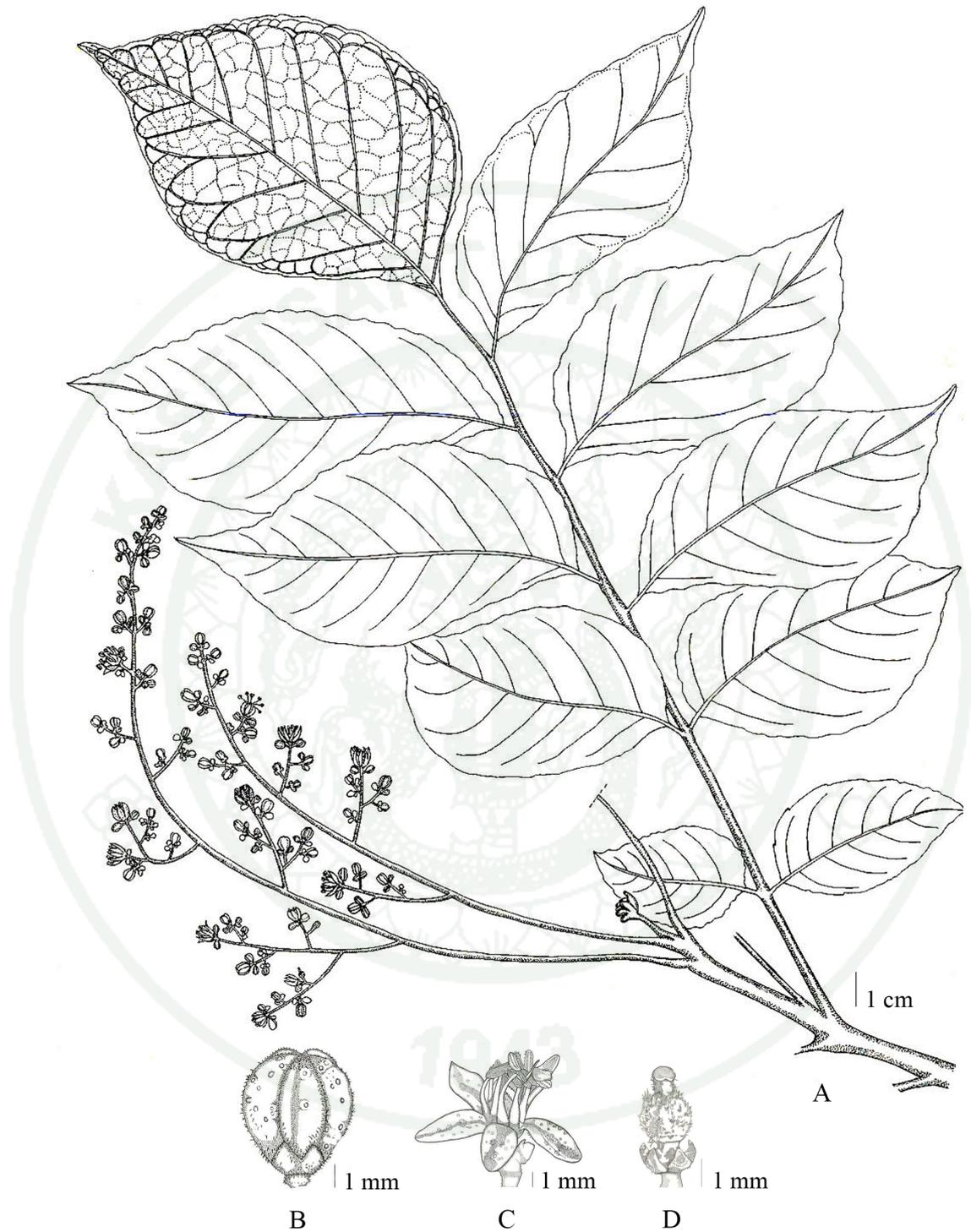


Figure 9 *Clausena lansium* Skeels

A. Leaves and Inflorescence; B. Flower bud; C. Flower; D. Ovary

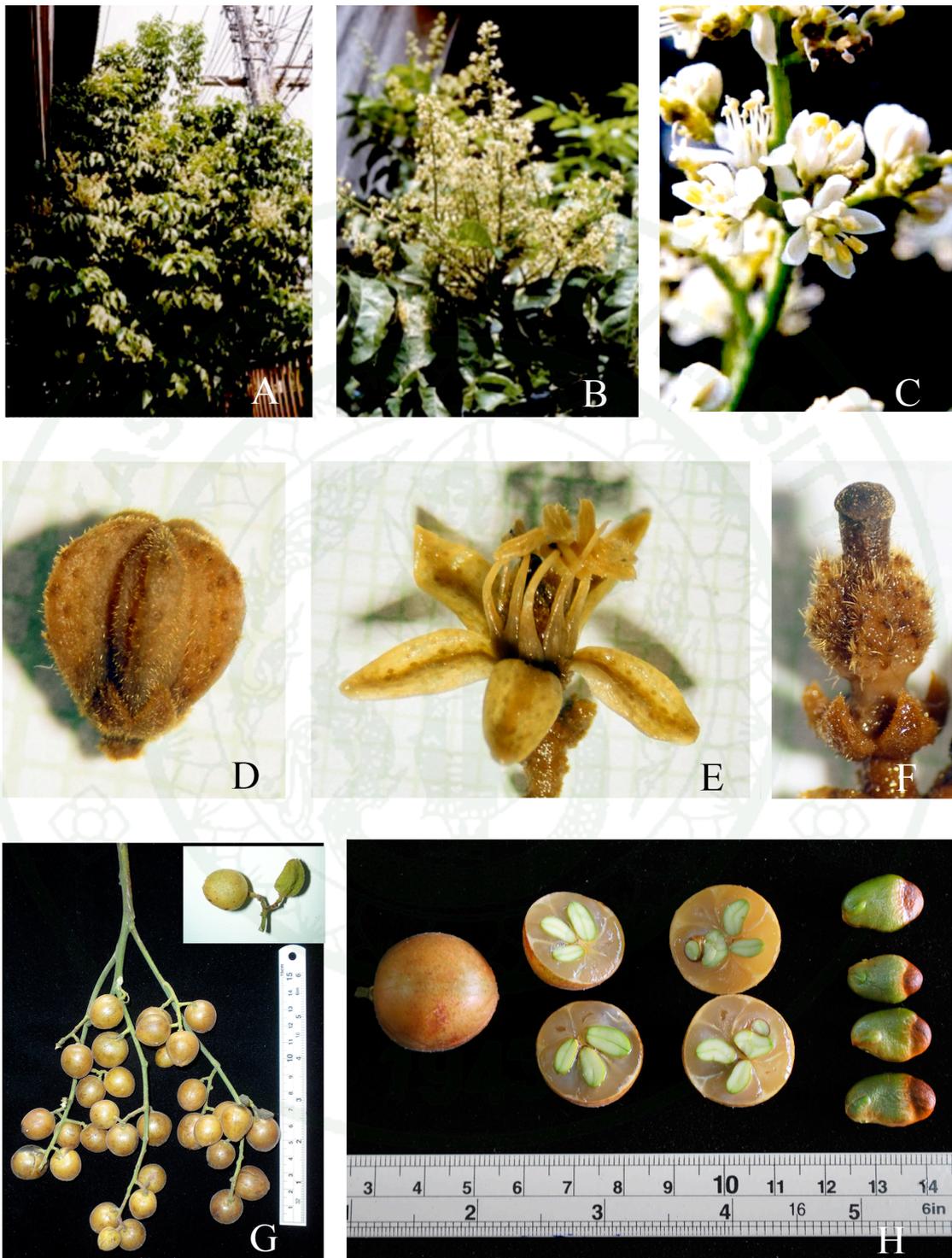


Figure 10 *Clausena lansium* Skeels

A. Small tree; B-C. Inflorescence; D. Flower bud; E. Flower; F. ovary;

G. Infructescence; H. Fruits & seeds

5 *Clausena longipes* Craib, Bull. Misc. Inform. Kew 340. 1926. —*Clausena dentata* var. *longipes* (Craib) Tan., Bull. Soc. Bot. France 75:709. 1928.

Shrub 4 m high, branchlets slender. **Leaves** 15-20 cm long, leaflet 7-9, petiole slender, 6.5 cm long and 2.5 cm wide, oblique, ovate-lanceolate, obtuse, acute or obtusely caudate-acuminate, crenulate, membranaceous. **Inflorescences** racemes, very slender, 10 cm long, few-flowered inflorescences ending in long, slender pedicels, 10-15 mm long and 0.2-0.3 mm wide. **Flowers** fragrant, usually 4-merous, 8 mm diam., whitish; buds globose; petals oblong, concave, glandular, ovary slender 1.5 mm long and 1 mm wide, merge gradually into the rather long style 2.5-3 mm long and 0.6-0.7 mm wide, no oil gland at the tip of each of the 4 locules of the ovary; very narrow radial locule walls, not swollen where they cross to make an axial pillar; and few tannin cells in the periphery of the ovary and none in the axis. **Fruits** globose, whitish-green, pellucid. Figure 11.

Type.— A.F.G. Kerr 5486, 23 May 1921, Mae Hong Son, Mae Lan. (BK)

Ecology.— On limestone rock; altitude: 700 m.

Note.— Description of this species was referred to Craib in Bull. Misc. Inform. Kew 8:340. 1926.



Figure 11 *Clausena longipes* Craib

A.F.G. Kerr 5486, 23 May 1921, Mae Hong Son, Mae Lan. (BK)

Key to varieties of **Clausena wallichii** Oliv.

Leaflet 7-15 with monomorphic oil gland var. **wallichii**

Leaflet 1-7 with dimorphic oil glands var. **guillauminii**

6 Clausena wallichii Oliv. var. **wallichii**, Jour. Linn. Soc. Bot. 5(2):35. 1861;
Hooker. f., Fl. Brit. India 1: 505. 1875; Kuze, Fl. Brit. Burma 1: 188. 1877.

Shrub 30 cm high. **Leaves** imparipinnate, 12-20 cm long, rachis with the very narrowly winged (0.3 to 1 mm wide); leaflets 7-15, rhomboid-lanceolate, or oblong, acuminate, glabrous, margins crenulate, 3.5-7.5 cm long and 1.5-2.5 cm wide, monomorphic oil glands. **Inflorescences** paniculate, 7.5-12.5 cm long. **Flowers** subsessile, 5-7 mm diam.; calyx 5-merous, lobes ovate; petals 5, margins slightly imbricate in the bud; stamens 10, filaments thickened at the middle; ovary tuberculate, 5 (or 4) locules, tipped with a large oil gland, often bearing a few rather long hairs, about 1.5-1.8 mm long and 1-1.5 mm wide; style 1.8-2 mm long and 0.2-0.4 mm wide. **Fruits** subglobose or round-ovoid, 5-6 mm long and 5 mm wide. Figure 12-13.

Thailand.— NORTHEASTERN: Loei; SOUTHWESTERN: Kanchanaburi.

Ecology.— Dry evergreen forest. Flowering: February-March, fruiting: March-April.

Vernacular.— Sa dao pa (สะเดาป่า)

Uses.— Young shoots edible. (Kanchanaburi)

Note.— This species stands apart from all the other species of the genus in the

Specimens examined.— *S. Siriseree* 119, 149, 150



Figure 12 *Clausena wallichii* Oliv. var. *wallichii*

A. Leaves and inflorescence; B. Flower bud; C. Ovary



Figure 13 *Clausena wallichii* Oliv. var. *wallichii*

A, C. Shrub & inflorescence; B. Rachis wing; D-E. Inflorescence;
 F-G. Infructescence; H. Flower bud; I. Flower; J. Ovary

Clausena wallichii Oliv. var. **guillauminii** (Tanaka) J.F.Molino, Bull. Mus. Natl. Hist. Nat., B, Adansonia Sér. 4, 16(1): 137. 1994. —*Clausena guillauminii* Tanaka, Bull. Mus. Natl. Hist. Nat. Ser. II. ii. 161. 1930.

Shrub 10-30 cm. high, springing from a root 1 cm diam, deciduous. **Leaves** imparipinnate, 8-12 cm long, leaflete 1-5, rachis narrowly winged (0.2-0.5 mm wide) between the leaflets, obovate or oblong, slightly crenate-serrate, base acute or rather obtuse, apex cuspidate, obtuse or rather acute, nearly equal-sided, lateral veins 7-12 pairs, sparsely black-dotted, dimorphic oil glands. **Inflorescences** 3-10 cm long. **Flowers** bud 2 mm long, 5-merous, petals and calyx lobes pellucid-spotted at the tips; filaments subulate; ovary ciliate, style long, stigma subcapitate. **Fruits** red when ripe, seed 1 per fruit. Figure 14-15.

Thailand.— NORTHEASTERN: Phetchabun, Sakon Nakhon, Nong Bua Lum Phu; EASTERN: Nakhon Ratchasima, Surin, Ubon Ratchathani; SOUTHWESTERN: Kanchanaburi.

Ecology.— Deciduous dipterocarp forest. Flowering: fruiting:

Vernacular.— Song fa (ส่องฟ้า)

Note.— This species stands apart from all the other species of the genus in the glands on the leaves are the dimorphic, most of them being small, but the larger ca. 1/3 to 1/2 mm diam., pale on young leaves but dark brown or nearly black on old leaves.

Specimens examined.— *S. Siriseree* 113, 132, 168; PS 1312, 1575 (BKF); TS 2574, 2599, 4519, 32192 (BKF), TDBS 11302, 2430, (BKF); *Winit sn.* 1687 (BKF).



Figure 14 *Clausena wallichii* Oliv. var. *guillauminii* (Tanaka) J.F. Molino



Figure 15 *Clausena wallichii* Oliv. var. *guillauminii* (Tanaka) J.F.Molino
 A-B. Leaves; C. Shoot & inflorescence; D. Flower bud; E. Ovary;
 F. Fruits

7 *Clausena macrophylla* Hook.f., Fl. Brit. India [J. D. Hooker] 1: 504. 1875; Kuze, Fl. Brit. Burma 1: 188. 1877; Stone, Tree Fl. Malaya 1: 370. 1972. —*Clausena heptaphylla* var. *pubescens* Oliv. Jour. Linn. Soc. Bot. 5(2): 30. 1861.

Shrub 1.5 m high, **Leaves** imparipinnate, 35-40 cm long, leaflets 5-7, 12.5-17.5 cm long and 3-6 cm wide, acuminate, small distance toothed, pale on both surfaces, tomentose beneath, nerves strongly arched, midrib stout, common petiole stout, equal or suboblique with very short petiolules. **Inflorescences** panicle 25-30 cm long. **Flowers** 4 merous, flower buds globose, glabrous, 2.5 mm diam.; calyx lobes 4, rounded-acute; petals 4, broadly oblong, concave, membranous, covered with large glands; stamens 8, equal; filaments much dilated below, very short; anthers large, oblong; ovary stipitate, glabrous, 4-lobed, with very large glands; ovules 2, collateral in each cell; style as long as the ovary and as broad as the stigma. **Fruits** immature, globose, seed 1 per fruit. Figure 16-17.

Thailand.— NORTHERN: Chiang Mai, Lampang; SOUTHWESTERN: Kanchanaburi.

Ecology.— Dry evergreen forest. Flowering: February, fruiting: March-April

Vernacular.— Rui chang (หรัยขาง)

Note.— This species stands apart from all the other species of the genus in the largest leaf and leaflet.

Specimens examined.— *S. Siriseree* 155, JF. Maxwell 93-592, 93-706 (BKF).



Figure 16 *Clausena macrophylla* Hook.f.



Figure 17 *Clausena macrophylla* Hook.f.

A. Leaves & Inflorescence; B. Young fruits; C. Fruits

1943

Morphological character of the genus **Micromelum** Blume

Micromelum Blume, Bijdr. Fl. Nederl. Indie 3:137. 1825; *Aulacia* Lour. Fl. Cochinch. 1:273. 1790; Ridl., Fl. Mal. Pen. 1: 351. 1967; Kuze, Fl. Brit. Bur. 1: 186. 1877; Stone, Tree Fl. Malaya 1: 383. 1972; Jones, Tree Fl of Sabah & Sarawak 1:398. 1995.

Shrub or small evergreen trees, spineless. **Leaves** imparipinnate, alternate; leaflets alternate on wingless rachis, oblique at base. **Inflorescences** terminal branching cyme or panicles often flat-topped. **Flowers** bisexual, flower bud ellipsoid or broadly ellipsoid to obovoid to oblong in bud, 5-merous; calyx cupular, 3-5 toothed; petals 5 valvate in the bud; stamens 10, in 2 whorls, filaments sublinear; disk annular or columnar; ovary with 2-6 (usually 3-5) locules with 2 ovules in each locule; style to 1.5 × as long as ovary, narrowed at the base, deciduous. **Fruits** berry, subglobose or ovoid, skin often with numerous oil glands, yellow, turning dull orange-red; seeds usually 1 or 2 per fruit, ellipsoid or broadly elliptic, testa membranous, with thin and crumpled cotyledon.

Five species were found in Thailand. Key to species was provides.

Key to species of **Micromelum** in Thailand

1. Petals > 7 mm long, pistil \geq 7 mm long **3 M. integerrimum**
1. Petals \leq 7 mm long, pistil < 7 mm long
 2. Leaves hirsute or puberulous, inflorescences very tomentose .. **2 M. hirsutum**
 2. Leaves glabrous or glabrescent, inflorescences pubescent or glabrous
 3. Leaflets narrow lanceolate, long-acuminate **1 M. falcatum**
 3. Leaflets lanceolate or ovate, acuminate
 - 4 Leaves soft-pubescent or glabrescent below, lateral veins 9-12 pairs, ovary pubescent, densely covered with straight golden hairs ... **5 M. pubescens**
 4. Leaves glabrous, lateral veins 5-8 pairs, ovary glabrescent **4 M. minutum**

1 *Micromelum falcatum* Tanaka, Bul. Mus. Hist. Nat. Paris, 2 sér. 2:157. 1930;
Aulacia falcate Lour. Fl. Cochinch. 1:273. 1790.

Shrubs 30 -50 cm high, branchlets woolly-pubescent, then glabrescent.

Leaves imparipinnate, yellowish-green, 14-31 cm long; leaflets 7-9, narrow lanceolate, long-acuminate, margins slightly crenulate, glabrous, except for the midrib above and the larger veins below (which are pubescent), lateral veins 6-8 on each side, prominent below, veinlets invisible, oblique at the base, usually 4 - 11 cm long and 1.5 – 3 cm wide; petioles cylindrical, pubescent, 4-10 mm long. **Inflorescences** pubescent; pedicels woolly, 5 mm long. **Flowers** 5 merous, flower bud oblong, 5 mm long, greenish-white; calyx woolly with 5 toothed; petals 5, long-elliptic, glabrous, 5 mm long; stamens 10, the largest as long as the petals, filaments subulate; pistil 3-4 mm long; ovary ovoid, velvety-hairy; style caducous, elongated, glabrous; stigma capitate, locules 5, with 2 ovules in each. **Fruits** ellipsoid, glabrous, yellow-orange. Figure 18-19.

Thailand.— NORTHERN: Chiang Mai ; NORTHEASTERN: Phetchabun, Loei ; SOUTHEASTERN: Chanthaburi; SOUTHWESTERN: Uthai Thani; PENINSULAR Narathiwat, Trang and Chumphon.

Ecology.— Dry evergreen to evergreen forest and deciduous dipterocarp forest. Flowering: September-April, fruiting: December-July.

Note.— This species differs chiefly from the other species by leaflets narrow lanceolate, long-acuminate.

Specimens examined.— *S. Siriseree* 201, 207, 218, 220, 225, 235, 247, 258, 261; *B. Hansen* 441 (BKF); *BS* 953 (BKF); *C. Phengkklai et. al.* 9130 (BKF).



Figure 18 *Micromelum falcatum* Tanaka

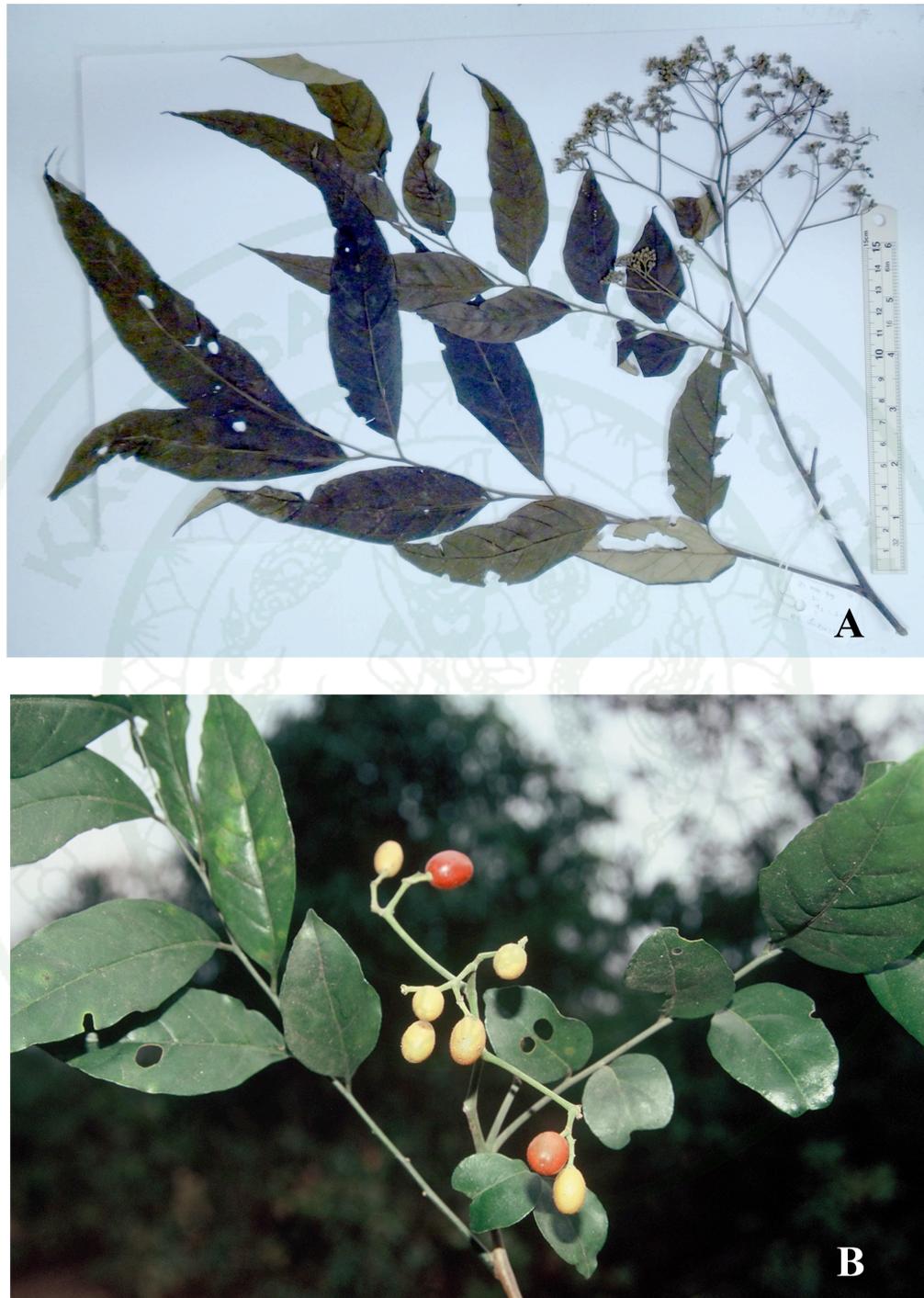


Figure 19 *Micromelum falcatum* Tanaka

A. Leaves & inflorescence; B. Infructescence

2 *Micromelum hirsutum* Oliv. Jour. Linn. Soc. Bot. 5(2):40. 1861; Hooker. f., Fl. Brit. India 1: 502. 1875; Kuze, Fl. Brit. Bumar 1: 187, 1877; Corner, Wayside Trees of Malaya 1: 576. 1940; Ridley, Fl. Malay Penins. 1: 352. 1967; Stone, Tree Fl. Malaya 1: 383. 1972.

Shrub or small tree 0.6-6 m high, all parts hirsute or puberulous (rarely almost glabrous). **Leaves** imparipinnate, 25-41 cm long, densely puberulous; leaflets 9-15, lanceolate or oblong-lanceolate, acuminate, margins slightly denticulate, sparsely pilose or glabrescent below, pilose or hirsute particularly near the rib and veins above, lateral vein 5-10 pairs, oblique at the base, shortly but slenderly-petioluled, 4-9 cm long and 2-4 cm wide. **Inflorescences** cymes terminal or axile of the upper leaves, very tomentose, 15-20 cm diam. but sometimes condensed to 5 cm in diam. **Flowers** 5 merous, on short hirsute pedicels; calyx shortly tawny hirsute, deeply 5-lobed; petals 4 mm long, narrow or linear-oblong, greenish; stamen 10; pistil 3-4 mm long; ovary densely tawny hirsute, 5-locular; stigma almost as long as the style. **Fruits** oblong or obovoid, very tomentose, gland-dotted, yellow or orange when ripe; seeds 1-2 per fruit. Figure 20.

Thailand.— NORTHERN: Chiang Mai, Lampang; NORTHEASTERN: Phetchabun, Loei; SOUTHEASTERN: Chanthaburi, Trat; SOUTHWESTERN: Uthai Thani; PENINSULAR: Chumphon, Ranong, Phuket, Songkhla, Trang, Satun.

Ecology.— Dry evergreen to evergreen forest. Flowering: September-January, fruiting: March-June.

Note.— This species differs chiefly from the other species by all parts hirsute or puberulous; inflorescences and fruits very tomentose.

Specimens examined.— *S. Siriseree* 202, 203, 205, 212, 213, 216, 219, 224, 227, 232, 244, 264; *G. Murata* et al. T17109, T15769 (BKF); *TDBS* 11974, 12380 (BKF); T. Santisuk 794 (PSU).

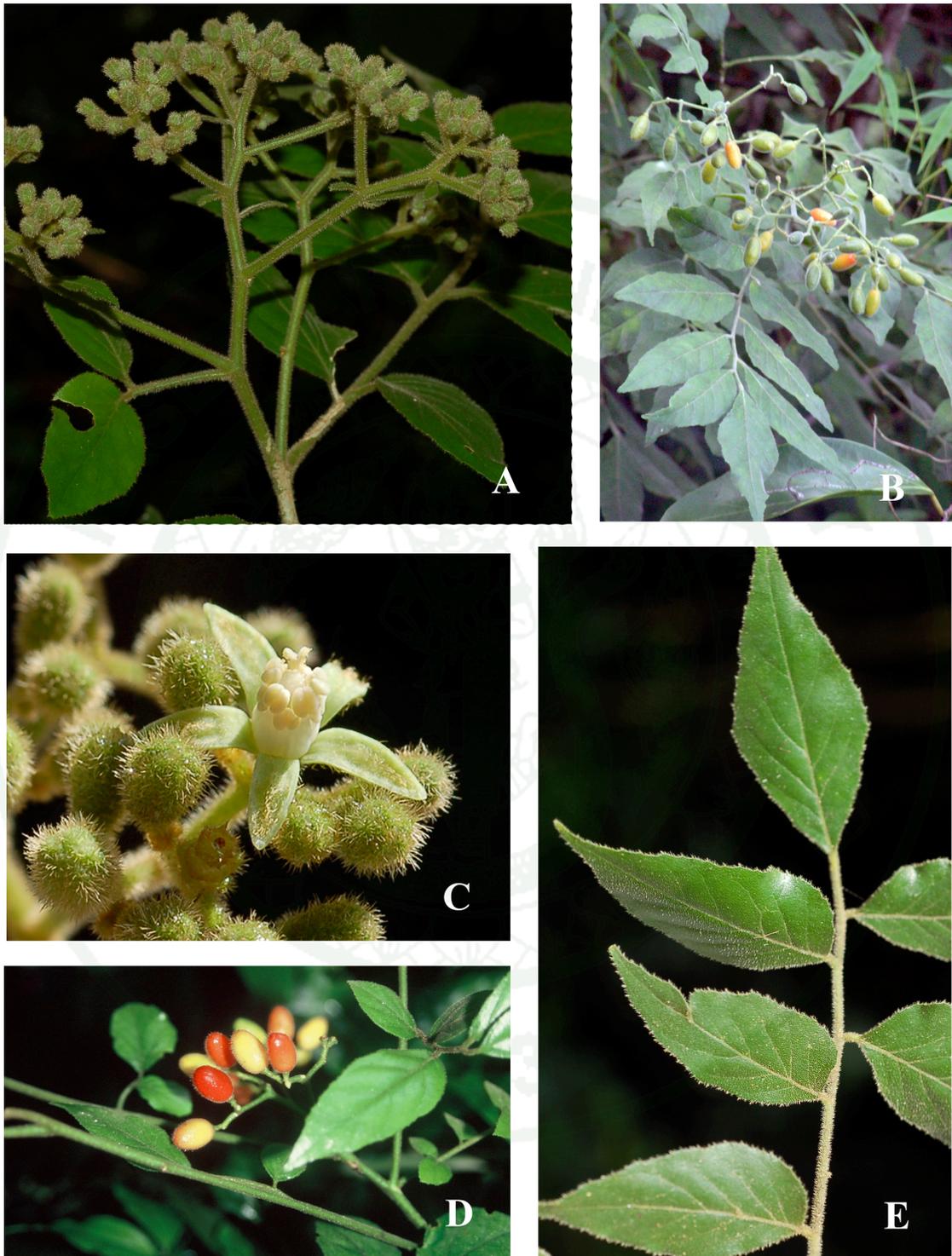


Figure 20 *Micromelum hirsutum* Oliv.

A. Inflorescence; B, D. Infructescence; C. Flower; E. Leaf

3 *Micromelum integerrimum* Wight & Arn. Prodr. Fl. Ind. Orient. 94. 1834; Kuze, Fl. Brit. Burma 1: 187. 1877; Hansen, Studies Fl. Thailand 36: 289. 1966; Chaudhuri, For. Pl. East. Ind. 156. 1993.— *Bergera integerrima* Buch.-Ham. ex Coleb. Trans. Linn. Soc. London 15:367. 1827; *Micromelum pubescens* Kuze, Fl. Brit. Bur. 1: 186. 1877; *M. pubescens* H. H. Haines, Forests of Bihar and Orissa 164. 1921.

Small tree 7-9 m high, evergreen, all younger parts more or less densely puberulous; bark smooth, whitish. **Leaves** imparipinnate, puberulous or glabrous, 20-97 cm long, the rachis usually puberulous; leaflets 7-15, alternating or nearly so, oblong-lanceolate to broadly lanceolate, acuminate, crenate or nearly entire, oblique at the base, 12-23 cm long and 5-20 cm wide, petiolated 2-5 mm long, **Inflorescences** 30 cm across, pubescent or tomentose. **Flowers** white, 13 mm diam. on short pedicels, calyx 5 toothed, pubescent; petals 8-12 mm long, glabrescent; stamen 10; pistils 6-7 mm long, ovary 2 mm long; style 3 mm long with many fine longitudinal furrows; stigma 1 mm high; disk 1.5 mm high. **Fruits** berry, ovoid-oblong, also when young, glabrous, gland-dotted, yellow, turning dull orange-red. Figure 21.

Thailand.— NORTHERN: Chiang Mai, Tak; NORTHEASTERN: Loei ; SOUTHEASTERN: Chanthaburi, Trat ; EASTERN: Nakhon Ratchasima; SOUTHWESTERN: Kanchanaburi; PENINSULAR: Trang, Surat Thani.

Ecology.— Dry evergreen forest to lower montane rain forest. Flowering: January-February, fruiting: July-August.

Note.— The flowers especially the pistils of this species are decidedly larger than those of all the other known species of *Micromelum*.

Specimens examined.— *S. Siriseree* 209, 210, 231, 241; *C. Phengklai et al.* 6482, 7436 (BKF); *H. Koyama* T-33873 (BKF); *J.K. Jackson* 6156 (BKF).



Figure 21 *Micromelum integerrimum* Wight & Arn.

A. Small tree; B-C. Inflorescence; D. Infructescence; E. Flower bud;
F. Flower; G. Ovary

4 *Micromelum minutum* (Forst.) Wt. & Arn. Prodr. Fl. Pen. Ind. Or. 1:94. 1834.; Backer, Fl. Java 2: 103. 1965; Stone, Tree Fl. Malaya 1: 383. 1972; Stone, Handb. Fl. Ceylon 5:454. 1985; Jones, Tree Fl. Sabah & Sarawak 1:400. 1995. —*Limonia minuta*, Forst. f. Prodr. 33. 1786; *Micromelum glabrescens* Benth. Hook., Jour. Bot. 2:212. 1843.

Shrub or small tree 2-3 m high, all young part densely short-hair, grayish. **Leaves** imparipinnate, 30 cm long or more; leaflets 9-15, ovate, acuminate, adult leaves glabrous, margin entire or wavy to shallowly dentate-crenate, lateral veins 5-8 pairs oblique at the base, 3-11 cm long and 1.5-4 cm wide; petiolules to 5 mm long. **Inflorescences** pubescent, 15-20 cm long. **Flowers** 5 merous, flower bud small, 3-4 mm long, calyx 5-toothed; sepal shortly hairy, sometime glabrous; petals linear-oblong to 5-6 mm long, pale green or yellowish- white; stamens 10, filament 3.5-5 mm long; pistil 2-3.5 mm long; ovary fusiform, 1.3-1.5 mm long, glabrescent; style 0.8-1.2 mm long, glabrous, somewhat hairy below, stigma flattened to subcapitate. **Fruits** ellipsoid-oblong, 8-10 mm long, glabrous, yellow or red when ripe; seeds 1-2 per fruit. Figure 22.

Thailand.— NORTHERN: Nakhon Sawan, Chiang Mai; NORTHEASTERN: Loei ; SOUTHEASTERN: Chanthaburi, Trat ; EASTERN: Nakhon Ratchasima; SOUTHWESTERN: Kanchanaburi; PENINSULAR: Songkhla, Trang.

Ecology.— Common in dry evergreen forest to lower montane rain forest. Flowering: September-October, fruiting: April-May.

Note.— This species has the smallest flowers and the pistils are shorter than the other species ca. 2-3.5mm long.

Specimens examined.— *S. Siriseree* 208, 215, 234, 237, 259, 255, 263; *W. Ramsri* 27 (PSU), *J.F. Maxwell* 87-489 (PSU).



Figure 22 *Micromelum minutum* (Forst.) Wigth. & Arn.

A. Shrub; B,C,E. Inflorescence; D. Infructescence; F. Fruit

5 *Micromelum pubescens* Blume. Bijdr. Fl. Nederl. Indie 3: 138. 1825; Hooker. f., Fl. Brit. India 1: 501. 1875; Corner, Wayside Trees of Malaya 1: 576. 1940; Ridley, Fl. Malay. Penins. 1: 352. 1967; Brandis, In. Trees 114, 1978.

Shrub or small tree up to 6 m high; puberulous when young. **Leaves** imparipinnate, alternate, 15 to 45 cm long; leaflets 7-15, lanceolate or ovate, acuminate, soft-pubescent below or glabrescent, nerves 9 to 12 pairs, base slightly narrowed oblique, 3-17 cm long, 1.5-7 cm wide; petioles up to 5-7 cm long. **Inflorescences** cymes 15-20 cm across, pedicels pubescent. **Flower** buds cylindric, 6-7 mm long and 1-1.5 wide, yellowish-green, cover with silvery pubescent hair; petals 5, greenish white, tomentose outside; stamens 10; pistil 3.5-4 mm long; ovary 1-1.5 mm long and 1 mm wide, pubescent, densely covered with straight golden hairs, fragrant. **Fruit** berry ovoid to oblong, glabrescent, orange-yellow, 6-10 mm long. Figure 23.

Thailand.— NORTHEASTERN: Phetchabun; PENINSULAR: Songkhla.

Ecology.—Open area in evergreen forest. Flowering: September, fruiting: September-October.

Note.— This species has leaves soft-pubescent below and flower strongly fragrant.

Specimens examined.— *S. Siriseree* 228, 260



Figure 23 *Micromelum pubescens* Blume

A. Shrub; B. Inflorescence; C. Flower bud; D. Ovary; E. Fruits

Morphological character of the genus **Murraya** Koen. ex L.

Murraya Koen. ex L., Mant. Pl. Altera 554. 1771; Stone, Handb. Fl. Ceylon 5:455. 1985; Jones, Tree Fl. Sabah & Sarawak 1:405. 1995. —*Chalcas* L., Mant. Pl. 68. 1767. —*Bergera* Koen., Mant. Pl. Altera 563. 1771. —*Murraya* Koen., Stone, Tree Fl. Malaya 1: 34. 1972.

Shrub or small trees. **Leaves** imparipinnate, alternate; leaflets alternate on wingless rachis, oblique at base. **Inflorescences**, rather large panicles, either axillary or terminal. **Flower** buds cylindrical or long-ovoid, 4 or 5merous, calyx of 4-5 ovate or lanceolate, petals 4 or 5, white, rather large, 1-2.5 cm long, lanceolate or linear, imbricate in bud; stamen 10, free, elongate, filaments flattened in some species, anthers small, broadly elliptic or oval; disk annular or cylindrical; ovary ovoid, with 2-5 locules, radial walls of locules straight; ovules 1 or 2 per locule; style rather long and slender, 3-7 time as long as ovary, finally falling off, stigma capitate. **Fruit** berry, ovoid or subglobose, with mucilaginous pulp, endocarp fleshy; seeds medium-sized, with membranous seed coat, cotyledons elliptic, plano-convex.

Three species were found in Thailand. Key to species was provided.

Key to species of *Murraya* in Thailand

1. Leaves 5-7 foliolate, flower 20-25 mm diam. when open
..... **2 M. paniculata**
1. Leaves > 7 foliolate; flower 9-11 mm diam. when open
 2. Ovary with 2 locules; petals with pellucid oil gland; fruits ellipsoid, 8-10 mm long **1 M. koenigii**
 2. Ovary with 4 locules; petals not distinctly gland dotted; fruits subglobose, 1.5-2 cm diam. **3 M. siamensis**

1 *Murraya koenigii* (L.) Spreng., Syst. Veg. 2:315. 1825; Hooker. f., Fl. Brit. India 1: 508. 1875; Kuze, Fl. Brit. Burma 1: 188. 1877; Corner, Wayside Trees of Malaya 1: 576. 1940; Maheshwari, Fl. Delhi 97. 1963; Backer, Fl. Java 2: 103. 1965; Ridley, Fl. Malay. Penins. 1: 406. 1967; Stone, Tree Fl. Malaya 1: 384. 1972; Brandis, Ind. Trees 113. 1978; Stone, Handb. Fl. Ceylon 5:459. 1985; Jones, Tree Fl. Sabah & Sarawak 1:406. 1995. —*Bergera koenigii* L. Mant. Pl. 563. 1771; *Chalcas koenigii* (L.) Kurz, Jour. Asiat. Soc. Bengal 44(2):132. 1875.

Shrub or Small tree, 2-4 m high, bark dark gray, glabrous or slightly puberulous. **Leaves** imparipinnate, the rachis usually pubescent, rarely quite glabrous; leaflets 11-21, puberulous petiolule, oblong-lanceolate or ovate, serrulate, acuminate, oblique at base, 2.5-3.8 cm long, membranaceous, glabrous, except on the midrib. **Inflorescences** terminal corymbs which is often puberulous. **Flowers** 5 merous; petals oblong-lanceolate, acute, 4-6 mm long, white; stamens 10; ovary 2-celled, the style short and thick; **Fruits** oblong, acute; seeds 1-2 per fruit, bluish-black.

Figure 24.

Thailand.— SOUTHWESTERN: Prachuap Khiri Khan; PENINSULAR: Narathiwat.

Ecology.— Evergreen forest and cultivated. Flowering: -; fruiting: June.

Vernacular.— Hom khaek (หอมแขก)

Note.— Description of this species was referred to Hooker. f. in Fl. Brit. India 1: 508. 1875.

Uses.— Young shoots edible. (Narathiwat), dry leaves boiled with the some kind of curry but thrown out of it before serving

Specimens examined.— *S. Siriseree* 301; *M.F. Newman et al.* 1133 (BKF).



Figure 24 *Murraya koenigii* (L.) Spreng.

A. Young shoot; B. Leaf & inflorescence; C. Flower & flower bud;
D. Flower bud; E. Ovary

2 *Murraya paniculata* (L.) Jack, Malay. Misc. i. 31: 1820; Corner, Wayside Trees of Malaya 1: 576. 1940; Maheshwari, Fl. Delhi 97. 1963; Backer, Fl. Java 2: 103. 1965; Stone, Handb. Fl. Ceylon 5:459. 1985; Jones, Tree Fl. Sabah & Sarawak 1:406. 1995. —*Chalcas paniculata* L. Mant. Pl. 68. 1767, Malay. Misc. 1:31. 1820. —*C. camuneng* Burm. f. 1768. —*Murraea exotica* L. Mant. Pl. 563. 1771 (*Murraea*).

Shrub or small tree 2-5 m high, bark pale to white, glabrous. **Leaves** imparipinnate 10-22 cm long; leaflets 3-7, glossy, glabrous; leaflets alternate, ovate or almost obliquely rhomboid, petiolules 3-4 mm long, acuminate, 3-10 cm long, coriaceous. **Inflorescences** terminal paniculate or cymes, few flowers, peduncle 1-4 cm long. **Flowers** rather large, 20-25 mm diam. when open, the pedicels 5-10 mm long; petals 5, elliptic to ovate elliptic, glabrous, 13-21 mm long and 4-6 mm wide, white, filaments slender, linear; stamens 10, alternately shorter, filaments slender, linear, anther oblong; disk annular, glabrous, 1 mm high; ovary ovoid-ellipsoid, 2.5-3 mm long, 2 locules, the style long with a capitate glandular stigma; **Fruit** ovoid-oblong, apex acuminoid, 10-13 mm long, orange-red when ripe; seeds 1-2 per fruit, villous. Figure 25-26.

Thailand.— NORTHERN: Chiang Mai, Uttaradit, Nakhon Sawan; NORTHEASTERN: Loei ; SOUTHEASTERN: Chanthaburi, Chon Buri, Trat ; EASTERN: Nakhon Ratchasima, Ubon Ratchathani; SOUTHWESTERN: Kanchanaburi; CENTRAL: Saraburi; PENINSULAR: Ranong, Songkhla, Trang.

Ecology.— Dry evergreen to evergreen forest, limestone hill or cultivated for ornamental. Flowering: February-March; fruiting: June.

Vernacular.— Kaeo (คเณศ)

Note.— Leaves glossy, glabrous; inflorescences flower few, largest, 20-25 mm diam. when open, strongly fragrant and fruits red when ripe.

Uses.— For ornament.

Specimens examined.— *S. Siriseree* 304, 315-17; *H&C* 141 (PSU); PS 44 (PSU);





Figure 25 *Murraya paniculata* (L.) Jack



Figure 26 *Murraya paniculata* (L.) Jack

A. Shrub; B., C., F., H., I. Flower; D. Ovary; E. Bark; G., J. Fruit

3 *Murraya siamensis* Craib, Bull. Misc. Inform. Kew 340. 1926. —*Chalcas siamensis* (Craib) Tan. Bul. Soc. Bot. France 75:710. 1928.

Small tree, trunk with fuscous bark having high ridges (*vide* Winit); young twigs with curly pubescence, year-old twigs puberulous, then fuscous, with small lenticels. **Leaves** 15-24 cm long, petiole 1-2.5 cm long, petiole and rachis almost terete with dense curly pubescence; leaflets 17-25, alternate or rarely subopposite, inequilateral (one half oblanceolate or lanceolate, narrowed at the base; the other half ovate, subtruncate at the base), apex obtuse, subacuminate, 2-7 cm long, 1-2.7 cm broad, chartaceous, above curly pubescent, very soon more or less glabrescent below, chiefly pubescent at the midrib, lateral veins 5-7 pairs, anastomosing near the margin above, later conspicuous, somewhat prominent below, veinlets somewhat conspicuous above, below forming a delicate rather prominent reticulation, margin subentire or more or less obscurely crenulate, petiolule about 2 mm long, covered with dense, curly pubescence. **Inflorescences** panicles terminal, subcorymbose, 15 cm long, bearing 10-15 flowers, pedicels 3-4 mm long with short curly pubescence. **Flower** buds small, oblong-ovoid, about 5-6 mm long, without glandular dots, sepals 5, ovate, lanceolate or deltoid, obtuse, 1.25 mm long; petals 5, greenish-white, linear-oblanceolate, incurving-apiculate, 6.5 mm long, 1.75 mm wide, glabrous, thickened at the middle, imbricate, disk fleshy, glabrous, slightly shorter than the calyx. stamens 10, alternate ones longer, filaments 4-5 mm long, narrowed toward the apex, the lower half slightly broader but scarcely complanate, anthers about 1 mm long, papillate. ovary slightly oblong, scarcely 1.5 mm long, glabrous, shortly stipitate; style 3-5 mm long, articulated at the base, glabrous, stigma capitate. **Fruit** 1.5-1.7 cm diam., black. Figure 26.

Type.— Winit 849. Mê Kat, Lampang, Thailand (K)

Ecology.— Deaiduous forest, alt. 250 m.

Vernacular.— Huat mon ton (หวัดหมอนตัน)

Note.— Description of this species was referred to Craib, Bull. Misc. Inform.
Kew 340. 1926.

Specimens examined.— Winit 849. Mê Kat, Lampang, Thailand (BKF)

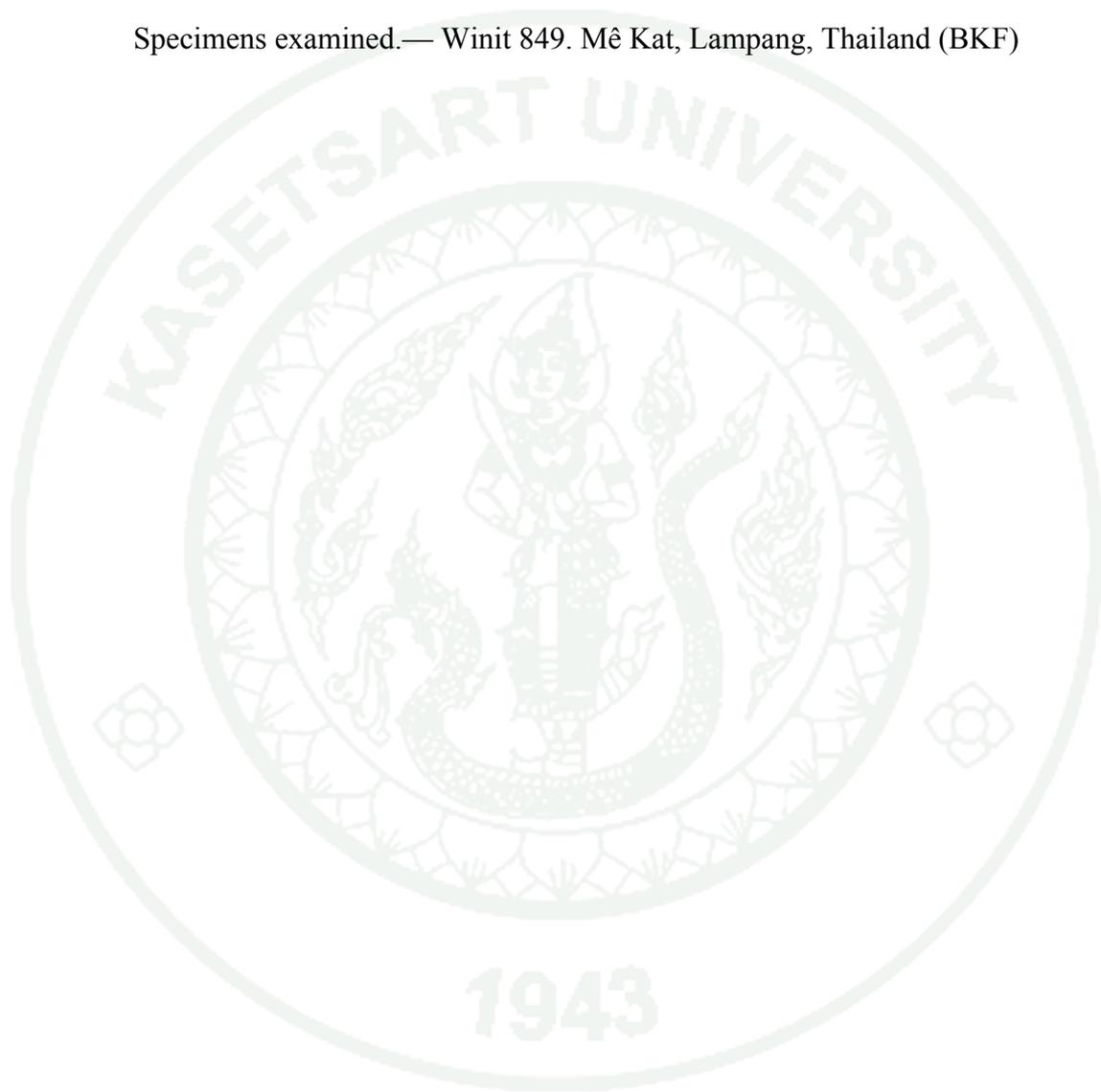




Figure 27 *Murraya siamensis* Craib

Winit 849, 24 April 1923 Mê Kat, Lampang, Thailand (K)

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CONCLUSION AND RECOMMENDATION

The genera *Clausena* Burm.f., *Micromelum* Blume and *Murraya* Koen. ex L. in Thailand were studied by searching literature, surveying in Thailand, describing, identifying and comparing herbarium specimens. The study provides identification keys to genera and species based on morphological characters. Full descriptions of species, including the ecology, vernacular names and uses are given, supported by line drawings and color plates of individual species.

Seven species and four varieties of *Clausena*, five species of *Micromelum* and three species of *Murraya* were identified, i.e. *Clausena excavata* var. *excavata* Burm. f., *C. excavata* var. *villosa* Hook. f., *C. harmandiana* Pierre ex Guillaumin, *C. heptaphylla* (Roxb. ex DC.) Wight & Arn. ex Steud., *C. lansium* Skeels, *C. longipes* Craib, *C. macrophylla* Hook. f., *C. wallichii* Oliv. var. *wallichii*, *C. wallichii* Oliv. var. *guillauminii* (Tanaka) J.F.Molino, *Micromelum pubescens* Blume, *M. falcatum* Tanaka, *M. integerrimum* Wight & Arn., *M. minutum* (G.Forst.) Wight & Arn., *M. hirsutum* Oliv., *Murraya koenigii* Spreng., *M. paniculata* (L.) Jack and *M. siamensis* Craib

Three species are new records of distribution in Thailand, i.e., *Clausena wallichii* Oliv. var. *guillauminii* (Tanaka) J.F.Molino, *Micromelum pubescens* Blume, and *M. falcatum* Tanaka. Two species, i.e., *Clausena longipes* Craib and *Murraya siamensis* Craib are likely to be rare species because they could not be found in this study by surveying. Moreover, there is only one specimen of *Clausena longipes* Craib in Thailand and it is the type specimen.

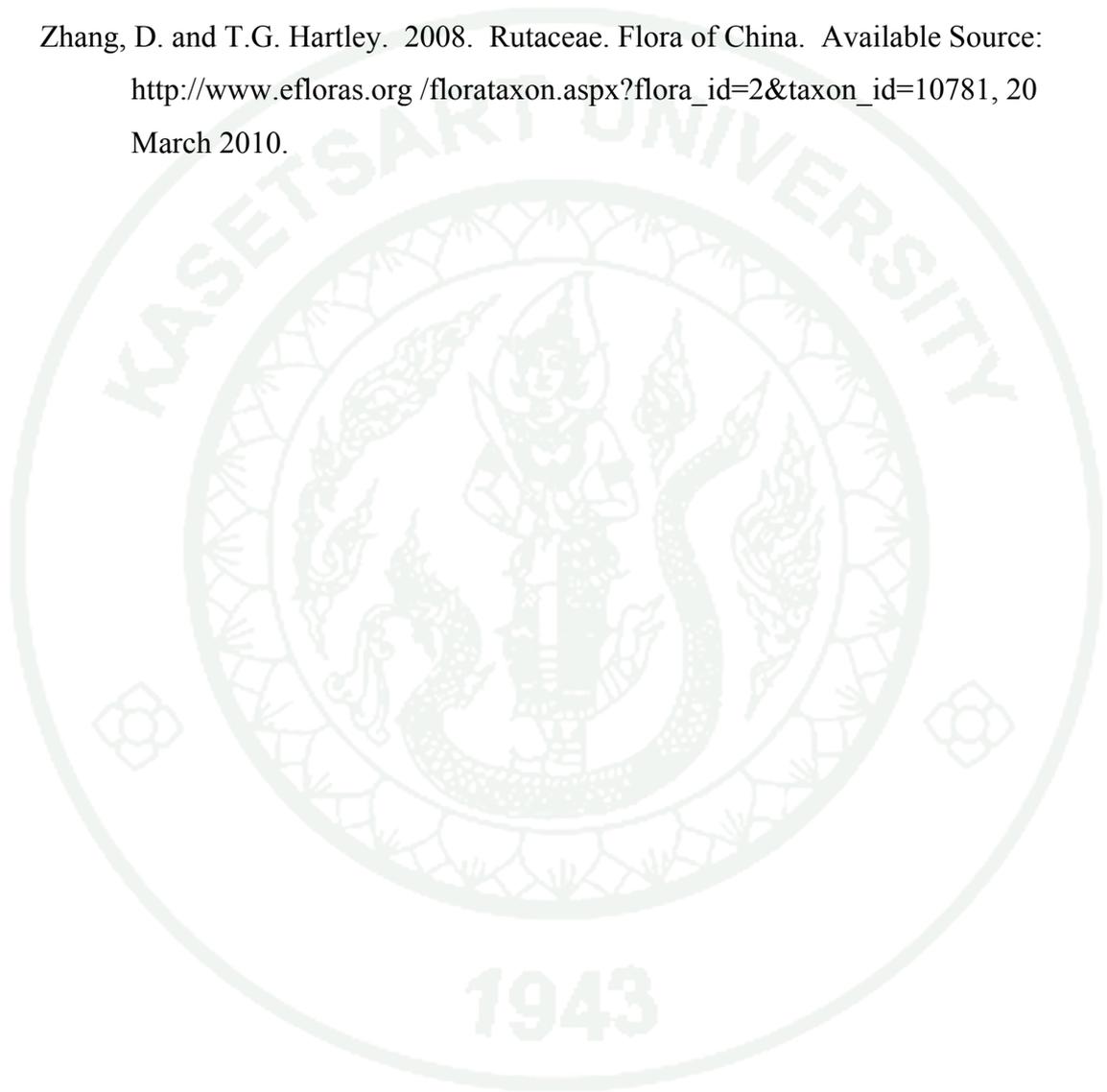
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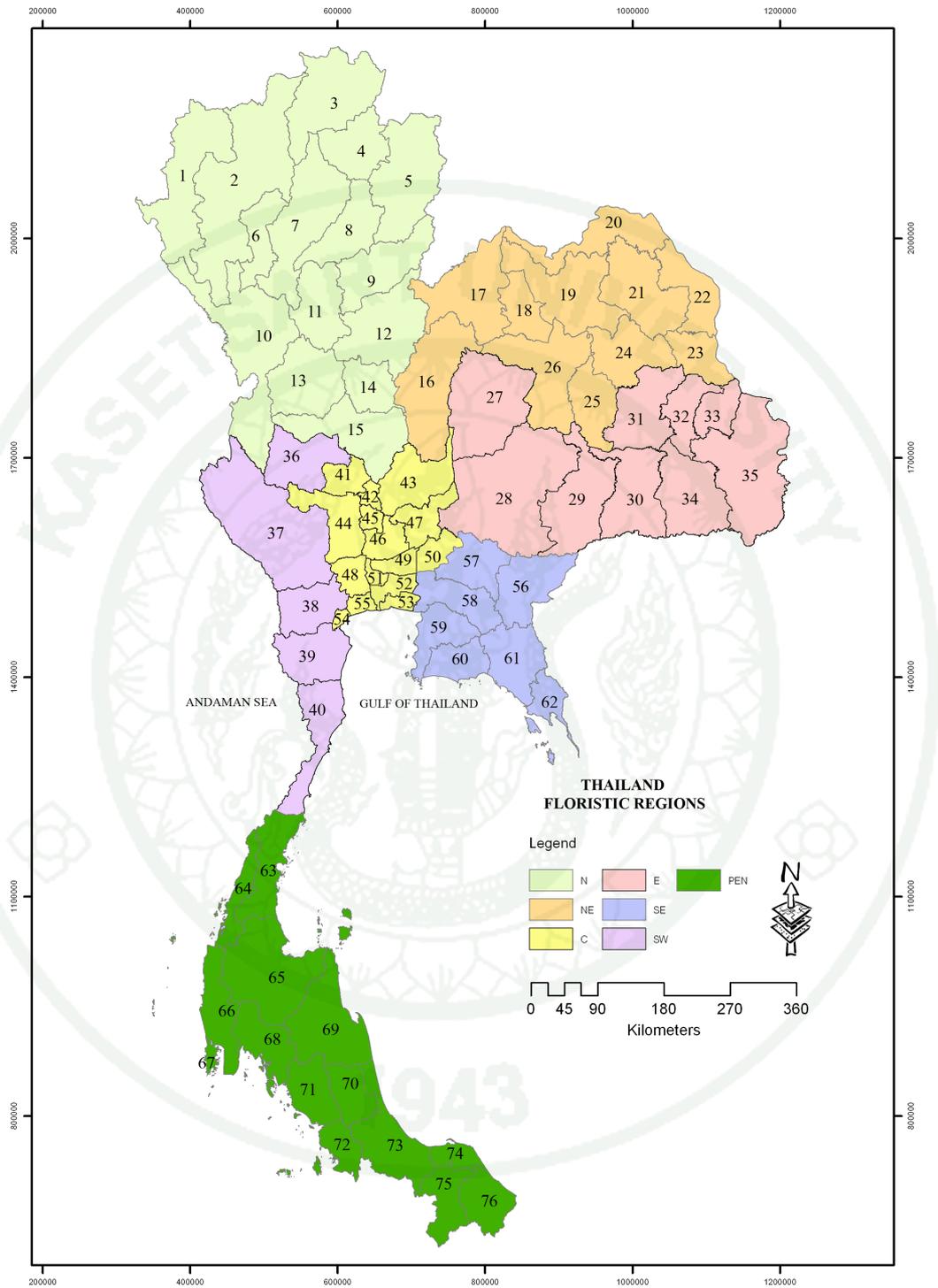
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APPENDIX



Appendix Figure 1 Floristic regions and provinces of Thailand

Floristic regions and provinces of Thailand

N (NORTHERN)

- 1 Mae Hong Son
- 2 Chiang Mai
- 3 Chiang Rai
- 4 Phayao
- 5 Nan
- 6 Lamphun
- 7 Lampang
- 8 Phrae
- 9 Uttaradit
- 10 Tak
- 11 Sukhothai
- 12 Phitsanulok
- 13 Kamphaeng Phet
- 14 Phichit
- 15 Nakhon Sawan

NE (NORTHEASTERN)

- 16 Phetchabun
- 17 Loei
- 18 Nong Bua Lum Phu
- 19 Udon Thani
- 20 Nong Khai
- 21 Sakon Nakhon
- 22 Nakhon Phanom
- 23 Mukdahan
- 24 Kalasin
- 25 Maha Sarakham
- 26 Khon Kaen

E (EASTERN)

- 27 Chaiyaphum
- 28 Nakhon Ratchasima
- 29 Buri Rum
- 30 Surin
- 31 Roi Et
- 32 Yasothon
- 33 Amnat Charoen
- 34 Si Sa Ket
- 35 Ubon Ratchathani

SW (SOUTHWESTERN)

- 36 Uthai Thani
- 37 Kanchanaburi
- 38 Ratchaburi
- 39 Phetchaburi
- 40 Prachuap Khiri Khan

C (CENTRAL)

- 41 Chai Nat
- 42 Sing Buri
- 43 Lop Buri
- 44 Suphan Buri
- 45 Ang Thong
- 46 Phra Nakhon Si Ayutthaya
- 47 Saraburi
- 48 Nakhon Pathom
- 49 Pathum Thani
- 50 Nakhon Nayok
- 51 Nonthaburi

Floristic regions and provinces of Thailand (Continued)

52 Krung Thep Maha Nakhon (Bangkok)

53 Samut Prakan

54 Samut Songkhram

55 Sumut Sakhon

SE (SOUTHEASTERN)

56 Sa Kaeo

57 Phachin Buri

58 Chachoengsao

59 Chon Buri

60 Rayong

61 Chanthaburi

62 Trat

PEN (PENINSULAR)

63 Chumphon

64 Ranong

65 Surat Thani

66 Phangnga

67 Phuket

68 Krabi

69 Nakhon Si Thammarat

70 Phatthalung

71 Trang

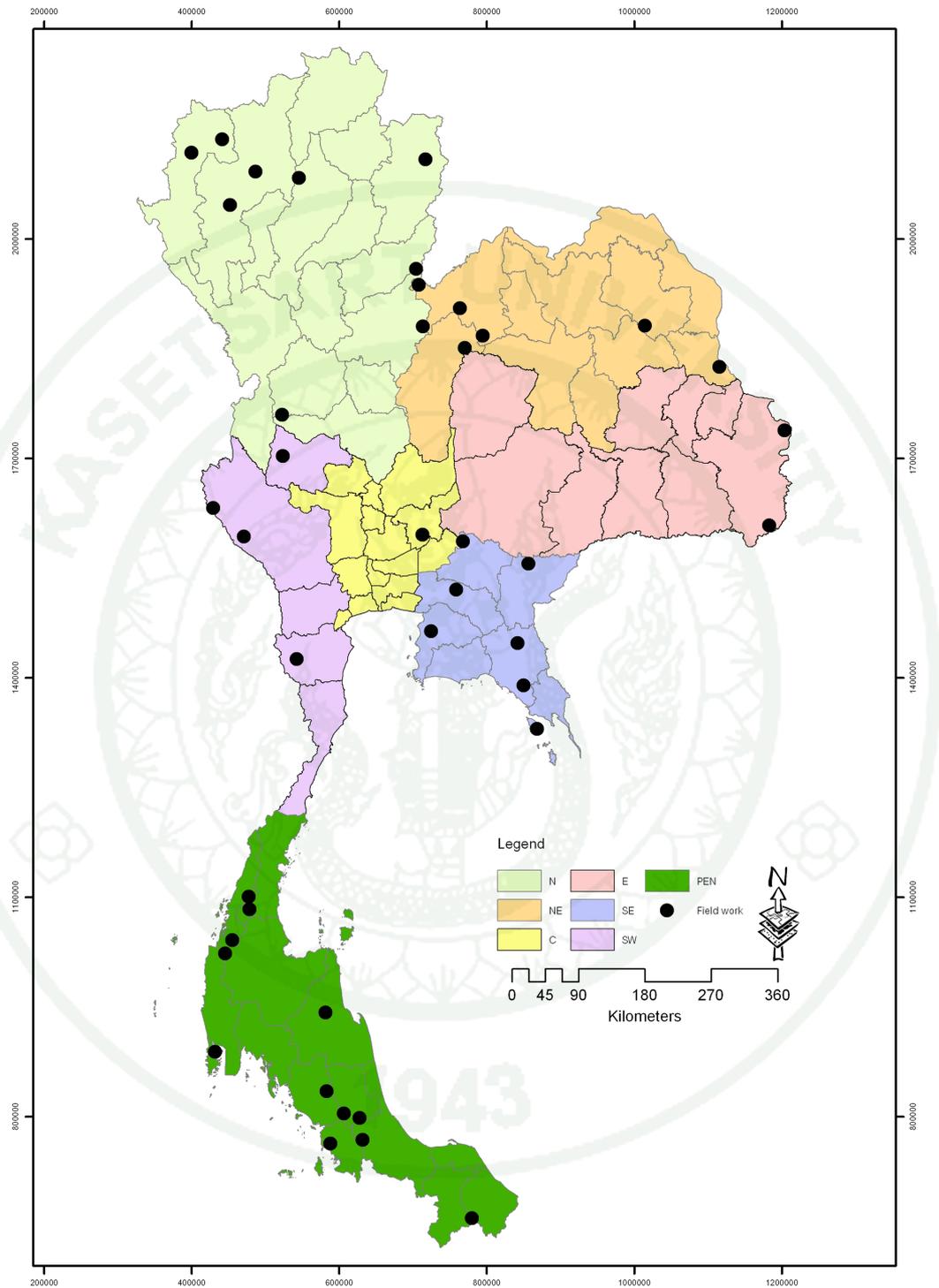
72 Satun

73 Songkhla

74 Pattani

75 Yala

76 Narathiwat



Appendix Figure 2 Field collection sites in 35 provinces of Thailand

CIRRICULUM VITAE

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